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Drivers and barriers of adaptation initiatives – How societal transformation affects natural hazard management and risk mitigation in Europe

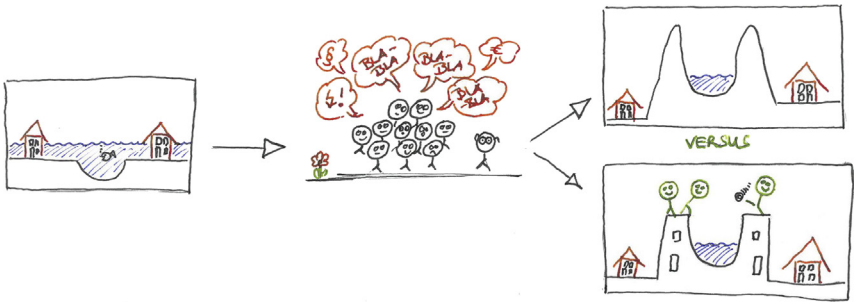
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HIGHLIGHTS

- Transformation in approaches to natural hazard management is occurring at local scales in Europe
- The transformative process is heavily led by bottom-up initiatives.
- Local natural hazard management strategies include niche innovations, which are clearly different to mainstream solutions
- The understanding and planning phases are critical in overcoming the main barriers in the development of societal transformation
- Natural hazard management policy could benefit from overcoming single-purpose solutions

GRAPHICAL ABSTRACT



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ABSTRACT

A key challenge of hazard risk management is finding novel ways to respond to future extremes amid increasing vulnerability. Societal transformation in the context of multi-functional protection schemes offers potential in this regard. However, the drivers and barriers of societal transformation in hazard management are poorly understood. Here we interrogate drivers and barriers of societal transformation in natural hazard management through case studies in Austria, France and Ireland focusing on attempts to integrate multi-functional protection schemes in the context of flood and avalanche hazards. We conducted qualitative semi-structured interviews with key stakeholders connected to proposed transformative strategies in the selected case studies. We find that transformative approaches have been mainly supported by local initiatives instigated by local governments, residents, or NGOs with the aim of complementing conventional hazard management policies. Our analysis shows that local actors and stakeholders often pursue initiatives to address local problems or to seize local opportunities rather than to contribute to a broader societal transformation. According to our findings, key drivers of

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Multi-functional
Societal transformation

community-based initiatives with multiple functionality and use include: (i) lack of funding, (ii) lack of legal protection or (iii) lack of space, where classical risk management measures can no longer respond to new circumstances. In contrast, key barriers relate to: (i) lack of local capacities, (ii) lack of local political support and (iii) technological challenges in the implementation phase. These insights support European regions currently working on the implementation of climate change adaptation strategies arising from natural hazards.
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1. Introduction

Natural hazards cause considerable damage to individuals, the environment and the economy (e.g., Munich Re, 2017). Despite considerable efforts to reduce disaster risk using technical and structural solutions, such as levees and retention basins, losses due to hydro-meteorological hazards remain high (IPCC 2014; Fuchs et al. 2015, 2017a; Röthlisberger et al. 2017; Bronstert et al. 2018). Changes in land use and climate may influence the frequency and magnitude of extreme events and have initiated debate at all levels regarding disaster management and risk reduction strategies (Keiler et al. 2010; Aubrecht et al. 2013; Jongman et al. 2014; Mallakpour and Villarini 2016; Zhang and Villarini 2017; Blöschl et al. 2017) with the challenge that climate change causes deep uncertainties in decision-making (IPCC 2014; Greiving et al. 2017). Eventually, societies will have to adapt when confronted with social and environmental changes (Keiler and Fuchs 2016; Zischg et al. 2018). Debates are often directed towards current cultural and socio-economic changes and developments which transform not only current policy discourses but also the roles of citizens and public administration in natural hazard management (Park et al. 2012; Mees et al. 2014; Adger et al. 2016; Clarke et al. 2016, 2018; Fuchs et al. 2017b; Felder et al. 2018). The result may be an evolutionary change in natural hazard management strategies, especially because the current debate goes beyond 'classical' natural hazard discourses (i.e. vulnerability assessment and structural protection schemes) that were standard practice in past decades (Wisner et al. 2004; Holub and Fuchs 2008; Fuchs 2009; Adger et al. 2013; Thaler and Hartmann 2016; Barraqué 2017; Andrade and Szlafsztein 2018). This encourages a new social contract[1] between governments and individual households, where new natural hazard management strategies could be seen as innovative and bottom-up initiatives at local level are promoted/encouraged (O'Brien et al. 2009a; Adger et al. 2013; Thaler and Priest 2014). An important outcome is that policy discourse in the field encourages local decisions and strategies to demand a transformation of the current system (Polanyi, 1944; Oxfam 2012; Nalau and Handmer 2015; Feola 2015; Few et al. 2017; Thaler et al. 2017).

