



# Revisiter la tempête de Xynthia et les inondations côtières en France : explorer les vulnérabilités aux risques des catastrophes et l'attribution de la responsabilité pour les conséquences

Ariadna Anisimov

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# Exploring vulnerability to disaster risks and attributing responsibilities for the consequences: Revisiting the Xynthia storm coastal floods and public trial in France

Thèse de doctorat de l'Institut Polytechnique de Paris  
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## Abstract

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The thesis revisits the Xynthia storm disaster in February 2010 and the public trial that followed in 2014 to explore i) vulnerability to the risk of coastal flooding in the municipality of La Faute-sur-Mer (Atlantic coast of France) and ii) the process of attributing responsibility for the consequences of the disaster. A case study analysis identifies risk governance gaps that have shaped vulnerability conditions in the commune. It investigates the relationships between these dynamic components of vulnerability linked to various social and institutional arrangements within a decentralized risk governance structure in France. This first analysis provides an important basis for examining the second research theme on the attribution of responsibility for the consequences of the disaster, in particular regarding the loss of life. This second analysis focuses on the public trial that took place in 2014, where local authorities were charged with involuntary homicide for the deaths of 29 residents who drowned from coastal flooding in their homes in La Faute-sur-Mer. Based on the court proceedings and the evolution of the case study between 2014 and 2017, the analysis sheds light on issues confronted by the legal process to define and attribute responsibility to individuals for the consequences of disasters that involve a natural hazard. These two research themes on i) the history of vulnerability associated with weaknesses in risk governance arrangements and (ii) the attribution of responsibility for the consequences of disasters, are informed by an analytical framework on the social, institutional and organizational processes that shape vulnerabilities and risk-responsibility relationships presented in a literature review. Finally, the thesis discusses findings from the case study analysis and proposes research opportunities on forward looking approaches to reduce disaster risks and the integration of responsibilities in these tools as part of participatory disaster risk governance frameworks.

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## Acronyms

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ASVL	l'Association Syndicale de la Vallée du Lay
AVIF	Association des Victimes des Inondations de la Faute et ses environs
Cat Nat	Le régime d'assurance en France pour la Catastrophe Naturelle
CCR	Caisse Centrale de Réassurance
DDE	Directions Départementales de l'Équipement
DDTM	Départementales Des Territoires
DGPR	Direction Générale de la Prévention des Risques
DGSCGC	Direction Générale de la Sécurité Civile et de la Gestion des Crises
DICRIM	le Document d'Information Communal sur les Risques Majeurs
EUFD	European Union Floods Directive
EUSF	European Solidarity Fund
FFSA	La Fédération Française de l'Assurance
FPRNM	Fonds de Prévention des Risques Naturels Majeurs
FRM	Flood Risk Management
GEMA	le Groupement des Entreprises Mutuelles d'Assurance
GEMAPI	Gestion des milieux aquatiques et prévention des inondations
MEDDE	Ministère de l'Écologie, du Développement Durable et de l'Énergie
MEEDDM	Ministère de l'Écologie, de l'Énergie, du Développement durable et de la Mer
MTES	Ministère de la Transition Écologique et Solidaire
NATECH	Natural Hazard Triggering Technological Disasters
NFIP	National Flood Insurance Program
ONRN	Observatoire National des Risques Naturels
PAPI	Les Programmes d'Actions de Prévention des risques liés aux Inondations
PCS	Le Plan Communal de Sauvegarde
PGRI	Plan de Gestion des Risques d'Inondation
PLU	Le Plan Local d'Urbanisme
POS	Le Plan d'Occupation des Sols
PPR	Plan Prévention des Risques
PPRI	Plan Prévention des Risques des Inondations
PPRL	Plan Prévention des Risques Littoraux
PSR	Plan Submersion Marine



## Resumé en Français

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### Contexte de la recherche

Le risque de catastrophes est un sujet important dans le domaine de la science et de la recherche, c'est un domaine clé pour les décideurs politiques, les gouvernements, les organisations humanitaires et les entreprises (Aitsi-Selmi et al., 2015; Kelman, Mercer, & Gaillard, 2017; Paton & Johnston, 2017). En effet, les événements à grande échelle déclenchés par divers risques naturels tels que les inondations, les tremblements de terre, les tempêtes tropicales et autres causent des pertes et des dommages, perturbent des vies et mettent à l'épreuve les capacités des sociétés, des entreprises, des services essentiels et des gouvernements à anticiper, à se préparer, à faire face et à se rétablir. C'est pourquoi la réduction et la gestion des risques de catastrophes constituent un domaine prioritaire pour de nombreux pays dans leurs programmes de protection civile, leurs plans de développement durable et leurs stratégies de renforcement de la résilience (McBean, 2012; OCDE, 2017). Ces motivations sont représentées dans les dialogues politiques internationaux tels que le Cadre de Sendai pour la réduction des risques de catastrophes 2015-2030 (Wahlstrom, 2015). En outre, les risques de catastrophes font l'objet d'une attention croissante dans la planification et la mise en œuvre de l'adaptation au changement climatique, car l'augmentation des températures et du niveau de la mer exacerbent les extrêmes climatiques (tempêtes tropicales, sécheresses, par exemple) et les risques côtiers (inondations, marées côtières) (IPCC, 2012; Stott et al., 2015; Hoegh-Guldberg et al., 2018; Magnan et al., 2019). Les catastrophes récurrentes préoccupent les responsables politiques, car les progrès réalisés dans la littérature scientifique sur les risques environnementaux, la gouvernance des risques, la résilience des communautés et la culture du risque, le rôle des instruments des marchés financiers (réassurance, obligations) et la réflexion sur la résilience des systèmes permettent de mieux comprendre la conception d'outils efficaces de planification de la gestion et de la réduction des risques de catastrophes et leur mise

en œuvre (Aldrich, 2017; Barquet & Cumiskey, 2018; Djalante, Holley, Thomalla, & Carnegie, 2013; Rammig et al., 2020).

La littérature scientifique sur les catastrophes permet de comprendre les risques environnementaux, la durée et l'ampleur des impacts (locaux, régionaux, nationaux et transfrontaliers) et les conditions qui rendent un lieu plus vulnérable et plus susceptible (Alexander, 1993). Les travaux pionniers des années 1990 ont jeté des bases importantes pour la recherche sur les risques de catastrophes, notamment en clarifiant la relation entre l'aléa, la vulnérabilité et le risque (Cannon, 1993; Cutter, 1996; Quarantelli, 1995) pour définir 'ce qu'est une catastrophe' (Perry, 2007; Kelman, 2011). Ces premiers travaux ont été le fer de lance de la recherche sur la vulnérabilité en cas de catastrophe et ont encouragé une approche pluridisciplinaire pour identifier et caractériser les facteurs qui contribuent aux conditions de vulnérabilité dans les processus sociaux, institutionnels, de gestion, politiques et économiques (Cardona, 2003; Cutter, Boruff et Shirley, 2003; Kates, Pandey et Okazaki, 2005; Colten, Laska et Leatherman, 2006; Colten, 2009; Pidot, 2013; Cannon et Schipper, 2014). La littérature traite de ces facteurs comme des 'drivers of risk' (Cardona et al., 2012) et inclut des questions liées à de mauvaises politiques de planification, aux lacunes des régimes d'assurance, aux effets secondaires des infrastructures de réduction des risques telles que les digues sur la perception des risques, et à d'autres activités qui perturbent le fonctionnement des écosystèmes telles que le développement des marais et des estuaires qui sont des éponges importantes pour réduire les risques d'inondation (Colten, 2006; Kunreuther & Useem, 2009; Duvat & Magnan, 2014). Des composantes de la vulnérabilité et des ensembles d'indicateurs pour l'analyse ont été identifiés et proposés, fournissant différents cadres pour l'analyse des catastrophes (Birkmann, 2007; Papathoma-Köhle, Cristofari, Wenk, & Fuchs, 2019).

Comme certains types de catastrophes sont récurrents, tels que les phénomènes météorologiques extrêmes saisonniers, ils offrent la possibilité d'étudier leur occurrence et les conditions qui ont déterminé l'ampleur de l'impact afin d'anticiper et de préparer les événements futurs. Compte tenu de cette riche base d'évaluation de la vulnérabilité pour comprendre les risques de catastrophes, il est intéressant de

procéder à une analyse approfondie des études de cas afin d'explorer les facteurs contextuels qui façonnent les vulnérabilités locales (Duvat & Magnan, 2014). Ces connaissances spécifiques au contexte permettent de déterminer comment la vulnérabilité est façonnée dans les différentes communautés face à différents types de risques. Comme la vulnérabilité est considérée comme dépendant de plusieurs facteurs dans le temps, les dépendances de trajectoire jouent un rôle important dans la compréhension des facteurs de risque, y compris les types d'interventions qui ont augmenté l'exposition et la vulnérabilité (Duvat et al., 2017). L'exploration de cette complexité et de la relation entre les facteurs (sociaux, économiques, institutionnels, culturels) peut contribuer à la mise en place de dispositifs appropriés de gouvernance des risques.

Dans la littérature, la gouvernance des risques fait référence aux lois, à la législation, aux processus décisionnels, aux acteurs et à l'expertise dans la conception et la mise en œuvre des politiques de gestion des risques de catastrophes (Renn, 2008; Renn & Schweizer, 2009; Parsons et al., 2016). Alors que les études précédentes sur la gouvernance des risques examinent les dispositions importantes pour une réduction efficace des risques de catastrophes et la préparation aux catastrophes (Thaler & Levin-Keitel, 2016; OCDE, 2017), y compris l'importance de la participation communautaire pour des sociétés plus résilientes (Hansford, 2011; Hunt, 2016), il est intéressant d'identifier comment les différents pays conçoivent leurs structures de gouvernance des risques et quels sont les défis et les limites qui se posent pour gérer et réduire les risques de catastrophes. Des recherches approfondies peuvent révéler des leviers et des obstacles au soutien de la réduction des risques de catastrophes qui sont propres au contexte d'un lieu ou même d'un type d'aléa.

Outre ce premier intérêt pour la recherche sur les risques de catastrophes, des études émergent sur la manière de déterminer la responsabilité des conséquences des catastrophes (Pellizzoni, 2004; Lauta, 2014). En particulier, la recherche explore les types d'outils juridiques, de régimes d'indemnisation et de secours disponibles pour les victimes (Lauta, 2018). Les catastrophes impliquant un risque naturel sont de plus souvent traitées et étudiées comme des accidents industriels à

grande échelle, dans lesquels les individus sont reconnus coupables de négligence ou d'erreur, et des procès sont utilisés pour déterminer les responsabilités (Cocco et al., 2015; Dodds, 2015; Benadusi & Revet, 2016). Parmi les exemples de catastrophes qui ont entraîné la condamnation d'individus, on peut citer le procès de L'Aquila en 2010 pour le tremblement de terre survenu en Italie en 2009 et le procès public de la tempête Xynthia en 2014 pour les inondations côtières en 2010 (Alexander, 2014; Cartlidge, 2015; Quenault, 2015; Benadusi & Revet, 2016). Ces procès ont attribué la responsabilité des conséquences de la catastrophe, en particulier des pertes humaines, à des fonctionnaires et élus locaux, et visaient parallèlement à rétablir la responsabilité dans le cadre de la gouvernance des risques. Si le premier motif est de fournir une sorte de secours aux victimes (Miyazawa, 2015), le second révèle un paysage complexe où l'attribution des responsabilités peut être répartie entre de nombreux acteurs impliqués dans des cadres de gouvernance participative.

Lorsqu'une catastrophe survient, la question de l'efficacité des mesures de réduction des risques se pose et de savoir qui doit être tenu responsable des échecs, des erreurs ou de la mauvaise gestion du risque (Dodds, 2015). La relation entre le risque et la responsabilité est intégrée dans des structures de gouvernance du risque (Giddens, 1999; Kermisch, 2010) représentés dans les mesures de *accountability* et *liability* (les régimes de compensation) (Bovens, 2007b; Janssen, Van Der Voort, & Janssen, 2017; Mulgan, 2002b; Scarwell, 2017). Le premier (*accountability*) représente l'établissement de règles et de normes visant à garantir que les responsables ou les personnes auxquelles des responsabilités sont attribuées s'acquittent de leurs tâches (Dubnick, 2002), tandis que le second définit la responsabilité (*liability*) comme une compensation, en accordant de l'importance au rôle de l'assurance dans la littérature sur la gouvernance des risques pour le financement et le transfert des risques pour faire face aux dommages matériels (Ewald, 1991; Baker & Simon, 2002; Faure & Bruggeman, 2008). L'exploration de ces différents types de responsabilité peut aider à éclairer les méthodes d'attribution et à définir l'appropriation des risques dans les cadres de gouvernance des risques. En particulier, il existe des opportunités de recherche pour relever les défis

auxquels sont confrontés les procès publics quand ceux-ci traitent de la gestion des 'catastrophes naturelles'.

## Axes de recherche et questions

Compte tenu du contexte général de recherche présenté dans la section précédente, l'objectif de la thèse est d'étudier les risques de catastrophes en utilisant l'analyse passée et présente de la vulnérabilité dans un contexte local et de se demander comment une telle méthode peut aider à identifier les lacunes en matière de gouvernance et à éclairer l'attribution des responsabilités des conséquences d'une catastrophe. Deux questions de recherche encadrent la thèse :

- (1) Quelles sont les lacunes de gouvernance qui contribuent aux conditions de vulnérabilité ? Comment les composantes identifiées de la vulnérabilité interagissent-elles dans les systèmes complexes et expliquent-elles les conséquences des catastrophes ?
- (2) Comment et pourquoi la définition et l'attribution des responsabilités pour les conséquences des catastrophes évoluent-elles ? Quel est le rôle des procès publics pour attribuer la responsabilité de ce type d'événements (catastrophes impliquant un risque naturel) ?

Ces deux questions de recherche sont explorées à l'aide d'une approche par étude de cas. L'objectif de cette thèse est de revisiter la catastrophe de Xynthia en 2010 afin d'analyser la vulnérabilité d'une zone locale touchée par les catastrophes et d'explorer le processus d'attribution des responsabilités pour les conséquences.

L'étude de cas utilisée dans la thèse est la catastrophe de la tempête Xynthia qui a déclenché des inondations côtières en France le long de l'Atlantique occidental en 2010. Cette catastrophe a causé des dégâts importants en France et dans les pays voisins (European Parliament, 2010). Cependant, la recherche se concentre sur les conséquences à l'échelle locale : la commune de La Faute-sur-Mer où 29 victimes se sont noyées dans leurs maisons pendant la nuit de la tempête suite aux inondations côtières (Vinet, Defosse, Rey, & Boissier, 2012; Chauveau et al.,



2017). Par conséquent, la thèse se concentre sur le risque d'inondation et en particulier sur la vulnérabilité des zones côtières aux risques de catastrophe, qui est éclairée par la littérature (Merz, Thieken, & Gocht, 2007; Jha, Bloch, & Lamond, 2012; Vinet, 2018). Suite à la catastrophe, un procès public s'est ouvert en 2014 accusant les fonctionnaires locaux d'être responsables des décès. L'enquête a souligné l'incapacité des agents publics locaux à mettre en œuvre des politiques de gestion des risques d'inondation. En s'appuyant sur une analyse approfondie de cette étude de cas, les questions de recherche visent à comprendre les obstacles qui empêchent de réduire de façon ambitieuse les risques de catastrophes, malgré la mise en lumière, il y a 10 ans, que Xynthia a apporté aux conséquences des catastrophes (décès et dommages). Xynthia a également permis de comprendre la complexité du recours aux procédures juridiques pour attribuer les responsabilités, compte tenu des incertitudes entourant les risques de catastrophes.

La thèse utilise cette analyse d'étude de cas pour tester les relations entre les composantes dynamiques de la vulnérabilité découlant des caractéristiques socioculturelles d'un lieu et les arrangements institutionnels au sein d'une structure de gouvernance du risque à plusieurs niveaux. L'analyse vise donc à identifier les relations entre les lacunes en matière de gouvernance (mauvaises décisions d'aménagement du territoire et de développement dans les zones à risque, mise en œuvre de politiques de gestion des risques d'inondation au niveau local, culture du risque et régimes d'assurance pour les risques de catastrophe) qui entraînent des tendances de vulnérabilité dans le temps. En même temps, l'analyse des études de cas se concentre sur le procès public au lendemain de la catastrophe de 2014, afin d'explorer le processus de définition et d'attribution des responsabilités aux individus pour les conséquences des catastrophes qui impliquent un risque naturel. Ces deux thèmes de recherche sont enrichis par un cadre analytique sur les processus institutionnels et organisationnels qui façonnent la vulnérabilité et les relations entre risques et responsabilités, qui est présenté dans une revue de la littérature (chapitre 3).

Cette recherche axée sur l'étude de cas Xynthia propose des réflexions sur le cadre de gouvernance des risques en France pour faire face aux risques de catastrophes,

qui s'est développé depuis les années 1980 et continue à être renouvelé et ajusté. Un tel cadre, avec des politiques, des outils de planification et un système d'assurance et de réassurance pertinents, a été conçu pour répondre aux niveaux élevés d'exposition et de vulnérabilité des communautés à une série de risques. En particulier, les risques côtiers sont critiques car le littoral français est un espace de développement attractif depuis les années 1960 pour les résidences secondaires et continue à faire face aux pressions du développement urbain. D'ici la fin du siècle, on prévoit que 5 000 à 50 000 maisons, certains grands ports et quelques grandes villes se trouveront dans des zones à haut risque de risque côtier et de catastrophes climatiques telles que les tempêtes comme Xynthia (voir : Madelenat, 2019). Si les dunes, la flore, la faune, les plages et les falaises se déplacent naturellement, la combinaison de stratégies de réduction des risques et l'étalement urbain accru au fil du temps ont conduit à des conditions de grande vulnérabilité, qui sont étudiées dans l'histoire de la vulnérabilité de la commune de La Faute-sur-Mer. Comme le montre l'étude de cas, les mesures structurelles telles que les digues et les murs maritimes ont été mal entretenus, cela représente un enjeu important dans la gouvernance de la gestion des risques de catastrophes en France. Par conséquent, le matériel de l'étude de cas vise à s'inspirer des travaux précédents et à fournir un aperçu des lacunes dans la gouvernance des risques en utilisant une analyse à l'échelle locale (Genovese, Przyluski, & Hallegatte, 2012; Elisabetta Genovese & Przyluski, 2013).

Un autre axe de recherche porte sur la responsabilité lors d'une catastrophe. Il y a une question sur la façon de définir et d'attribuer la responsabilité, lorsque la vulnérabilité est sujette à des *path dependencies* et à des lacunes de gouvernance au fil du temps. Jusqu'à présent, la définition de l' 'appropriation du risque' en France est vague et répartie entre de multiples entités, notamment le niveau du gouvernement central dans le processus de formulation des politiques et la conception des instruments de financement (divers outils de planification de la prévention et le partenariat public-privé en matière d'assurance et de réassurance), un *patchwork* de partenariats, d'associations et autres qui gèrent les infrastructures de risque d'inondation (digues, murs) et le niveau local pour la mise en œuvre. Ce

contexte a été abordé lors du procès public, où les autorités locales ont été reconnues coupables d'avoir développé des zones urbaines à risque à La Faute-sur-Mer. Cependant, la thèse explore le procès public, les motivations du verdict et les acteurs impliqués. Plusieurs évolutions autour des enquêtes testent la base de preuves autour de *la négligence* en raison des incertitudes lors de la gestion d'événements à risque de catastrophe impliquant un risque naturel.

En conclusion, la recherche se concentre sur la vulnérabilité aux risques de catastrophes, en particulier sur l'analyse du passé et l'explication des facteurs de risque causés par les lacunes de la gouvernance. Ce premier axe soutient la deuxième question sur la manière dont la responsabilité de ces événements est attribuée et les défis auxquels l'on est confronté lorsqu'on traite des catastrophes dans les procès. Ces deux thèmes sont éclairés par une étude de cas sur les conséquences locales de la tempête Xynthia et des submersions marines à La Faute-sur-Mer et par le procès public dans le cadre institutionnel de la gouvernance des risques de catastrophes et d'inondations en France.

## Méthode de recherche

La thèse évalue l'évolution de la vulnérabilité de la commune de La Faute-sur-Mer en retraçant l'histoire du développement de la zone et les évolutions du cadre de gestion des risques de catastrophes en France. Pour trouver les relations entre les deux, une enquête approfondie a été menée sur l'histoire de la gouvernance des risques de catastrophes en France et sur les tendances démographiques et urbaines de la commune. Tout d'abord, une revue des études et rapports scientifiques existants a été faite sur la catastrophe et le procès de Xynthia. Ensuite, une recherche documentaire a été effectuée sur les lois, les politiques et les rapports gouvernementaux relatifs à la réduction des risques de catastrophes depuis les années 1980 afin d'aider à identifier les principaux instruments de planification et les institutions impliquées dans l'élaboration et la mise en œuvre des politiques. L'objectif de cet exercice était de fournir une compréhension complète des dispositions de gouvernance des risques spécifiques à la France. Plus précisément,

un intérêt a été porté aux mécanismes de coordination des politiques au niveau national et à sa mise en œuvre au niveau local dans un cadre décentralisé dans le cadre de la gestion des risques d'inondation. La plupart des documents et rapports politiques étaient accessibles sur les sites web du gouvernement, tandis que d'autres ont été obtenus lors de visites sur le terrain et d'entretiens avec les parties prenantes. Pour étayer l'étude de localisation, des cartes historiques, des études techniques et des cartes de risques ont été fournies par le conseil municipal. En outre, des entretiens avec la population locale et la municipalité ont été réalisés afin de comprendre en profondeur l'histoire du développement et la culture de la commune.

