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Research, part of a Special Feature on Toward More Resilient Flood Risk Governance

Dealing with change and uncertainty within the regulatory frameworks for flood defense infrastructure in selected European countries

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ABSTRACT. Whereas existing literature on the interactions among law, adaptive governance, and resilience in the water sector often focuses on quality or supply issues, this paper addresses adaptation in national water laws in relation to increasing flood risks. In particular, this paper analyzes the extent to which legal rules governing flood defense infrastructure in a selection of European countries (England, France, Sweden, and The Netherlands) allow for response and adaptation to change and uncertainty. Although there is evidence that the legal rules on the development of new infrastructure require that changing conditions be considered, the adaptation of existing infrastructure is a more complicated matter. Liability rules fail to adequately address damages resulting from causes external to the action or inaction of owners and managers, in particular extreme events. A trend toward clearer, and in some cases, increased public powers to ensure the safety of flood defense infrastructure is observed. The paper concludes that legal rules should ensure not only that decisions to build flood defenses are based on holistic and future-oriented assessments, but also that this is reflected in the implementation and operation of these structures.

Key Words: *Adaptive governance; flood defense; flood risk; flood risk management; water law*

INTRODUCTION

Flood defense, also referred to as flood protection or flood control, entails the use of infrastructural works such as dams, embankments, and ditches to decrease the probability of flooding (see Klijn et al. 2008, Hegger et al. 2014). Although flood defense has historically been the predominant means of dealing with floods, in recent decades, it has become the object of considerable criticism not least as a result of the emergence and development of sustainability and resilience concepts (Kundzewicz 2002, Vis et al. 2003, Adger et al. 2005, Samuels et al. 2006, Aerts et al. 2008, Klijn et al. 2008, Wilby and Keenan 2008). In particular, flood defense is regarded as an attempt to control nature and resist change, when the focus should also be on learning, adjusting, and adapting to change, here in the form of increasing flood risk (Milly et al. 2008, Hegger et al. 2014).

As flood defense infrastructure is designed with a specific capacity and is a centralized solution, it is difficult to adapt it to changing boundary conditions such as floodplain urbanization or upstream deforestation (Pahl-Wostl 2002, Liao 2014). This is made more complex by climate change, whose impact on components of the hydrological cycle, and consequently on floods, remains uncertain (see Jones et al. 2012, Kundzewicz et al. 2013, Liao 2014). The need for engineered options to cope with the uncertainties associated with predicting climate change effects is emphasized in the "Adaptation Needs and Options" chapter of the latest Intergovernmental Panel on Climate Change (IPCC) report (Noble et al. 2014). The chapter provides examples of infrastructure that has been designed or upgraded in a manner that allows climate change risks to be taken into account, including the phased expansion approach adopted in the English Thames Estuary 2100 Plan (Environment Agency 2012).

Although there is much evidence to suggest that flood defense is a less desirable strategy, it should also be acknowledged that, in some cases, it may be the only feasible option. Therefore, it is necessary to investigate the implications of new understandings about social–ecological systems even in these cases. The construction, maintenance, and alteration of flood defense infrastructure are all matters commonly controlled by national law. The aim of this paper is to study if, and to what extent, the applicable legal rules in a selection of European countries—namely England, France, Sweden, and The Netherlands—allow for response and adaptation to change and uncertainty.

The analysis is conducted within the framework of the growing body of literature on the interactions among law, adaptive governance, and resilience, both generally (e.g., Ebbesson 2010, Ruhl 2011, Ebbesson and Hey 2013, Garmestani et al. 2013) and particularly in the field of water governance (e.g., Bruch and Troell 2011, Keessen and van Rijswick 2012, Green et al. 2013, Clarvis et al. 2014, Cosens et al. 2014). This literature often focuses on legal adaptation for water quality or water supply. There are few examples of comprehensive studies on adaptation in national water laws in relation to increasing flood risks (see, e.g., Godden and Kung 2011, Hartmann and Albrecht 2014, Gilissen 2015). Our intention is to contribute to this scientific area by exploring the legal rules governing flood defense in several countries and by providing insights on the manner in which these enhance or hamper adaptive governance; this is in line with identified needs for further research (see Ebbesson and Hey 2013, Chaffin et al. 2014).