The idea of transformation has become a very widely used term for describing social change in a new system structure. Although it is often merely used as a metaphor (Feola 2015), transformation can occur in reaction to an impact (i.e. reactive adaptation/transformation), but can also be triggered in anticipation of an event/impact (i.e. proactive adaptation/transformation). Equally, transformation can incorporate a series of (incremental) adaptation strategies which may coalesce into something which is retrospectively considered as transformative over a longer timeframe (see Pelling 2011; Kates et al. 2012; Burch et al. 2014).

In this paper, we investigate the barriers and drivers of initiatives aimed at societal transformation in response to extreme events. In particular, we explore the preconditions and antecedents for the development of community based multi-functional natural hazard management strategies. We take multi-functional approaches to include strategies that provide more than one purpose of the alleviation scheme, such as how retention basins can be used for leisure activities; fountains and artwork (see Fig. 1). Such multi-functional strategies are transformative as they require changes in individual risk perception, network collaborations and co-ordination, new institutional arrangements and administrative practices. By incorporating diverse case studies from across Europe our aim is to determine the main drivers and barriers to such societal transformation (Moser and Ekstrom 2010; Biesbroek et al. 2011; Wamsler and Pauleit 2016; Runhaar et al. 2018). We define drivers as actions to encourage, strengthen and accelerate transformation. Examples include financial subsidies, land use pressures, policy entrepreneurship[2] or local capacities (Bulkeley 2010; Jordan et al. 2010; Uittenbroek et al. 2013; Eakin et al. 2016). We define barriers as actions, which delay or de-rail the transformation process. Barriers to transformation can be deeply rooted in cultural perceptions, social norms, legislation and resource management (Biesbroek et al. 2013; Eisenack et al. 2014; Uittenbroek 2014; Uittenbroek et al. 2014). In contrast to limitations, i.e., thresholds after which system features cannot be maintained even in a modified form, barriers can be overcome with concerted effort e.g. by taking actions at local, regional and/or national level (Adger et al. 2007; Burch 2010; Moser and Ekstrom 2010; Ekstrom and Moser 2014).

The paper is organised as follows: section 2 considers more deeply the concept and processes of transformation. Section 3 provides an overview of the case studies employed and the identification of key stakeholders and methods employed. Results are presented in section 4 before distilling key conclusions and reflecting on future directions in section 5.

2. Societal transformation in natural hazard management

We understand societal transformation as a process which provokes an extensive change of the current situation and can be defined as 'a fundamental alteration of the nature of a system once the current ecological, social or economic conditions become untenable or are undesirable' (Nelson et al. 2007: 397). Transformation might be at micro (individual/household), meso (regional/national) or macro level (national/international). Within this definition it is implied that the process of transformation is triggered by external or internal deviations, which creates the need for a system (e.g. society) to change. Transformation is strongly interconnected with other terms, such as resilience, transition, adaptation, adaptive capacity and sustainable development (Geels and Schot 2007; Fischer-Kowalski and Haberl 2007; Fischer-Kowalski and Rotmans 2009; Grin et al. 2010; Shove et al. 2012; Burch et al. 2014, 2017; Feola 2015).

Recent discussions on adaptation have focused significant attention on the concept of transformation (Nelson et al. 2007; Dow et al. 2013; Rickards 2013). Kates et al. (2012) take a rather radical standpoint, stating that incremental change (adaptation) is insufficient to actually achieve transformation. Accordingly, they suggest that there are three adaptation classes which lead to transformation, (1) strategies implemented at a large-scale or for large-scale events (2) existing strategies transferred to new locations and (3) adaptations that transform place-based systems or shift these to another location.

[1] Social contracts define and organise the relationship and division of responsibility and task between public administration and citizen (O'Brien et al. 2009a; Adger et al. 2013).

