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Sticks and carrots for reducing property-level risks from floods: an EU–US comparative perspective

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ABSTRACT

Post-flood policies and compensation regimes tend to focus on the resilience of public spaces and improving the adaptive capacity of future private property developments. This article focuses on the instruments associated with the resilience of existing privately owned residential buildings from the perspective of post-flood policies and compensation regimes. By reviewing the relevant legal and policy landscapes it aims to provide mutual lessons learned between the EU, its member states and the US and to set forth generally applicable recommendations for improving post-flood policies for existing buildings.

KEYWORDS

Post-flood policy; mitigation; privately owned buildings; insurance; USA; European Union; UK; Netherlands

Introduction

In both the European Union (EU) and the United States (US), flood risk governance is an urgent societal issue as more and more communities are likely to experience more frequent extreme flood events or sea level rise due in part to global climate change. For example, in the US, the Houston, Texas, metropolitan area experienced three 500-year floods between 2015 and 2107 (Ingram, 2017). New research continues to expand the extent of urban areas which will be inundated by sea level rise (Sanders, 2018). A variety of strategies, including flood risk prevention, protection, risk mitigation, preparation and recovery, may be used to address flooding (Driessen, Hegger, Bakker, Van Rijswick, & Kundzewicz, 2016; European Floods Directive, 2007; Larrue, Hegger, & Trémorin, 2013). Flood risk prevention relates to efforts to keep people away from high-risk zones, and protection relates to keeping the water away from the population, such as with dykes and dams (Driessen et al., 2016). Preparation aims to inform the population about what to do in the event of a flood. Most of the flood risk management literature focuses on the prevention of flood events or the minimization of property damage and the loss of human life when a flood event occurs (Morrison, Westbrook, & Nobel, 2018). The more limited post-flood literature assumes that there are two objectives: ‘returning to normal conditions as soon as possible and mitigating both the social and economic impacts on the affected population’ (CEC, 2004). Little attention has

been given to the use of flood recovery instruments to mitigate the costs of future flood events.

This article focusses on the rather neglected nexus between flood mitigation and recovery and argues that post-flood recovery must be used both for humanitarian relief and to plan and construct more resilient spaces. Examples of post-flood measures associated with the mitigation strategy are adaptive building requirements, resilient reinstatement efforts and green infrastructure, whereas the prime measure of the recovery strategy relates to financially compensating people following the occurrence of a flood event, be it through public ex post compensation schemes or insurance mechanisms (Suykens, Priest, Doorn-Hoekveld, Thuillier, & van Rijswick, 2016). Such schemes and mechanisms within the recovery strategy can and should have an important positive impact on strategies such as mitigation and prevention.

The analysis is guided by the research question, What are the legal and policy requirements applicable to existing buildings after a flood event has occurred in the US and the EU, taking England and the Netherlands as examples? The following structure guides our findings. We set the scene by shedding light on the institutional DNA of the relevant countries and the EU. We then analyze the differences in flood risk management approaches in the US and the EU, the Netherlands and England. We then delve into post-flood policies specifically, and scrutinize the main key barriers in the recovery–mitigation nexus for all countries studied. Finally, we offer country-specific recommendations and more general conclusions on resilient post-flood policies.

The article takes a legal research approach; more specifically, it contains a legal comparison. The comparison is a combination of dogmatic and functional approaches (Gorlé, Bourgeois, & Bocken, 1991). The dogmatic aspects relate to the in-depth analysis of primary and secondary legal sources (legislation of national governments, decentralized legislation, guidance and policy documents, case law) and a comprehensive overview of the legal system of the studied jurisdictions. The functional aspects regard the notion that a legal institution should not be considered on its own, but only in relation to its function, more specifically in relation to the society. The article therefore shows cases as illustrative examples of good practices drawn from the different jurisdictions (Dai, Wörner, & van Rijswick, 2017; Groothuijse, Boeve, Broek, van Den, Keessen, & van Rijswick, 2018; Kaufmann, Doorn-Hoekveld, Gilissen, & van Rijswick, 2016).

Setting the scene

Institutional DNA for multilevel flood risk governance in the EU and the US

Before focusing on the specific flood-related context, it is relevant to mention the institutional differences between the EU and US and their respective relationship with the states in question. The EU is a *sui generis* legal order whereby member states have a distinct legal personality under international law. This is not the case for US federal states. Moreover, federal institutions in the US have more extensive competences than EU institutions, e.g., in terms of follow-up on implementation. Legislative acts issued at the federal level in the US are directly binding upon the population, in contrast to the EU (Hoornbeek, 2004; Kimber, 1995; Lavranos, 2006).

Within the EU, the institutional DNA differs significantly between member states. This is also the case for the Netherlands and the UK (England). The Netherlands is a decentralized unitary state, with so-called functional decentralization. Specific responsibilities are transferred from the central government to specific administrative bodies specially created to fulfil these responsibilities (Burkens, Kummeling, Vermeulen, & Widdershoven, 2012); the regional water authorities (van Rijswijk & Havekes, 2012). The Dutch constitution obliges public authorities to keep the country habitable and to protect and improve the environment. This generally formulated constitutional duty of care – upon which citizens cannot rely directly before the courts – is further implemented in regular legislation in the field of planning, environmental and water law. The corresponding responsibilities are divided among different public authorities, including the regional water authorities (Doorn-Hoekveld, 2017; van Rijswijk & Havekes, 2012). Water management is highly institutionalized in the Netherlands.

In the UK, the institutional set-up is very different. Although legislation passed in Parliament often governs the UK as a whole, a distinction is made in statute law between different regions of the UK. Flood risk management is one of these devolved responsibilities, and therefore only England will be discussed here. English flood risk governance is complex, with many different public, private and civil society actors involved on national, sub-national and local scales. In contrast to the Dutch system, England does not have a written constitution, and therefore governmental responsibilities for flood risk management are only defined by legislation.

Differences in flood risk management approaches

Mitigation-hampering legacies in the United States

In the US, the primary responsibility for preventing flood and sea level rise damage rests with the state and federal governments. There is no over-arching policy comparable to the 2007 Floods Directive. Instead, an unintegrated accumulation of policies and laws have been adopted during the 200-plus years of flood control policy.