The selected countries are quite diverse in terms of both physical and socioeconomic circumstances and, consequently, also with regard to the nature and scale of their flood risk situation. However, all are projected to face increasing flood risks as a result of not only population and economic growth, but also climate change (Jongman et al. 2012, Kovats et al. 2014, Alfieri et al. 2015, European Environmental Agency (EEA) 2015). These contextual factors, together with the fact that the countries are representative of various legal traditions (civil law, common law, and Scandinavian law), entail that the legal rules applicable to flood defense differ in both content and form across the countries.

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It follows also that the adaptation needs of each of the countries are different. This can be understood in two senses. Firstly, each country has its own needs when it comes to building or improving flood defense infrastructure in order to face future flood risk. This can, to some extent,be envisaged in their adaptation plans and programs (see, e.g., Ministry of Ecology, Sustainable Development, Transport and Housing (MEDDE) 2011, Her Majesty's Government 2013, Ministry of Infrastructure and the Environment and Ministry of Economic Affairs (I&M and EA) 2015, Sveriges Hydrologiska och Meterologiska Institutet (SMHI) 2015). Secondly, the extent to which adaptive governance elements can be found in, or incorporated into, the legal rules applicable to flood defense also varies across the countries.

The next section of this paper introduces key concepts related to the interactions between law and adaptive governance. Then, following an account of methods, the legal rules on flood defense in the selected countries are presented and analyzed in light of those concepts. A discussion and conclusion section closes this paper.

ADAPTIVE GOVERNANCE AND LAW

The adaptive governance approach has developed in connection with the understanding that change in a social–ecological system is a complex, surprising, and unpredictable process (see, e.g., Dietz et al. 2003, Folke 2006, Chaffin et al. 2014). Given this, approaches that are focused on single issues, based on steady-state views, or that disregard interactions across scales, are less useful, and there is instead a need for approaches that aim to understand, respond to, and cope with changing conditions and disturbances (Folke et al. 2005). The academic literature emphasizes adaptive management, polycentricity, and scale as key components of adaptive governance (see Chaffin et al. 2014).

Adaptive management refers to a "systematic process for continually improving policies and practices by learning from the outcomes of implemented management strategies" (Pahl-Wostl et al. 2007). It serves to reduce uncertainty, build knowledge, and improve management over time in a structured and goal-oriented manner (Allen et al. 2011). This process does not occur in a vacuum; it is conditioned by social and institutional settings (Gunderson and Light 2006, Pahl-Wostl et al. 2007). Moreover, although management alone may be sufficient where a single entity pursues a singular goal, complex systems such as hydrologic basins involve multiple scales of jurisdiction as well as competing interests and goals, which must be taken into account (Cosens et al. 2014). Polycentric and diverse institutional arrangements may be a significant aspect in adapting responses to change and disturbance at different scales (Folke et al. 2005, Cosens et al. 2014).

Thus, adaptive governance is considered to provide the information, flexibility, coordination, and conflict resolution that is necessary to remain within desired states in the face of change and uncertainty (Dietz et al. 2003, Folke et al. 2005, Allen et al. 2011). The notion of desired states, which refers to the ecological and social outcomes that are mediated by adaptive governance, is explicitly normative (see Chaffin et al. 2014). Keessen et al. (2013) clarify that determining the direction of adaptation entails giving resilience a specific meaning: to resist, to adapt, or to transform. Therefore, adaptive governance must also foster legitimacy and accountability (Cosens 2013, Cosens et al. 2014).

The law is a pivotal factor in adaptive governance, and consequently, in society's capacity to deal with change, disruption, and uncertainty, not least in its function as an instrument to achieve environmental and social goals, including the protection against floods (Ebbesson and Hey 2013). A point of departure on the topic of interactions between law and adaptive governance is that there is no absolute incompatibility between, on the one side, the rule of law and its requirement of legal certainty and, on the other side, adaptive governance elements such as flexibility and adaptability; the challenge lies instead in finding "appropriate relations" between these (Ebbesson 2010:417). Whereas legal certainty provides for "clear, equal and foreseeable" rules (Neuhaus 1963:795), flexibility and adaptability allow rules to cope with changing conditions. Cosens et al. (2014) explain that the quest for this balance begins with a consideration of the structure and adaptive capacity of the current social–ecological system, in order to then provide the necessary legal authority to collaborate and respond adaptively as well as to remove the legal barriers that unnecessarily constrain adaptation.