[2] Policy entrepreneurs can be seen as key players who act outside from (local or national) government. These actors introduce and encourage to implement new ideas and strategies into public practice (Roberts and King 1991).



Fig. 1. Examples of multi-functional protection schemes in Galtür and Großkirchheim, Austria. a) Picture of Alpinarium. Credits: M. Keiler; b) Galtür avalanche dam. Credits: S. Fuchs. c) Entrance shooting range in Großkirchheim; Credits: A. Rieger; d) Insight picture of shooting range in Großkirchheim. Credits: A. Rieger.

Further, transformation at a local level may provide a mechanism for such processes to be upscaled to a regional level. Drivers for such upscaling processes vary greatly. Nevertheless, an important external driver is a so-called window of opportunity (or policy window), e.g. in the aftermath of natural disasters such as the 1999 Marmara earthquake, which created a political change in Turkey (Pelling and Dill 2010; Westley et al. 2013; Few et al. 2017; Fuchs and Thaler 2017). Extreme events often create such policy windows, providing a tipping point to initiate large-scale adaptation efforts, which may lead to transformative change (Kates et al. 2012). The transition from one adaptive cycle into another can consequently lead to a new system and, in this way, allows a transformation of the current system status (Gunderson and Holling 2002, Walker et al. 2004, Folke et al. 2010). Nevertheless, Walker et al. (2004) argue that the outcome is not necessarily positive. When change is desired, deliberate transformation takes place, whereby the system is analysed in its current state versus an alternative and perhaps undesired state (Walker et al. 2004; Westley et al. 2013). Thus, transformation is also considered at different scales in which thresholds are exceeded in order to form new system states (Folke et al. 2010). Nevertheless, the outcome of transformation does not always foresee negative results (Von Wirth et al. 2016; Clarke et al. 2018).

In the context of natural hazards research on societal transformation a central discussion has been the question of who assumes responsibility for risk reduction (Adger et al. 2013; Mees et al. 2014), such as if a natural hazard event enables a bounce forward process within communities and individual households to reduce losses caused by future events (Alexander 2002, 2015). Emerging strategies expect local organisations to take a lead role in decision-making regarding risk management and vulnerability reduction (Thaler and Priest 2014), with the transformative outcome that existing social contracts are replaced or reformed in the process. In such instances where local organisations are expected to assume such responsibilities, root causes of vulnerability should be considered so that the balance between responsibility and rights may be maintained through the transformation (Wisner et al. 2004). Such scenarios may also imply negative outcomes, especially for those who benefit from the current state of the system (Penning-Rowsell and Pardoe 2012; Thaler et al. 2018).

Societal transformation in the context of natural hazards can involve innovative risk management solutions that are clearly different (or niche) relative to mainstream solutions (Clarke et al. 2016; Edelenbos et al. 2017). During the period of transformation, the 'old' and 'new' systems can co-exist, but within the process of change the 'new' will overtake the 'old' leading to a change in society. Transformation is often driven by specific local governance initiatives instigated by local governments, residents or NGOs – often during a recovery phase – with the aim of complementing or overcoming the limitations of

conventional natural hazard management policies. The transformative potential of these initiatives may come from replication or transfer of initiatives to other contexts or they may induce wider institutional changes facilitating uptake of novel initiatives (Patterson et al. 2016, 2018; Beunen et al. 2017). Of particular interest, given the involvement of diverse actors, is the multi-functional use of the same place or several (spatial and/or social and/or economic) interests (Fuchs and Thaler, 2017). These initiatives are often pursued by local actors and stakeholders (e.g. bottom-up community initiatives or mayors). However, such attempts at novelty are often derailed due to conflicts between the different parties involved in natural hazard management, e.g. farmers vs. natural hazard protection (Dow et al. 2013; Thaler 2014; Kuhlicke et al. 2016; Boyd et al. 2017; Fünfgeld 2017). We investigate what makes attempts at transformation, in the context of multi-functional approaches succeed or fail.