Des entretiens semi-structurés ont été réalisés entre septembre 2013 et mars 2017 avec les acteurs publics et privés concernés par la gestion des risques de catastrophes en France. Il s'agit notamment de personnes travaillant dans des agences gouvernementales, à la mairie de La Faute-sur-Mer, dans des compagnies d'assurance et chez les habitants de la commune. Ces entretiens ont permis de recueillir des informations sur trois sujets principaux: (i) les modalités de gouvernance pour la réduction des risques de catastrophe, (ii) le rôle des différentes institutions, et (iii) l'histoire du développement et de la gestion des risques d'inondation dans la commune. Les informations obtenues lors des entretiens avec les parties prenantes ont été comparées à des recherches documentaires, afin de permettre l'identification des lacunes en matière de gouvernance et des facteurs qui ont conduit à des niveaux d'exposition et de vulnérabilité plus élevés dans la commune. Des discussions informelles avec la population locale de la commune ont permis de saisir la perception des risques et l'expérience acquise lors de la catastrophe ou d'autres événements.

Enfin, une source importante d'informations a été le travail de terrain et l'observation du procès public en 2014. Le travail de terrain a permis d'analyser l'étude du site et d'interagir avec la population locale. Les observations du procès ont permis d'obtenir des informations sur la structure de gouvernance des risques, les rôles et responsabilités des différents acteurs publics (dans une gouvernance multi-niveaux) et les dynamiques locales dans la commune avant et après la

catastrophe. Pour tenir compte de toutes les audiences, une analyse a été effectuée sur la transcription complète du procès disponible en ligne. Cette source a fourni des informations complètes sur l'étude de cas compte tenu de la vue d'ensemble approfondie des preuves utilisées pour motiver le verdict dans le procès.

## Résultats et opportunités de recherche

La présente thèse a été conçue pour étudier la vulnérabilité aux catastrophes. En particulier, l'analyse de l'étude de cas de la tempête Xynthia a exploré les lacunes de gouvernance qui ont conduit à des conditions d'exposition et de vulnérabilité plus élevées, autrement appelées dans la littérature 'facteurs de risque' (*drivers of risk*) (Cardona et al., 2012). Le concept de vulnérabilité est présenté dans une revue de la littérature. Les travaux pionniers des années 2000 aident à identifier les composantes de l'écosystème, de l'environnement construit et du contexte socio-économique dans les cadres de gouvernance des risques qui contribuent à des niveaux de vulnérabilité plus élevés. L'analyse montre également comment d'autres facteurs jouent un rôle dans la formation de la vulnérabilité au fil du temps, tels que le comportement, la perception du risque (la notion du *culture du risque*) et les données démographiques, complétant ainsi les conclusions d'autres études sur la vulnérabilité (Burby, 2006; Cutter, 2006; Meur-Férec, Flanquart, Hellequin et Rulleau, 2010). Les résultats de cette enquête complètent ceux d'études antérieures sur l'identification et la caractérisation des différents facteurs de risque.

Les lacunes en matière de gouvernance dans l'étude de cas mettent en lumière les retards dans la planification urbaine fondée sur la connaissance des risques et, plus généralement, la complexité du paysage politique de la gestion des risques et de la planification urbaine, qui est dirigé par le gouvernement central et dont la mise en œuvre au niveau local est lente. Cela met en lumière les problèmes potentiels des structures de gouvernance décentralisées. En France, l'élaboration de la politique de gestion des risques est dirigée au niveau central et repose sur une chaîne de prise de décision à travers une structure administrative à plusieurs niveaux pour une planification et une mise en œuvre décentralisées. Il existe différents ensembles de

responsabilités au sein de cette structure de gouvernance à plusieurs niveaux, où les mécanismes de communication et de coordination sont importants pour l'efficacité. La participation a été une force motrice dans le renforcement de la résilience ces dernières années afin de créer une appropriation du risque par les parties prenantes (locales, associations, secteur privé, communauté). Si des mécanismes ascendants sont en place, comme dans le cas de la planification urbaine - où le Plan local d'urbanisme (PLU) est décidé par la municipalité - des tensions apparaissent entre les réglementations de l'État central et les intérêts locaux. En outre, les politiques de l'État central en matière de risques (Plan de prévention des risques d'inondations (PPRI) et autres, comme le Plan de prévention des risques littoraux (PPRL) et plus généralement le Plan de prévention des risques (PPRN) ont la priorité, ce qui remet en question le pouvoir de décision des municipalités en matière d'urbanisme.

L'importance du PPRI est examinée en détail dans l'analyse de l'étude de cas en tant que principal document réglementant le développement urbain dans les zones à risque d'inondation. Cependant, les acteurs locaux ont tendance à considérer cette politique prescriptive comme une pression de l'État central qui remet en cause d'autres intérêts, notamment parce que le zonage des risques limite le développement. Par conséquent, l'analyse met en lumière les risques d'une gouvernance décentralisée des risques et les défis des compromis dans la gestion des risques. Une priorité pour une réduction efficace des risques de catastrophes repose sur la coordination entre les dispositifs descendants et ascendants. Elle renforce l'idée, dans la littérature, que l'acceptabilité et le consensus des parties prenantes constituent le fondement d'une gestion efficace des risques (Cinner & Barnes, 2019; Losada et al., 2019).

Dans ce cadre de gouvernance participative, l'analyse explore la signification de la culture du risque, qui fait référence à la perception du risque par la communauté locale et à son engagement dans la gestion du risque pour réduire la vulnérabilité. La culture du risque est un élément central des stratégies de gestion des risques en France, en particulier dans le domaine de la gestion des risques naturels, car elle entoure l'importance de la sensibilisation, de la transparence de l'information et des canaux communautaires dans le renforcement de la résilience des systèmes sociaux

et naturels. Les associations des collectivités territoriales soulignent le rôle de la culture du risque pour se préparer à vivre avec le risque d'inondation, en formulant le message principal 'Vivre avec les inondations' et développer la culture du risque et repenser nos espaces' (France Nature Environnement, 2018).

L'analyse accorde une attention particulière à la notion de culture du risque et l'examine en termes de démographie, ce qui est souvent suggéré comme une caractéristique de la vulnérabilité sociale aux catastrophes dans la littérature. Bien que les données raciales ou socio-économiques ne soient pas mises en évidence, les entretiens sur le terrain permettent de révéler les problèmes liés au taux de rotation élevé qui caractérise les communautés côtières et qui entraîne une perte de mémoire du risque. En particulier, les obstacles à la construction d'une culture du risque sont expliqués par le fait qu'une majorité de la population possède des résidences secondaires utilisées pour les périodes de vacances d'été, ce qui ne suscite que peu d'intérêt ou de sensibilisation au risque de cyclones hivernaux ou à la participation de la communauté aux politiques de gestion des risques d'inondation (comme la consultation publique du PPRI). Au contraire, les habitants qui vivent dans la commune toute l'année sont pour la plupart retraités, ce qui est souvent considéré comme un segment de la population plus vulnérable aux catastrophes dans la littérature (Ngo, 2001). Les principaux résultats montrent que la démographie au sein de la commune contribue à un manque de culture du risque parce qu'il n'y avait pas de participation dans la gestion des risques d'inondation au niveau local. En plus, cela entraîne des lacunes dans le partage des informations (par exemple, raconter des histoires au fil du temps comme dans les communautés des bassins fluviaux) qui soutiennent la connaissance du risque, en tant que partie inhérente à la construction d'une culture du risque. La thèse confirme l'importance de la culture du risque, en termes de problèmes de manque de sensibilisation aux risques et de préparation aux catastrophes, où les processus d'apprentissage (par exemple les expériences des catastrophes et l'apprentissage itératif) sont des facteurs clés contribuant à la vulnérabilité. Ces résultats complètent d'études sur le rôle du capital social, de la culture et de la tradition dans la réduction de la vulnérabilité et l'adaptation au changement climatique (Aldrich & Meyer, 2015).

Les résultats de la thèse donnent un aperçu de l'importance des mécanismes d'assurance dans la gouvernance de la gestion des risques de catastrophes en analysant le système français Cat Nat dans l'étude de cas. Alors que le principe de solidarité qui a façonné le système Cat Nat a permis de surmonter plusieurs obstacles rencontrés par les dispositifs d'assurance contre les risques de catastrophes (parmi les options proposées par le privé, le public ou par le biais de partenariats), comme le montrent les ouvrages spécialisés (par exemple, Kunreuther, 1984; Crichton, 2008; Paudel, 2012; OCDE, 2015), on peut se demander comment ce dispositif en France construit ou limite les incitations, en particulier en matière de financement de la prévention (c'est-à-dire la prise en compte du risque d'aléa moral). Cela s'explique par le fait que l'assurance contre les risques de catastrophes est obligatoire et associée à une série d'aléas tels que l'incendie, ce qui crée un coussin de risque diversifié, une forte pénétration et un mécanisme efficace de compensation des dommages matériels. Cependant, on peut s'interroger sur le rôle des assureurs, car il n'existe pas de véritable marché et il y a un risque de manque d'incitations fiscales à investir dans la prévention entre les parties prenantes, ce qui est décrit comme un *aléa moral systémique* (voir Huber, 2002). Ces observations soulèvent des questions sur la nature des différents dispositifs d'assurance contre les catastrophes, en particulier le rôle de l'État et du secteur privé, et sur la manière de mettre en place des dispositifs de gouvernance qui inciteront systématiquement les parties prenantes à s'engager dans des activités de réduction des risques (à court terme et planifier sur le long terme).

Le rôle de l'assurance dans la gestion des risques de catastrophes continuera d'être important, en particulier avec les questions cruciales sur i) qui a la responsabilité d'investir dans la prévention ? et ii) qui devrait fournir une indemnisation après une catastrophe ? Ces questions sont de plus en plus fréquentes, et touchent une question clé sur la demande croissante de responsabilité; étant adressée à des entreprises privées, comme la compagnie d'énergie (Pacific Gas and Electricity) en Californie, qui doit assumer la responsabilité du vieillissement des réseaux de distribution qui ont déclenché des incendies majeurs et ont causé de nombreuses victimes.



Cette conception rétrospective de l'étude de la vulnérabilité aux catastrophes vient s'ajouter au corpus de recherche sur les dispositifs de 'bonne gouvernance' pour une gestion et une réduction efficaces des risques de catastrophes. Les études de cas approfondies sont précieuses pour mieux identifier les facteurs de risques spécifiques au contexte et leurs interactions (en terme d'approche systemique) afin d'élaborer des outils politiques appropriés. Dans la mesure où la thèse montre l'importance d'utiliser l'histoire des risques et de la vulnérabilité en fonction du contexte, il convient d'être prudent dans la promotion d'une approche ou de principes de gouvernance uniques pour tenir compte des divers contextes culturels et traditionnels contre divers types de risques naturels.

L'analyse de la vulnérabilité donne un aperçu de l'importance des lacunes de gouvernance en tant que facteurs de risque dans le temps, ce qui permet de passer en revue les avantages et les limites des structures décentralisées de gouvernance des risques, comme c'est le cas en France. Cette méthode rétrospective d'étude de la vulnérabilité est une approche traditionnelle et a été appliquée à plusieurs autres catastrophes, comme l'ouragan Katrina (Nouvelles Orleans) et la triple catastrophe de Fukushima (voir Duvat & Magnan, 2014). Par conséquent, l'objectif de cette analyse est de fournir une base pour le deuxième thème de recherche sur la responsabilité. Le suivi de la vulnérabilité dans le temps aide à comprendre l'évolution de la définition et de l'attribution des responsabilités pour les conséquences des catastrophes, car il montre qu'il existe plusieurs relations risque-responsabilité intégrées dans les cadres de gouvernance des risques. Toutefois, les résultats de cette analyse concluent que la responsabilité finale des risques de catastrophes tend à s'étendre. Cela s'explique par l'absence d'instruments juridiques et de responsabilisation permettant d'attribuer systématiquement les responsabilités pour ces événements. Par conséquent, si le suivi de la vulnérabilité en fonction des lacunes de gouvernance est une méthodologie solide pour étudier les catastrophes, comme l'explore la thèse, la notion de responsabilité comme élément central des régimes de gouvernance reste absente de ce processus. Comme l'a montré le procès Xynthia, alors que quelqu'un devrait être tenu responsable des conséquences des catastrophes, les stratégies de gouvernance des risques inclusives encadrées par 'la

construction de la résilience' présentent le potentiel de trop nombreuses lignes de responsabilités, où personne n'est légalement responsable à la fin.

Ces conclusions ouvrent des voies potentielles pour de nouvelles recherches sur les catastrophes. Tout d'abord, la recherche sur l'exploration de l'interaction dynamique entre les multiples composantes de la vulnérabilité dans les systèmes socio-écologiques complexes pourrait approfondir la manière dont ces interconnexions au fil du temps conduisent à des 'catastrophes organisées'. Cela signifie que, à l'instar des études sur les accidents dans les systèmes socio-techniques complexes (Pidgeon, 1997; Turner, 1994), la gouvernance de la gestion des risques de catastrophes devrait être suffisamment souple pour intégrer les erreurs normales, lorsqu'un certain degré de vulnérabilité est inhérent au système. Cela inspire davantage de recherches sur les méthodes prospectives, telles que la manière de renforcer la résilience et d'adapter les systèmes socio-écologiques dynamiques dans le temps, avec des intérêts émergents notables sur le rôle des capacités d'adaptation en tant que potentiel d'adaptation et la méthodologie de prise de décision des 'voies d'adaptation'. La question de savoir comment accroître la capacité d'adaptation face aux événements climatiques extrêmes est au cœur du lien entre la recherche sur l'adaptation au changement climatique et la réduction des risques de catastrophe. Ce domaine de recherche bénéficie d'une "analyse médico-légale" des catastrophes afin d'identifier les éléments de vulnérabilité qui peuvent contribuer à orienter les actions de réduction des risques à l'avenir dans le cadre de différents types de scénarios de réchauffement climatique. Ce premier axe de recherche est complété par un appel à la réalisation d'autres études sur la relation entre la gouvernance du renforcement de la résilience et les responsabilités en matière de risques entre de multiples acteurs. Les recherches futures devraient intégrer l'appropriation des risques dans les stratégies de réduction des risques à long terme, en clarifiant ces différents types de responsabilités. Le développement de cette recherche pourrait fournir des outils et des méthodes sur la manière dont les structures de gouvernance devraient être mieux équipées pour traiter systématiquement la responsabilité des catastrophes qui impliquent un risque naturel. En outre, la question se pose de

savoir comment des outils juridiques pourraient être développés pour traiter les catastrophes et assurer le fonds de soutien aux victimes.

## Schéma de la thèse

Les chapitres suivants traitent des questions de recherche présentées plus haut dans la section 'Axes de recherche et questions'. Le chapitre 2 fournit des informations générales sur l'étude de cas de la tempête Xynthia en 2010 (impact et conséquences à La Faute-sur-Mer) et le procès public qui a eu lieu en 2014. Le chapitre 3 passe en revue la littérature sur les risques de catastrophes, la vulnérabilité, la gouvernance des risques et les relations entre risques et responsabilités. Le chapitre 4 présente les méthodes de recherche utilisées pour la thèse, en particulier l'approche qualitative des études de cas et le processus de collecte des données. Le chapitre 5 présente l'analyse des tendances de la vulnérabilité à La Faute-sur-Mer à partir de cinq lacunes de gouvernance. En particulier, ce chapitre explore l'influence des différentes modalités de gouvernance, de l'échelle locale à l'échelle nationale, qui ont contribué aux conditions de vulnérabilité. Dans le chapitre 6, l'analyse de la vulnérabilité et des lacunes de gouvernance associées est utilisée pour dériver l'attribution de la responsabilité conformément au procès public qui a eu lieu de septembre à octobre 2014. Les résultats des chapitres 5 et 6 sont positionnés en s'appuyant sur le cadre analytique fourni par la revue de la littérature du chapitre 3. Enfin, les résultats combinés sont utilisés pour discuter des implications futures de la recherche, en particulier sur les méthodes de réduction des risques prospectives telles que l'approche des voies d'adaptation ainsi que des méthodes d'attribution. Les conclusions des résultats et les limites de la thèse sont présentées dans ce dernier chapitre 7.

## Chapter 1: General introduction

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## Research context

The risk of disasters is an important research field, and a key area for policy-makers, governments, humanitarian organizations and businesses (Aitsi-Selmi et al., 2015; Kelman, Mercer, & Gaillard, 2017; Paton & Johnston, 2017). This is because large-scale events triggered by various natural hazards such as floods, earthquakes, tropical storms and more, cause loss and damage, disrupt lives and test the capacities of societies, businesses, critical service operators and governments to anticipate, prepare, cope and recover. Therefore, disaster risk reduction and management is a priority area for many countries in their civil protection programs, sustainable development plans and strategies for building resilience (McBean, 2012; OECD, 2017). These motivations are represented in international policy dialogues, such as the Sendai Framework for Disaster Risk Reduction 2015-2030 (Wahlstrom, 2015). Moreover, disaster risks are drawing increasing attention in climate change adaptation planning and implementation, as rising temperatures and sea levels exacerbate climate extremes (e.g. tropical storms, drought) and coastal risks (flooding, coastal surge) (IPCC, 2012; Stott et al., 2015; Hoegh-Guldberg et al., 2018; Magnan et al., 2019). Reoccurring disaster events are a concern for policy-makers whereby advancements in the scientific literature on environmental hazards, risk governance, community resilience and risk culture, the role of financial market instruments (reinsurance, bonds) and systems resilience thinking provide insights on the effective design of disaster risk management and reduction planning tools and implementation (Aldrich, 2017; Barquet & Cumiskey, 2018; Djalante, Holley, Thomalla, & Carnegie, 2013; Rammig et al., 2020).

The scientific literature on disasters provides a comprehensive understanding of environmental hazards, the duration and scales of impacts (local, regional, national and across borders) and the conditions that make a place vulnerable and susceptible to harm (Alexander, 1993). Pioneering works from the 1990's set important foundations of disaster risk research, notably clarifying the relationship between hazard, vulnerability and risk (Cannon, 1993; Cutter, 1996; Quarantelli, 1995) to

define 'what is a disaster' (Perry, 2007; Kelman, 2011). These early works spearheaded the focus of disaster research on vulnerability and encouraged a multi-disciplinary approach to identify and characterize those factors that contribute to vulnerable conditions across social, institutional, managerial, political and economic processes (Cardona, 2003; Colten, 2009; Cutter, Boruff, & Shirley, 2003; Pandey & Okazaki, 2005; Kates, Colten, Laska, & Leatherman, 2006; Pidot, 2013; Cannon & Schipper, 2014). The literature discusses these as 'drivers of risk' (Cardona et al., 2012) and includes issues related to poor planning policies, gaps in insurance schemes, the side effects of risk reduction infrastructure such as levees on risk perception, activities that disrupt ecosystem functioning such as development on marshes and estuaries that are important sponges to reduce flood risk among other drivers (Colten, 2006; Kunreuther & Useem, 2009; Duvat & Magnan, 2014). Given this wide range of vulnerabilities, classifications and sets of indicators for analysis have been identified and proposed to frame such assessments (Birkmann, 2007; Papathoma-Köhle, Cristofari, Wenk, & Fuchs, 2019).

Given this rich basis to assessing vulnerability to disaster risks, there is interest for in depth case study analysis to explore context-specific drivers that shape local vulnerabilities (Duvat & Magnan, 2014). These context specific insights enable to identify how vulnerability is shaped across different geographies, communities and institutional contexts. As vulnerability is discussed as dependent on several factors over time, path dependencies play an important role in understanding the drivers of risk, including what kinds of interventions have increased exposure and vulnerability (Duvat et al., 2017). For example, the historic center of New Orleans and many parts of the greater area are below sea level and rely on a system of levees to reduce flood risk that are contingent on history of economic interests in the area, urban development and socio-economic trends (Pearcy & Colten, 2002; Colten, 2008). Hurricane Katrina exposed this stratification of low-income neighbourhoods in high flood risk areas. Exploring this complexity and the relationships between factors (social, economic, institutional, political), can help to

inform appropriate risk governance arrangements to reduce vulnerability to disaster risk and avoid those lock-in effects.

In the literature risk governance refers to the laws, legislation, decision-making processes, stakeholders and expertise involved in the design and implementation of disaster risk management policies (Renn, 2008; Renn & Schweizer, 2009; Parsons et al., 2016). While previous studies on risk governance discuss arrangements for effective disaster risk reduction and preparedness (Thaler & Levin-Keitel, 2016; OECD, 2017), including the importance of community participation for more resilient societies (Hansford, 2011; Hunt, 2016), there is interest to identify how different countries design their risk governance structures and the barriers to ambitious disaster risk reduction. In-depth research can reveal the levers and barriers for supporting disaster risk reduction that are context specific to a place or even a type of hazard. For example, within multi-level risk governance frameworks, the literature highlights the importance of coordination, information exchange, stakeholder acceptability, risk ownership and participation for effective disaster risk reduction (Nalau, Preston, & Maloney, 2015; Thaler & Levin-Keitel, 2016).

In addition to this first interest in disaster risk research on the trajectory of vulnerability over time and associated governance gaps, there are emerging studies on the responsibility for the consequences of disasters (Pellizzoni, 2004; Laut, 2014). In particular, research explores what kinds of legal tools, compensation schemes and relief is available to victims (Laut, 2018). This is because disaster events that involve a natural hazard are increasingly treated and investigated as large-scale industrial accidents, where individuals are found guilty of negligence or error, and trials determine responsibility (Cocco et al., 2015; Dodds, 2015; Benadusi & Revet, 2016). Examples of disasters that convicted individuals are the L'Aquila trial in 2010 for the earthquake in Italy that occurred in 2009 and the Xynthia storm public trial in 2014 for coastal floods in 2010 (Alexander, 2014; Cartledge, 2015; Quenault, 2015; Benadusi & Revet, 2016). These trials attributed responsibility to civil servants and functionaries for the consequences of the disaster, in particular human loss. In parallel, they aimed to re-establish

accountability in the risk governance framework. While the first motive is to provide some kind of relief to victims (Miyazawa, 2015), the second reveals a complex landscape where the attribution of responsibilities is spread across many actors involved in participatory governance frameworks.