Clarvis et al. (2014) have reviewed the literature addressing the challenge of applying adaptive governance principles to law as well as evaluating the capacity of different facets of the legal system to support such principles. An example relevant to this paper, as it addresses adaptation in legal rules for flood risk management, is the contribution of Keessen and van Rijswick (2012). Accordingly, promoting resilience through law requires (1) striking the right balance between legal certainty and flexibility in the form of rules that deal with change without becoming arbitrary, (2) improving the adaptability of rules to allow for learning by means of iterative processes of decision making, (3) openness and participation in decision making and access to justice; (4) multilevel governance on a bioregional scale; and (5) effectiveness, in the sense that the legal framework should provide the necessary conditions for its implementation and enforcement (Keessen and van Rijswick 2012:40–41).

On the basis of their literature review, Clarvis et al. (2014) have proceeded toward an identification of "actionable governance mechanisms" for adaptive water law. These authors maintain that: *flexibility* can be promoted through time-limited licensing as well as emergency provisions and powers; *iterativity* can be favored by permit systems, time-bound review periods, and administrative requirements in secondary legislation; *subsidiarity* can be supported through locally appropriate standards and conditions tailored to local circumstances; and finally, *connectivity* can be enhanced by participation processes and monitoring standards in order to make data available.

METHODS

Previous studies of this kind indicate that both administrative law and substantive law, including property rights, are relevant for adaptive governance (Ebbesson 2010, Barnes 2013, Cosens 2013). Therefore, this study commenced by identifying these three facets in the legal rules governing flood defense infrastructure in England, France, Sweden, and the Netherlands, namely: (a) administrative rules, in terms of licensing processes and supervisory responsibilities, including participatory requirements in connection thereto, (b) substantive rules, including environmental considerations, safety standards, and liability, and (c) property rights connected to water and flood defense

infrastructure. The study of the legal material is qualitative and, in principle, limited to national legislation currently in force.

In order to facilitate a clearer presentation of the findings, these have been organized into rules relating to the development of new infrastructure, the maintenance obligations and liabilities connected to existing infrastructure, and the supervision of defense infrastructure. Maintenance and supervision should be understood as separate activities, which moreover often fall to different actors. Within each of the subsections, the relevant administrative rules, substantive rules, and property rights are assessed in relation to the concepts, criteria, and examples proposed in literature and summarized in the previous section.

THE REGULATORY FRAMEWORKS FOR FLOOD DEFENSE INFRASTRUCTURE

The development of new flood defense infrastructure

Flood defenses constitute physical measures on land and water areas and, as such, directly affect property rights as well as planning and environmental legislation. This section examines the decision-making processes that are necessary for the construction of new flood defense infrastructure, with a focus on how private and public interests are taken into account.

Riparian ownership seems to carry most weight in England and Sweden, where public competences for flood defense are generally permissive. In accordance with the Swedish Environmental Code (SEC; 1998:808), measures such as regulating a watercourse or constructing an embankment are considered "water operations" (ch. 11, ss. 2–3, SEC). In order to undertake a water operation, it is necessary to have disposition over the water resources in the area (*Act on Special Provisions concerning Water Operations* (WOA; 1998: 812 (ch. 2, s. 1)). Having disposition over the water is a procedural prerequisite to apply for a water operations permit (see Strömberg 1984). The disposition follows the ownership of the land. Hence, it is the landowners who, as a rule, have disposition over the water on their land (ch. 2, s. 2, WOA). Nonetheless, for some water operations, the law grants disposition also to persons other than the landowner (ch. 2, ss. 4–5, SEC). For example, the state or a municipality have disposition for operations desirable from a health or environmental perspective. However, neither the Swedish state nor the municipalities have a concrete legal obligation to construct flood defenses (Andersson 2009).

The position in England with regard to defense construction is complex, not least as a result of the transition from a common law approach, which focused on the relationships among individual landowners, to a catchment-based approach, which embodies a systems perspective and thus focuses increasingly on the actions of individual landowners on the performance of the system as a whole. Although riparian rights and responsibilities are principally still governed by common law, they are also affected by modern legislation (e.g., *Water Resources Act 1991*, *Land Drainage Act 1991*, *Natural Environment and Rural Communities Act 2006*; also see Environment Agency 2014). For example, the development of flood defense infrastructure requires an environmental permit (for flood risk activities) to be issued by the flood risk management authority (prior to April 2016 these were known as Flood Defense Consents) (see the *Environmental Permitting Regulations 2016*, SI 2016/475 (Government of England and Government of Wales 2016)). Moreover, landowners may not alter, remove, or replace any existing natural or artificial feature that has been designated as a flood risk management asset without the permission of such an authority. In England, the shift toward collective action has, however, created permissive powers only; authorities have the possibility, but not the obligation, to provide flood defenses.