3. Methods

3.1. Case studies

We examine the drivers and barriers of attempts at transformative change to multi-functional approaches to risk management across seven European case studies from Austria, France and Ireland. The case studies are Galtür, Pfunds and Großkirchheim, Austria; Skibbereen and Clontarf, Ireland; and Le Mans and Angers, France (Fuchs et al. 2018). Table 1 provides a summary of each case. Case studies were chosen with the explicit objective of including diverse political and environment settings across European member states. Case studies also represent a diverse set of natural hazards (river and coastal flooding and mountain hazards) as well as distinct social, economic, cultural and institutional characteristics. We explicitly include both successful and unsuccessful attempts at transformation to examine the fundamental drivers and barriers. In the selected countries natural hazard management has been institutionalised for decades but within different settings, including type of hazard, vulnerability, history or current/past political systems. We subsequently argue that these cases may assist in identifying wider lessons for other regions currently working on adaptation implementation strategies in the context of changing risks (Butler and Pidgeon 2011; Hanger et al. 2013).

3.2. Data collection and analysis

Semi-structured in-depth interviews with national, regional and local stakeholders and citizens as well as practitioner workshops were organised in each country between May 2015 and March 2016. In total, 68 standardised semi-structured interviews with key actors involved in the case studies were conducted (24 interviews in Austria (Thaler and Fuchs 2016); 30 interviews in France (Gatien-Tournat

Table 1
Overview of the selected case studies.

Country	Main hazard challenges at the community	Key actors and stakeholders	Succeding or failing	Short description of multiple use of natural hazard scheme
Austria				
Galtür (year of planning: 1999; year of implementing: 1999)	Exposure and frequency/magnitude as well as evacuation	Federal State of Tyrol, Austrian Torrent and Avalanche Control Services (national authority), municipality of Galtür (local authority)	Succeding societal transformation process	Multi-use of avalanche protection dam as avalanche protection, local emergency response centre, museum, underground parking, and indoor climbingwall
Großkirchheim (year of planning: 2000; year of implementing: 2011-2013)	Impact of flooding (exposure and emergency)	Municipality of Großkirchheim (local authority), Federal Water Authority	Succeding societal transformation process	Multi-use of flood embankments: flood protection and indoor shooting range
Pfunds (year of planning: 2005; year of implementing: 2006-2013)	Impact of flooding and chance of flooding (exposure)	Municipality of Pfunds (local authority), Austrian Torrent and Avalanche Control Services (national authority)	Succeding societal transformation process	Multi-use of flood embankments: flood protection and cultural installation and leisure park
France				
Angers (year of planning: 1970s; year of implementing: 1970s)	Impact of flooding especially on land planning, water infrastructure and flood mitigation	Deconcentrated national department of Ecology, local authorities, associations	Succeding societal transformation process	Multi-use of flood plain for agricultural land use (extensive grazing and mowing), leisure park, cycling road, patrimonial protection of natural heritage of Loire Valley, Creation of a 'green and blue infrastructure'
Le Mans (year of planning: 2000; year of implementing: 2003-2008)	Impact of flooding especially on land planning, water infrastructure and flood mitigation	Deconcentrated national department of Ecology, local authorities, associations	Succeding societal transformation process	Multi-use of flood plain for leisure park (music festival, kids garden etc.), place for teaching and awareness to biodiversity
Ireland				
Clontarf (year of planning: 2011)	Impact of flooding - reducing exposure to and consequences of coastal and pluvial flooding.	Dublin City Council, the Office of Public Works (OPW), Clontarf Residents Association, Clontarf Business Association	Failing with communtiy demand for multi-use flood defences due to value placed on local amenity	The local authority proposed to develop flood defences along the promenade to protect residential and commercial premises from future coastal flooding. This involved the construction of an earthen mound through the centre of the promenade and erecting flood walls at several locations along its course.
Skibbereen (year of planning: 2009)	Impact of flooding - reducing exposure to and consequences of coastal and fluvial flooding.	Partnership for change, National Flood Forum, Skibbereen flood forum, the Office of Public Works (OPW), Cork County Council	Failed proposal for multiuse environmental park as a community led initiative in multi-use flood mitigation measure.	Following extensive flooding in 2009 a local environmental group proposed to develop an environmental park in a marsh area on the towns periphery. The environmental park was to serve as a multi-functional facility and incorporate woodlands, waterbodies, valleys, hills and numerous habitats.

et al. 2016); 14 interviews in Ireland (Clarke and Murphy 2016). The interviewees included institutional stakeholders (civil servants, former and current elected representatives of local authorities), local NGOs, community groups and other relevant stakeholders, such as unions and a Railway Company. They were questioned about the societal transformation process within the case study, the role of different stakeholders in the project, the general process surrounding implementation of the proposed adaptation measure, the governance structure and drivers and barriers of societal transformation (see also Table 2). Each interview was recorded and transcribed verbatim. This research used pseudonyms to preserve participants' anonymity. Additionally, an analysis of the institutional context of hazard and risk management systems in each country was conducted, including an extensive desktop analysis of relevant policy documents, newspaper articles, other grey literature sources, and scientific literature.