When a disaster strikes, there arises a question about the effectiveness of risk reduction measures and who should be held responsible for failures or errors (Dodds, 2015). The relationship between risk and responsibility is embedded in risk governance frameworks (Giddens, 1999; Kermisch, 2010) represented in accountability measures and liability schemes (Bovens, 2007b; Janssen, Van Der Voort, & Janssen, 2017; Mulgan, 2002b; Scarwell, 2017). The former represents rule-setting and standards to ensure that those in charge, or who are allocated responsibilities, fulfill their tasks (Dubnick, 2002). The latter frames responsibility as compensation, giving importance to the role of insurance in the risk governance literature for financing and transferring risk to deal with the cost of material damages (Baker & Simon, 2002; Ewald, 1991; Faure & Bruggeman, 2008). Exploring these different types of responsibility can help inform methods of attribution and to define risk ownership within risk governance frameworks. In particular, there is room to address the challenges that public trials face on account of arguments of risk and uncertainties with treating disasters.

## Research questions

Given the general research context presented in the previous section, the focus of the thesis is to study disaster risks using past to present analysis of vulnerability in a local context and ask how such a method can help to identify governance gaps and inform the attribution of responsibility for the consequences of a disaster. Two research questions frame the thesis:



- (1) What are the governance gaps that contribute to vulnerable conditions?  
How do the identified components of vulnerability interact in complex systems and explain the consequences of disasters?
- (2) How and why does the definition and attribution of responsibilities for the consequences of disasters evolve? What is the role of trials to attribute responsibility for these kinds of events (disasters that involve a natural hazard)?

#### Research focus

The research questions presented in the previous section are inspired by case study material. The aim of the thesis is to use an analysis of a specific disaster event to inform 1) disaster risk governance gaps that contribute to vulnerability and 2) how responsibility is attributed to different actors for these events and the challenges confronted by legal processes due to uncertainties and risk surrounding disasters. The case study used to explore these themes in the thesis is the Xynthia storm disaster that triggered coastal flooding in France along the Western Atlantic in 2010. This disaster caused wide-spread damage in France and neighboring countries (European Parliament, 2010). However, the research focus is on local scale consequences in the commune La Faute-sur-Mer, where 29 victims drowned in their houses during the night of the storm from coastal flooding (Vinet, Defosse, Rey, & Boissier, 2012; Chauveau et al., 2017). Therefore, the focus of the thesis is on flood risk and particularly vulnerability of coastal communities to disaster risks, which is informed by the literature (Jha, Bloch, & Lamond, 2012; Merz, Thieken, & Gocht, 2007; Vinet, 2018).

In line with the second research interest on responsibility for disasters, the case study offers a critical reflection on the use of trials for such events. Following the disaster, a public trial commenced in 2014 accusing local public officials for responsibility of the 29 deaths. The trial investigated evidence against local public officials for failures to implement flood risk management policies such as building

in hazard prone areas and lack of maintenance of the local dike. Based on an in-depth analysis of this case study, the research questions aim to understand the obstacles that prevent ambitious disaster risk reduction, despite the consequences of the Xynthia storm. Xynthia also provided insight into the complexity of using legal procedures to assign responsibility, given the uncertainties surrounding disaster risk.

This research focus on the Xynthia case study provides reflections on the risk governance framework in France to address disaster risks. This framework has been developing since the 1980's and continues to evolve on account of challenges faced with environmental hazards, disaster risks and climate change. Such a framework, with relevant policies, planning tools and a insurance-reinsurance scheme has been designed in response to high exposure and vulnerability levels of communities to a range of hazards. In particular, flooding and coastal risks are critical as the French coastline has been an attractive space for development since the 1960's for secondary residences and continues to face urban development pressures. By the end of the century, it is expected that 5,000-50,000 houses, some major ports and a few large cities will be in high-risk zones to coastal risk and climate disasters such as storms like Xynthia (Madelenat, 2019). While dunes, flora, fauna, beaches and cliffs move naturally, a combination of risk reduction strategies and increased urban sprawl over time have led to high vulnerability conditions, which is surveyed in the history of vulnerability in the commune La Faute-sur-Mer. As the case study shows, structural engineering measures such as dikes and sea walls have been poorly maintained over the last decades, which represents an important issue in the governance of disaster risk management in France. Therefore, the case study material aims to draw from previous works on coastal and flood risk governance in France, and provide insight on gaps in arrangements using a local scale analysis of this case study (Genovese, Przyluski, & Hallegatte, 2012; Elisabetta Genovese & Przyluski, 2013).

Another research focus that benefits from an analysis on the history of vulnerability, is on responsibilities within risk governance frameworks and on limitations to convict and hold accountable individuals for the consequences of

disasters that involve a natural hazard. So far the definition of 'risk ownership' in France is loose and allocated across multiple entities, including the central government level in the risk policy formulation process and design of funding instruments (various prevention planning tools and an insurance-reinsurance public private partnership against disaster risks), a patchwork of partnerships, associations and more that manage flood risk infrastructure (sea walls, dikes) and the local level for implementation. This multi-level governance context was addressed in the public trial, where local authorities were found guilty for urban development in risk prone areas in La Faute-sur-Mer on account of development interests and delays in implementing risk zoning maps. The thesis explores the public trial, the verdict motivations and the actors involved, whereby several evolutions around the investigations test the evidence base for *negligence* on account of uncertainties when dealing with disaster risks that involve a natural hazard.

In conclusion, the research focus is on vulnerability to disaster risks, particularly from a past to present analysis and explaining drivers of risk as caused by governance gaps. This first focus supports the second question on how responsibility is attributed for these events and the challenges confronted when treating disasters in trials. Both these themes are informed by case study material on the local consequences of the Xynthia storm and coastal flooding in La Faute-sur-Mer and the public trial within the institutional disaster risk and flood risk governance framework in France.

## Research method overview

The thesis evaluates changes in vulnerability in the commune La Faute-sur-Mer by tracking the history of development in the area and evolutions in the disaster risk management framework in France. To find the relations between the two, an in-depth investigation was carried out on the history of disaster risks governance in France and demographic and urban trends in the commune. Firstly, a review of existing scientific studies and reports was made on the Xynthia disaster and trial.

Secondly, desktop research was made on the laws, policies and government reports related disaster risk reduction dating back to the 1980's to help identify the main planning instruments and institutions involved in policy making and implementation. The aim of this exercise was to provide a comprehensive understanding of risk governance arrangements specific to France and their evolution. Specifically, interest was made on the mechanisms to coordinate national level policies and local level implementation in a decentralized framework in the scope of flood risk management. Most of the policy documents and reports were accessible on government websites, while others were obtained during fieldwork visits and interviews with stakeholders. To inform the location study, historical maps, technical studies and risk maps were provided by the municipal council. In addition, interviews with the local people and municipality were carried out to gain in-depth understanding of the commune's history of development and culture.

Semi-structured interviews were carried out between September 2013 and March 2017 with relevant public and private stakeholders concerned with disaster risk management in France. These include persons working in government agencies, the municipal office of La Faute-sur-Mer, insurance companies and local people in the commune. These interviews helped gather information on three main topics (i) the governance arrangements for disaster risk reduction, (ii) the role of different institutions, and (iii) the history of development and flood risk management policies and infrastructure in the commune. Information obtained from stakeholder interviews was compared to desktop research, to enable the identification of governance gaps and factors that led to higher exposure and vulnerability levels in the commune. Informal discussions with local people in the commune helped to capture risk perception and experiences with the disaster or other events.

Finally, an important source of information was field-work and observation of the public trial in 2014. Field-work allowed to analyze the site study and interact with local people. Observations of the trial allowed to gain information on the risk governance structure, roles and responsibilities of different tiers of government and local dynamics in the commune before and after the disaster. To account for

hearings that were not attended, an analysis was carried out of the full transcript of the trial available online. This source provided comprehensive material on the case study given the thorough overview of the evidence used for verdict motivations in the trial.

## Thesis outline

The following chapters address the research questions presented earlier in section 'Research questions'. Chapter 2 provides background information on the case study of the Xynthia storm in 2010 (impact and consequences in La Faute-sur-Mer) and public trial that took place in 2014. Chapter 3 reviews the literature on disaster risk, vulnerability, risk governance and risk-responsibility relationships. Chapter 4 introduces the research methods used for the thesis, in particular the qualitative case study approach and the data collection process. Chapter 5 presents the analysis of trends of vulnerability in La Faute-sur-Mer based on five governance gaps. In particular, this chapter explores the influence of different governance arrangements from the local to the national scale that contributed to conditions of vulnerability. In Chapter 6, the analysis of vulnerability and associated governance gaps is used to derive the attribution of responsibility in line with the public trial that took place from September to October 2014. The results from Chapter 5 and Chapter 6 are positioned drawing from the analytical framework provided by the literature in Chapter 3 in the final chapter. Finally, the combined results are used to discuss future research implications, particularly on forward looking risk reduction methods such as the adaptation pathways approach as well as attribution methods. Concluding remarks and the limitations of the thesis are presented in this concluding Chapter 7.

## Chapter 2: Case study: the Xynthia storm and trial

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## Overview

The aim of this chapter is to provide the research setting of the thesis. The thesis focuses on the Xynthia storm in 2010 that triggered coastal flooding in the commune La Faute-sur-Mer on the Western Atlantic in France. This chapter provides an overview of the storm's characteristics, impact and the consequences in this commune. Due to the high damages and human consequences in a local area caused by coastal flooding, important issues are identified for the research setting such as problems of urban development in hazard-prone areas zones and poorly maintained protective flood risk infrastructure. These issues begin to shed light on risk governance gaps that surfaced in the aftermath of the disaster. These weaknesses in risk management gave motivations for a judicial investigation that led a public trial. Following a description of the storm, an overview of the public trial is presented, which started in 2014 and lasted several weeks. In this section, the chapter presents the allegations and verdict motivations, the supporting evidence and themes of the hearings. It concludes by outlining the final verdict of this trial and following discussions until 2017 at the end of the research period. The impact of the storm this coastal commune and the proceeding trial are the main interests of the thesis. This led to the selection of an analytical framework and research methods that are presented in the following chapters.

## The Xynthia storm

On the 27<sup>th</sup> to the 28<sup>th</sup> of February 2010 the powerful windstorm Xynthia surged through Europe's Atlantic coastline. The storm was first noticed on the 23<sup>rd</sup> of February when meteorologists observed a depression in the mid-Atlantic (Kolen, Slomp, & Jonkman, 2013). It first crossed the Canary Islands resulting in some damages. On the 27<sup>th</sup> of February the storm intensified due to a rapid drop in pressure and was given the name Xynthia upon reaching the Iberian Peninsula (Kolen et al. 2013). The storm continued its course through the northern provinces

of Spain and Portugal before reaching the western coast of France. Widespread damages from the storm occurred across Germany, France, and the Benelux countries, including wind damage to housing stock and infrastructure and the disruption of electricity and transportation networks due to flying debris (Cour des Comptes 2012; Mercier & Chadenas 2012; Kolen et al, 2013) Economic costs totaled to €3 billion of insured losses (FFSA & GEMA, 2011). The human consequences of the storm resulted in 65 fatalities across Europe, of which 47 casualties were caused by flooding on the western coast of France in the Vendée and Charente-Maritime departments (département<sup>1</sup>) (Kolen et al. 2013).

The low pressure of the storm was considered rather characteristic for winter depressions (Denis Mercier, Creach, Chevillot-Miot, & Pardo, 2020) and was labeled a *classique* hazard for the season (Anziani, 2010b). Previous storms on the Atlantic such as Lothar and Martin in December 1999, and Klaus in January 2009 had similar characteristics to Xynthia with higher winds (EQE, 2009). A combination of natural phenomena gave Xynthia forceful dynamics, which includes high winds and a high tide coefficient of 102 (where 120 is the highest), which corresponds to a 'spring tide' impacting high wave levels heights that triggered coastal surges (Anziani, 2010a). These physical processes of the storm combined with ocean tides, and together with the low topographical nature of some highly exposed coastal communities and agricultural lands led to storm surge and flooding in areas in France along the western Atlantic (Chauveau et al., 2017) .

France experienced the severest impact when the storm crossed from 0h00 to 17h00 on Saturday, the 28th February 2010 from the south-west commune Arcachon (Gironde Department) to the northern Department of Calvados in Normandy (Kolen et al., 2010). The storm caused damages from high winds and triggered floods, mudflows, landslides, and sea surges. Wind and flood damages occurred in Charente-Maritime, Vendée, Loire Atlantique and Gironde Departments, while Deux-Sèvres and Vienne were mainly affected by strong

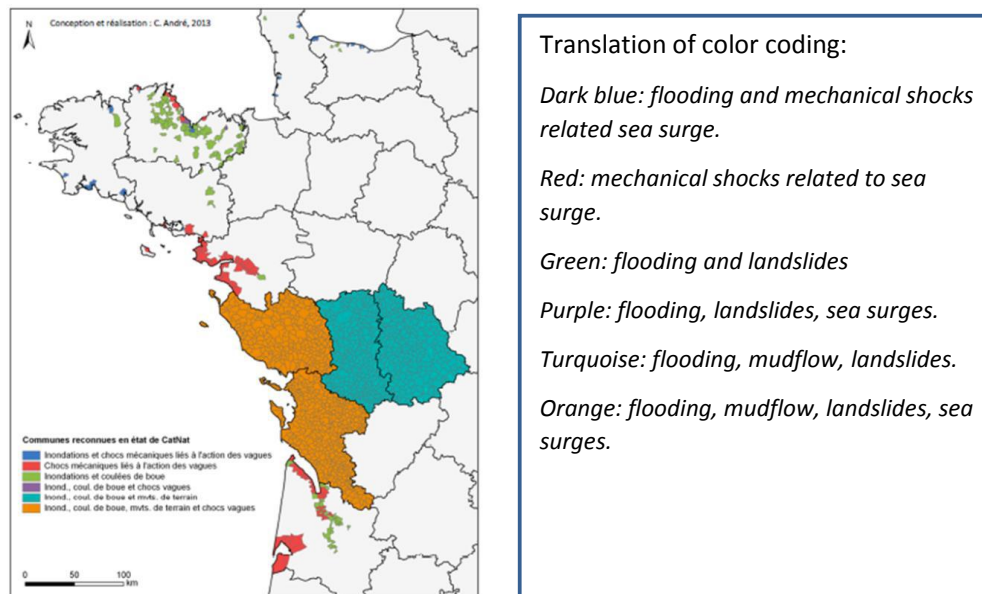
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<sup>1</sup> The department is a territorial division of France and a collective territory (collectivité territoriale). The departmental territory is administered by a prefect to carry out policies designed by the state.



winds. After the night of the storm 1,553 municipalities spread over 11 Departments declared effects. Wind damage was widespread while localized flooding was the most severe problem in coastal communities, which resulted in 10,000 people evacuating their homes along the Western Atlantic (Camille André, Meur-Ferec, & Meur-Férec, 2014) (See Figure 1 for a map of areas in France affected by the Xynthia storm). On the morning of the 28<sup>th</sup> February one million households were without power (Kolen et al., 2013). The storm caused dozens of injuries from wind and falling trees, with 79 persons seriously injured and 47 fatalities in France, six due to direct or indirect causes of wind, and at least 41 of whom were victims of drowning in storm-induced floods (Vinet, Lumbroso, Defossez, & Boissier, 2012)

**Figure 1** Map of the impacts of the Xynthia storm across several departments in France



**Source :** Camille André et al., 2014

As observed in the map provided in Figure 1. the coastal departments of Charente-Maritime and the Vendée (in orange) experienced flooding, mudslides, landslides, and coastal surge. The communes La Faute-sur-Mer and l'Aiguillon-sur-Mer both in the Vendée incurred the highest magnitude of damage from coastal flooding. The storm's impact in these two communes was a significant deciding factor for the

state declaration of Xynthia as a national natural disaster (*catastrophe naturelle*) in France (March 2010) because of the high concentration of damages and deaths in a local area (Bersani, Gerard, et al., 2010). The next part will specifically look into the effects of the Xynthia storm in La Faute-sur-Mer, as this commune is the central focus of the thesis.

#### Marine submersion in La Faute-sur-Mer

The Vendée and Charente-Maritime departments experienced the highest impact from the Xynthia storm, facing winds gusts up to 160 km per hour and storm surges up to eight meters. The combination of high tides, a coefficient of 102, strong winds and a barometric pressure decreases contributed to strong storm dynamics (Chauveau et al., 2017). Storm surge was evaluated at 1.6 meters and the tide approximately 2.75 meters (Kolen et al., 2013).

On the 27<sup>th</sup> of February at around 16h00, some first warnings were issued to alert the risk of a major storm heading towards the western regions of France along the coast. These alerts signaled a danger level of 'red' (categorized as the highest level of danger) indicating a high risk of strong wind gusts especially between the hours of 1h00 and 6h00 on the morning of the 28<sup>th</sup> of February. As a precautionary measure, state authorities in coordination with the central hydro-meteorological service (Météo-France) advised people to close window shutters to protect themselves against strong winds and flying debris (Anziani, 2010b). There were also warnings of high waves that were based on estimations of wave heights reaching seven to eight meters signalling an increased risk of possible coastal surges and flooding, especially in low lying areas. The warnings for coastal flooding was not properly signaled nor precise about locations (Anziani, 2010a). The coastal surge risk communicated to local authorities was underrated and mixed in with the other usual hazards of a storm (Kolen et al., 2013). Therefore, some campsites in Charente-Maritime were evacuated yet a large-scale evacuation was not called for. Coastal surge and marine flooding was the major cause of loss of life

and damages to housing stock in France, especially in the towns La Faute-sur-Mer and L'Aiguillon-sur-Mer.

La Faute-sur-Mer is situated on a peninsula between the Lay estuary and the strait of Pertuis Breton (Figure 2). The sister town, L'Aiguillon-sur-Mer is located across the Lay estuary. Due to the particular combination of physical characteristics of the storm and the location of La Faute-sur-Mer, the commune found itself squeezed by hazards from both sides. The storm put pressure on the dune systems in the north and at the same time overtopped dikes along the estuary (Kolen et al., 2013). Rapid flooding was caused by water surging in from the ocean through the entrance of the breach and from the estuary, which got trapped behind the port in La Faute-sur-Mer. An additional factor contributing to the scale of consequences in the commune is the wide funnel shape of the estuary (Chauveau et al., 2017). Even in the absence of a flood, the influx of water from the mainland causes an additional increase to the water level throughout the estuary because of how the outlet is shaped.

Figure 2 Map of the commune La Faute-sur-Mer and the effects of Xynthia



Source: Agence France-Presse, 2015

The Xynthia storm triggered flooding across 22,000 hectares in Charente-Maritime and 11,000 hectares in the Vendée (Anziani, 2010a). In Charente-Martime single

story houses were completely submerged (Cour des Comptes, 2012). The towns of La Faute-sur-Mer, L'Aiguillon-sur-Mer and La Tranche-sur-Mer were inundated up to an average of 1.5 meters of water (Genovese et al., 2012) and up to 4 meters surveyed in some areas. Areas behind the dike in La Faute-sur-Mer experienced rapid flooding, where waters rose up to 2.5 meters within thirty minutes in the middle of the night (Cunge & Erlich, 2014). The section of La Faute-sur-Mer that was severely flooded is the lowest part of the commune topographically and is referred to as the basin, in French *la cuvette*, thereby creating higher vulnerability levels to damages and deaths (Chauveau et al., 2017).

As a consequence of the storm, 47 people perished in France. In total seven towns identified deaths, all of which occurred between Charente-Maritime and the Vendée departments. Out of this death toll, six were attributed to direct effects of wind, and 41 (90% of total deaths) were caused by coastal flooding on the Atlantic coast (Vinet, Lumbroso, et al., 2012). A total of 29 deaths (61% of the total victims in France) occurred in the commune La Faute-sur-Mer, a majority of which drowned in their dwellings. The age of these victims were on average 60 years (22 persons) and 20% were over 80 years old, which largely corresponds to the demographics of the area, composed of retirees living year-round or secondary family houses used for vacation that were unoccupied during this period (Denis Mercier et al., 2020). There were also two persons in their 50's, two children and a baby of two years old that lost their lives in the flooding in La Faute-sur-Mer.

It was the deadliest flood in France since the floods in 1992 that killed 42 people in the town Vaison-La-Romaine. If the same event had occurred during the summer vacation months, the human consequences could have been exponentially worse. The risk of winter storms and cyclones is predominately between November and February, when there are fewer residents in these coastal communities.

#### Costs and compensation schemes

Databases on disaster statistics list the Xynthia storm in the ten costliest disasters in the last ten years and since 1900 in France (EM-DAT, 2019). An estimated

500,000 people in France suffered material damage (Kolen et al., 2013). Direct costs were calculated up to €2.5 billion (Anziani, 2010b). For insurers, estimated losses reached €1.5 billion as assessed by the French Federation of Insurance Companies (FFSA) (FFSA & GEMA, 2011). Out of this total, losses of up to €700 million were caused by floods and undertaken by the natural disaster insurance scheme (Cat Nat) in France associated to 40,000 claims (FFSA & GEMA, 2011).