The US has seen flood policy evolve from riparian landowner responsibility to prevent damage, to the construction of locally and state-funded levees, to the construction of large, upstream multipurpose reservoirs (Shallat & Goetzman, 1994) and finally to the downward devolution of responsibility back to the state and local governments (Chizewer & Tarlock, 2013). Following the great Mississippi River flood of 1927, the federal government began to assume the primary responsibility for damage prevention and later for post-disaster relief. However, federal dam and levee construction, which peaked in the last quarter of the twentieth century, has left two legacies that hamper current damage mitigation efforts. The first is the illusion that dams and levees can prevent all flood damage. In the early twentieth century, advances in hydrology contributed to the comforting notion that historic flood patterns would persist, and thus levees and dams could prevent the worst damage. But they could not. This failure led to the second legacy, moral hazard behaviour encouraged by the dams and levees, also referred to as the 'levee effect' (Di Baldassarre et al., 2018). The problem was first recognized by the great American geographer Gilbert White, who argued that levees and dams opened up floodplains to more intensive development, and thus when floods came, damage would

be increased; this insight has shaped thinking about flood control in the US and elsewhere (Macdonald, Chester, Sangster, Todd, & Hooke, 2011).

The federal government now offers three basic kinds of post-flood financial and humanitarian relief: subsidized federal flood insurance for certain private residential and commercial properties; assistance from the Federal Emergency Management Agency (FEMA) to administer a general federal disaster relief programme; and special federal legislation for an area damaged by a major hurricane or flood.

Risk-centred EU Floods Directive as the primary tool

At the EU level, the main legislative instrument for flood risk governance is the 2007 Floods Directive. In contrast to the US, flood insurance and compensation schemes in the EU are administered by the respective member states. The Floods Directive adopts a risk-based approach by focusing on dealing with the risks associated with floods, rather than assuming that flood events can be prevented altogether. Compensation for flood damage and how these mechanisms are sculpted is very much at the discretion of the member state. No legislative framework for the recovery strategy exists; the Floods Directive does not tackle it. The main instrument for ex post compensation at the EU level is the EU Solidarity Fund, which channels funds to the states to compensate them for damage to public infrastructure from flood events on their territories. Besides flood risk governance regulations and direct funding from the EU to its member states, other horizontal legislation is relevant. For example, the EU framework on state aid is relevant, as support measures need to be reported in an official notification to the commission. However, national support for damage from natural disasters is exempted from these mandatory state aid notification requirements under EU law.

Public responsibilities in the Netherlands

In the Netherlands, the responsibility for flood risk management is concentrated in public authorities, which is in line with the high institutionalization of water management in general. After the disaster of 1953, when a large storm surge hit the Dutch coast causing over 1800 casualties, a probability-reducing approach was adopted in line with the maxim ‘never again’ (Kaufmann et al., 2016). With the high flood risks in the country, protection through hard flood defence structures has historically been the most dominant Dutch flood risk management strategy (Doorn-Hoekveld, 2014; van Rijswijk & Havekes, 2012). Flood protection is the main responsibility of the central and regional water authorities. Recently there is a visible shift from protection alone towards a combination of protection and prevention through spatial planning (Doorn-Hoekveld, 2017); see examples in [Boxes 1](#) and [2](#).

A drawback of this institutionalized protective flood risk management is the lack of awareness of citizens of the fluvial flood risks they are facing. This is caused by little responsibility being assigned to individual citizens. Only those living outside of dikes and protection (at the river or seaside) have responsibility, which in practice even sometimes goes beyond the legally binding flood protection standards that the public authorities have to guarantee. Another factor is that the need for flood risk management has never been the subject of public debate. Furthermore, there is a large amount of expertise on flood



Box 1. Mitigation in the Noordwaard Project in the Netherlands.

An example of the combination of flood protection with mitigation is the Noordwaard depoldering project. It is one of the 34 projects of Room for the River. This overarching programme is intended to give rivers more room to increase their drainage and storage capacity and, where possible, develop nature and recreation in the area. The Noordwaard polder forms a new route for water of the Nieuwe Merwede canal in case of high water discharges.

The project had far-reaching consequences for the residents and users (farmers) of the polder. Every resident of the Noordwaard was offered the chance to continue living in the area. To provide reasonable flood risk,¹ some of the houses needed to be rebuilt on terps or mounds. 'Agricultural terps' were also built, on which farms are located and that form a safe haven for cattle as well. Evacuation routes were created for the residents in case of high waters. A warning system was established, and regular evacuation drills are conducted.² All these mitigative measures were created by the competent authority and were financed by the state (Groothuijse et al., 2018).

Box 2. Mitigation in Project Zuidplaspolder.

Two types of floods demand two different approaches in the Netherlands. Fluvial floods are the responsibility of water authorities and are mainly dealt with in the protection strategy. For fluvial floods, municipalities also have responsibilities, laid down in legislation (the duty of care, as stated in Article 3.5 of the Dutch Water Act). To prevent pluvial flooding, private parties are more involved and mitigative measures exist as well. This is visible in the Zuidplaspolder.

The Zuidplaspolder, located in the western part of the country, sits at 6.76 meters below sea level, one of the lowest points of the country. Because of the pressure on the housing market in the urban agglomeration of Western Holland (Randstad), the area is designated as a 'development location', despite the flood risks. For fluvial flood risks, the area depends on dykes (protection). For pluvial flood risks for new urban development, raised floor levels were advised by the regional water authority and incorporated in the spatial zoning plan of the municipality.³ This is a form of private action, imposed by legislation, because developers must comply with the rules of the municipal spatial zoning plan that imposes these floor levels (Kaufmann et al., 2016).

protection. Finally, the high safety standards and limited governmental risk communication (Terpstra & Gutteling, 2008) are relevant in understanding the lack of awareness. However, lack of awareness of flood risks is remarkable in such a flood-prone country. The axiom that characterizes flood risk governance in the Netherlands is that every inhabitant pays taxes, and these taxes are used to keep the whole country safe, and this is done by the state (Doorn-Hoekveld et al., 2016). In several surveys, 'major flooding in your area' has been the second-smallest worry regarding risks (Terpstra, 2009).