In contrast, France has experienced a clearer transition from a system based on ownership to one where flood defense is considered an issue of civil security and, consequently, a governmental task. Landowners have a right (but not an obligation) to protect their land against flooding. The state may construct flood defenses on the beds of main rivers, as these are in the public domain, as well as expropriate private land in order to build such defenses, if this is in the public interest. The construction of flood defenses requires an authorization granted by the state. The Netherlands differs significantly from the other three countries; here, flood protection is a constitutionally ensured responsibility of public authorities (Art. 21 of the Dutch Constitution).

In England, France, and Sweden, the development of flood defenses is subject to decision-making processes based on statutory substantive provisions under environmental and planning legislation. Planning processes are typically separate from those of environmental permitting. For Sweden, the SEC requires permit applications to be evaluated in relation to a number of environmental requirements, such as environmental quality standards, precaution, best available technology, and appropriate localization. Moreover, for a permit to be granted, the benefits of the operation, considering both public and private interests, must be greater than the costs and damages associated with it (ch. 11, s. 6. SEC). A permit may not be granted in conflict with municipal planning instruments (ch. 2, s. 6, SEC). In England, the permit application must include, besides construction plans and a description of the impacts on the environment, a detailed assessment on how the works will affect flood risks. Furthermore, defenses are also required to obtain planning permission by a local planning authority (*Town and Country Planning Act 1990*, *Planning and Compensation Act 1991*). In France, the authorization to build flood defenses is granted on the basis of a risk study that "takes into account the probability of occurrence, the kinetics and severity of potential accidents using a thereby defined methodology [and] defines and justifies appropriate measures to reduce the probability and effects of such accidents" (art. L 211-3 *French Environmental Code*, FEC, authors' translation).

The regulatory design in The Netherlands is radically different as it is based on codified safety standards. For primary flood defenses, i.e., the structures that form part of a dike ring or are situated in front of a dike ring, the safety standards are prescribed by the *Dutch Water Act* (DWA). The standards for nonprimary structures are established in provincial bylaws. Current standards are based on flood hazard calculations: if a flood defense structure has a safety standard of 1:1250, then it should be able to resist a water level that will take place once in 1250 years (van Rijswick and Havekes 2012). A change toward a risk-based approach has recently been proposed; new safety standards for primary structures will henceforth be calculated by multiplying the

probability and the consequences of a flood event. The competent national or regional water authority is responsible for meeting those standards. In order to construct a water structure, the water authority must draw up a project plan describing the structure and how it will be implemented as well as the measures meant to limit or reverse of the adverse effects of such implementation (s. 5.4 DWA).

The legal rules in the examined countries are more or less explicit on the matter of climate change effects. It is outside the scope of this paper to examine whether, for instance, multiple future flood scenarios are considered in individual cases (see Gersonius et al. 2013, Lawrence et al. 2013). In England and Sweden, requirements to consider climate effects are primarily found in planning legislation. The need to account for a changing climate in the design of flood defenses is instead addressed in authoritative technical guidelines (see, e.g., Environment Agency 2009, Svensk Energi et al. 2015). Although Swedish law (quite vaguely) requires that climate aspects be considered in planning (ch. 2, s. 3, *Planning and Building Act* (2010:900)), in England, there is a statutory duty for local planning authorities to include policies designed to tackle the impact of climate change in their plans, for example by adopting "proactive strategies to mitigate and adapt to climate change, taking full account of flood risk" (Department for Communities and Local Government (DCLG) 2012: para. 94). Moreover, the Environment Agency (EA) is required to specify "the current and predicted impact of climate change" in the national flood risk management strategy (s. 7, *Flood and Water Management Act 2010*). In France, although risk studies for flood defenses should assess flood risks as potentially exacerbated by climate change, this is practiced only in relation to coastal defenses (see Circular of 27 July 2011 on marine submersion), as available knowledge on such effects in relation to fluvial floods is considered weak. In relation to river defenses, requirements to monitor the evolution of the hydrological system may instead be applicable (see, e.g., Maurin et al. 2013). In The Netherlands, the calculation of the new safety standards will include, among other things, the future demographic and economic development as well as climate change.