Damages were attributed to different kinds of structures (public, private housing stock), economic sectors (fishing, agriculture, transportation) and hazards (winds, coastal erosion and coastal flooding). Although calculating economic damages is subject to methodological issues (Pelling, Özerdem, & Barakat, 2002), the effects of the Xynthia storm were evaluated by public agencies, independent auditors and insurance groups to assess the financial costs (Camille André et al., 2014). The reports presented loss and damage categorized into categories based on structure types and business sectors (e.g. non-agricultural, agricultural and state budgets for re-building), which will be presented in the next section.

## Damages

Residential flooding was the main category of damage caused by the storm and attributed to more than 40% of the total cost (FFSA & GEMA, 2011). 1,000 houses in the Vendée and 4,000 in Charente-Maritime faced water damage. The scale of costs was mainly dependent on the height of water levels, but also includes the salt content of the water and the materials of the structures.

The second amount of highest damages was attributed to companies based in non-agricultural sectors at an estimated amount of €438 million. Several industries were impacted, in particular tourism, which is a main economic activity in the coastal region. Tourism infrastructure and facilities such as campsites, mobile home sites and tourist attractions faced water damage. Disruption of tourism activities was also caused by environmental degradation and damage to beaches and the coastline. In addition to tourism, large network operators faced economic loss such

as the electrical grid operator in France (*Électricité Réseau Distribution France*<sup>2</sup>) and France's train network operator (SNCF, France's railway company) .

The agricultural sector was another source of damage classified in the reports (FFSA & GEMA, 2011). A total of 500 farms, including 192 in Vendée and 350 in Charente-Maritime were flooded, corresponding to 11,000 to 12,000 hectares in the former, and 40,000 to 45,000 hectares in the latter submerged under water, with some places 15 kilometers inland from the coast (Kolen et al., 2013; Chauveau et al., 2017). Mainly large fields were damaged, two thirds of which were used for grain cultivation and one third as grazing pastures for livestock (Palleau, 2010). Due to the salt content of the water and the duration of flooding exceeding several days to weeks, the land remained infertile for a few years disrupting agricultural activities in the region. In addition to on-land cultivation, shellfish, fish farming and in particular oyster farming faced business disruptions, especially because of equipment damage that threatened water conditions and the ecosystem (Chauveau et al., 2017).

The costs to the state from Xynthia were estimated at €526 million (FFSA & GEMA, 2011). These costs are attributed to recovery and reconstruction of roads, public infrastructure and flood protection structures. Following the disaster, it was assessed that an estimated 75 kilometers of dikes out 103 kilometers needed reconstruction in the Vendée department, and 120 kilometers of dikes out of 224 had breaches and required reconstruction in the Charente-Maritime department (Anziani, 2010a).

#### Insurance and reinsurance

The French Federation of Insurance Companies (*La Fédération Française de l'Assurance* (FFSA)) and Group of Mutual Insurance Enterprises (*Médiateur du Groupement des entreprises mutuelles d'assurance* (GEMA)) carried out a joint assessment on the total amount of insured losses caused by the Xynthia storm

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<sup>2</sup> Formerly known as ERDF, the company changed its name to ENEDIS in 2016 and is the electric grid operator for much of France.

estimated at €1.5 million (June 2010) (FFSA-GEMA, 2011). According to the report, the storm incurred €1,480 million insured losses and 470,000 claims. The volume of claims was large relative to the average amount per claim of approximately €3,150 (Table 1).

**Table 1 Data of Losses for the Xynthia storm**

Event	Direct costs	Insured Losses	Number of Claims	Average amount/claim
Xynthia	2.5 B €	1,480 M €	470,000	3,150 €

The highest amount of damages was concentrated in the Departments of Charente-Maritime and Vendée. The report showed that 37.6% of claims were paid in Charente-Maritime and 16.4% in Vendée (FFSA & GEMA, 2011). The remaining amount of claims was spread out across several other departments, such as cases of flooding caused by the estuary in Gironde and the Arcachon basin, and wind gusts that reached Hautes-Pyrénées and the Pyrénées-Atlantiques.

Insurance was able to cope with the claims and provide compensation to victims of the storm that faced material damages. However due to the magnitude and geographical spread of the damages, the public reinsurance program was activated. The French government announced an official state of 'Natural Disaster' (*Catastrophe Naturelle - Cat Nat*) after the Xynthia storm in four departments that faced the most severe damages, which included Charente-Maritime, Deux-Sèvres, Vendée and Vienne (Cunge & Erlich, 2014). A declaration of a *catastrophe naturelle* by the prefect (préfet) is important decision-making process after a disaster as it activates the Cat Nat public private insurance-reinsurance scheme for disasters and in particular, the state funded reinsurance, Caisse Centrale de Reassurance (CCR) (Michel-Kerjan, 2001; André, Monfort, Bouzit, & Vinchon, 2012). Therefore, with this activation, the CCR guaranteed extra coverage to insurers to cope with compensation for flood damage in the designated departments. Benefits paid under the Cat Nat plan amounted to €745 million for 35,000 claims (FFSA & GEMA, 2011). This represents half of the total cost for 7% of claims with an average cost per claim at €21.286.

The Cat Nat reinsurance scheme also provided compensation for direct costs suffered in the agricultural sector. It covered the destruction of crops and equipment, the loss of livestock and the degradation of properties of the soil that led to significant operating losses. Uninsurable damages, such as some particular pre-defined crops, herds and equipment received relief from the National Guarantee Fund for Agricultural Disasters (FNGCA), established by the Ministry of Agriculture, which compensated for up to 75% of the damages (Chauveau et al., 2017).

#### Request for an EU grant

In March 2010, due to the high costs caused by Xynthia, especially in the Vendée and Charente-Maritime departments, French authorities began inquiring about European aid (European Parliament, 2010). The European Commissioner for Regional Policy at the time made a visit to France to show EU solidarity and discuss with the French delegation possible actions including the application procedure for European relief. The European Solidarity Fund (EUSF) set up in 2002 provides a source of financial relief for natural disasters across Europe based on European member state collectivity (European Commission, 2019). Aid from this fund allocated to financing emergency operations executed by public authorities for non-insurable damage, repair of critical infrastructure, rescue teams, and provision of temporary accommodation. To this purpose, the fund does not cover damage to private property nor loss of income to individuals.

Following the French application for the EUSF in March, the European Parliament released a resolution in December 2010 agreeing to mobilize the European fund to help recovery and reconstruction in certain regions of France hit by Xynthia as well as for landslides and flooding in Portugal that happened in the same year<sup>3</sup> (European Parliament, 2010). This is the fifth time France has received an EU grant

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<sup>3</sup> Funding provided to France post Xynthia and disasters that hit Portugal in the same year, culminated in a grant total of €66,891,540 (European Parliament, 2010).



for natural disasters<sup>4</sup> in the last 15 years. In addition to the EUSF, France also benefitted from other EU funding sources to help with reconstruction costs including, €9 billion from the European Regional Development Fund and €5.4 billion from the European Social Fund, totaling to €14.4 billion.

All the funds mobilized after Xynthia triggered a question about the allocation of public funds following disasters, including how much is invested in risk prevention. The issue was investigated by the independent accounting body, the Cour des Comptes in 2012 (Cour des Comptes, 2012). In addition to questionable financing after Xynthia, the storm put to test the governance framework for flood risk management in France and revealed several issues with existing flood risk prevention policies and tools.

### Issues and investigations

The consequences of the Xynthia storm raised several concerns across communities in flood risk areas and for decision-makers involved in flood risk management in France. The event itself was described as having: 'no novelty meteorologically', and its destructive nature 'was related to strong tidal coefficients' (Chauveau et al., 2017: 3). Due to the storms seasonal normalcy, early investigations looked into problems surrounding emergency management and early warning systems (Bersani, Gerard, et al., 2010). Although warnings had been issues for the area, they signaled strong winds, which instructed people to protect themselves against damage to flying debris, whereby many people closed their electric shutters (Cunge & Erlich, 2014). Warnings for flooding had been communicated indirectly even though they did signal dangers of wave heights reaching seven to eight meters. While warnings for coastal surges were issued, flooding was not emphasized nor precise about locations (Anziani, 2010a; Chauveau et al., 2017). In this setting, the risk of flooding was underrated and

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<sup>4</sup>€21 million in 2002 for floods in the Gard region, €19.6 million in 2004 following floods in the Rhône valley, €5.3 million in 2007 for Cyclone Gamède in Réunion Island and €12.8 million for Hurricane Dean in Martinique and Guadeloupe; and €109.4 million in 2009 following Hurricane Klaus (European Commission, 2018).

mixed in with the other usual hazards of a storm (Kolen et al., 2010; Kolen et al., 2013). The result of these failed early warning communication channels to warn people about the dangers of storm-induced flooding led many inhabitants in La Faute-sur-Mer to become trapped in their homes, because they closed their electric shutters that cannot be opened if damaged by flooding waters. In addition to problems of early warnings, the local dike was not properly overseen during the storm. Surveillance of the dike could have possibly led to awareness about the risk of breaches or overtopping.

In addition to issues related to early warning systems, crisis management and lack of overseeing the dike, the Xynthia storm has been periodically reviewed on account of several other issues, with a main focus on problems that led to higher exposure and vulnerability levels in the commune (Cunge & Erlich, 2014; Genovese et al., 2012; Quenault, 2015; Scarwell, 2017). These refer to the following three themes:

- Flood risk management, urban development and land-use planning, including issues with regulatory flood risk maps.
- The state involvement following the storm, via reinsurance and a large-scale expropriation project.
- The social consequences, in particular the 29 deaths in the single commune La Faute-sur-Mer.

#### Development in hazardous areas and flood risk management

The human consequences of the Xynthia storm triggered an emotional and political inquiry, especially on issues surrounding urban development in hazardous coastal areas (Denis Mercier et al., 2020). The coastline in France has largely become an artificial space due to human pressures to maintain beaches through various structural protection measures and aggressive urban development, which has led to increasing exposure and vulnerability levels (Madelenat, 2019). In the 20 years before Xynthia many homes were built along the coastline in high risk areas (Genovese et al., 2012) and this trend has continued on account of high demand for beachfront retirement or second vacation houses (Madelenat, 2019). However, in

many areas this presents unlawful development, as land use planning is subject to building and zoning regulations that recognize natural hazards based on the national Act on Environmental Protection of 1995. The Act requires communes at risk to floods to have regulatory risk zoning maps, which constrains land-use rights and prohibits from building in zones at high risk to coastal and fluvial floods.

The consequences of the coastal flooding triggered by the Xynthia storm in the two coastal towns La Faute-sur-Mer and L'Aiguillon-sur-Mer, were argued to do with an overall lack of risk perception across local authorities and community members (Chauveau et al., 2017). In their study on territorial management and coastal urbanization of areas affected by Xynthia, Chauveau and colleagues (2017) wrote that a long term failure of risk assessment and carelessness (also referred to as negligence) in an area at risk to marine submersion were the main factors for the scale of consequences in these two communes. In addition, the housing structures created higher vulnerability levels as a majority were one story buildings and built on the ground level. In La Faute-sur-Mer the majority of deaths occurred in single-story housing structures, where an additional level could have served as a refuge zone. The predominance of these kinds of residential properties can be explained by urban planning, historical trends in architecture and social demand (Quenault, 2015).

Investigations of the disaster led to evaluate the governance of disaster risk management and in particular flood risk prevention policies in France. At a local level the investigation focused on awareness of risks, the availability of flood risk information and any hazard maps or risk assessments. The commune's all-hazards document, *Plan Prevention du Risque* (PPR) showed that the community is exposed to storms, floods and other natural hazards (earthquakes yet rare, and fires). In addition, flood risk prevention documents meant to inform flood risk zones and development restrictions, the Flood Risk Prevention Plan (*Plan Prevention du Risques des Inondations* (PPRI)) had been prescribed in 2001 and contained flood risk zoning maps. Despite the prescription of the PPRI, urban development had occurred in the area leading to increased exposure. This led to

examine the flood risk management and land use planning in the commune in the years preceding the disaster.

The issues of the dike failing during the storm was also a point of investigation (Anziani, 2010b). All the 29 deaths occurred within 400 meters behind the dike. Following the storm, reports showed that the dike was too low in height relative to the risk level, and had not been maintained for many years (Anziani, 2010b). These protective measures were evaluated at a capacity of a hydraulic load level that occurs once every 100 years (Kolen et al., 2010). The dike was originally constructed in 1937 requiring updated risk and capacity assessments. Several studies carried out on the dike revealed issues of fragmented ownership, an unclear set of responsibilities, lack of resources for maintenance and an outdated legal framework governing these protective structures (Anziani, 2010b; Cour des Comptes, 2012; Quenault, 2015)

#### The expropriation project

Another factor that drew attention to the consequences of the Xynthia storm was the decision-making of the state immediately after to launch a buyout program of highly exposed houses in the area (Mercier & Chadenas, 2012; Chauveau et al., 2017). After recovery operations had been carried out, the state launched an expropriation plan of highly exposed houses in areas hit by coastal flooding from Xynthia, most notably in the communes La Faute-sur-Mer and l'Aguillon-sur-Mer. This action led to survey how public funds were being managed in regards to risk prevention at a larger scale across France. In addition, the decision had implications on the commune's perception of centralized top down flood risk policy-making that appeared to lack an appropriate integration of local interests and individual cases, which will be mentioned in this section.

On the 16<sup>th</sup> of March, Nicola Sarkozy, the then President of France announced several emergency measures for the areas that were most affected by Xynthia. At the same time, the prefecture (préfecture) was asked to draw up maps of zones along the coast hit by the storm deemed in extreme danger to coastal flooding. The

Minister for Ecology and Sustainable Development<sup>5</sup> (*Ministère de l'écologie et du développement durable*) labeled these zones as *black zones* (*zones noires*), which did not have any legal definition but symbolically signaled death in the area<sup>6</sup>. The first zoning was carried out rapidly and sent to the ministry on the 21<sup>st</sup> of March (Chauveau et al., 2017). This time frame gave very few days to carry out a comprehensive risk study and assessment, which is said to have been based on coarse topographical data (Chauveau et al., 2017). On the 8<sup>th</sup> of April 2010 the government began mapping *black zones*.

The decision of this buyout program led to skepticism about the scientific basis of these zones and the use of public budgets (Mercier & Chadenas, 2012) as each home-owner was promised full compensation of the value of the house before the storm estimated at an average of €150 000 to €250 000 per house (Kolen et al., 2010). Many local people were not willing to leave their homes and were not confident with the risk assessments and mapping (Chauveau et al., 2017). The prefecture of Charente-Maritime issued 19 maps indicating *black zones*, including some areas that had not been flooded by Xynthia. As a result, several homeowners rejected these proposals. The departmental council of Charente-Maritime made a formal opposition by a unanimous vote demanding further investigations about the risk levels of these zones. Demands asked for reconsideration of the zoning and more research into protection measures against floods, before declaring areas as uninhabitable.

In May 2010, the government changed the regulations and renamed the black zones as *solidarity zones* (Mercier & Chadenas, 2012). *Solidarity zones* are defined as areas where there is high risk to natural hazards and deem the houses located in the area as potentially subject to expropriation 'amicably' by the state through the

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<sup>5</sup> The Ministry for Ecology and Sustainable Development (*Ministère de l'écologie et du développement durable*) (2007-2012) evolved into the Ministry for Ecology, Sustainable Development and Energy (*Ministère de l'Écologie, du Développement durable et de l'Énergie*) in 2012 and later became The Ministry of the Environment, Energy and the Sea (*Ministère de l'environnement, de l'énergie et de la mer*) in 2016. Currently, up until 2019 the ministry dealing with environmental issues including natural hazards and disaster risks is The Ministry for the Ecological and Inclusive Transition (*Ministère de la Transition écologique et solidaire*).

<sup>6</sup> As Chauveau and colleagues describe, 'The concept of creating designated 'black zones' was aimed to avoid more victims of marine flooding (and coastal surge)' (Chauveau et al., 2017: paragraph 27)

public Natural Risk Prevention Fund (FPRNM) (Cour des Comptes, 2012). Since this change of zoning names, *solidarity zones* did not require for people to compulsory leave their homes (Anziani, 2010b), however should homeowners wish to keep their property in such a zone the case must be reviewed in an administrative court. This procedure is explained because as of December 1, 2010, the *solidarity zone* was categorized as a 'Public Utility Zone' or 'Zone of Expropriation' (Mercier & Chadenas, 2012).

Given the death toll caused by Xynthia, the government decided to purchase and destroy existing houses in these high-risk zones, with the aim of reducing exposure to coastal flood risk in the region. By the end of 2015, the total amount of houses purchased amicably came to 1,162 for a total amount of € 317.71 million paid by the Natural Risk Prevention Fund (FPRNM) and associated Barnier Fund (*fond Barnier*) (MEDDE, 2017). Each house that was destroyed was promised full compensation based on market value of the property before the storm, at an average cost of €150,000 per house. For properties not acquired amicably, expropriation proceedings were transferred to an administrative tribunal in order to assess individual cases. In the Vendée department the communes La Faute-sur-Mer and l'Aiguillon-sur-Mer accounted for allocations of €10.7 million in 2013, €1.2 million in 2014 and €1.7 million in 2016 for the expropriation of houses. This amount involved 93 units of property in L'Aiguillon-sur-Mer and 10 land units in La Faute-sur-Mer. Since 2013, a total of €32.07 from the FPRNM had been allocated for the compensation of expropriated properties in Vendée and Charente-Maritime (MEDEE, 2017).

**Table 2 Balance of the acquisitions of properties following the Xynthia storm**

	Vendée	Charente-Maritime	Total
<b>Number concerned</b>	841	826	1 667
<b>Number used for habitation</b>	811	757	1 568
<b>Propositions of acquisition made by the State</b>	804	535	1 339
<b>Propositions accepted</b>	703	464	1 167
<b>Agreement rate for the propositions</b>	87.43%	86.7%	87.1%
<b>Number of acquisitions made</b>	701	461	1 162
<b>Total</b>			
<b>Amount (in M €)</b>	159.8	159.46	319.26
<b>Average price of FPRNM by acquisition (additional costs included)</b>	€227 960€	€345 900	€573 860

*Source:* MEDDE, 2017

La Faute-sur-Mer was most impacted by the expropriation plan, resulting in 472 demolitions corresponding to 20% of the commune (MEDDE, 2017). In the sister commune L'Aiguillon-sur-Mer, 289 houses were expropriated (MEDDE, 2017). Together, expropriation in these two communes resulted in a total cost of €150 million financed by the solidarity zone expropriation project introduced by the state. This amount did not include the additional costs of immediate works that were undertaken calculated at €18 million in La Faute-sur-Mer and €12 million in L'Aiguillon-sur-Mer, which would bring in additional €180 million of public funds spent after Xynthia (Cour des Comptes, 2012).

### Social consequences of the disaster and the victim's association

Social consequences of the storm led to the evacuation of 10,000 people along the Atlantic coast and 47 fatalities in France. The 29 deaths in the commune La Faute-sur-Mer drew public and media attention and led to further investigations about the disaster. Questions were raised about the high death-toll in a small area. All the deaths occurred in the part of the commune known as the '*cuvette*' (translated as basin), just behind the dike which is characterized by low topographical levels giving rise to questions about urban development planning and regulations.

In the aftermath of the disaster, inhabitants in the commune mobilized and a victim association called AVIF, the *Association des Victimes des Inondations de La Faute-sur-Mer et de ses Environs* was formed on the 3<sup>rd</sup> of April 2010. Originally it had 800 members, equal to almost the totality of the number of the commune's year round residents. Initially AVIF was organized to respond to immediate needs such as cleaning houses, resettlement, problems of insurance declarations and payments and lost documents. Following these relief concerns, the association gained political and strategic power on account of investigations surrounding the human toll in La Faute-sur-Mer. The public procurer visited the commune and asked if people would like to make complaints. A total of 40 complaints were made and an investigation file was opened. This led to a public trial evaluating the consequences of the Xynthia disaster in light of the risk governance issues presented.



## First Assessment: The Xynthia trial

One of important follow up measures after the Xynthia storm in France was the judicial proceeding. In March 2010, the public prosecutor of Les Sables d'Olonne opened an investigation file to look into the damages that occurred in La Faute-sur-Mer and in particular survey a question about the responsibility for the deaths of 29 people (Benadusi & Revet, 2016). Shortly after, in November the Prosecutor received 40 complaints from individuals who were both members and non-members of the association of victims (AVIF) explaining their experiences of the disaster and human loss. Following the review of these complaints, the prosecutor issued an indictment against local public office holders on charges of involuntary manslaughter (*homicide involontaire*), putting in danger the lives of others, and taking decisions out of personal interests that are illegal.

At the end of November 2010, the judge responsible for the case asked for investigations to proceed and evidence to be gathered. In the following years, evidence was gathered on the availability of risk information in the commune and yet failed communication of risks, issues with risk prevention planning documents, illegal licensing and issuing building permits in flood risk zones and lack of maintenance or studies on the dike. Bringing together these pieces of evidence the aim of the case was to i) explain the causes of the disaster ii) treat the case judicially and iii) seek a form of compensation for the victims to address human loss.