Private responsibilities in England

Responsibility for flood risk governance in England primarily rests with the property owner established through common law. Riparian owners have the right to protect their property from flooding as well as a legal duty to ensure that the use of their property does not increase the risk of flooding elsewhere (Environment Agency, 2012). Another key feature of the English approach to flood risk management is its comprehensiveness. A broad range of strategies for managing flood risk have been present for many decades, a reflection of the susceptibility of England to flooding from a number of different sources.

A further key feature of flood risk management in England is taking the opportunity to learn lessons from flooding events. Following flooding there is often a period in which the performance of existing strategies is examined and decisions analyzed (e.g.,

Bye & Horner, 1998; Pitt, 2008; HM Government, 2016). This scrutiny offers the potential to influence flood risk management moving forward and a wholesale change and shift in approaches to managing risk, by reinforcing the need to be more resilient.

Post-flood policies: exchanging experiences

Both at the EU level and in the member states investigated, post-flood policies are currently under heavy scrutiny. In the EU, the presumed lacuna in the legal framework is under evaluation. In the Netherlands, debates have been going on in the past years to analyze whether insurance coverage for fluvial flooding needs to be increased. The English system has recently been subject to significant changes. Lessons have been learned in these three levels of governance from the best practices and the failures of the existing regime in the US, and vice versa.

US: broken flood insurance system

In the US, the National Flood Insurance Programme, induced by the cost of moral hazard behaviour, dates from 1968. Federal flood damage prevention and post-disaster relief laws provide classic examples of tendencies of politicians to distribute resources rather than compel costly behaviour changes. Influenced by White's thinking, the legislation both provides post-flood insurance not available on the private market and requires communities to regulate development in areas prone to flooding. The programme provides reduced-rate flood insurance to residents in high-risk areas only when local governments enact zoning ordinances that discourage future development in these flood-prone areas. Community participation is voluntary. Under the programme, the federal government provides reduced-rate flood insurance to property located in a special flood hazard area, a 100-year floodplain, in a participating community. Insurance is mandatory for all properties that apply for a federally backed mortgage.

The programme is widely considered to be broken (General Accounting Office, 2017). For example, after Hurricane Harvey in 2017, FEMA faced a USD 1.1 billion shortfall in payouts and revenue, on top of the over USD 21 billion it has borrowed from the US treasury over the years. Despite efforts to use evolving technology, many floodplain maps are out of date. FEMA is still using the 100-year floodplain paradigm instead of mapping broader at-risk areas and accounting for climate change. Recent legislative attempts to fix the system did not succeed.

Multilevel governance issues impacting post-flood policies

The Mississippi River flood of 1927 led to a shift in flood protection policy from levees to dams and started a debate about whether disaster relief was a federal or state responsibility. Congress enacted the first federal disaster relief legislation in 1950. The current general act, the Stafford Disaster Act, was passed in 1974 (Public Law 93–288 (1974), 43 USC § 5121 et seq.). The act requires disaster prevention planning which provides a framework to help individuals who have lost their property or livelihood to obtain temporary relief. The second option is a special act for the damaged area, which can obtain a combination of grants and structural measures. The act is triggered by a

state-of-emergency declaration by the president and provides a wide variety of disaster relief to public facilities and private-property owners. Owners whose homes have been damaged are eligible for temporary housing assistance and grants for the repair or replacement of damaged structures (43 USC § 5174). However, if the damaged property is in a mapped floodplain, FEMA may not waive federal flood insurance requirements. FEMA may also purchase or relocate damaged properties to open up floodplains.

For the most part, the use of land use control instruments to minimize flood damage rests with local governments, and they have traditionally used their land use control authority to regulate new development in high-risk areas. The US Supreme Court, however, has not been as receptive to refusing to compensate moral hazard behaviour (Albrecht & Tarlock, 2018). Thus, despite the success of local governments in upholding flood control regulations in state courts, the Supreme Court's takings jurisprudence holds out the hope that land use regulation to minimize flood damage is potentially subject to the challenge that it represents an unconstitutional expropriation (Chizewer & Tarlock, 2016).

State building codes: cost-saving sticks

All states have adopted statewide building codes, and many require that new construction minimize flood and hurricane damage (see Boxes 3 and 4 for examples of regional/local initiatives). They are often based on international codes, and these requirements for more resilient structures have been very successful in minimizing water and wind damage. However, they are not mandatory in all states (Insurance Institute for Business and Home Safety, 2015). For example, Florida has a mandatory statewide hurricane code, but Texas gives local governments the choice of whether to adopt its statewide code. And unfortunately, in the current climate of climate change denial, several Gulf Coast states, which experience frequent hurricanes, have weakened their codes.

Box 3. New Orleans: The Dutch Structural Solution with State and Local Rebuilding Standards.

Hurricane Katrina struck New Orleans and much of the Gulf of Mexico coast in late August 2004. Katrina was a Category 5 hurricane (the highest category) when it passed over the warm gulf waters and diminished slightly to a Category 3 storm (130–156 mph [209–251 km/h] versus 157-plus mph [252 km/h]) when it made landfall. The federal government's poor response to the devastation and social costs of Katrina, as well as New Orleans's iconic status as a tourist destination, led to a special recovery act. The federal Congress followed Rotterdam's example and authorized USD 14.5 billion for new, higher levees and flood gates to close the ship channel, the source of the devastating storm surge. However, a political decision was made to use a lower standard than previously existed for flood protection. In 1965, Congress mandated a system strong enough to repel a storm consisting of 'the most severe combination of meteorological conditions that are considered reasonably characteristic of the region' (Public Law 89–298 (1965)). However, after Katrina, the Corps was only directed to raise levees 'to provide the level of protection necessary to achieve the certification required for a 100-year level of flood protection in accordance with the national flood insurance program under the base flood elevations current at the time of construction of the levee' (Public Law 110–114, § 7012(a) (2007)). The system has only bought time and must be supplemented by land use controls, because New Orleans is sinking due to soil subsidence (Richard Campanella, 'Humans Sank New Orleans', *The Atlantic*, 6 February 2018, <https://www.theatlantic.com/technology/archive/2018/02/how-humans-sank-new-orleans/552323/>), its barrier coastal wetlands are disappearing, and bigger future storms are expected. The city has used FEMA funds to finance the rebuilding of most new construction and post-Katrina elevation projects on open foundations, consistent with international standards. Floodwaters flood through an open first/ground floor. In subsequent floods, these buildings consistently had minimal, if any, damage compared to adjacent non-elevated properties (Ingargiola & Ghori, 2015).