The permitting processes in England, France, and Sweden thus denote flexibility and adaptability elements in the form of integrative assessments and performance-based rules (see Ebbesson 2010, Hartmann and Albrecht 2014). Performance-based rules entail that the actual boundaries for the activity are set by the conditions of the permit, which also favors subsidiarity. The process in France seems, however, to have a more technical character than in the other two countries. A safety standard of 1:2000 will be applicable to structures built after the year 2020 in areas where no such structures yet exist (art. R214-119-3 FEC). New safety standards in The Netherlands account for a wide range of factors and have a long-term perspective. Their codification favors certainty, as authorities have defined obligations toward the people, but also may constrain other alternatives to managing flood risk. For example, the so-called "multilayered safety approach" introduced in the Delta Program (I&E and EA 2015) should make it possible to lower flood defense standards by simultaneously introducing spatial measures or evacuation plans, but there is still uncertainty about how it will be implemented.

In all four countries, requirements for consultation and public participation are applicable to processes leading to the construction of flood defense infrastructure. However, the forms of participation, as well as to what extent input provided by stakeholders and citizens is taken into account, varies among countries (see Ek et al. 2016). In England, stakeholder participation has, for many years, been a standard component in the process of realizing flood defenses, as it has been recognized as a fundamental requirement for public acceptance. However, in France, public inquiry takes places before the final approval by the authority, and therefore, possibly too late to result in substantial changes to the project. In The Netherlands, even the new safety standards were open for public consultation, but as these are part of a change of an *Act*, no judicial review is possible.

Maintenance requirements and liabilities associated with flood defense infrastructure

Maintenance is essential to the effectiveness of flood defense infrastructure. Maintenance activities aim to prevent or correct functional losses caused by the aging of components, external causes (both expected and unexpected), or human errors at any stage in the life of a structure (see van der Toorn 1994). In the case of flood defenses, loss of function can have catastrophic consequences. All the examined countries, therefore, establish obligations to regularly assess and maintain flood defenses as well as liability systems that activate in case of failure. From an adaptive governance perspective, it is interesting to examine, for instance, the extent to which these rules, not only allow for the early discovery of undesirable developments, but also create opportunities to reflect on, and implement, necessary changes (see Pahl-Wostl et al. 2007). As for liability rules, Ebbesson (2010) has already raised the question of how individual responsibility can be established when the risk and the damage are unpredictable.

Maintenance obligations seem to be best defined in The Netherlands, where, moreover, they fall on public powers. The water authorities have a "duty of care to guarantee the legally set level for protection against flooding" (Tennekes et al. 2014) even if the structure is owned by another private person or public body. As the duty of care entails an obligation to avoid acts, or reasonably foreseeable omissions, that may cause damage, it places far-reaching maintenance responsibilities on the authorities. Based on the local (regional) needs and circumstances, the authorities must further interpret and elaborate these duties in their management plans, which must be revised and updated at least once every 6 years (Art. 4.8 DWA, Gilissen 2015). The competent water authority may also issue regulations containing restrictions and instructions on the use of a structure.

In England, France, and Sweden, the responsibility for maintenance principally resides with the owner of the structure. The pertinent rules establish a general responsibility, which may be concretized through conditions in individual permits. Moreover, in the last decade, all three countries have intensified control over dam safety issues, by including classification systems and regular assessment requirements into legislation. It should, however, be pointed out that in Sweden, although the relevant rules are technically applicable to embankments (dams for protection), it is mostly hydropower and tailing dams (dams for storage) that fulfill the applicability criteria, namely that dam failure could have significant consequences at a local, regional, or national scale (see Government of Sweden 2013/2014).

However, the SEC contains a general obligation on persons conducting operations that may cause detriment to human health or the environment to keep themselves informed and to continually plan and monitor the operation in order to prevent such effects (see ch. 26, s. 19, SEC and Ordinance (1998:901) on operator's control).

In accordance with French law, the ownership of flood defenses can be shared among several public bodies and/or private persons. Owners may moreover contractually transfer maintenance responsibilities to a manager. As a result, it can be difficult to establish and enforce legal responsibilities in relation to the structures. In fact, one-third of the dikes in France have no identified owner (Deliancourt 2013, Cans et al. 2014). In 2007, legislative reforms were introduced with the intention of setting flood defense infrastructure under a coherent legal framework. Thus, the risk study described in the previous section must be carried out even for existing infrastructure and must be updated every 10 years (art. L214-117 FEC). The state can also impose an update at any time if the assumptions in the risk study become outdated, for example as a result of climate change effects.