Drawing on the work of Moser and Ekstrom (2010), we categorised barriers and drivers using three different phases of implementation (Table 3); (1) Understanding phase, e.g. defining and developing societal transformation actions and activities. This phase primarily refers to the social, cognitive and governance arrangements and structures within current risk management system; (2) Planning phase, focusing on the development, assessment and selection of potential options for societal transformation in natural hazard management, and; (3) Managing phase which includes the policy aspects of implementation, monitoring and evaluation of the societal transformation process.

4. Results

4.1. Drivers of transformation

Results highlight that key drivers of societal transformation in natural hazard management were found within political actions, local capacities, and resources such as local leadership and financial support (Table 4). In all case studies, we observed that local stakeholders play a critical role in initiating and managing local transformation processes. Principally, during engagement in the decision-making process we observed strong local interest and resources (e.g. time, funding, people as well as social network and cultural capital like educational background) within the selected case studies. This was only possible if there was a strong local capability to engage and lead the process. In Großkirchheim (Austria), the interviewees confirmed the importance of local engagement, especially with respect to local knowledge and interest that influenced the design and outcome of innovative local solutions, such as the indoor shooting range where local hunters lobbied for a multi-functional protection scheme.

However, the motivation and the possibility to engage in the transformation process varied between the case studies. For example, in Le Mans (France), an important driver, apart from flood management, was the potentialities for urban renewal on a brownfield site and the ambition of local residents to design a green park. Additionally, involvement of local actors in the discussion process facilitated a move away from a strong top-down approach, where local stakeholders have limited ability to influence decision-making processes, to a process where local stakeholders were recognised as partners in decision-making processes. In other words, governance processes need to move away from consultation only towards broader co-operative decision-making processes.

Similarity was also evident across case studies concerning the main actors engaged in decision-making. Data analysis primarily highlighted that – depending on local capacities – in most of the case studies the local government (municipalities, mayors) acted as the central actor and initiator in the decision-making process. Here, an important process included questions of responsibility, such as who is legally liable if a person is injured in the event of a natural hazard event. The public administration has a dominant role in the policy process, making them the gatekeeper for the realisation of a societal transformation process according to national law and administrative practice.

Drawing on Table 3 important drivers of transformation can be observed during the understanding phase, followed by the planning and management phase. Two of three Austrian cases (Galtür and Pfunds) showed that the transformation process begun in the wake of severe natural hazard events (window of opportunity). Similar results can be observed in the two French examples, where the 1995 flood events encouraged the local transformation process. However, windows of opportunity do not always derive from a recent extreme event. In Großkircheim (Austria), the development of a local risk management plan created a window of opportunity. Moreover, a key factor in facilitating local transformation was related to scarcity of land, where communities face the challenge of integrating competing land use and users without increasing exposure to natural hazards. Windows of opportunity fostered the transformation process, but also affected other

Table 2
Drivers and barriers for societal transformation in natural hazard management.

Drivers/opportunities - Barriers	Examples
Political drivers	Related to political leadership, change in legislations or policy documents, legal restrictions
Technological drivers/barriers	Related to culturally undesirable and economically infeasible conditions to implement new technologies; or development of new technologies
Resources – local capacity	Related to lack of resources, such as financial resources, lack of people, social and cultural capital or policy entrepreneurs
Informational and cognitive barriers	Related to knowledge gaps about flood hazards
Social and cultural drivers/barriers	Related to the view, values and beliefs of individuals or groups, lack of risk awareness and interests

Source: adapted from Moser and Ekstrom (2010); Thaler (2014); Uittenbroek et al. (2013, 2014).

Table 3
Drivers and barriers for societal transformation in natural hazards management in the different stages of the policy cycle.