Box 4. Cedar Rapids, Iowa: Opening a Floodplain through Buy-Outs.

Cedar Rapids is a small city in Iowa on a river that has seen repeated flooding. There are no flood retention dams upstream (Linhart & Eash, 2010). After the highest recorded flood, in 2008, the city developed what can be described as a semi-Dutch flood damage reduction approach. In brief, the city has hardened the protection of the central business district but expanded the room for the river on the opposite bank. The city used federal funds from FEMA and the Department of Housing and Urban Development to voluntarily acquire over 1000 properties to expand the existing floodway (Tate et al., 2016). In the journal *Nature Climate Change*, a trio of Stanford researchers examined 27 recent cases of managed retreat affecting 22 countries and 1.3 million people. They found that, regardless of a country's wealth and level of development, relocations are most likely to happen when a government and its citizens are in accord.

Local government power to retrofit damaged buildings: thin sticks

More sophisticated flood mapping upgrades and the growing dissemination of the scientific consensus about increased flood risks with global climate change strengthen the case for shifting some of costs of adaptation to private-property owners (Serkin, 2014). However, local government's power to require the modification or removal of existing buildings without compensation is limited because existing structures enjoy strong constitutional and statutory protection from new local regulations. There is a major exception to this protection of the status quo that is increasingly being used after floods and hurricanes. If a property is destroyed or substantially damaged by an act of God such as a flood or hurricane, most zoning ordinances only allow its rebuilding as a use that conforms to current zoning regulations (*Sams v. Dep't of Env'tl. Protection*, 63 A.3d 953 (Conn. 2013)). State law, however, may restrict municipal options to terminate non-conforming uses by granting extra-constitutional protection to vested rights, thus encouraging inappropriate rebuilding (Code of Virginia § 15.2-2307).

Post-flood policies are lacking at the EU level

As mentioned, the EU Floods Directive does not include post-flood policies. Its procedural framework requires a three-step approach from member states. Since its entry into force, the directive has required member states to undertake preliminary flood risk assessments, draw flood risk and hazard cartography, and submit flood risk management plans to the EU Commission. The directive does not include any substantive obligations, which means that member states are in compliance if they fulfil their procedural requirements, e.g., submitting the plans in a timely fashion (Priest et al., 2016). The significant amount of discretion for member states in the specific measures they adopt as part of their flood risk governance framework can be explained by the institutional differences, as well as the geographical differences in aspects such as susceptibility to floods across the EU.

But the times they are a-changin'?

In recent years, there has been debate at the EU level as to how to move forward with disaster insurance, in terms of both the best way to design these schemes and the degree of harmonization that is desirable at the EU level. At the time of the first wave of evaluation in 2013, taking into account *inter alia* the regional differences between the states in terms of types of flood risks and the resulting economic losses, the European

Parliament did not support a mandatory framework for compensation of natural disasters steered from the EU level, but instead endorsed a flexible insurance market for natural disasters designed at the national level.

As is clear from the following analysis, Dutch and English post-flood policies and their respective approaches to the recovery strategy are related to all flood risk management strategies, and changing only the recovery strategy might affect other strategies in an unforeseen and unwanted way. The discrepancies between these approaches might be too significant to reconcile (Doorn-Hoekveld et al., 2016; Priest et al., 2016; Suykens et al., 2016). As of now, the main incentivizing tool in the hands of the EU Commission for inducing risk reduction measures through financial schemes is the abovementioned EU Solidarity Fund. This fund has been subject to heavy criticism, which led to a reform in 2014. One of the elements of the reform relates to the ability to link compensation of the member state in question to the measures taken by the member state in question, with the EU Court of Justice empowered to determine failure to comply with EU legislation on disaster risk prevention and management. The UK received about €60 million for flood events in January 2016; the impact of Brexit on its future eligibility remains unclear.

Weak ad hoc public compensation scheme and marginal insurance coverage in the Netherlands

The Netherlands has a governmental compensation scheme, the Calamities Compensation Act. It is an entirely public system, funded by public resources. The act can come into force after a natural disaster. When it does, a specific ministerial regulation is written in which the rights to compensation are laid down. The damage will not be fully compensated, and the act contains many imponderables. It is not clear beforehand whether the act will come into force after a flood and if so, which damage will be compensated and in what amount. At this moment the act has been used five times and compensated losses in the range of €1,115,647 to €147,209,966 (Veiligheid en Justitie, 2017).

No mandatory flood insurance exists. Only one insurer offers a flood insurance, the Neerlandse. Discussions have been held on insurance for secondary floods, i.e., fluvial floods caused by breaches of secondary flood defence structures.

Currently, the system of compensation for flood damage is plagued by uncertainties. This is especially true for losses due to minor flooding events that cannot be designated as disasters and so will not be compensated by the governmental scheme.

Dominance of insurance scheme in England, and existing barriers

In England, very much in contrast to the Dutch situation, insurance and individual responsibilities play a major role in flood risk governance. One might therefore expect a close relationship between flood risk management and individual responsibilities and the encouragement of those living with flood risk to take action to reduce their risk. Although there are some situations where this has occurred, there have been a number of intervening factors. First, although there are no statutory duties for the government to provide flood management, the State has intervened for many years and has provided protection. This intervention has in many cases established a disconnect between individual residents and

their responsibilities for managing flood risk. Although having only permissive powers, the English government has consistently invested in flood risk management approaches (Defra, 2014, 2017) over many years, which has led to many expecting intervention. However, the situation is changing. Many of the higher risks have received investment in England, so cost-benefit analyses for unprotected areas are becoming more difficult to justify. The high cost, coupled with the nature of flooding, makes it difficult to offer protection, meaning that it is not technically or economically feasible to offer protection as a solution to flood risk management in all communities. As in much of Europe, flood risk management in England has moved towards a greater emphasis on individual and community responses (Alexander et al., 2016). This shift places increasing responsibility and pressure on at-risk communities to manage their own risk, key actions being raising preparedness and adopting measures to improve community resilience. The English context differs from many other countries in that for decades England has adopted a broad spectrum of approaches. In the recent context, it has been recognized that government approaches should also aim to facilitate local-scale approaches to resilience and look to opportunities to help individuals and communities manage their own risk (Cabinet Office, 2011; Environment Agency, 2012).