Although maintenance responsibilities for flood defenses in England principally lie with their owners, the EA may assume such responsibilities, for instance, where there are defenses with multiple owners, and the standard of protection is reliant on the integrity of all defenses in the system. A defense owner is permitted to increase its standards; however, this is likely to be treated as a modification of the defenses and, as such, could require a new permit and associated participation requirements. For dams in England, monitoring and maintenance differ depending on the size of the dam and if it is considered to be high risk, with more stringent and frequent monitoring for those classified as per the *Reservoir Act 1975* (as amended). However, all reservoir owners are required to employ civil engineers to inspect dams for safety at least once a year; for lower risk dams, any recommendations issued by these are not mandatory, but considered best practice (Bowles et al. 2013). For higher risk dams, an independent and qualified Inspecting Engineer is also required to undertake an inspection at least every 10 years; any recommendations they make being mandatory (s.10, *Reservoir Act 1975* as amended by the *Flood and Water Management Act 2010*).

Under Swedish law, the owner of a water structure is responsible for maintaining it so that changes in water conditions do not damage public or private interests (ch. 11, s. 17, SEC). The maintenance responsibility includes performing routine repairs and rebuilding outdated structures or parts thereof, but not measures to improve the efficiency of the structure (Government of Sweden 1997/1998, Vattenverksamhetsutredningen 2014). Following Ordinance 2014:214 on dam safety, the person responsible for the maintenance of a safety classified dam must ensure that there is always an updated analysis of the consequences of a dam failure; establish a safety management system; report to the supervisory authority on a yearly basis; and conduct an overall assessment of dam safety every 10 years.

A measure implemented to maintain a water structure may in itself constitute a water operation and consequently require a permit, unless the maintenance measures have been included in the original permit and are thus covered by its legal effects (ch. 24, s. 1, SEC; Naturvårdsverket 2008). The legal effects of permits are indeed a factor of consequence, especially considering that permits involving construction in water areas are, as a rule, granted without time limits (see Government of Sweden 1997/1998). The following decisions by the Swedish Land and Environment Court of Appeal (LECA), although they concern hydropower dams, illustrate some of the complexity associated with the permit requirement for maintenance and improvement works.

In case MÖD 2004:1, the LECA maintained that an application to take safety-increasing measures must be handled as a new permit request and not as a permit revision request if the measures do not pertain to any conditions in the existing permit. The first instance had, therefore, correctly dismissed the application when the applicant failed to produce an environmental impact assessment. In MÖD 2009:44, the LECA confirmed that when an applicant seeks a permit to take measures to refurbish a dam with the sole purpose of increasing safety, it is not justified to reassess the entire operation or even permit conditions that do not directly relate to those measures sought. However, in a similar case, MÖD 2012:56, the court partially revised its case law by attaching conditions on minimal drainage to a permit for safety-increasing measures, as a protected area would otherwise have been compromised.

Liability rules establish that damages associated with flood defense infrastructure can generate an obligation to compensate. Fault liability is the rule in all four countries: to be held liable, the person responsible for the infrastructure must have been negligent, and it principally falls upon the injured party to establish this circumstance. Whether the owner or manager has been negligent is commonly determined with reference to requirements in legislation or, where applicable, the individual permit. Consequently, owners or managers do not face liability as long as they formally comply with the legal rules, regardless of the actual risks. However, strict liability rules, where the obligation to compensate is not attached to negligence, are applicable in certain cases.

In France, it is explicitly stated that the manager cannot be held liable if the dam is designed, operated, and maintained in the rules of art and in accordance with legal and regulatory obligations (art. L562-8-1 FEC). In England, legal action can be taken both in the case of actual damage to property or person (negligence) and in the case of suffering inconvenience or distress (nuisance) due to the consequence of dam or defense failure. Similar to the situation in France, those owning and maintaining dams in England are somewhat protected from negligence liability if they comply with current and recognized regulatory standards (Bell et al. 2013). In the case of nuisance, it is the proprietary interests (e.g., interference with how a claimant is able to use or enjoy that land) that will have been affected and the reasonableness of defendants' actions will be considered. There is a high burden of proof to be established by the claimants in both negligence and nuisance cases, and consequently, it can be difficult for claimants to successfully obtain damages.