In 2014 a public trial commenced based on investigations and evidence brought forward spanning across the years before the storm to explain the high exposure and vulnerability levels to flood risk in the commune. The criminal trial was accompanied by civil proceedings to ask for compensation for victims and to permit victims to take an active part in the trial and not just as passive witnesses (Revent, 2016). In total five people were brought to court based on accusations of: 1) involuntary manslaughter or involuntary homicide (*homicide involontaire*) (unintentionally causing death) and 2) exposing people to immediate risk of death

or permanent injury. The persons who were accused in the trial are listed as follows:

- The mayor of the commune, Mr. René Maratier, who served from 1989 to 2010.
- The 1<sup>st</sup> Deputy Mayor and president of the urban planning commission (Commission d'Urbanisme) of the commune, Mrs. Francoise Babin.
- The son of Mrs. Babin, Mr. Phillipe Babin who is both a real estate agent and president of the association responsible for managing the dike, l'Association Syndicale de la Vallée du Lay (ASVL)/ sometimes also referred to as: Association du Marais.
- Mr. Patrick Maslin, a municipal councilor and member of the urban planning commission, and representative of two building companies (*Construction d'Aujourd'hui* and *Techniques d'Aujourd'hui*).
- Mr. Alain Jacobsoone, the deputy regional director of marine territories of the Vendée at the time of the storm who is responsible for dike and estuary maintenance.

The trial lasted for one month, with the first session taking place on the 15<sup>th</sup> of September and the final on the 17<sup>th</sup> of October culminating in a total of 19 hearings. The trial took place in the south west of France in Les Sables d'Olonne, in the Congress center, Centre Congrès d'Atlantique. At the trial there were approximately 60-120 plaintiffs, who had five civil defense lawyers. There were also defense lawyers for the state of France, ranging from ten to fifteen depending on the hearing. The mayor also had a defense lawyer. Journalists and the press attended the trial, which usually consisted of around 10 persons at each hearing. At the bar sat the President of the jury, who had three judges seated beside him. The trial also had two additional criminal judges. In the back of the room, chairs were available for the public to attend the trial, which usually consisted of about one hundred visitors. The setting was very important as it represented a formal courtroom setting. The atmosphere was characterized with tension. However, there was a fluidity of public visitors stepping in and out, while journalists were also carrying out interviews.

**Table 3 List of hearings of the Xynthia trial**

<b>Dates of hearing</b>	<b>Content of hearing</b>
<b>Monday, 15 September 2014</b>	The trial and summary of the case/preliminary statements/vital defendants/ procedural matters/call of witnesses
<b>Tuesday, 16 September 2014</b>	Technical expertise/expert testimony
<b>Wednesday 17 September, 2014</b>	Expert testimony/ 1 <sup>st</sup> part of civil parties
<b>From 18 – 24 September 2014</b>	Hearings of civil parties
<b>Thursday, 25 September 2014</b>	Transfer to the site of La Faute-sur-Mer, findings on site
<b>Friday, 26 September 2014</b>	End of hearings of the civil parties, and readings by those who did not wish to testify
<b>29 September – 3 October 2014</b>	Evidence and witness hearings
<b>6 October – 10 October 2014</b>	Warned interrogations

The trial was organized by thematic phases in order to gather different sources of information on aspects of investigation. More details on this organization and a timeline are presented in Table 3. Firstly, victims (plaintiffs) were given a week to express individually their experiences of the storm. During these hearings, the jury was silent and the atmosphere in the trial was particularly emotional. Some questions to plaintiffs asked about their level of knowledge of flood risk in the commune and any information on exposure of their properties to flood risk that might have been found in leasing agreements or procedures to obtain building permits. Other hearings brought in witnesses and civil servants working at different levels of government, who were responsible for various aspects of flood risk management and prevention. During this time of the trial, questions pertained to risk policies and the implementation of documents such as plans of emergency response, land use and urban planning and flood risk zone maps. Evidence provided during the trial included photos, scientific presentations on the geography and geological evolutions of the area, topographical maps, correspondences,

minutes of municipal council meetings, and other material. This period brought to light issues of a lack of information on flood risk in the commune and the illegal construction of buildings in high flood risk areas.

#### Accusations and evidence in support

The trial began on the 15th of September 2014 with defining the terms of accusation by the president of the jury (Hearing, 15 September 2014<sup>7</sup>). The accusations were based on two accounts of prevention explained as:

- *Homicide* (defined in article 221-6 of the Criminal Code)
- *The risk caused to others* (defined in article 223-1 of the Penal Code)

The two offenses are recognized and punished under criminal law. The former is defined under the Criminal Code while the latter under the Penal Code. There are two types of assumptions for these accusations, which was introduced by the president of the jury. Firstly, there should be a *material element* and secondly, an *intentional element*.

The first accusation involuntary manslaughter or involuntary homicide (*homicide involontaire*), ‘rests on the determination of misconduct and a *causal link* between that conduct and the harmful. The characterization of the *cause* influences the *qualifications of the fault*’ (Hearing, 15 September 2014). Two terms causation and fault were clearly defined by the court. *Cause* was explained by intentionality and referenced to by an existing law that was implemented in 2000. Thus, the court explains that in some cases unintentional facts have led to a decriminalization of the case because of the cause. This law on causation implemented in 2010 has contributed to a dual system that separates direct and indirect causation. *Indirect causality* as applied to the case of Xynthia suggests that authorities in public offices have certain responsibilities under statute for prevention measures. This point was clarified by stating that, ‘those vested with decision-making power are affected by

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<sup>7</sup> The transcriptions of all the trial hearings can be found online at the association for victims website: <http://www.lafautesurmer.net/proces/>

this causality, since they have not taken measures to prevent the damage as is the case in the facts that interest us' (Hearing, 15 September 2014).

Following a detailed description of cause, the term fault was distinguished between four categories: a) simple fault, b) qualified fault, c) deliberate fault and d) characterized fault. Although each has particular definition attached to it legally, they all share the notion of *negligence*. For some of these fault classifications, negligence appears rather laxly described as, 'inattention, carelessness, or clumsiness', while other terms are attributed legal force such as the, 'violation of obligations of safety or prudence'. In conclusion, the first accusation involuntary homicide rests on two pillars, the indirect cause of death and the link to fault determined by improper fulfillment of prevention defined statutorily in the obligations and responsibilities delegated to public office holders.

The second accusation *the risk caused to others*, leads to consider two aspects, the individual behaving in a risky way and the result of it, whether it put at risk the lives of others. A clarification about these two sides of risk and result clarified that, 'The *behavior* (i.e. taking the risk) is voluntary, but the *result* in actual damage to life of physical integrity is not'. Prevention is an important element to the accusation and supporting evidence to explain preemptive actions, because the offence occurs before the result. The aim is to suppress any dangerous actions before damage occurs. Therefore, there is a disassociation between risk and result, as the court claimed, 'Prevention is the cause, not the effect' (Hearing, 15 September 2014). To make clear, the jury gave the example of driving, because when someone drives recklessly fast, it puts lives at risk, which is a penalty even if no accident occurs. However, if actual damage occurs then the penalties correspond to the level of damage.

In the case, the accusation of putting at risk to others was based a result, meaning death had occurred and by the code of endangerment (endangering the lives of others) (code pénal mise en danger de la vie d'autrui) in reference to prevention. The code of endangering the lives of others, suggests whether the individual is required by law, the obligation to *take care* or *précaution* under certain statutes or

regulations. And thus, if this obligation is not fulfilled, it is characterized as misconduct, which leads to the endangerment offense and the offense of putting at risk to others.

These two accusations were made on account of several issues that the trial would proceed to investigate during the hearings. The first session concluded with a summary of the Xynthia storm and verdict motivations. The evidence for the verdict presented during the trial is listed as follows:

- Knowledge of the flood risk by the elected;
- The human consequences of the disaster;
- Lack of studies on the capacity of the dike and little maintenance;
- Management of the alert by the prefecture services;
- Information on flood risk amongst authorities in public offices;
- Improper fulfillment of flood prevention documents;
- Information issues on flood risk between buyers and real estate agents;
- The diagnosis of vulnerability for the commune;
- The illegal issuance of building permits in flood risk zones.

### Testimonies

The trial lasted from the 15 September to the 10 October 2014, with more than 50 persons asked to present at hearings. Three phases of hearings and testimonies can be identified including expert and scientific testimonies, the victims (civil parties), and evidence and witness hearings. The identity of persons who spoke at the trial will be acknowledged by referring to their expertise and backgrounds, however full names are not included in the text. The focus remains on the theme of the testimonies and not on the individuals, in order to provide a better understanding of the kind of information sought by the jury on the case.

### *Expert and Scientific testimonies*

Scientific experts presented factual aspects of the case for the second two hearings of the trial, 17 and 18 September 2014. These hearings provided the following information:

- The geography of the territory and historical documentation of disasters in the commune presented by a historian, Mr. Thierry Sauzeau. In this part, the court surveyed the role of risk knowledge about disasters in the area, and in particular the role of memory and culture in risk perception.
- A forensic expert provided information about the cause of deaths during the storm particularly the scientific basis of drowning as examined in the deceased.
- A psychiatrist presented the traumatic effects of living through the Xynthia storm upon following up with victims and maintaining communications with them. Several victims were facing severe conditions of grave health and post-traumatic stress disorder.
- An expert on the physical processes of oceans, Mr. Luc Hamm presented the particular environmental phenomenon that contributed to the impact of the Xynthia storm and the law of probabilities for extreme natural events.
- The director of the case file, Mr. Raffy, gave a synthesis of the issues in the case and some conclusions drawn from evidence found during investigations.

### *Hearings of victims and civil parties*

On the part of victims, a total of 37 hearings were made out of 121 civil parties participating in the trial. These included people who experienced the storm first-hand and others who came after the event to mourn the loss of a family member and find their properties destroyed by water damage. Each account lasted between 15 and 30 minutes and some lasted up to an hour. This time was an important opportunity for victims to share their traumatic experience during the storm and the psychological effects of it on them in the years that followed. Due to the need for brevity, each account will not be described in full detail. Instead, these accounts will be synthesized according to general information drawn from these testimonies.

Hearings of the victims and civil parties were emotional. The victims shared troublesome stories of their experiences of the disaster. On account of the sensitivities surrounding these hearings, there were hesitations at times to make any questioning on the part of the jury. When and if questions were made, they often touched upon risk information availability. The jury asked questions about any communications about flood risk, especially regarding leasing contracts. Perception and knowledge of risk were the main questions posed by the jury to plaintiffs.

The victims demonstrated a desire to ‘know the truth’ and find who is accountable for their loss. Many of them expressed anger at elected officials, in particular at the mayor, who they repeatedly stated ‘under statue is responsible for protecting citizens’. During this phase, questions were posed on individual dwellings, some of which had been licensed and authorized by the mayor and urban planning commission in recent years. This did not apply to all dwellings as some were built several years before the mayor took office in 1989. On this topic, the judges questioned when the properties were bought and whether flood risk information on properties could be found in the lease agreement. In addition, civil parties were asked if they had properly implemented flood risk mitigation measures for their homes, such as building above a building code (above the baseline of 20 cm) or putting in place a second story, and if these measures were communicated by building companies.

To support the case of the victims, the president of the association for victims (AVIF) Mr. Renaud Pinoit spoke on behalf of all the civil parties and their collective interests. The Xynthia trial was initiated by AVIF, which remained active in the commune until 2017 and was still fighting the case to receive compensation for the human loss experienced by victims of Xynthia.



## *Evidence and witness hearings*

### *The questioning of: the prefecture, the mayor, the president of the planning commission and other public officials*

Evidence and witness hearings focused on public authorities in charge of different phases in flood risk management policies. Three issues were central to this part of the trial, the flood risk information document called the *Plan Prévention des Risques Inondations (hereafter PPRI)*, the issuing of building permits especially in flood risk areas, and the lack of inspection and maintenance of the dike during the storm. Officials from different levels of government were asked to come to the bar for hearings, including:

- Senator Anziani, who commented on the chain of responsibility in the French government and the facts about the case in reference to the governance framework. He has contributed two senatorial reports on the case, referring to legal frameworks and risk policies.
- At the departmental level, the Direction of Departmental Equipment *Directions Départementales de l'Équipement (DDE)* (now under new administration, directions *Départementales Des Territoires (DDT)*), several persons were asked to hearings. Their services operate under the ministry for environment, *Ministère de l'Écologie, de l'Énergie, du Développement durable et de la Mer*<sup>8</sup>(MEEDM). They have the role of overseeing that flood prevention policies are properly administered and communicated to lower levels of government. This includes:
  - Mr. Jean-Louis Détente, responsible for development and urbanization;
  - The former engineer for public works, Mr. Robert Saint-Ignan;
  - The chief of maritime service and risks, Mr. Stéphane Raison;
  - Adjoint departmental director, Mr. Jacobsoone.
  - Chief of risk unit at the DDTM, Mr. Loïc Cairo.
- The prefect of the Vendée from July 2007 until January 2010, Mr. Thierry Lataste. The prefect oversees the implementation of flood prevention documents and is a reference for the issuing building permits, public works (e.g. the dike), and overseeing the consultation phase of the PPRI.

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<sup>8</sup> In 2016, this ministry was renamed the Ministry for Ecology, Sustainable Development and currently, it is the Ministère de la Transition écologique et solidaire

- At the municipal council level, the mayor, president of the urban planning commission, president of the association for managing the dike, and the person responsible for overseeing and maintaining the dike.

The president of the jury verified what kinds of responsibilities in flood risk management these different public office holders were assigned. Several dates about meetings, correspondences and circulations were referred to regarding studies and assessments of flood risk, hazard mapping and zoning regulations. Issues led to questioning about the illegality of development in flood risk areas and comments about a 'conflict of interest' between commercial profits and security.

To address the failure of the dike, the president of the association, Association of the Estuary (*Association de Marais*) that manages dikes was asked about regular inspection and maintenance before and during the storm. This included questioning of the person delegated duties from the association to oversee the dike, who did not take action to see the condition of the dike during the night of the Xynthia storm. It also revealed a general weak ownership framework and lack of maintenance.

#### Final verdict and on-going issues

On December 12, 2014, the verdict of the trial was announced. The mayor of the commune La Faute-sur-Mer, Mr. René Maratier was sentenced to 4 years in prison, of which two had to be spent inside the prison and the other two in house arrest. The president of the planning commission, Mrs. Françoise Babin was sentenced to 2 years in prison (house arrest) and a fine of €75 000. Charges against her were on account of promoting urban development in flood risk areas. In particular, evidence showed the issuance of a building permit to Dr. Ahmed Bounaceur in 2007 in an area at risk to marine submersion. Dr. Bounaceur lost his two children and wife to the floods. The real estate agent and president of the association for dikes, Mr. Philippe Babin was sentenced to 18 months in prison. His sentence was based on development in hazard-prone zones and failing to organize any surveillance of the dike on the night of the storm. Finally, Mr. Patrick Maslin, the owner of two construction companies, who died during the trial was fined €30 000. His sentence

was based on not adhering to legal requirements in the regulatory hazard zoning document (PPRI) and for not building a second story in cases where this was required.

The verdict is a symbolic and controversial case, as it condemns public officials for the consequences of a disaster involving a natural hazard. Arguments for this pertained to statutorily defined obligation of public authorities to protect and provide security to inhabitants, that led to charges of professional *negligence*. However, the case is complex and evolutions led to changes in the initial penalties.

In January 2015 three persons (Mr. Maratier, Mrs. Babin and Mr. Babin) accused in the trial applied for an appeal. On the 16 November 2015, the Court of Appeal of Poitiers was opened and lasted for three weeks to review the charges. In contrast to the first trial, this one was much more technical and closed to the public, with only five hearings from civil parties. The association for victims (AVIF) and its members, insurance and those who filed for appeal participated in the trial. In April 2016, the results of the appeal were released after revisiting the case. The mayor's sentence was reduced to two years of imprisonment, retaining the restriction to work in public office. Mrs. Françoise Babin, the former deputy in charge of urban planning, and also the owner of land where houses were built, was acquitted. Her son, Mr. Philippe Babin, also a real estate agent who sold plots and built houses in high-risk zones was acquitted by the court of appeal. Following the appeal, the civil parties and their demand for indemnity were referred to administrative tribunals.

On the 1<sup>st</sup> of December 2015, the administrative tribunal of Nantes opened and hearings started to revisit the case. In this third appraisal, the state and the commune were found guilty for the consequences of the disaster. The public prosecutor asked the judges to condemn 'in solidarity'<sup>9</sup> the state, the commune, and the association for managing the eastern dike (the Union Association of the Valley of the Lay (*l'Association Syndicale de la Vallée du Lay*, ASVL)), including the payment to the insurance group, Crédit Mutuel a sum of €1 491 038 53. This verdict was made due to several arguments using evidence of the first trial in

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<sup>9</sup> in French, using the term 'solidarity' is important as it reflects the solidarity approach of the insurance-reinsurance natural disaster program set up by the state in the 1980's

support. Firstly, the argument against the municipality was for the failure to carry out normal dike maintenance. Secondly, the commune was found guilty of a general ignorance surrounding obligations to ensure security by the mayor and lastly, on account of illegal issuing of building permits. The state was convicted due to failure to put in place the PPRI and ASVL for having not participated in any reinforcement works on the dike.

The members of AVIF continued to fight for their case until 2017 regarding an indemnity on the part of victims. The situation was complex as the only way for indemnity to be made is through a public fund that would have had to be opened by a minister who would accept to defend the case.

## Summary

This chapter gave background information on the case study used for the thesis on the Xynthia storm in 2010 and the public trial that began in 2014. This disaster put at test the flood risk governance structure in France, revealing several issues such as failure of flood risk prevention and urban planning to restrict building in high flood risk areas and lack of maintenance of protective flood risk infrastructure. These issues were addressed in the public trial. The chapter described the trial and the accusations and evidence presented in support. The case is interesting to analyze based on the rich literature that exists on exploring the causes of disaster and how to better effectively manage and reduce risks. However, although the trial provided sufficient evidence to support accusations, the appeal in the following years led to reduced charges and some defendants were acquitted. Therefore, there is still room to integrate in the law how disaster researchers contribute to explaining human contributions to vulnerability to natural hazards and how responsibilities are then shaped. With having the background on the research setting, the next section describes the literature that is mobilized for the analysis, that can contribute to this integration.

## Chapter 3: Literature Review

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## Overview

The literature review presents pioneering works from the 1990's and early 2000s on the study of disaster risk from various disciplines. The interest in these works is to shed light on their pertinence to dealing with present day disasters. In particular, the scientific literature explored in this review deals with the importance of vulnerability in disaster risk management and governance research. These works show that there is a keen interest to identify and characterize why and how these conditions shape, and propose the governance arrangements needed to anticipate, reduce and manage disaster risks. Finally the literature reveals an important question of responsibilities in these governance frameworks around risk and uncertainty. The literature review aims to shape the analytical framework that provides the tools to analyze the case study in Chapters 5 and 6. Therefore, the literature review is organized around the following themes: i) vulnerability and the risk of disasters, ii) the governance of disaster risk management and iii) responsibilities in the governance of disaster risk management (risk-responsibility relationships) (See Table 4).

**Table 4 Literature review**

Section	Sub-content
<b>Vulnerability and the risk of disasters</b>	<ul style="list-style-type: none"><li>• Defining vulnerability</li><li>• Flood risk and hazard (technical parameters of a hydrological hazard)</li><li>• Underlying drivers of vulnerability: using exposure and susceptibility indicators</li><li>• Disaster: concept and definition</li><li>• Disaster synonyms and typologies</li></ul>
<b>The governance of disaster risk management</b>	<ul style="list-style-type: none"><li>• Risk and governance</li><li>• Governance and disaster risk management</li><li>• Preparedness: the role of insurance in disaster risk governance</li></ul>
<b>Responsibilities in the governance of disaster risk management</b>	<ul style="list-style-type: none"><li>• The point on attribution</li><li>• Risk-responsibility relationships</li><li>• Capacity-responsibility: moral and professional</li><li>• Accountability</li></ul>





## Vulnerability

The focus of this part of the literature review is on the concept of vulnerability. The literature on disaster risk management pays particular attention to vulnerability because it explains the potential harm and disruption that a physical force, otherwise known as the hazard, may have on a place and people. Factors that influence potential harm are biophysical and socially constructed, such as the economic, cultural, demographic, risk governance conditions of a place. While some of these variables are quantifiable such as risk probabilities, the exposure of assets to a hazard, and even economic inequalities, others components of vulnerability are qualitative and aim to capture the role of community coping capacity, risk perception and individual preparedness. There are many categories and sub-components of vulnerability, which make it complex and multi-factorial, and has led to different conceptualizations and applications (Hufschmidt, 2011). Therefore, it is important to highlight these different components of vulnerability as they are surveyed in the thesis to reinforce the perspective that disasters are not natural events (Cannon, 1993).

The aim of this part of the literature review is to survey some of the main scientific contributions of characterizing vulnerability proposed in the literature. It does not propose a framework to assess vulnerability. Instead, it aims to draw from these various works that have largely informed disaster risk management frameworks to organize various components of vulnerability that will be used later to guide the analysis of the case study. Therefore, vulnerability is mainly discussed in the context of flood risk. The aim is to reinforce the perspective that the consequences of disasters can be effectively reduced by understanding the multi-factorial composition of vulnerability and the underlying drivers that increase such conditions.

## Definitions of vulnerability

The origins of the concept vulnerability are presented in several papers and not the purpose of this part (Janssen et al., 2006). It is given that a variety of disciplines treat vulnerability differently, which leads to alternative employments of the concept (Hufschmidt, 2011). In the thesis, vulnerability is defined and determined in relation to an environmental stress. Therefore, vulnerability is the interaction between a physical force in the natural environment, such as a climatic hazard or other (earthquake) and the degree to which objects and people are affected (Kazmierczak & Cavan, 2011). The relationship between these components are described as  $\text{Risk} = \text{Hazard} \times \text{Exposure}$  (number of assets and people in a hazard prone area)  $\times \text{Vulnerability}$  (conditions) (Cardona et al., 2012). *Exposure* is a determinant of vulnerability because in order for damage to be realized the person or object needs to be first exposed to the hazard (otherwise referred to as objects at risk in a hazard-prone area, such as to drought or floods) (Peduzzi, Dao, Herold, & Mouton, 2009). Complimentary to exposure, vulnerability describes how and to what extent the entity is prone to suffer negative effects. Many combine exposure with vulnerability to explain overall vulnerability, defined as, 'an internal risk factor of the subject of system that is exposed to a hazard and corresponds to its intrinsic predisposition to be affected, or to be susceptible to damage' (Cardona, 2003: 38). Therefore, vulnerability is realized by impact of the hazard, which is external to system (Birkmann, Sorg, & Welle, 2017).