A second barrier to individuals' adopting post-recovery resilience has been the wide availability and use of flood insurance. Comprehensive flood insurance has been available since 1922 (Arnell, Clark, & Gurnell, 1984) and has relatively high penetration (Association of British Insurers, 2017). In 2016, 72% of households had contents insurance, and 61% had building insurance. Post-event recovery has been a key strategy for many years and thus has been acting as a buffer for those affected by flooding and offered financial assistance for recovery (Penning-Rowsell, Priest, & Johnson, 2014). As such, insurance is a key factor in incentivizing and facilitating more resilient recovery.

Promising potential of the private insurance market

Greater potential can be found in the private market. Insurance provision is the key measure whereby individual homeowners can be encouraged to adopt more resilient approaches after a flood and make their properties better adapted to resist or absorb future flood events. The adoption of individual risk reduction measures is in principle beneficial to all interested stakeholders. For property owners, the risk reducing benefits are clear and obvious, offering less damage and disruption from future events and protecting their assets. Similarly, for mortgage lenders the protection of the asset is critical. For insurers, the adoption of individual property-level resilience measures will reduce their overall exposure and make the coverage of that property more attractive. From a government perspective, the use of these measures recognizes that property owners are aware of the risk and are taking some individual responsibility for their risk, and in turn increasing communities' resilience to flooding.

However, the use of these measures remains relatively low in comparison to the overall number of properties at risk, with opportunities to influence the uptake of these measures being curtailed by various factors in the context of a private market flood insurance approach. These factors include annual premiums, the Competition Act of 1998, scope within the premium cost to provide a reduction, awareness by those insured that they are at risk, an appreciation of those measures that can be taken to reduce risk, and unwillingness of those insured to adopt measures. (For an example, see [Box 5](#).) Following

Box 5. Planning for Success: The Property Flood Resilience Action Plan (Defra, 2016).

In England, property-level resilience measures are increasing being recognized as important for improving the ability of individual householders to manage their own risk and managing residual risk not cost-effective to manage with larger-scale flood management approaches. However, despite considerable efforts to encourage broader adoption of these measures, including government pilots to demonstrate their use, uptake has been modest. To address existing deficiencies a governmental roundtable was established and a five-year action plan created. Five task groups focus on issues including removing the barriers to accessing funding and piloting an advisory service; embedding resilience in the standard operating procedures of SMEs and insurers; better sharing of information; establishment of consistent standards for resilience measures and the skills of professionals (surveyors, builders) for implementing them; exploring different options for communication; and leading to behavioural change. The aim for the end of the five years is to standardize practices and normalize the use of property-level measures in the portfolio of flood risk management approaches.

flooding under standard insurance coverage agreements, private insurers are required to provide recompense on a like-for-like basis. Insurers increasingly recognize that only reinstating properties to their pre-flood condition does nothing to reduce future risk. There are informal guidance documents in place that demonstrate the willingness of the insurance sector to encourage adaptive development. Moreover, the Association of British Insurers and the government are producing a flood risk report template for homeowners to declare resilience measures to their insurance provider (although it is not clear how such measures will be rewarded). However, in general the encouragement of risk reduction measures is limited, as the process of 'betterment' would be more expensive. The nature of annual premiums means that it is not in the interest of insurers to spend more on recovery than they are contracted to, as the insured could switch to a new insurer in the next year. Insurers are also prevented to a certain extent from working together to agree to provide betterment by the Competition Act of 1998, which views this type of collaboration as anti-competitive.

Some of these challenges, and in particular the ability of flood insurance to better incentivize resilient reinstatement and future adaptation, are key features, which may be tackled in the future through the adoption of a new UK flood insurance system, Flood Re. Implemented in April 2016, Flood Re is a government-regulated but privately run flood insurance system which was introduced to ensure the continuation of universal affordable insurance in high-risk areas. For those in high-risk areas, it caps insurance premiums (maintaining affordability), which are then ceded by private insurers to Flood Re. To cover any claims for these properties, a levy of c. £11 is applied to all domestic flood insurance premiums, which is put into an insurance pool (Flood Re, 2018). The Flood Re scheme is advocating an approach to encouraging risk reduction measures either proactively or following a flood event. Therefore, a key feature of Flood Re is the production and update of a transition plan in which the premium cap will be slowly raised, providing an incentive for policyholders to adopt risk reduction to reduce the premiums they pay for insurance. The first of these transition plans was released in February 2016 (Flood Re, 2016), but formal incentive mechanisms to promote risk reduction measures at the property scale are absent from the new Flood Re scheme, and there is a lack of guidance on how to deal with repeated claims. Currently, there is no requirement for insurers to inform property owners that they are at high risk and ceded into the scheme, so some property owners may not realize they are at risk, although the

EU Floods Directive aims to raise awareness by prescribing flood risk hazard maps that should inform citizens of the risks they face. Also, the decision about whether it is cost-effective to adopt risk reduction measures (essentially, the cost of the risk reduction measures against the benefits of premium reduction) is a complex one, particularly when insurers are themselves not clear on what premium reductions might be offered. In the consultation documents, the government stated an expectation for Flood Re to 'set out clear proposals on how it will create incentives for policyholders to take ownership and invest in resilience measures, including through all appropriate financial incentives' but this is currently lacking.

Grant schemes that hold potential in England

The UK government does not in principle offer many forms of compensation, but following flooding it has used a number of different ad hoc approaches which offer different types of financial and other assistance or support to different groups of those affected. A key governmental approach which has helped homeowners, and which tackles the issue of betterment, is the introduction of the Property Level Flood Resilience Grant Scheme (previously known as Repair and Renew Grants). This aims to encourage movement away from standard reinstatement techniques and a 'return to normal' discourse. Property owners may apply to their local authority (although the scheme is ultimately funded by central government) for a grant of up to £5000 to fund additional flood resilience and resistance measures for their property. For the most part, the funds will be paid by the insurance company, the specific aim of these grants being to enable resilient reinstatement and to bridge the gap between returning a property to its pre-flood state and adaptation measures for the future (DCLG/Defra, 2016).