In Sweden, the person responsible for the maintenance of a dam constructed for the purpose of water regulation is strictly liable for damages resulting from dam failure (ch. 11, s. 18, SEC). Dam failure is defined as "an uncontrolled outflow of the water [...]

that the dam is intended to dam up or obstruct" (ch. 11, s. 4, SEC). The definition includes outflows caused by collapse, gradual erosion, or incorrect operation of the dam, but not cases where the dam retains its function, but water nevertheless flows over and causes damage (Government of Sweden 1997/1998). Embankments are excluded from this strict liability provision, as they are instead constructed with the purpose of flood protection (Government of Sweden 1997/1998). Damages resulting from the failure of an embankment would thus, as a rule, follow fault-based liability rules (cf., however, Government of Sweden 1996/1997, Bengtsson 2011, as well as Vattenverksamhetsutredningen 2014).

Both fault and risk liability systems play a role in Dutch flood risk management (Art. 6:162, 6:163 and 6:174 of the *Dutch Civil Code*). Fault liability entails that if a flood results in damage of any kind, injured parties may argue that the responsible water management authority has been negligent regarding its legal duty of care and should, therefore, compensate for the damage. The injured party must prove that the water management authority, by not having taken adequate preventive or restrictive measures, imputably acted in breach of the law. In case law, it is, however, accepted that the competent authority has wide discretionary powers regarding the prioritization of measures.

Risk liability in the Dutch context means that a water authority can be held liable for flood damages resulting from a defective water management structure if it had legal possession over that structure. According to case law, a construction is assumed to be defective, unless the possessor proves that it actually did meet the applicable requirements. It is not necessary that the water management authority was aware of the defect and the related risk; only an "objectively unknowable risk" precludes strict responsibility (Gilissen 2014). The malfunction of a dike near the town of Wilnis in 2003, due to a long-lasting drought, was considered to be such a risk. This liability system has, however, been criticized in legal literature, as it is feared that it could hamper the overall management task of the water authorities (Hartlief 2012, Gilissen 2014, van Doorn-Hoekveld 2014).

Supervision of flood defense infrastructure

Supervision is important to the enforcement of the legal rules applicable to flood defense infrastructure. The distribution of supervisory powers varies across the countries. The tendency seems to be toward clearer, and in some cases, more extensive supervisory powers. A focus lies on authorities being able to gather information on the existence, condition, and ownership of the infrastructure.

In England, the EA principally performs supervisory functions, although there are growing responsibilities at the local level, namely the Lead Local Flood Authorities (LLFA) or Internal Drainage Boards (IDB). The EA may inspect and supervise structures and serve notice on any structures that have been built without permission or not in accordance with the permission provided, requiring landowners to abate any nuisance. They may also remove flood defenses and recover the costs of this work. If a LLFA or an IDB want to undertake any flood risk management actions, they are also required to follow the guidance and seek permission from the EA. All LLFAs are also required to maintain a register of structures or features that have a significant effect on flood risk in their area (s. 21, *Flood and Water Management Act 2010*). These registers should contain detailed information about these structures, including ownership and the state of repair.

In The Netherlands, both national and regional authorities play a significant role. The primary flood defenses are supervised by the Minister of Infrastructure and the Environment (I&E) (s. 3.9 DWA) who informs both Chambers of Parliament (s. 2.12 DWA). A report on the general condition of primary flood defense structures must be submitted to the Minister every 12 years. The assessment of nonprimary flood defense structures is not regulated by the DWA; the provinces are responsible for providing rules for the assessment of these structures and supervising the regional water authorities.

In Sweden, compliance with the SEC is controlled by the County Administrative Boards, which are representatives of the state at a regional level, with a possibility for local authorities to assume these responsibilities (see ch. 26, ss. 3–4, SEC). The supervisory authority may issue orders and prohibitions in relation to a specific water operation, but these may not restrict the permit on which the operation is based, except in two circumstances (ch. 26, s. 9, SEC). Firstly, the supervisory authority may always issue orders and prohibitions that are urgent and necessary in order to avoid adverse health impacts or serious environmental damage. Secondly, since the 2014 reforms of dam safety, orders and prohibitions regarding safety-increasing measures for classified dams are also allowed. The supervisory authority may, furthermore, seek a revision of a permit on the grounds stated by the SEC—which include improving the safety of a structure and significant changes in the surrounding conditions—but this may not result in conditions so extensive that the operation can no longer be pursued or is significantly hampered (ch. 24, s. 5, SEC). Of note is that when an authority requests a permit revision, the investigative burden falls upon them, rather than on the infrastructure owner (ch. 22, s. 2a, SEC *a contrario sensu,* Vattenverksamhetsutredningen 2014). As permit revision can be a rather cumbersome process, authorities also consider alternative ways for modifying water operations, for example, voluntary agreements with the permit holder (Naturvårdsverket 2007).