Stage	Drivers/opportunities - Barriers
Understanding phase	- Use of information (such as availability, accessibility, relevance, credibility and trust, or legitimacy) - Define objective (such as threshold of concern, threshold of response need, threshold of response feasibility, or level of agreement or consensus) - Develop options (such as who takes the leadership, ability to identify and agree on goals/objectives, ability to develop and agree on different options and criteria, control over process and options) - Assess options (such as availability of data and information, availability of methods to assess and compare options and ideas, or agreement on assessment approaches) - Selection of final option(s) (such as agreement on selecting option(s), threshold of concern over potential negative consequences, or definition of responsibility-sharing between the different organisations and authorities)
Planning phase	- Implement option(s) (such as accountability, or legality) - Monitoring process of implementation(such as agreement on monitoring targets, ability to store monitoring data, or availability of economic and human resources to undertake the monitoring of implementation process) - Conflict management - Sufficient resources (such as funding, availability of technology, or social capacity)
Managing phase	- Clear definition of who is responsible for which tasks (such as question of funding) - Technical aspect of failure (such as residual risk) - Sufficient resources (such as funding, information, personal resources) - Social cohesion (such as avoidance of social exclusion and gentrification)

Source: adapted from Moser and Ekstrom (2010); Thaler (2014); Uittenbroek et al. (2013, 2014).

Table 4
Enhancing societal transformation in selected case studies.

Drivers	Key factors	Decision-phase	Case studies						
			Galtür	Großkirchheim	Pfunds	Angers	Le Mans	Clontarf	Skibbereen
Political drivers	Resident pressure	Understanding	X				X		
	Political will	Understanding and planning	X	X	X		X		
	Political support	Understanding	X	X	X				
	Political leadership	Understanding						X	
	Liability in case of hazard events	Planning	X		X				
	Collaboration between citizens and public administration	Understanding				X			
Technological drivers	Implementation of nature-based solutions	Understanding							X
Resources – local capacity drivers	Policy entrepreneur	Understanding	X	X	X				X
	Local capacities	Understanding	X	X	X				
	Financial support/subsidies	Understanding	X	X	X	X	X		
Informational and cognitive drivers	Economic development	Understanding							X
Social and cultural drivers	Security/safety request	Managing	X	X	X				
	Risk awareness	Understanding				X	X		X
	Lack of trust into engineering solutions	Understanding							X

factors, such as an existing policy entrepreneurship at the local level as well as social activism, which played a vital role in the transformation process. Where transformation was successful, politicians in particular acted as policy entrepreneurs within the selected case studies. In Le Mans, local politicians living near the project site were strongly involved in the residents' association promoting the creation of a green park while the municipality was more in favour of a new residential area. Here, local leaders supported and convinced the local and regional public administration to support the transformation process. Social activism and pressure at the local scale was used to affect change within the current system using a window of opportunity to ensure local interests were met and to generate political will. Overall, across all case studies, the interviews revealed that the local level is seen as a decisive factor in the successful implementation and development of societal transformation.

4.2. Barriers to transformation

The empirical results showed that there are various barriers hindering successful initiation and support for local transformation processes in natural hazard management (Table 5). One central barrier at many case studies was the lack of local resources and/or capacities, such as financial resources, policy activism or stakeholder engagement at local level. On the other hand, in Skibbereen (Ireland), it was that the community groups had significant resources and strong connections with influential authorities that resulted in the non-implementation of an environmental park, and the pursuit of a structural flood defence. The presence and effectiveness of local engagement, in terms of creating local organisations, played a central role in societal transformation in natural hazard management. In Austria, societal willingness to engage in planning and decision-making processes seemed to be higher in the

Table 5
Barriers hinder societal transformation in selected case studies.

Barriers	Key factors	Decision-phase	Case studies						
			Galtür	Großkirchheim	Pfunds	Angers	Le Mans	Clontarf	Skibbereen
Political barriers	Citizen groups	Understanding							X
	Political representative	Understanding							X
	Lack of transparency	Understanding						X	
	Political will	Understanding					X		
	Property rights	Planning					X		
Technological barriers	Technological restriction in the use of natural flood management strategies	Understanding							X
	Pollution (brownfield land)	Planning					X		
Resources – local capacity barriers	Community engagement	Understanding							X
	Decline of motivation and interest at local level	Understanding							X
	Lack of policy entrepreneur	Understanding							X
	Lack of financial capacities to implement and to manage the project	Planning and managing							X
Informational and cognitive barriers	Lack of national example (lack of imagination)	Understanding							X
	Possible negative economic impacts to local businesses	Understanding						X	
	Different view of how to manage flood hazard	Understanding						X	
Social and cultural barriers	Lack of adequate flood protection	Understanding							X
	Communication	Understanding							X
	Community value	Understanding						X	
	Place attachment	Understanding						X	
	Profit speculation	Planning					X		

wealthier rural case studies than in urban areas, such as Galtür. The lack of citizen engagement was often based on a lack of political willingness (institutional barrier) to involve and to encourage stakeholders to contribute. This institutional barrier was often a result of power inequalities, where public administrations use top-down decisions to ensure their political will and interest.