In principle, these grants should increase the resilience of properties that have been affected by flooding, but how they have been implemented may limit their effectiveness.

Conclusions

We have engaged with the literature on flood risk management, the bulk of which focuses on preventing flood events and limiting property damage and the loss of human life (Morrison et al., 2018; Surminski, 2018). We have delved into the nexus between recovery and mitigation strategies and scrutinized how measures related to the mitigation strategy are addressed in post-flood policies and mechanisms. In line with the UN's International Strategy for Disaster Reduction, nations need a flood policy that links risk prevention and mitigation and post-flood compensation (Bubeck, Botzen, Kreibich, & Aerts, 2013; Surminski, 2018). The emphasis must be on the promotion of property redevelopment and land use choices, such as retreat or limited development, that reduce the risks of future damage. However, our research has shown, in line with the international literature referred to throughout the article, that the link between measures related to the recovery strategy (e.g. financial compensation) on the one hand and the prevention strategy and mitigation strategy on the other hand (e.g. keeping people away from the water or offering incentives to flood-proof their houses) are ineffective or lacking.

The nations considered here have very different post-flood policy set-ups and approaches to the compensation of properties damaged by a flood. Post-flood compensation plays a major role in the US, an important but more limited role in England, a very limited role at the EU level and an even more limited role in the Netherlands. The reasons for the limited impact of EU flood regulations on post-flood compensation in its member states are twofold. First, the emphasis of the EU Floods Directive is on risk-based prevention. Second, the directive does not have a substantive impact on the scope and content of member states' flood risk governance measures, as its nature is entirely procedural (Herman, 2010). Post-flood compensation schemes in EU member states are impacted somewhat through various EU policies beyond the Floods Directive, e.g., the Solidarity Fund and financial regulations set forth at EU level related to, for example, state aid.

In general, the main instruments of post-flood relief are flood insurance and government payments. In the US and England, both serve two purposes. The first is humanitarian: victims should be restored to the status quo. The second links post-flood compensation to flood damage prevention and uses compensation as a way to promote more resilient building construction and land use. The two objectives often conflict; the human drive for real estate development by industry, property owners and local governments has outweighed resilience objectives and related costs. As sea level rise and inland flooding become more frequent due to global climate change, the pressure for post-flood compensation will increase.

The legal and policy frameworks analyzed in this article are mutually inspiring, laying the groundwork for future research, notwithstanding the importance of context specificity and avoiding transplants. As post-flood compensation in the Netherlands is in its infancy, a closer look at the drawbacks and positive experiences of the elaborate scheme applicable in the US can be beneficial. Likewise, existing instruments such as the resilient reinstatement grants issued after floodings, as in England, are straightforward and versatile in promoting the link between risk prevention and mitigation and post-flood compensation. However, these grants have been unsuccessful in the past – the underlying cause of this problem is useful for other nations.

In the US, despite the lack of a coherent national flood and climate change policy, local governments are taking important steps to link post-flood recovery efforts with flood management strategies which will minimize future flood damage. These efforts would benefit from uniform federal flood management guidelines and grant programmes that reward innovative local programmes which seek to reduce moral hazard behaviour.

In the Netherlands, the strong emphasis on flood protection has proven to be effective in general. However, such a strong role for the government might not fit with the DNA of other countries. The sophisticated Dutch legal framework, with its standards, policy instruments that provide for easy implementation of flood protection measures, and a strong long-term planning approach, as well as investments in knowledge, innovative approaches and in recent years incorporating nature-based solutions, may serve as an example, especially for those countries that are vulnerable to the effects of climate change. However, moral hazard behaviour, including the levee effect, exists, as sometimes other values and interests prevail over flood protection. More attention should be paid to ex post recovery systems and increasing awareness. Individual flood protection is almost impossible due to the physical circumstances in the Netherlands.

However, the idea of stricter – more flood-proof and resilient – building requirements in general, and especially when rebuilding after a flood, is inspiring. Regulating this is feasible in the Dutch system, as it will not be regarded as expropriation of property rights, as it would in the US. Introduction of an insurance scheme might raise awareness but should not hamper the current focus on prevention, as this would make the country as a whole less habitable, as the risks might rise to an unacceptable level. Also, legally binding safety standards that oblige the government to guarantee a high level of protection and which in the near future might be qualified as obligations of result will influence any insurance system. In the possible evolution towards a more elaborate insurance scheme, premiums should be differentiated to stimulate prevention and mitigation measures by citizens.

In England, the strong reliance on insurance has had some positive impacts in terms of mitigation, but also drawbacks. There is high potential there, but realizing and incentivizing it is challenging and time-consuming. Recognizing the role of a public–private partnership between government and insurers is something that might be further developed in the other countries. The grants for resilient reinstatement following flooding (i.e., bridging the insurance gap), although in their infancy, can provide a good model for elsewhere – although these have their own challenges.

In both the Dutch and the English systems, building regulations should be improved so that properties are less likely to become damaged in the first place. In England, the greatest opportunities at this time are in the private market, which avoids government regulation when it can. Paramount is a smooth transition to differentiated, i.e., risk-reflective pricing, through a much stronger tie between insurance premium pay-outs and resilient reinstatement. But there currently are many barriers in relation to information provision and clarity about the transition approach. Furthermore, more technical evidence is required to demonstrate the effectiveness of resilience measures – providing confidence to property owners (that it is worth their investment), insurers (that it is worth a premium reduction) and government (that money is provided as a grant – that it is an efficient use of public funds).

Having looked at the Dutch and English post-flood legal and policy landscape, it is clear that a harmonization imposed by the EU in this area is not feasible in the foreseeable future. However, post-flood measures could be integrated into the procedural framework of the Floods Directive, and more specifically the flood risk management plans. The lack of reference to post-flood policies in the Floods Directive and its implementation hampers resilient flood risk management, as linking flood risk management strategies is an important condition of achieving such resilience (Driessen et al., 2016; Gilissen, Alexander, Matczak, Pettersson, & Bruzzone, 2016).