Definitions of vulnerability refer to the relationship between a physical trigger and the negative impact realized, defined as the extent to which persons or things are likely to be affected by physical force (Flanagan et al., 2011). An assessment of vulnerability can lead to a better understanding of potential damage. Evaluating the extent of loss and damage is a good starting point to understand vulnerability in an area because it takes into account the exposure people and assets to a potential hazard represented in a quantifiable output. High vulnerability and exposure is often linked to urbanization and development in hazardous zones, which creates the conditions for disastrous consequences (Cardona et al., 2012). From this

perspective, vulnerability is a combination of risk and hazard exposure notwithstanding several other components that will be discussed.

Assessing the risk of a potential impact of a hazard expands beyond the biogeophysical and built environment. It should include economic, institutional and socio-cultural aspects of a place (Klein and Nicholls, 1999). Certain demographics such as the elderly, lower-end socio-economic conditions, community experience with hazards, gaps or failures in risk management governance and poorly informed or maintained risk reduction measures are highlighted as contributing factors (Colten, 2008; Morrow, 1999). To understand the likelihood of consequences, the role of social response is also presented as an important component of vulnerability (Cutter & Finch, 2008). These factors widen the concept of vulnerability, as discussed by Birkmann (2006), from something intrinsic to multi-dimensional, which includes coping capacities and the ability to recover. This is because even the most biophysically vulnerable places may not intersect with most vulnerable populations (Cutter, Mitchell, & Scott, 2000).

Therefore, definitions of vulnerability reveal a complex relationship with other concepts such as sensitivity, susceptibility and coping mechanisms, which also refer to potential damage and effects on the physical environment and community. The UN definition captures the range of qualities of vulnerability: 'The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards' (UNDRR, 2017).

Studies on vulnerability point to different variables. and while establishing categories may present limitations because forms can be transversal, several studies propose a set of classifications. Such classifications are helpful to organize a study on vulnerability and assess it. Alexander (1997) proposes six classifications of vulnerability described as total vulnerability, economic, technological or technocratic, newly generated, residual un-ameliorated and delinquent. Each of these classifications is characterized by the social and socio-economic context. For example, wealthier households have different household resilience levels and

coping capacities (Colten, 2008). Other descriptions of the social and institutional context refer to building in hazardous zones coupled with deterioration of the environment, the effects of unreinforced mitigation and prevention measures and failures of other types of policies and regulations such as building codes. This classification grasps the conceptual breadth of vulnerability as a social product and explains vulnerability using qualitative variables.

Vulnerability is multi-factorial and stems from the interaction between these various physical and social components presented that is particular to a space relative to interaction with a hazard (Velimirovic, 1980). To this purpose, it is important to determine the spatial dimension of a vulnerability analysis, whether it is at the local, regional or larger scale (Cutter & Finch, 2008). In addition to the spatial quality of vulnerability, it is also temporal and changes over time. For example, populations change, which impact physical exposure (Peduzzi et al., 2009). Other factors play a role such as the development of prevention measures, for example the levees and dikes often discussed in reference to New Orleans (Gordon & Little, 2009). Vulnerability is dynamic and can be explained by the interaction of different factors that influence each other in space and over time (Magnan, 2018). Therefore, understanding current vulnerability of a place can benefit from longitudinal studies that trace pathways of exposure and drivers of risk.

Given the multi-dimensional characteristic of vulnerability, some theoretical demarcations have been proposed, such as vulnerability as risk/hazard exposure, vulnerability as social, and vulnerability as place (Cutter, 1996). Conceptual differences on vulnerability inspire different methods to study, appraise and identify key components (Hufschmidt, 2011). One way to approach explaining vulnerability is using indicators to define the quantitative and qualitative variables. Moving forward, broad indicators are reviewed in the next section that can be found in the literature, which help frame a method to identify and organize the biophysical and social components of vulnerability.

## Exposure and susceptibility indicators

Some have discussed the indicators exposure and susceptibility to analyze the vulnerability level of a specific area to bring together the various components of vulnerability (Messner & Meyer, 2006). These indicators are not comprehensive, yet help to treat the various factors of vulnerability by distinguishing them between quantitative outputs (exposure and potential loss and damage) and qualitative characteristics (susceptibility, fragility and coping capacity). This distinction does not overlook that vulnerability is determined by the interactions between the factors, nor that these may be limited. Together exposure and susceptibility indicators are broad enough to provide an umbrella to fit a multitude of sub-components to organize an appraisal of vulnerability. The example of flood hazards is discussed to show how this vulnerability framework could be put into practice.

The *exposure* level can be translated into the quantitative outcome of all the objects in the area physically exposed to the hazard such as infrastructure, ecological systems, and people (Green, 2004). The exposure indicator is helpful by obtaining information on potential damage, that can be a financial output thanks to methods developed by engineers and actuarial scientists. In this way it looks closely at the technical parameters of the hazard and built environment (Messner & Meyer, 2006). For flood hazards, this includes the elevation level of terrain, duration, velocity and inundation depth (Kazmierczak & Cavan, 2011). It also includes factors such as frequency calculations described in flood time-return periods. Exposure analysis provides information on the physical environment including the natural ecosystem (geomorphologic processes) and elements at risk to different hazards, such as floods from coastal surges or surface water flooding that have different technical parameters and potential impact on objects and communities (Kazmierczak & Cavan, 2011; van Slobbe et al., 2013).

Exposure indicators describe the conditions of a society or element at risk that also determine the potential of the hazard's impact in terms of losses and damages (Birkmann, 2007). In other words one component of vulnerability is potential damage captured by the exposure indicator. The output is reached by evaluating all

the *elements-at-risk* in a given area, defined as objects in the human system, the built environment, and the natural environment that are at risk to flooding (Merz et al., 2007). The calculation of *elements-at-risk* take into account the time and space function of the flood hazard, meaning the duration and rate of water rising combined with location analysis of properties and natural systems at risk (Marco, 1994). These technical elements provide a robust quantifiable result of potential damage to different kinds of flood hazards including potential biodiversity loss in the natural environment. This component of overall vulnerability (exposure) captures a risk assessment of the potential damage of flood hazards to human assets (Romieu, Welle, Schneiderbauer, Pelling, & Vinchon, 2010).

Calculations of exposure based on overall potential loss can be acute by taking into account the value of infrastructure based on their use-function (Apel, Thielen, Merz, & Blöschl, 2004). Here exposure analysis reviews the kinds of assets in the area such as residential housing, public infrastructure, industrial buildings or businesses. The use-function aids to calculate economic costs of a natural hazard event including potential indirect costs caused by disruptions to business activities. The exposure level is the result of the aggregate of all the objects at risk, their use-functions to different simulations of flood intensity scenarios. This method can also be useful to give insight into the age and material of building structures which may be more susceptible to damage.

The advantages to the exposure indicator is that it allows arrive to a quantifiable result of the sum of all the valorized elements-at-risk to the hazard. The importance of this exercise is that it contributes to the development of flood risk maps, which are important management tools. Flood risk maps use information derived from exposure indicators to illustrate spatial distribution of flood hazard probabilities (Merz et al., 2007). These maps help to visually understand the exposure of communities to flood risk and can serve as a risk communication tool to inform members of the community and local authorities. An advantage of these maps is the ability to illustrate the flood hazard in terms of the intensity of floods and associated exceedance probability in which potential direct economic damages are calculated within a certain area (Merz et al., 2007). Therefore, they are also used by

insurance to calculate risk exposure and potentially the pricing of premiums as well as local authorities to guide urban development and planning. Within this vulnerability framework, exposure levels communicate an understanding of the spatial distribution and physical exposure to the hazard while also introducing the role of mapping exercises to communicate flood risk.

Human interventions can change the environment and augment exposure and vulnerability, such as building in hazard prone areas and installing protective infrastructure (Colten, Kates & Laska, 2008). For flood risk, activities like pumping and draining water, digging, destroying and depleting marshlands and estuaries, and modifying beach-lines impact physical vulnerability because they modify natural barriers or buffer zones (Pearcy & Colten, 2002; Colten, 2005). Vulnerability of coastlines are especially dynamic and require to look at, 'the exposure of social (and environmental) systems to stress as a result of the impacts of environmental change. This environmental change may be some combination of natural or anthropogenic forcing factors' (Pethick & Crooks, 2000: 359). Therefore, exposure indicators address the hazard and elements-as-risk within a space, as well as the role of human interventions that modify the natural environment and ecosystem services.

Exposure as part of vulnerability should also address the socio-economic context, which plays an important role in the potential damage a natural hazard event may have on a particular area (Cutter et al., 2003). The *susceptibility* indicator is proposed to include other vulnerability components such as the socio-economic context, function of objects and the capacity of social units to deal or cope with a risk (Merz et al., 2007). *Susceptibility indicators* refer to the sensitivity of elements-at-risk if confronted by a risk by analyzing the social and economic fabric of the community, which enables to answer 'how the elements will be damaged' (Messner & Meyer, 2006). The indicator describes the weakness of a system or element exposed, and even the existence of coping capacities, such as positive resources to deal with the negative impacts of a hazardous event (Birkmann, 2007). Therefore, preparedness is often discussed as way to reduce vulnerability.

Susceptibility indicators cover a wide range of social factors of vulnerability including access to community resources, networks and social capital, otherwise described as, 'The social fabric which, includes community experience with hazards, and community ability to respond to, cope with, recover from, and adapt to hazards, which in turn are influenced by economic, demographic, and housing characteristics' (Cutter, Boruff, & Shirley, 2003: 243).

Social vulnerability recognizes the role of communities and social infrastructure such as personal networks to cope with disasters, which if absent can lead to higher and long-standing impacts (Aldrich & Meyer, 2014). This explains why community-based approaches are used to tap into the local dynamics of vulnerability and propose participation that creates strong social networks (Allen, 2003). This explains why enhancing local participation through community leadership and empowerment are highlighted to foster preparedness, as individuals are more informed about hazards, and build trust networks through sharing these experiences (Pandey & Okazaki, 2005). Public hazard education programs have not been proven to encourage individual preparedness, as often responsibility for safety is transferred from the self to others (e.g. emergency response, local governments) (Paton, 2003). Nevertheless, studies show that *linking social capital* may help overcome any information gaps about natural hazards and build trust within community networks which can influence social vulnerability conditions (Aldrich & Meyer, 2014). Access to resources such as knowledge, information and technology can influence social vulnerability (Birkmann, 2007; Kazmierczak & Cavan, 2011).

Social scientists have been developing indicators to appraise social and institutional norms that contribute to social vulnerability (Birkmann, 2007; Tate, 2013; Saja, Teo, Goonetilleke, & Ziyath, 2018). These are complex models given that they need to take into account uncertainties of human behavior. In addition, different socio-economic contexts access to information and resources have implications on social cohesion (Morrow, 1999). For example, poorer households may have less



resources and access to supplies to anticipate an event, and cope in the aftermath. In addition, housing structures often reflect income status and less resilient buildings are more susceptible to damages from natural hazards, thereby showing the relationships between exposure (elements-at-risk and function) and socio-economic context (susceptibility). In addition, political processes influence development in hazard prone areas (Morrow, 1999). Studies show how risk is concentrated in certain demographics and socio-economic contexts in areas on account of development trends and post disaster rebuilding methods (Morrow, 1999).

Social vulnerability and can be informed by demographics such as age, race, health, type of dwelling, employment and the socio-economic context (Cutter et al., 2003). This is because studies show how certain demographics may have more difficulty to cope in an event. for example, elderly, handicapped and young children are often considered more vulnerable segments of society because of reduced mobility and difficulty to respond to warnings (Rapaport, Manuel, Krawchenko, & Keefe, 2015). Seniors tend to be more reluctant to leave their homes in the case of a disaster event. In addition, socio-economic conditions of the demographics are also linked to coping capacity and preparedness, which relates to access to mobility. For example, in the case of Hurricane Katrina in New Orleans emergency plans did not take into account the risk that poorer communities might not have the means to evacuate such as vehicles.

In conclusion, there are many sub-components of susceptibility that together with exposure indicators help to build a framework that may be useful for evaluating vulnerability to an identified space (Turner et al., 2003). The framework takes into account risk calculations and probabilistic modeling to determine *exposure* levels by valorizing the objects, also termed ‘elements–at-risk’ to determine a potential loss (Messner and Meyer, 2006). The framework is further elaborated upon by taking into account the social, cultural and economic context, which includes coping capacities (Romieu et al., 2010). The exposure and susceptibility indicator

model is useful to explain vulnerability to flood risk. It calls for some reflection on the interaction between components in the natural system, built environment and socio-cultural characteristics of the area that is analyzed. Furthermore, it does not discuss the role of temporal changes in vulnerability.

Differently, to appraise vulnerability, other indices have been proposed so to enable comparative analysis (Bersani, Dumas, et al., 2010). Birkmann (2006) explores some of the methods used to assess vulnerability, for example at the national or global level, such as the Disaster Risk Index, the use of identifying hotspots of disasters approach by using human and economic loss as vulnerability measurements, and a more comprehensive approach based on a multi-layered indices and sub-indices. All of the approaches have advantages and disadvantages in their applicability as discussed by Birkmann. Similarly, local scale assessments can take various approaches such as using a community based index.

## Disaster risk

Disaster risks are the main interest of this thesis. Several lines of evidence suggest that arriving to one single definition of a disaster is as Quarantelli (1995) phrased it 'chimerical'. A first interest is to identify some variables of disasters by reviewing the definitions of the concept proposed in the scientific literature and by international organizations (Ilan Kelman, 2011).

### Defining disasters

One kind of definition of disaster centers on the relative occurrence and consequences, otherwise explaining disasters as events that are low-probability and incur a large destruction (Perry, 2007; Quarantelli, 1987). The variables important in this definition are the probability of occurrence, the level of loss and the relative impact. Firstly, the low probability of occurrence suggests that there are uncertainties surrounding these events. Given technological advancements, modeling capabilities and scenario analysis, the interest in uncertainties and the risk of disasters are dealt with in terms of emerging risks and complex disasters. Nevertheless, uncertainty and risk are considered inextricable (Knight, 1921). Therefore, disasters provide data that allow to reevaluate risk and uncertainties, which are important for informing risk management and reduction practices (Berkes, 2007).

Secondly, definitions of disaster refer to an event that is characterized by a high magnitude of damage and loss. These damages and losses are often categorized as tangible and non-tangible, and include damage to people, assets and the environment, with increasing attention to cascading affects such as disruption to social and business activities and even impacts on global value supply chains (OECD, 2011). Loss is distinguished from individual experiences with a traumatic event and aggregated consequences. Most definitions of disasters refer to an event that impacts a large group of individuals by a single event, which make them

collective experiences (Tierney et al., 2001). Then we should ask if there are agreed upon thresholds and when they are reached does it mean that an event is unanimously defined as a disaster? It is suggested that they are quantitatively defined on the basis of number of fatalities and monetary loss relative to thresholds which distinguish them from mere incidents (Alexander, 1997). For example, databases often set a minimum damage and loss threshold to systematically gather data on disaster and categorize them. EM-DAT criteria for inclusion of events requires at least ten fatalities and at least one hundred people affected (EM-DAT, 2019).

Some definitions of a disaster describe the characteristics of the event such as its source and the temporality of impact. Shaefer (2003) suggested that a disaster is, 'A sudden or disruptive event or set of events that overtaxes a community's resources so that outside aid is necessary.' Both of these definitions attempt to characterize the event either by pointing to the trigger that could be natural or man-made and the duration of impact. Disasters are not only events that entail an immediate impact but include events where negative effects are realized over time. The UN Office for Disaster Risk Reduction (UNDRR) also provides sub-points to clarify its definition of disaster, which includes: i) small-scale disaster, ii) large-scale disaster, iii) frequent and infrequent disasters, iv) a slow onset disaster, and v) a sudden onset disaster (UNDRR, 2017). This need for clarification suggests that there are different kinds of disasters, involving different hazards and physical forces, temporalities and scales of impact.

A disaster could also be defined by the characteristics of the event and explained by the context in which it occurs. For example, Hood & Jackson (1992) explore disasters in complex modern societies and define these events as, 'an out-of-the ordinary event that result in extensive death, injury, damage or economic loss, and which reveal the weakness of social arrangements designed or believed to prevent such occurrences' (Hood & Jackson, 1992: 17) From this approach, disasters are associated to risk management practices that aim to reduce their consequences. According to this definition, disasters reveal the break-down down of social coherence and the limitations of prevention and control, which brings attention to the role of risk management practices. Therefore a study on disasters highlights an

interest in governance schemes involving different stakeholders and policies surrounding risk reduction practices.

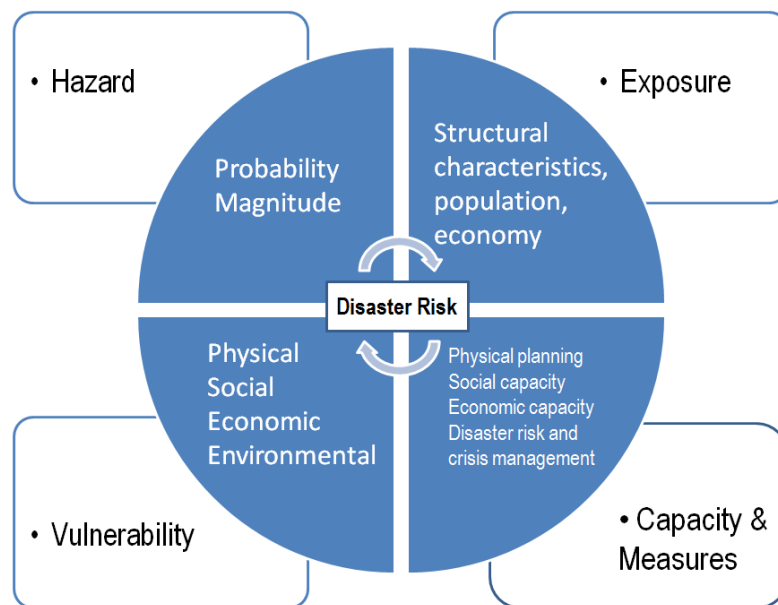
Many disaster definitions do not only refer to the magnitude of damages but include the extent to which society is disrupted and can cope with the event. The International Federation of the Red Cross (IFRC) defines the term as, 'A disaster is a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources' (IFRC, 2019). The IFRC relates to the internal coping capacity of the social fabric to withstand the event. Similarly in the scholarly work on disasters in large organizations, disasters mean that organizational capacity of local units are overwhelmed to deal with the event (Perrow, 2002).

The definition provided by IFRC is broken down in the following equation (vulnerability + hazard) / capacity = disaster. Given this equation, the interaction between social systems and the physical hazard define overall vulnerability which can be reduced by coping capacities. The disaster is defined by the level of vulnerability to a potential magnitude of loss and damage, based on exposure and susceptibility indicators that was presented in the literature review on the concept of vulnerability. Similarly, Britton's (1986: 354) definition focuses on the social construction of disasters, 'Disaster is a social product. The propensity for disaster is dependent upon the interplay between humans and their use of the physical and social world.' Therefore, disasters clarify the relationship between risk and vulnerability, and in particular the role of human activities in increasing the potential effects of natural hazards in a given area as presented by the UNDRR definition,

*'A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.'* (UNDRR, 2017)

Based on a selected set of definitions, some themes identified that characterize disaster events include risk (probabilities and uncertainties), magnitude of loss,

limitation of risk management and reduction measures, the role of vulnerability to hazards and coping capacities. The definitions reveal the relationship to vulnerability and significance of exposure and susceptibility explored in the last section. This relationship is captured in Figure 3, which includes 'capacity and measures' which refers to the capacity to anticipate, prepare, cope and respond to disasters risks such as physical planning schemes, social and economic capacities. Given these interconnected relations, the consequences of disasters are explained because of pre-existing conditions of vulnerability which are dependent on and related to the other factors.



**Figure 3 The relationship between disaster risk, hazard, vulnerability, exposure and capacities**

Source: Davidson, 1997; UNU-EHS, 2013

This section dealt with the definition of disaster risk, which was explored in the scientific literature since the 1990's and largely dealt with the relationship of this risk to other concepts including hazard, vulnerability and exposure. The next section clarifies why disaster risk was the term adopted in the thesis by presenting

other terms that are used to define extreme or large-scale events and appear in the disaster risk governance and management literature.

#### Other terms

Different disciplines have approached the question 'What is a Disaster?' (Perry, 2007) to distinguish the term from other concepts and to better define the criteria of disaster events. Although Quarantelli rightfully expressed that 'any attempt to derive an absolutely final conceptualization that will be forever accepted is a chimerical exercise' (1986), reviewing other terms give clarity on why the term disaster is used in the thesis. Given that there is no universally agreed definition because disasters are treated differently across disciplines, this section distinguishes disaster from other terms that can be used to describe the same event or a phases of an event (Shrivastava, 1993). In research and studies on disasters, often times other concepts are used to describe the disaster or a phase of the event, which includes concepts such as crises, emergencies, incidents, failures, and catastrophes among others (Tierney et al., 2001). The semantics are important to ensure clarification of the terms and in particular what characterizes a disaster as used in the thesis.