In addition, the influence of local stakeholders in the risk management planning and decision-making practice was dependent on local capacity as well as trust and openness in public administration, especially in both of the Austrian case studies (Galtür and Pfunds) as well as French case studies. Following flooding in 2009 in Skibbereen (Ireland), Skibbereen flood committee (a representative community group of residents and business owners) established the Irish National Flood Forum, a national body to represent and advocate the interests of flooded communities with flood authorities, policymakers and elected representatives. They were subsequently involved in lobbying flood authorities for traditional flood relief works both nationally and in Skibbereen as following quote shows.

"Skibbereen flood committee as a core group have been most effective because we kept driving it [lobbying for structural flood defences] and looking at the bigger picture... we have been hugely influential because we have driven it [lobbying for structural flood defences] from the start, we have formed the Irish National Flood Forum. We've got honest and real recognition and cooperation from the Department of Environment and the OPW (national flood authority)."

The local involvement in all selected case studies in the discussion and decision-making process depended on the local capacity (capacity to act), such as resources (technical knowledge, finance, time), interest, as well as social networks and networks to public administration. In addition, the success of local transformation was also strongly dependent on whether local stakeholders were able to represent their interest and needs at national level. Most local stakeholders had strong interdependent interests, such as individual economic interests or different views of how to manage natural hazards, which caused conflicts between them. In Ireland the failure for a multi-functional green space at Skibbereen was influenced by the dominant role that the insurance industry plays at national level in linking availability of insurance with traditional flood defences.

"The big concern for communities like us is the restoration of insurance. It's an issue at government level with the insurance federation that they are very slow to restore full or even partial cover until such time as the risk is gone. What really copper fastens our mandate from the 230 businesses and residents is that practically none of them [can] get insurance so that's what's driving us."

"Because we don't have flood insurance the value of our properties are worth nothing."

Conflicts mainly arose due to a lack of political support at local level, such as lack of transparency and consultation in public decision making processes. In Clontarf, a lack of transparency and consultation was frequently cited by interviewees as a primary reason why the community refused to support multi-functional flood defences in the community. Consequently, unanimous community opposition resulted in a favourable community outcome. This case study highlighted the barriers that exist when flood risk management strategies are contentious at a local level.

5. Discussion and conclusion

In this paper, we outline the barriers and drivers that hinder or encourage societal transformation in natural hazard management in seven case studies in three European countries (Austria, France and Ireland). The starting point of transformation can be both unexpected/unintended or a deliberate result (Folke et al. 2010; O'Brien 2011). Across many of the case studies, the results showed that transformation was deliberate as it was started and initiated by local stakeholders, with the exception of Clontarf (Ireland). The main reason was that adaptation was necessary as a response to the challenges of future development at the local level (O'Brien 2016). Key drivers in encouraging societal transformation were mainly initiated by local citizens who proposed the idea (Hegger et al. 2017). Drivers of societal transformation were influenced by a range of factors including political, social/cultural, physical, technological and financial resources. On the other hand, key barriers to empowering societal transformation emerged from stakeholders (such as regional or national politicians) other than those who proposed the initial idea. Similar to drivers, we identified key barriers that occurred in the understanding or planning phases of the project and which were influenced by a range of factors, such as political, social/cultural pressure, unclear property rights, and lack of social capacities at the local level.