Finally, enhancing the synergies between public and private actors involved in flood risk governance is important in both the EU and the US. Indeed, linkages between flood risk management strategies are often hampered by issues such as a lack of up-to-date risk cartography, which could be remediated through improved public–private partnerships. Future research could further flesh out and compare specific instruments in the post-flood policies realm. Furthermore, research could focus on such public–private partnerships and how these could be used to further post-flood policies, in both a public ex post compensation setting and an insurance-centred policy landscape.

Notes

1. The houses and their foundations needed to be able to withstand a flood that could occur once every 25 years.
2. Website of 'Ruimte voor de Rivier', <https://www.ruimtevoorderivier.nl/english/> (visited 9 April 2018).
3. Spatial Zoning Plan Westergouwe B01034.513000 (GU0001), August 2008.

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References

- Albrecht, J., & Tarlock, A. D. (2018). Potential constitutional constraints on the regulation of flood plain development: Three case studies. *Journal of Flood Risk Management*, 11(1), 48–55.
- Alexander, M., Priest, S., Micou, A. P., Tapsell, S., Green, C., Parker, D., & Homewood, S. (2016). *Analysing and evaluating flood risk governance in England: Enhancing societal resilience through comprehensive and aligned flood risk governance*. Retrieved from <http://www.starflood.eu/documents/2016/03/wp3-en-final-webversion.pdf>
- Arnell, N. W., Clark, M. J., & Gurnell, A. M. (1984). Flood insurance and extreme events: The role of crisis in prompting changes in British institutional response to flood hazard. *Applied Geography*, 4, 167–181.
- Association of British Insurers. (2017). *UK insurance & long-term savings key facts*. London: Association of British Insurers. Retrieved from <https://www.abi.org.uk/globalassets/files/publications/public/key-facts/abi-key-facts-2017.pdf>
- Bubeck, P., Botzen, W. J. W., Kreibich, H., & Aerts, J. C. J. H. (2013). Detailed insights into the influence of flood-coping appraisals on mitigation behaviour. *Global Environmental Change*, 23(5), 1327–1338.
- Burkens, M. C., Kummeling, H. R. B. M., Vermeulen, B. P., & Widdershoven, R. J. G. M. (2012). *Beginnelsen van de democratische rechtsstaat. Inleiding tot de grondslagen van het Nederlandse staats- en bestuursrecht* [Principle of the democratic constitutional state. Introduction to the foundations of Dutch constitutional and administrative law]. Deventer: Kluwer.
- Bye, P., & Horner, M. (1998). *1998 Easter floods: Final assessment by the independent review team. Volume 1. Report by the independent review team to the board of the Environment Agency*. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/292915/geho0807bnay-e-e.pdf
- Cabinet Office. (2011). *Strategic national framework on community resilience*. Civil Contingencies Secretariat. London: Author.
- Calamities Compensation Act. Act of 25 May 1998 on the Regulations on Contribution for the Damage and the Costs in Case of Freshwater Flooding, Earthquakes or Other Catastrophes and Large Accidents, Stcrt. 11 June 1998.
- CEC. (2004). *Flood risk management: Flood prevention, protection and mitigation* (COM(2004) 472 final). Brussels: Commission of the European Communities.

- Chizewer, D. M., & Tarlock, A. D. (2013). New challenges for urban areas facing flood damages. *Fordham Urban Law Review*, 40(5), 1739–1792.
- Chizewer, D., . M., & Tarlock, A. D. (2016). Living with water in a climate changed world: Will federal flood policy sink or swim? *Environmental Law*, 46(3), 491–536.
- Dai, L., Wörner, R., & van Rijswick, H. F. M. W. (2017). Rainproof cities in the Netherlands: Approaches in Dutch water governance to climate-adaptive urban planning. *International Journal of Water Resources Development*, 34(4), 652–674.
- Department for Communities and Local Government (DCLG)/Department for Environment Food and Rural Affairs (Defra). (2016). *Property level flood resilience local authority guidance*. London: Crown copyright. Retrieved from https://www.bitc.org.uk/sites/default/files/berg_-_property_level_flood_resilience_local_authority_guidance.pdf
- Department for Environment Food and Rural Affairs (Defra). (2017, September). *Central government funding for flood and coastal erosion risk management in England*. London: Crown Copyright.
- Department for Environment, Food and Rural Affairs (Defra) (2014, December). *Reducing the risks of flooding and coastal erosion: An investment plan*. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/389789/fcerm-investment-plan-201412.pdf
- Di Baldassarre, G., Kreibich, H., Vorogushyn, S., Aerts, J., Arnbjerg-Nielsen, K., Barendrecht, M., ... Ward, P. J. (2018). Hess opinions: An interdisciplinary research agenda to explore the unintended consequences of structural flood protection. *Hydrology and Earth System Sciences*, in review. doi:10.5194/hess-2018-333
- Doorn-Hoekveld, W. J., van, Goytia, S. B., Suykens, C., Homewood, S., Thuillier, T., Manson, C., ... van Rijswick, H. F. M. W. (2016). Distributional effects of flood risk management: A cross-country comparison of pre-flood compensation. *Ecology and Society*, 21(4), 26.
- Doorn-Hoekveld, W.J., van (2017). Transboundary flood risk management: Compatibilities of the legal systems of flood risk management in the Netherlands, Flanders and France. *European Energy and Environmental Law Review*, 26(3), 81–96.
- Doorn-Hoekveld, W.J., van (2014). Compensation in flood risk management with a focus on shifts in compensation regimes regarding prevention, mitigation and disaster management. *Utrecht Law Review*, 10(2). doi:10.18352/ulr.279
- Driessen, P. P. J., Hegger, D. L. T., Bakker, M. H. N., Van Rijswick, H. F. M. W., & Kundzewicz, Z. W. (2016). Toward more resilient flood risk governance. *Ecology and Society*, 21(4).
- Environment Agency. (2012). *Flood plan guidance for communities and groups*. Bristol: Author.
- European Floods Directive. (2007). Directive 2007/60/EC on the assessment and management of flood risks – entered into force on 26 November 2007.
- Flood Re. (2016). *The first Flood Re transition plan: Transitioning to an affordable market for household flood insurance*. London: Author. Retrieved from <https://www.floodre.co.uk/wpcontent/uploads/Flood-Re-Transition-Plan-Feb>
- Flood Re. (2018). *How Flood Re works*. Retrieved from <https://www.floodre.co.uk/how-flood-re-works/>
- General Accounting Office. (2017). *Progress on high-risk areas while substantial efforts needed in others*. Washington, DC: US Government Printing Office. Retrieved from <https://www.gao.gov/assets/690/682765.pdf>
- Gilissen, H. K., Alexander, M., Matczak, P., Pettersson, M., & Bruzzone, S. (2016). A framework for evaluating the effectiveness of flood emergency management systems in europe. *Ecology and Society*, 21(4), 27. Retrieved from <https://doi.org/10.5751/ES-08723-210427>
- Gorlé, F., Bourgeois, G., & Bocken, H. (1991). *Rechtsvergelijking*. Brussels: Story-Scientia.
- Groothuijse, F. A. G., Boeve, M. N., Broek, G. R., van Den, Keessen, A. M., & van Rijswick, H. F. M. W. (2018). *Juridisch-bestuurlijke evaluatie van Ruimte voor de Rivier*. Utrecht: Utrecht Centre for Water Oceans and Sustainability Law.
- Herman, C. (2010). Will the floods directive keep our feet dry? Policies and regulations in the Flemish region and Scotland. *Journal of Water Law*, 21(4), 156–166.