The term crises are often used to describe the period right after impact of a physical force (Shaluf, 2007). It is characterized by a timeframe where decisions need to be made quickly signifying the urgency of the situation (Baubion, 2013). Some propose that there are different timeframes of crises (Fink, 1986). The term crisis emerged in medical literature to describe organisms facing fatal conditions in which recovery could not be made self-sufficiently. In risk management literature, crises can be used to describe different events such as business or corporate crises, organizational accidents, socio-technical system failures, and community crises triggered by any kind of physical agents (Quarantelli, 1987; Shrivastava, 1993; Howell & Miller, 2006). Therefore, crises are not determined by a particular physical trigger, but imply negative impacts and in particular a disturbance to a social system (Boin & McConnell, 2007). While emergencies are situations where normal resources and capacities are exceeded (Alexander, 2002), crises result in a

breakdown of symbolic frameworks that legitimize the pre-existing socio-political order. Crises and emergencies in the context of disaster risk management often refer to organizational accidents or the response phase associated with *crisis* or *emergency* management (Davies & Walters, 1998; Baubion, 2013). Therefore, to distinguish a *disaster* from a crisis, it assumes the event is characterized by not only a high magnitude of damage and loss of life but long-term damages to community livelihoods, infrastructure and property (Boin & McConnell, 2007).

*Incidents, accidents and failure(s)* are other terms that emerge when a large-scale event occurs. Often times these are used to describe a disaster attributed to a major technological -industrial -accident or collapse of some kind of social system (financial, organizational). In the risk management literature especially on complex organizations, disasters refer to large-scale accidents in socio-technical systems which are caused by failures or errors in inter-related technical and human components of the system (Perrow, 1984; Turner, 1994). Therefore, failure is often discussed in the context of ‘safety-culture’ in organizations to prevent such occurrences (Gilbert, Amalberti, Laroche, & Paries, 2007). Although an accident and failure are not often used to label an event that involved a natural hazard, they can come up in the aftermath to explain the extent of consequences. The effects of Hurricane Katrina in New Orleans takes into account the failure of the levee system and questionable emergency management decisions (Colten, 2009). The concept of failures explored in risk management literature on socio-technical system accidents provide valuable insight on the role of technology, infrastructure, and risk reduction policies that fail and contribute to the magnitude of consequences in natural hazard induced disasters.

*Catastrophe* is also a concept that emerges in studies on disasters to describe an event (Alexander, 2000). Some suggest that catastrophes are in a league of their own and events that are on the furthest end of the magnitude scale (Boin & McConnell, 2007). However, the difference between these two words can be described as ‘merely semantic’ (Boin & McConnell, 2007: 53). In French a natural disaster is translated as *catastrophe naturelle*, but its meaning is disaster. It is not clear then if magnitude plays a role in the use of the term in French to distinguish a



*un desastre*<sup>10</sup> from *une catastrophe*. Similarly, it does not appear that there are unanimously agreed thresholds to label an event a disaster or catastrophe, if the latter is suggested to be in a league of its own. The same event can be described as a catastrophe, calamity or incident and often include references to an emergency phase, a crisis and failures or errors, which is why a review of all concepts is pertinent to a study on disasters.

### Classifying types of disasters

The interest in reviewing the terms in the literature on disasters is not only because they may be used interchangeably but because they can explain many different kinds of events. As expressed by Quarantelli, 'The referent of the very word 'disaster,' as used in the English language, has changed through time, At least the source of the phenomena has been attributed differently at different historical times' (1987: 8). Different kinds of events such as pandemics, industrial accidents, cyber-attacks and extreme weather can be labeled a disaster. Each of these events imply low probability, disruption and destruction, and reveal limitations of technology, organizational risk management practices and social structures to control or prevent the event, as suggested as main variables in the definition of disaster discussed in the previous section. However, the work on classifying disasters and relevant criteria has been discussed conceptually and in practical terms to manage databases. Most data-bases on disasters broadly classify events across man-made, technological or natural (Sapir & Misson, 1992). The EM-DAT database covers several categories, sub-groups and sub-types to classify disasters (Table 5). These nine different classifications of disasters set by the EM-DAT database require a minimum threshold for each type of event yet includes different kinds of occurrences.

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<sup>10</sup> *Disastre* comes from two latin words 'Dis, astro', which roughly means, formed on a star (Quarantelli, 1987: 8)

**Table 1 EM-DAT disaster classifications**

Geophysical	Meteorological	Hydrological	Climatological	
Earthquake Dry mass movement Volcanic activity	Extreme temperature Fog Storm	Flood Landslide Wave action	Drought Glaciallake outburst Wildfire	
Biological	Extraterrestrial	Industrial	Transport	Misc.
Epidemic Insect infestation Animal accident	Impact Space weather	Chemical spill Collapse Explosion Fire Gas leak Oil Spill Radiation	Air Road Rail Water	Collapse Explosion Fire Other

Source: EM-DAT, 2019

A conceptual analysis of categories of disasters should consider: what factors to include for defining a group of disasters? Quarantelli asks, ‘can they {disasters} be treated as members of one relatively homogenous class or are there some quantitative or qualitative differences which necessitate the development of subtypes?’ (Quarantelli, 1987). For example, the Bhopal gas disaster in 1984 that was one of the worst industrial accidents exposing hundreds of thousands to toxins. Separately, Hurricane Katrina triggered flooding, which led to human loss and the displacement of an entire community. 9/11 was one of the worst terrorist attacks on US soil. All of these events are deemed disasters. The question is if there a commonality between various kinds of disasters or is it important to make a distinction?

Some scholars have proposed typology frameworks to distinguish disaster events from one another (Berren, Beigel, & Ghertner, 1980). Berren and colleagues suggested the classification of disasters using five different dimensions. The first dimension calls on a review of whether the event was *purposeful* or an ‘*act of God*’. The second and third factors focus on the temporal and spatial components of disasters, including the *duration* and time-effect, and the degree of personal impact. Fourth factor reviews the potential for occurrence or reoccurrence. Lastly, the fifth factor considers the extent to which it is possible to control future impact. According to this typology, a disaster can describe various depending on the measurement of each indicator, and how they combine.

The five factors typology proposed by Berren and colleagues is useful as it indicates a common trend for disaster studies. However, further work is required to deal with interesting notion provided in factor one: *purposeful* or '*Act of God*' as it brings forward the interest in explaining cause-effect of disasters. Given that 'act of God' is an outdated term and no longer applicable, disasters imply 'Acts of Men' or events that involve social and human attributes (Britton, 1986; Cannon, 1993; Quarantelli, 1987).

Disasters open an interest into causation, which is attributed to a physical trigger. Since the consequences of unwanted effects mean that there was involvement of a physical force, then both are constant variables to define any kind of disaster (Sugarman, 2007). The force may be associated to something human, the natural environment and technological based on broad classifications found in databases. While research has broken down the polarization between defining technological-, social-, and natural- disasters by explaining that consequences are rooted from multi-factorial vulnerabilities (Hood & Jackson, 1992), environmentally triggered events are sub categorized to help inform data-bases.. Natural hazard induced disasters are often classified as geophysical (earthquake, volcano, dry mass movement), meteorological (storm), hydrological (flood, wet mass movement) and climatological (extreme temperature, drought, wildfire), as found in the NatCatService data-base managed by MunichRe.

Exploring classifications of disasters presents 'hybrid' events that involve several agents. While hybrid may be a term used to avoid defining something, in this case it aims to explain the complexity of modern day disasters including those that stem from natural hazards (Hood & Jackson, 1992). 'Hybrid' disasters refer to human error and natural forces as agents of the disaster. Examples to explain the involvement of several components point to flooding in a built flood-plain or 'the extensive clearing of jungles causing soil erosion and subsequently heavy rain causing landslides' (Shaluf, 2007: 697). 'Hybrid disasters' is a part of the increased tendency to review natural disasters as caused by social conditions, rather than a result of purely geophysical agents (Quarantelli, 1995). This is further explained by the focus of disaster studies on pre-existing risk conditions described as the

exposure and susceptibility of assets and communities to natural hazards (vulnerabilities).

These works from the late 1980's and early 1990's on defining disaster types remains pertinent to our research today on disaster risk management. This is because of increasing cases of combined disasters. One example of a disaster wavering between natural, man-made and technological is the Fukushima Daiichi nuclear disaster that occurred on the 11<sup>th</sup> March in 2011. An initial earthquake created a tsunami that hit the nuclear site situated on the eastern coastline. This prompted equipment damage and a nuclear meltdown. Direct source of the disaster to the nuclear site was environmental. At the same time social decisions led to higher conditions of vulnerability. The social dimension focuses on issues such as building plans for the nuclear site in a risk-prone area and failure of management decisions at the site to have certain preparedness measures in place, such as technical plans in the case of equipment failure. Airplane crashes are another example of events that can be a hybrid category, depending on a combination weather conditions, decisions made by the pilot and technological errors.

## Governance and disaster risks

In this part of the literature review, the focus is on the concept of *risk* and the governance structures that drive disaster risk management policies and practices to address hazards, exposure and vulnerability. While the previous part focused on the conceptual relationship between vulnerability and disasters, risk governance envelopes a framework of stakeholders, tools and decision-making processes that aim to reduce the potential consequences of disaster risks, also referred to as mitigation, prevention and preparedness measures (Renn & Walker, 2008). As disasters are also complex events, as just described in the previous section, because they involve different kinds of physical forces and uncertainties, risk reduction is equated to vulnerability reduction, which involve different tools, expertise and approaches (Cardona et al., 2012)

The literature on disaster risk management and similarly risk management in organizations suggests that managing risks and reducing them is complex because decision-making is often based on available data derived from previous events around an anticipated future. Decision-making around risk and uncertainty bring interest into risk perception, judgment, values, trade-offs and interests that can influence choice (Kahneman & Tversky, 2013; Renn, 1998). At the same time, risk has been described as a 'driving force', meaning it has an agency quality that frames organizational management and governance regimes (Hutter & Power, 2005; Renn, 2008). Furthermore, the literature on risk sheds light onto some barriers or challenges that play a role in disaster risk management because they also help explain the underlying drivers of vulnerability. Here we present some of the literature that discusses the concept of risk and its significance to framing complex risk governance frameworks that intend to manage and reduce disaster risks, hazards and vulnerabilities.

## Risk and governance

*Disaster management* and disaster *risk* management are different approaches. *Risk* refers to the pre-existing conditions associated to damage, otherwise known as exposure and vulnerability as was the central theme of the first part of the literature review (Cardona et al., 2012). The significance of this distinction here, is that they frame how we manage and deal with disasters in anticipation and to cope with their effects. Therefore, the former is response-based and the latter views the problem of disasters in terms of not only damages and losses, but also the natural hazard and associated effects. The first part of the literature review dealt with the concepts of vulnerability and disaster, the former explaining how and why the conditions of a hazard-prone area became that way and the latter on different kinds of physical forces. While the hazard cannot be influenced, vulnerability and exposure can be through various risk reduction policies and management practices. Hence, the interest in this part of the literature review is on the concept of risk that shapes those different planning tools and policies to deal with risk, otherwise referred to as risk governance regimes.

Risk has been studied by a wide range of disciplines, which explains why risk governance structures aim to integrate the entire portfolio of expertise to tackle the risk problem (Renn, 1992). Engineers, contractors and managers tend to approach risk from a technical perspective defining it as a value measured in probabilities (Knight, 1921). Often times, risk is translated into a probabilistic future, described as a ‘risk triplet’, which, ‘includes a scenario, the likelihood of the manifestation of that scenario, and the consequences of events within that scenario’ (Francis & Bekera, 2014: 91). This *realist approach* presents risk objectively, as a probability based on scenarios that assess the likelihood of an event in the future and an outcome (Bradbury, 1989; Hope, 2017). Such an angle in risk governance permits to deal with risk as a tangible peril, or simply the probability of a certain outcome, which could be positive or negative (i.e. a hazard). Often, risk is associated to disruptions from the norm and *unwanted effects*, defined as the probability of an ‘adverse event’ multiplied by the impact (i.e.  $\text{risk} = \text{probability} \times \text{damage}$ ) (Zinn, 2008). Disaster risks, as the main interest in the thesis are defined by their low

probability occurrence and associated negative effects (Quarantelli, 1995), which shape certain kinds of governance arrangements.

Risk as a probability is observed in several technical practices such as actuarial science used by insurance and finance, as well in disciplines of engineering and epidemiological research (Renn, 1992). These various fields play an important role in risk governance frameworks. To assess the probabilities of risks, past events are often used. The more data there is available to calculate risk, the easier it is to compare with a hypothetical future. In cases of disaster risks where the hazard is associated to recurring events such as tropical cyclones or flooding in floodplains, the risk is easier to calculate. However, any kind of limitations to these risk assessments are often associated to uncertainties, as the two concepts are considered inextricable (Knight, 1921). Uncertainties can be overcome with the accumulation of knowledge and complex modeling. Therefore, Knight suggested that uncertainty could not be calculated because it is not based on past data. This means that *zero risk* does not exist. Others approach uncertainty differently, such as O'Malley who described uncertainty as an 'alternative to risk' (2004). From this perspective, uncertainties surrounding risks are complex, especially for emerging risks, where there are few references to past events. With growing complexity of interconnected societies and human-ecological systems, as well as growing work on the impact of climate change patterns on hazards, disasters are associated with some uncertainties (OECD, 2011).

Risk has also been studied by social scientists and cultural theorists, looking at how persons deal with risk, expectations, and uncertainties in everyday matters (Zinn, 2008). These studies are interesting to inform the notion of social construction of risk, risk framing, and culture of risk studies (Hilgartner, 1992; Cannon & Schipper, 2014; Cornia, Dressel, & Pfeil, 2016). These complementary approaches to risk have widened risk governance research from risk management practices to incorporating social and cultural approaches to risk, which include the role of social capital, information communication channels and perception in disaster risk reduction and preparedness (Cutter, 2016).

Other approaches to risk have shed light on risk information and communication in governance frameworks, including studies on risk perception and choice. Cognitive psychologists have contributed to studies on decision-making under risk and uncertainty, which have led to some striking evidence on systemic biases, showing that subjective interpretations of risk transform risk probabilities into something easier to digest and relatable according to a person's experience with risk (among others, see Kahneman & Tversky, 2013). Studies on the perception of risk brought forward valuable information on behavior and choice to design risk governance regimes by showing that individuals tend to rely more on intuition and familiarity when assessing risks. These studies on systemic biases towards evaluating risks are significant in the context of natural hazards, where experience can play a role in heightened or lowered perception of disasters and the decision-making processes behind choosing different tools to manage and reduce risks. Biases depend on a variety of factors, including different methods of risk communication and availability of information, which are important for informing effective risk communication channels to decision-makers as well as to different segments of the population that may be impacted by risks (Lichtenstein et al., 1978; Fischhoff et al., 1993).

Psychological, sociological, and cultural approaches extend the concept of risk from an objective probability to one that incorporates behavior, social structures and culture, and values (Hope, 2017; Renn, 1992).

Interests for developing studies on risk in cognitive psychology were inspired by earlier studies in risk economics. Economists have evaluated behavior and risk starting from the notion of expected utility (Arrow, 1968). A certain assumption in this normative model is that people are rational (Camerer & Kunreuther, 1989). From this *homo-economicus* paradigm, an individual assesses risk by comparing the likelihood of gains and losses in different probable outcomes. However, studies in behavioral economics on risk and decision-making informed by psychological research presented limitations to such a model bringing in normative theories on how people make choices. In particular, research put to test the rational agent paradigm and utility-theory on making decisions and introduced *bounds* of human



behavior. These bounds are known as *bounded rationality*, *bounded willpower*, and *bounded self-interest* (Simon, 1955; Mullainathan & Thaler, 2000;) . Each of these bounds explore how people do not behave necessarily according to economic assumptions about utility maximization, stable set preferences, rational expectations and information processing (Jolls, Sunstein, & Thaler, 1998). Instead, systemic biases indicate that individuals are influenced by a range of other factors when making decisions. These insights have led to interesting studies on insurance for disaster risks, which is an instrument that is often discussed in the disaster risk governance literature (Ericson, Doyle, & Barry, 2003) and will be given particular attention at the end of this chapter.

Integration across disciplines of risk allow to understand the significance of the concept in a variety of contexts, which are pertinent to understanding the multitude of actors and processes involved in risk governance structures. Even more, an understanding of these various approaches to risk provide insight into how risk governance functions to address complex risks, where some present opportunities and others disastrous consequences. Against this backdrop, some pertinent questions arise, such as how to identify and assess different kinds of risks? What to do about them? Who has the expertise to decide the right response? These questions are captured by risk governance frameworks that aim to integrate different disciplines of risks, which is presented in the next section.

#### The governance of disaster risk management

Governance has been a central focus in the area of disaster risk management and is has been put forward as a leading theme by several international organizations such as the UNDRR, IRGC, OECD and is the second pillar of the Sendai Framework for Disaster Risk Reduction (IRGC, 2017; OECD, 2014b; UNDRR, 2015). In general, governance refers the complex system of institutions, organizations and other actors involved in decision-making processes and the policies in place to address an issue (Keping, 2018). Drawing from the risk governance literature, components of good governance are associated with having in place legitimacy, transparency,

accountability, rule of law, responsiveness and effectiveness in decision-making processes, policy design and implementation (Keping, 2018). Processes of good governance involve bottom up engagement, partnerships and coordination to mobilize many stakeholders that have different skills and expertise on risks (Renn & Jäger, 2008; Renn & Schweizer, 2009). Hence, understanding the concept of risk and the various approaches as presented in the previous section are important to grasp this multi-stakeholder framework.

The rise in governance is marked by a shift towards a non-hierarchical governing structure involving many public and private actors including society in the decision-making process, where the government is no longer the sole body making social and political decisions (Renn, Klinke, & van Asselt, 2011). Risk governance is the conceptual and normative framework of institutions and actors making decisions about different risks, managing them and communicating them. Risk governance deems varying skills and expertise of actors, knowledge bases and perceptions for understanding risks and values and interests that influence decision-making. As Renn and colleagues (2011) described this, risk governance is enveloped by a diversified and multi-layered socio-political landscape. Risk governance has implications on society's expectations that negative consequences can be prevented. Making decisions about risks and implementing regulations or policies to control them and protect society, can also put pressure on governments and experts to deal with them (Tierney, 1999).

'Good governance' is earmarked as a framework and process for effective disaster risk reduction (Amundsen, Berglund, & Westskogh, 2010; Bauer, Feichtinger, & Steurer, 2012; Janssen et al., 2017). To inform the analytical work on good governance, case studies shed light on levers and barriers to implementing good governance in practice to address different kinds of risks (Bauer et al., 2012; Granberg & Elander, 2007). These studies explore a variety of political, economic and social contexts that shape risk governance regimes.

Actors are important agents in activating and making sense of risk management, as the very responses '...depend on perspectives of the different actors in society'

(Bradbury, 1989). Even more it may be viewed that the responses to risk in parallel define and construct it (Gilbert, 2003). Governments are often believed to be the ‘ultimate risk manager’ because they have the fundamental task to maintain security and protection for citizens. However, institutions are also important instruments of risk communication, and thereby can shape risk perception in society (Douglas & Wildavsky, 1983). The politics of risk reveal at times competing perspectives and interests (Gilbert, 2003). Issues in policymaking include budgetary concerns about precautions taken and how some prevention measures may damage powerful interests.

Disaster risks stemming from natural hazards are complex events in dynamic socio-ecological systems (Barnes et al., 2017; Cinner & Barnes, 2019). Disaster risk governance refers to ‘the way in which the public authorities, civil servants, media, private sector, and civil society coordinate at community, national, and regional levels in order to manage and reduce disaster and climate related risks’(UNDP, 2013).The disaster risk governance framework is characterized by coordination, information-sharing, decision-making tools across the risk management cycle. Disaster risk governance seeks to explain the political, technical, social, cognitive, cultural, social and resource challenges to manage and reduce risks.

Given that exposure and vulnerability stem from intricate interactions in human-ecological systems and that disasters are multi-component events, then drawing from the literature on risk governance and risk management in organizations provides useful insights to inform the complexity of the disaster risk management framework. Risk management studies in socio-technical systems shed light onto challenges that may arise in disaster risk governance frameworks such as risk perception, communication and decision-making (Pidgeon, 1991; Turner, 1994; Vaughan, 1996). This includes the theory of ‘normal accidents’, in which the complexity of interconnected socio-technical systems creates the inevitability of failures and disasters (Perrow, 1984). Such work provides insights for the study of disasters that involve natural hazards, as there are parallels made with the complex intersections between socio-ecological systems reflective of systems of systems thinking (Huiteima et al., 2009; Barnes et al., 2017).

Disaster risk management is sometimes presented in a cycle approach, for example by multi-national organizations (United Nations Disaster Risk Reduction (UNDRR) to highlight the importance of delegating roles and responsibilities to stakeholders across different phases of risk reduction (assessment, prevention, preparedness, response and recovery) (UNISDR, 2013). From this approach there are phases of disasters, notably distinguished between before and after the shock (Khan, Vasilescu, & Khan, 2008). The value of approaching disaster risk management in cycles is the potential role that feedback loops can play (Coles & Buckle, 2004). Disasters test the governance arrangements in place that aim to reduce consequences and allow re-evaluating the effectiveness of various risk reduction policies.

The disaster risk management cycle often starts with the phase of identification and assessment of the hazard and the potential consequences of an event in a given area. The concept of risk assumes that disaster risks are predictable and identifiable. Risk management traditionally uses a bottom-up approach starting with the collection of hard data and analysis. This includes evaluation of the hazard and vulnerability to assess disaster risks. Risk as a probability supports a linear process for management. In the 1970's risk was defined as probability multiplied by consequences. In the 1980's risk management included defining and measuring: the hazard, exposure and consequences, also translated into threat, vulnerability and consequences. Specific knowledge and quantification are needed for each of these components.