Our results show that societal transformations are highly context-specific, but show strong overlaps between the different cases. Multi-functional natural hazard protection, for example, can be transformative for natural hazard management governance structures, but it can also be transformative for communities involved. We found that demands for transformation arise from issues including: (1) lack of funding, legal protection and space, (2) communities demanding increased input into planning/implementation, and (3) blurred boundaries between public and private spaces and responsibilities. Moreover, some attempts at multi-functional approaches failed, such as in Skibbereen (Ireland) because the dominant voice of the local community voted for a classical engineered natural hazard management strategy (given the dominant influence of insurance) rather than for a multi-functional innovative solution. If access to land was not an issue, new innovative adaptation strategies might not be realised by community and government. Critical however is the understanding phase which starts with co-operation with communities. If the understanding and planning phases cannot encourage a societal transformation process, transformation will fail to materialise from the beginning. Where barriers were overcome in the understanding and planning phases within the case studies, the likelihood of successful implementation and management of the transformation project increased.

In all the case studies, the results show that the challenges of natural hazard management in the community are often associated with other societal pressures that are driven by local stakeholders. For instance, in the case study of Le Mans (France), changing natural hazard dynamics, in tandem with a desire for better urban environments facilitating community wellbeing were key motivating factors. Deprived areas (like in Le Mans (France)) that are often (historically) linked with few greenspaces for sport, recreation and leisure, were successful in disrupting the traditional approaches of natural hazard management, resulting in two urban environments that are leading the way in community-led multi-functional natural hazard schemes. We found that multi-functional protection schemes provide multiple benefits through reducing pressure on limited land and thus mitigation of land-use conflicts. These new solutions can also offer new financial resources for providing and maintaining natural hazard protection schemes to complement scarce public finances (Handmer 2008; Thaler and Priest 2014; Thistlethwaite and Henstra 2017).

Across most of the case studies, attempts at transformation were undertaken during a window of opportunity, typically after the occurrence of a major hazard event. For example, in the Austrian case studies of Galtür and Pfunds societal transformation was heavily driven by recent events in 1999 and 2005, respectively; similarly, in Le Mans and Angers (France), attempts for change commenced following inundation in 1995. In cases where a window of opportunity did not exist (e.g. Clontarf, Ireland), attempts for societal transformation were stifled by conflicts between the government and the communities.

The role that each of the communities across the case studies played in influencing the outcomes provides important lessons for managing adaptation, particularly so as climate change is likely to compound the need for greater adaptation at various scales. The window of opportunity encouraged successful societal transformation processes only

when key individuals or groups of activists acted as a policy entrepreneur with the political will to change the current system, such as in the case of Galtür (Austria) where this role was initiated by the local community or in Pfunds (Austria) where this role was assumed by the local mayor.

Further, a central role in all cases was community engagement. However, our results showed that 'community-based' initiatives are still dominated by local governments (municipalities) as the key actors, initiators and decision-makers as was evident in the Austrian, French and Irish case studies. This can be explained by differences in social capacities within the community, and by differences in facilitation from the side of the local governments (Thaler and Levin-Keitel 2016). Therefore, success at societal transformation heavily depends on the current institutional framework, which either allows or hinders deep public engagement. In particular, to facilitate transformation, the institutional framework needs to allow communities to engage in planning from the outset and in meaningful ways. Such engagement facilitates renegotiation of existing social contracts between governments' facilitation and private-individual responsibility (O'Brien et al. 2009b; Adger et al. 2013; Mees 2017). Thus, effective deliberate transformation should prioritise ways to increase community' participation beyond consultation and information-sharing towards co-creation of solutions.

Transformative natural hazard management therefore demands a stronger position of local stakeholders in the decision-making process. However, the actual political strategy in the different European countries was more aligned with a top-down approach with limited engagement of stakeholders beyond presentation of final plans at the end of decision making processes. Across the case studies, where transformation occurs local stakeholders demand a say in influencing discussions from the outset. However, the results show that only some local stakeholders have the capacity to effect such outcomes (Talley et al. 2016).

Our results highlight that various conditions, often locally contingent, can act as a barrier to or enable societal transformation. This raises questions as to how transformation at local scales can be upscaled to effect lasting change at higher levels or the role of the state in the current complex and fragmented political situation (Duit et al. 2016; Patterson et al. 2018). To upscale societal transformation requires extensive change of the current institutional settings within society. This change includes all subsystems, such as the legal framework, administrative practices as well as institutional frameworks, including norms and individual behaviours. These modifications within the system might evolve interdependently, but may also take time as institutions are established based on long-term perspectives (Turnpenny et al. 2008). Our results show societal transformation at local scale, but not an extensive change of the current institutional framework at national or European scales. Transformation is happening but it remains the exception rather than the rule.

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