- HM Government. (2016, September). *National flood resilience review*. Crown copyright 2016. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/551137/national-flood-resilience-review.pdf
- Hoornbeek, J. A. (2004). Policy-making institutions and water policy outputs in the European Union and the United States: A comparative analysis. *Journal of European Public Policy*, 11, 461–496.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/292939/LIT_5286_b9ff43.pdf
- Ingargiola, J., & Ghori, L. (2015). Did Katrina change the way we build? A building science perspective. *Association of State Floodplain Managers News & Views*, 28(4). Retrieved from http://www.floods.org/ace-files/documentlibrary/News_Views/News_Views_Aug2015.pdf
- Ingram, C. (2017, August 29). Houston is experiencing third 500 year flood in 3 years. *Washington Post*.
- Insurance Institute for Business and Home Safety. (2015). Rating the States. Retrieved from <http://disastersafety.org/wp-content/uploads/2015/07/rating-the-states-2015-public.pdf>
- Kaufmann, M., Doorn-Hoekveld, W. J. V., Gilissen, H. K., & van Rijswijk, H. F. M. W. (2016). *Analysing and evaluating flood risk governance in the Netherlands: Drowning in safety*. Utrecht: STAR-FLOOD Consortium.
- Kimber, C. J. M. (1995). A comparison of environmental federalism in the United States and the European Union. *Maryland Law Review*, 54(4), 1658–1690.
- Larrue, C., Hegger, D., & Trémorin, J.-B. (2013). *Researching flood risk governance in Europe: Background theories*. Utrecht: STAR-FLOOD Consortium.
- Lavranos, N. (2006). The MOX plant and IJzeren Rijn Disputes: Which court is the supreme arbiter? *Leiden Journal of International Law*, 19(2006), 223.
- Linhart, S. M., & Eash, D. A. (2010). *Floods of May 30-June 15, 2008- Iowa River and Cedar River, Eastern Iowa*. US Geological Survey Open-File Report 2010-1190. Retrieved from <https://pubs.usgs.gov/of/2010/1190/pdf/of2010-1190.pdf>
- Macdonald, N., Chester, D., Sangster, H., Todd, B., & Hooke, J. (2011). The significance of Gilbert F. White's 1945 paper 'Human adjustment to floods' in the development of risk and hazard management'. *Progress in Physical Geography*, 36(1), 125–133. doi: 10.1177/0309133311414607
- Morrison, A., Westbrook, C. J., & Nobel, B. F. (2018). A review of the flood risk management governance and resilient literature. *Flood Risk Management*, 11, 291–304.
- Penning-Roswell, E. C., Priest, S. J., & Johnson, C. J. (2014). The evolution of UK flood insurance: Incremental change over six decades. *International Journal of Water Resources Development*, 30(4), 694–713.
- Pitt, M. (2008). *Learning lessons from the 2007 floods: The Pitt review*. London: Cabinet Office.
- Priest, S. J., Suykens, C., Van Rijswijk, M., Thuillier, T., Goytia, S., Kundzewicz, Z., & Homewood, S. (2016). The European Union approach to flood risk management and improving societal resilience : Lessons from the implementation of the floods directive in six European countries. *Ecology and Society*, 21(4).
- Sanders, E. (2018, March). Sinking land will exacerbate flooding from sea level rise in Bay Area. *Science Daily*. Retrieved from <https://www.sciencedaily.com/releases/2018/03/180307141411.htm>
- Serkin, C. (2014). Passive takings: The state's affirmative duty to protect property. *Michigan Law Review*, 113(3), 345–404.
- Shallat, T., & Goetzman, W. H. (Ed.). (1994). *Structures in the stream: Water, science, and the rise of the U.S. Army Corps of Engineers*. Austin: University of Texas Press.
- Surminski, S. (2018). Chapter in *Oxford Research Encyclopedia of Natural Hazard Science*. Oxford, UK: Oxford University Press.
- Suykens, C., Priest, S. J., Doorn-Hoekveld, W. J. van, Thuillier, T., & van Rijswijk, M. (2016). Dealing with flood damages: Will prevention, mitigation and ex-post-compensation provide for a resilient triangle? *Ecology and Society*, 21(4), 1. doi:10.5751/ES-08592-210401.

- Tate, E., et al. (2016). Flood recovery and property acquisition in Cedar Rapids, Iowa. *Natural Hazards*, 80(3), 2055–2079. Retrieved from <https://link.springer.com/content/pdf/10.1007/s11069-015-2060-8.pdf>
- Terpstra, T. (2009). *Flood preparedness: Thoughts, feelings and intentions of the Dutch public*. Diss., Albani Drukkers, The Hague.
- Terpstra, T., & Gutteling, J. M. (2008). Households' perceived responsibilities in flood risk management in the Netherlands. *International Journal of Water Resources Development*, 24(4), 555–565.
- van Rijswijk, H. F. M. W., & Havekes, H. J. M. (2012). *European and Dutch water law*. Groningen: Europa Law.
- Veiligheid en Justitie. (2017). *Factsheet Wts*.