Ongoing legislative changes in France entail a movement from state to local supervision of dam safety (see *Act on Modernization of Territorial Public Action and Affirmation of the Metropolis* (MAPAM) of 27 January 2014). Local authorities will be given coercive powers to manage the safety of dams even on lands they do not own. For example, these authorities will implement work programs to develop or strengthen defenses. This new responsibility will, moreover, be exercised on consistent areas ("diking systems"), thereby avoiding the management of flood defenses on a case-by-case basis, which the ownership approach has hitherto sustained. Local authorities are, furthermore, strongly encouraged to pool their powers at the catchment scale via Basin Public Organizations, but there is no evidence that public authorities are tending to renounce their responsibility for management of flood defenses and transfer powers to these organizations. The reason seems to be that flood management is a source of political legitimacy, which drives local authorities to retain the issue on their own political agendas (see Larrue et al. 2016).

DISCUSSION AND CONCLUSION

This paper investigates the extent to which the regulatory frameworks for flood defense infrastructure allow for actors to handle change and uncertainty associated with flood risks, while simultaneously upholding legal principles such as the rule of law.

The analysis is conducted on the basis of existing literature on adaptive governance, in particular focusing on studies that address its interactions with law. The initial implication of this is that the paper cannot be limited to examining rules pertaining to the capacity of defenses to resist increasing water flows and levels, but must also consider rules relevant to the complex functions, effects, and responses of the defenses in the wider context of the social–ecological system.

The paper finds that legal rules are most open to complexity and uncertainty when the infrastructure does not yet exist. The legal frameworks governing the development of flood defenses denote elements such as performance-based rules and integrative assessments, which generally allow for diverse factors, interests, and objectives to be considered and balanced before flood defenses can be constructed. A more formal inclusion of climate effects in the Swedish and English frameworks could, however, better support permitting authorities in requiring that uncertainties be investigated.

Furthermore, the paper finds that dealing with changing flood risks will require not only that the decisions to build flood defenses are based on holistic and future-oriented assessments, but also that this is reflected in the implementation and operation of these structures. It should not be underestimated that the legal rules pertinent to the maintenance and supervision of flood defense infrastructure often focus on safety issues (i.e., ensuring the level of protection as well as preventing structural failure) and that over time it becomes increasingly difficult to balance safety with other desirable outcomes. The rules themselves raise questions from both legal certainty and adaptation perspectives. For example, how far do maintenance obligations and connected liabilities extend in a context where change is neither incremental nor foreseeable? What possibilities exist for authorities to effectively intervene when other negative developments than those relating to structural safety are detected? It should, however, be noted that the trend toward applying the same risk assessment and precaution requirements to both new and existing flood defenses is valuable, not least because it allows for vital information to be updated and made available.

Against this background, and given that the actual requirements of the operation are often set by their permits, it is important that these, on the one hand, fully cover all aspects of the operation's long-term social and environmental impacts, and, on the other hand, allow for flexibility in terms of compliance measures and adjustment periods. In this sense, adaptive mechanisms such as time-bounded reviews are also relevant for the flood risk domain. Likewise, the legal frameworks could better support voluntary or cooperative ways to generate changes that would otherwise require restrictive coercive means.

Finally, it should be recalled that there are indeed no one-fits-all solutions in adaptive governance. In the quest for information, flexibility, coordination, and conflict resolution necessary to remain within desired states in the face of change and uncertainty, each country departs from their particular set of physical, socioeconomic, and institutional conditions. For example, The Netherlands has relied on legally enforceable safety standards, but faced with the impossibility of endlessly strengthening flood defenses, must now consider and resolve the challenges posed by other alternatives such as the multilayered safety approach. France and England find themselves in periods of transition, with the former more attached to notions of resistance and the latter embracing adaptive elements to a greater extent. In France, centuries of investments in defenses as well as centralist and technocratic approaches weigh heavily in flood risk governance; however, decentralization and diversification movements have been initiated. The English desire for adaptation reflects long-held notions of flexibility, diversification of management approaches, and learning within flood risk governance. The recognition of insufficient resources to prevent all floods has encouraged policy makers to refocus on promoting ways to adapt to future flood risk, particularly at the local level. In Sweden, the applicable legal framework is principally meant to serve purposes other than flood risk management, but as this becomes a growing concern, opportunities to rethink the framework will arise. Nonetheless, in generating these kinds of insights, comparative legal research proves valuable to our understanding of the role of law in the governance of complex social–ecological systems.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/issues/responses.php/8908

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