The shortcomings of calculative approaches arise for managing complex risks and uncertainties. The assessment of disaster risks stemming from the natural environment requires to consider how they can manifest in different ways, and includes evaluating potential knock-on effects and indirect costs that are more difficult to appraise. In the 2000's instead of managing *absolute risk*, complex algorithms and matrices allowed to integrate risks. The utility of different matrices may be matched with management strategies more suitable for novel types of risks. Such an approach is useful to assess disaster risks in complex societies and take

into account the effects of disasters on interconnected critical infrastructure and potentially global supply chains (Boin & McConnell, 2007; OECD, 2011)

Assessment and evidence to inform policies presents the important role of scientific agencies (for example, hydro-meteorological agencies) that can provide data on hazards that has been collected over time. At the same time, it is important to update risk information to inform different kinds of measures and gain understanding on complex, interrelated or interconnected risks. The use of scenarios and foresight are good ways to think outside of the box. Disaster assessments are presented in several forms, such as damage and loss reports, press conferences, investigations and even trials. The purpose of these different forms serves different outcomes. In some reports the focus is on damage assessments, such as the assessment reports on the impact of Hurricane Irma in the Caribbean (ECLAC, 2018). In this case, the assessment is used to gain understanding of needs and available funding mechanisms. Other reports inquire on the lessons learned from the event. Post disaster inquiry give the assumption that something could have been done to prevent the damage or at least should be used to avoid similar occurrences in the future. By reviewing them publicly it provides a level of reassurance that some kinds of ‘lessons are learned’ to deter future occurrences, negligence or errors in managing risks. Post-disaster inquiries are important moments of seeking out explanations for the cause of the damages, and also bring into question responsibilities.

Disaster and disaster risk assessments help to inform prevention and mitigation. The effectiveness of risk governance is observed by the success of decision-making processes and policies to prevent negative consequences of the risk of disasters. Measures for disaster risk reduction are usually distinguished between structural measures such as seawalls, dikes, levees and dams; and non-structural referred to as building codes, land-use planning, restoring wetlands, raising risk awareness as well as semi-structural measures (Jha et al., 2012). In addition, there are other types of measures such as grey infrastructure, nature-based solutions or ecosystem-based measures, which are often used in flood risk management for example planting mangroves can decrease flood risk along the coast (Depietri & McPhearson, 2017).

The state as risk manager means that the politics behind managing risks require priorities to be made about resources and addressing public demands. In the book *La Fabrique du Risques* (2003), Claude Gilbert explores why some risks draw attention, and how hierarchies across public organizations prioritize risks. The government aims to integrate risk management practices to achieve an overall collective security. However, information about risks across institutions and society may be different and this could lead to influencing which risks are prioritized and how resources are allocated. Perceptions of risk often require tradeoffs between scientific expertise— in the ‘objectification’ of risk and public perceptions of it. Expertise on hazards can collectively involve universities and research communities. What is done with this data and information is another process, which may find contention on how science is incorporated into a larger organizational culture within public agencies and public organizations (Gilbert, 2002). As public authorities deal with a large amount of risks, prioritizing them depend on public opinions, budget strains and the overall political agenda (Gilbert, 2003).

The economics of disaster risk management looks at immediate costs of investing in prevention, and the long-term benefits for low probability risks (Mechler, 2016). Cost benefit analysis (CBA) is considered a useful decision-making tool because if ‘zero risk does not exist’, then the management of risks requires to make certain trade-offs. Cost-benefit applications in economics analyze the trade-offs between the risk, and the costs (or investments) of implementing prevention and mitigation measures to reduce the risk. The basic principle of CBA requires that a project results in an increase of societal welfare, so that societal benefits exceed the costs over time (Jonkman, Brinkhuis-Jak, & Kok, 2004). It remains difficult to prove such social benefits before disasters occur, and decisions should account for other influential factors such as the politics surrounding risk management. Investments require to justify costs, even if we might consider ethics of mitigation as a tool to save lives, there remain barriers:

*‘As disaster costs continue to rise and as politics continues to shift towards justifying actions in financial terms, the demand has increased to demonstrate the economic benefit of disaster risk reduction to policy makers and decision makers’ (Shreve & Kelman, 2014: 214).*

It is argued that managing disaster risk is driven by policies that tend to weigh more on emergency and crisis response. This is explained by the tendency to gain votes and public support depending on how civil protection services and government carried out crisis management (Arceneaux & Stein, 2006). However, the costs of repairing and reconstructing are often considered to outweigh the costs of investing in risk reduction measures, in the long-term (Shreve & Kelman, 2014). CBA is a useful tool, however the ethical problem is the sensitivity behind valorizing human life as a function of economics. The problem with cost-benefit analysis as basis to risk assessment and management is the valuing social issues, ‘...these models are virtually devoid of sociological content, not only because they ignore key social processes that define risk, but the element most important to people in making risk choices as well’ (Short & Rosa, 2008: 93). Two factors contribute to the complexity of cost-benefit approaches, complexity of the system and differences between expert opinions and public perception of risk (Kunreuther & Useem, 2009).

Given the cycle discussed, there are also different frameworks to organize governance arrangements. Disaster risk reduction, building resilience, adaptation and integrated approaches are all policy frameworks advocated by governments,

*“Disaster governance enables people to overcome the culture of disasters and transform it to a culture of **resiliency and adaptability** through the combined efforts of the government, nongovernment organization (NGO), private sectors, academics, and other people in society with regard to the various phases of disaster planning, disaster prevention and mitigation, disaster response, disaster rehabilitation and recovery programs, policies, and projects” (Blanco, 2015: 744).*

In practice, all of them aim to reduce risk and vulnerability, however propose different conceptual frameworks. Different risk reduction and mitigation strategies

are defined generally as anticipation or resilience, or a mix of the two (Hood & Jackson, 1992: 10)<sup>11</sup>. Recently hazard related disaster risk management has shifted from control and protection to one that emphasizes adaptability and building resilience (Linkov et al., 2014). From this standpoint the idea is to ensure systems and organizations accept the risk by ‘absorbing it’ and ‘bounce-back’ from it, instead of trying to control it ex-ante (Manyena, 2006). Several disciplines discuss the concept of resilience from ecological origins, psychology, engineering, economic and complex systems (Alexander, 2013). A general agreement is made that the concept rests on three ideas, that a system can: a) absorb b) adapt c) restore and recover (Klein, Nicholls, & Thomalla, 2003). Resilience is a useful concept that has contributed to several theoretical presentations on how to define it in the scope of vulnerability, hazards, and disasters, and what kinds of indicators could be used to capture the full range of adaptive capacities (including, preparedness, social capital, mitigation, risk perception among many other variables) (Beccari, 2016; Cutter, 2016; Saja et al., 2018). However, the usefulness of this concept in applied research confronts limitations, because it is not clear how to operationalize it (Aldunce, Beilin, Howden, & Handmer, 2015; Parsons et al., 2016).

Disaster resilience has been distinguished from risk management as an approach that aims to increase the abilities of a system to prepare, recover and adapt (Linkov et al., 2014). This put into question whether the feedback loops associated with resilience processes means returning to a status-quo (i.e. normal state or pre-disaster state) or if the system should adapt to changes, for example by increasing its threshold to adverse events (Kelman et al., 2016). The key interest surrounding resilience is that it looks at the nature of the system over time and how it deals with threats. In practice, one may distinguish the use moving sea walls as a ‘building resilience’ approach because it allows memory adaptation and flexibility. Differently the installation of stockpiles of sand to resist entry of the sea are considered as protective infrastructure to reduce flood risk. Water exclusion strategies are about building resistance (risk management) which is different from

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<sup>11</sup>Mitigation techniques: Anticipation considered more rational based on models of predictability, and the approach of ‘looking forward’. Resilience deems ability to bounce back, could be financial or operational.



water entry strategies that are about building resilience (e.g. floating houses). Therefore, resilience has emphasized the use of soft measures, spatial planning techniques and nature based solutions. In addition, building resilience approaches complements integrated risk management frameworks (Paton & Johnston, 2017).

The different frameworks proposed on building resilience or increasing adaptive capacities (adaptation to climate change) both aim at similar outcomes, which is risk and vulnerability reduction but propose different conceptual frameworks and approaches. In this way, they are both inside the larger risk governance framework, suggested to frame a certain way to govern society (O'Malley, 2004). This is described with the rise of the governance of risk across regulatory and managerial tools involving a range of actors and experts with specialized agencies that work to address societal risk problems. At the same time, risks keep emerging, and modernity is described as the 'risk society' where manufactured risks and external uncertainty arise, as the technologies meant to manage risk in-end seem to produce more risks (Beck, 1992). Proliferation of the perception of risk is reflexive of the growth in risk management practices and regulatory instruments, including how society is communicated about these risks. The 'risk management of everything' described by Power (2004) is a momentum fueled by continuous crises and uncertain conditions, which puts to use a range of external and internal control mechanisms.

#### *Risk culture in governance*

Risk culture/culture of risk is widely used in the discourse on the governance of disaster risk management across policy-makers, practitioners and governments (MEDDE, 2014). The French state emphasizes risk culture (*culture du risque*) as an integral part of managing flood risk (MEDDE, 2014). There is no agreed upon definition of risk culture, however it is an attractive concept because it reinforces the idea of participatory risk governance frameworks by referring to the role of social resilience and adaptive capacities of communities in the face of disaster risks (Quenault, 2015). In general, risk culture describes the experience of communities

with hazards, accumulated knowledge and the perception of risk (Peretti-Watel, 2005; Revet & Langumier, 2015). For example, Bankoff and colleagues (2015) studied risk culture in the Philippines where natural hazards are common and integrated in daily life, and associated this experience with hazards as building a community that has a 'disaster culture'. It assumes that if there is awareness it will lead to some kind of prevention and preparedness activities and therefore a risk culture.

A first interest in the notion of risk culture stems from cultural and sociological approaches, which gives risk a value. Instead of risk as an objective probability, the role of subjectivity and the interpretive quality of risk creates a value function (Renn, 2008). The cultural approach discusses the measurement of risk as a value formed by shared perceptions, which are then reflected in institutional decision-making (Rose, 1996). Institutions can prioritize certain risks based on policy agendas, creating more momentum in terms of activities and awareness of these risks (Gilbert, 2003). There is also the role of the community and the structuring of beliefs and assumptions about risk and disasters (Cornia et al., 2016). These are reflected in certain values in society which create a set of frames or framing of how we understand them (Tierney, 2014). This lens explores how one's culture and value structures influences risk perception (Douglas & Wildavsky, 1983).

Risk culture has significance in different contexts. In financial organizations risk culture refers to risk appetite and the formal and informal processes that organizations use to manage (e.g. monitor or facilitate) risk-taking and the relevant internal control mechanisms (Power, Ashby, & Palermo, 2013). From an organizations point of view risk culture looks at individual behavior, and the factors that influence more risk-taking or risk averse behavior and how it shapes and is shaped by a larger organizational culture (Bozeman & Kingsley, 1998). Risk culture within organizations can be analyzed based on individuals attitudes towards risk relative to the propensity to take risks or be more risk averse, defined as, 'the perception that co-workers and top managers take risks and promote risk-taking' (Bozeman & Kingsley, 1998: 110).

Differently, Lash, (2000) described risk culture as a 'reflexive or indeterminate disordering' that displaces the previously determined order of institutional society (Lash, 2000: 47). Lash drew from the work of Douglas and Wildavsky on *Risk and Culture* (1983) which assumed that there are no increased risks in modern society, just increased risk perceptions. From this sociological and political perspective to risk culture, much attention is about communication of risk and how individuals construct beliefs and behavior towards risk. Therefore, risk culture as a policy instrument in disaster risk management is used to reinforce risk communication channels, social resources and coping capacities (MEDDE, 2014). As the concept is used in the French flood risk management strategy and arises in disaster risk governance discussions, it is further explored in the thesis based on case study analysis.

#### The role of insurance in disaster risk governance

Disaster preparedness often refers to a variety of mechanisms in place to enable response and coping, structurally (e.g. physical readiness) and socially (Tierney et al., 2001). This involves early warning systems, evacuation plans, community plans and financing mechanisms. Here preparedness will be presented through the lens of insurance. This is because in the disaster risk management literature, insurance is often an integral instrument in financial preparedness while at the same time plays an important role in risk governance frameworks (Ericson et al., 2003; OECD, 2015). The interest in insurance as governance is explained by the various arrangements between the private and public sector to design an insurance market for disasters that can overcome several challenges, which will be explored in this section. These insights from the literature on disaster insurance provide a perspective on another governance aspect to be reflected upon in the analysis of the case study, such as why the French disaster insurance scheme has been set up in its unique way and what are the benefits and challenges to this particular set up.

The literature on insurance in disaster risk management are important for the analysis because it sheds light on risk governance and the various arrangements

between insurance and the government in financing disaster risks. Insurance is a technology of risk, working on the logic of probabilities, where the premium represents risk as a financial object set in the future (Ewald, 1991). Insurance has an important role in the governance of risk management by having information-gathering capabilities and a large portfolio to diversify risks that can help absorb the costs and facilitate compensation, that would otherwise be a costly budget for the state. In addition, insurance provides insight on decision-making and choice under risk and uncertainty, including the notion of moral hazard, as studied by behavioral economists and psychologists (Faure & Bruggeman, 2008; Hudson, Botzen, Czajkowski, & Kreibich, 2017; Rothschild & Stiglitz, 1976). The next section describes in more detail these various elements found in the literature on insurance for disaster risks, with a particular focus on risk governance and natural hazard induced disasters.

Insurance as a risk management technology refers to very basic dynamics of a solvency cycle. The success of insurance working on the basis of future risks is attributed to the solvency cycle, meaning ‘the stream of premiums and stream of compensation’ that relies on a delayed exchange (Huber, 2004: 5). The time lag between collecting premiums and compensation makes insurance an efficient firm in financial risk management because it is complimented with large pools of risk spreading. Diversification of risks is done by spreading insurance policies across different segments of society with different risk exposures. To ensure sufficient capital is available, insurance engages also in spreading risk across a platform of financial institutions, banks and reinsurance to protect against solvency<sup>12</sup> (Baker & Moss, 2009). Insurers compliment investment capital in the political economy also by providing extra tax revenues to the state (Ericson et al., 2003). The main sources of funding come from premiums, but also include reinsurance coverage and government funding either in compensation or reserves (Paudel, 2012)

In the scope of financial risk management, insurance works on the logics of aggregation, segregation and the law of large numbers (Lovaglio & Kahneman,

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<sup>12</sup>The market of reinsurance is whole market that requires further investigation in my research, including alternative risk transfer mechanisms and CAT Bonds.

2003) One large-scale event can potentially trigger a large number of claims, resulting in the law of large numbers as problematic. Insurance usually operates in a specific geographic area, in which risks to one natural disaster are aggregated and not segregated enough between 'good risks' and 'bad risk' across individuals' exposure levels. Therefore, in several cases insurance has deemed natural disaster risks as uninsurable and has excluded coverage for damage to property caused by these types of events (Botzen & Van Den Bergh, 2008).

There are other reasons that may interfere with the market supply of insurance for disaster risks involving natural hazards aside from insolvency, such as uncertainties associated with low probability high frequency risks and adverse selection if only high risk profiles purchase insurance (Paudel, 2012). Regarding the former, risk has been distinguished from uncertainty by Knight (1921) because it has a calculative probability based on past statistics, models and evidence. As insurance operates as a function of risk assessed in the future (Cevolini, 2016), probabilities may become complex to calculate on account of uncertainties surrounding rare extreme natural events, which has implications on how to set premiums accordingly. Therefore, premiums can be either risk based or flat, depending on the insurance arrangement within different governance frameworks (Michel-Kerjan, 2001; Surminski & Thieken, 2017).

Lack of historical evidence and scientific knowledge has been argued to contribute to a disparity about premium pricing. The premium is set by underwriting risks, giving the future event a price, described as the, 'principle of equivalence' in which 'indemnity payments expected by the company must be at least equal to the sum of the incoming net premium' (Cevolini, 2016: 167). Setting prices of a future, whether observable or not has been less of an issue thanks to increasing capabilities of catastrophe modeling, forecasting and innovative financial risk products. as insurers are continually setting up a 'new approaches to managing risk' (Grossi, 2005). Nevertheless, premiums are usually set lower than the actual risk-level in order to make insurance policies affordable against disasters. Economists have studied the economic efficiency of compensation schemes by looking at distribution, suggesting that welfare maximization through the minimization of

costs, including transaction costs means that efficiency is intrinsically connected to the provision of compensation (Bruggeman, 2010). Insurance has lower administrative costs than for example governments when managing relief funds, grants and aid programs. On the other hand, evaluating the efficiency of insurance schemes to cover disasters can also result in reducing overall social welfare. This because it has led to schemes that rely on cross subsidization between high risk and low risk profiles, such as the case with the National Flood Insurance Program (NFIP) in the U.S., which faces challenge to collect enough capital reserves to deal with large-scale flood events (Abbott, 2014).

In some countries insurance does not offer extension of policies to cover natural disasters, or may exclude certain natural hazards (Paudel, 2012). Where a market does exist, 'The extent to which insurers can help society depends very much on how flood insurance cover is arranged and this varies depending on the country' (Crichton, 2008: 118). Where insurance is available for natural hazard disaster risks, often there are two kinds of approaches: (1) the option system or (2) the bundle system. In terms of dealing with floods, the former means that insurers extend policy to include flood with an additional premium (as an option); while the latter floods are bundled into the coverage along with other perils (for example earthquakes). The advantages and disadvantages of both approaches have been described in reference to the risk of adverse selection and the extent of market penetration (Crichton, 2008). In the option model, prices will generally be high for customers living in risky areas, but insurers will prefer to offer coverage to those in safer areas, thereby reducing internal risk. The result however is often low market penetration. The bundle system is characterized by less adverse selection and higher market penetration because people who seek out coverage for one hazard are covered for other perils even if they are not at risk to the entire range. With this system insurers may be able to use differential pricing (Crichton, 2008).

Insurers hypothetically could charge a risk premium which would reflect real risk levels. However, such a strategy has often been met by government regulations requiring limits or caps on premiums in order to make them available (Huber, 2004; Michel-Kerjan, 2001). In the US the Homeowner Flood Insurance

Affordable Act of 2014 capped future premium increases, which made it difficult for the National Flood Insurance Program (NFIP) to reach the necessary target of capital reserves. The result is that the NFIP has continued to rely on premium subsidies and pricing practices that do not take into account extraordinary events (Abbott, 2014). Interventions in the insurance market through regulations has implications on competitiveness in the market, and results in governments often times inclined to present public schemes or act as an insurer of last resort to compliment or incentivize insurance for natural hazard disaster risks, as in the case of France (Michel-Kerjan, 2001).

Regulations on the price of premiums could affect market efficiency. It has been commented that even if insurance charges risk-based premiums, in a competitive market people will shop for best prices, which could result in adverse selection. This means that smaller insurers will probably end up bearing the costs by accepting high-risk policies (Jha, Bloch, & Lamond, 2012). In the UK, insurance brokers play a critical role for helping high-risk customers, by directing them to insurers willing to offer coverage for flood risk. Under the UK Flood Re scheme, cross-subsidization of policies for floods allows for sufficient amount of reserves and even funding for reinsurance (DEFRA, 2014). The current state of the market means insurance prices are conditioned upon access to capital in reinsurance or Cat Bonds thereby allowing for the offsetting of premiums (Bruggeman, Faure, & Fiore, 2010).

**Table 6 Insurance arrangements for disasters in different countries**

Country	Insurance arrangements for natural hazard disasters
<b>Czech Republic</b>	Coverage for the full range of natural hazard risks is available within the insurance market, and provides coverage for households, companies, agricultural producers and the government. Disaster insurance coverage is not compulsory. Risks can be bundled (sold together in one policy), or the policy could be designed only for one peril/damage. The only persistent problem reported by the government regarding insurance coverage is the existence of buildings or properties in flood zones (built in the past) that are not insurable.
<b>Germany</b>	In Germany, insurance coverage for natural catastrophes ("Elementarschadenversicherung") includes floods and can be obtained for more than 99% of areas. Coverage is generally provided at the building's replacement value (i.e. automatically adjusted to the price

	trend, thereby reducing the possibility of underinsurance). Market penetration remains low (approximately 33%). In addition, natural catastrophe cover and especially flood insurance is not available in certain high risk areas (like river valleys); however, there have been recent discussions on how to make coverage available in such areas.
<b>New Zealand</b>	New Zealand's The Earthquake Commission(EQC) provides automatic first loss cover for valid claims for all policyholders of residential fire insurance. The hazards covered are earthquake, natural landslide, tsunami, volcanic eruption, hydrothermal activity, restricted storm or flood damage to residential land, and fire following any of the aforementioned events. Premiums are collected through a compulsory levy added to all homeowner policies. Private insurers transfer the levy to the EQC for investment by the Natural Disaster Fund. Owners of non-insured properties can expect no help from government.
<b>Spain</b>	The Consorcio de Compensacion de Seguros (CCS) established in 1941 insures catastrophic risks directly. It became a permanent state-run, private-public partnership in 1954 providing nationwide, state-guaranteed cover for extraordinary risks, including natural disasters. Coverage for 'extraordinary events' is compulsory for all insurance policies for life, fire and natural perils, motor vehicle damage, property damage and personal accidents.
<b>Switzerland</b>	There is a dual system for the provision of natural disaster insurance. Private insurers are obliged to offer natural catastrophe coverage (flood, storm, hail, snow, avalanche, snow pressure, rock fall, rockslide and landslide) as part of fire insurance for buildings in the seven cantons that do not have a cantonal monopoly insurer, and for home contents in 23 of 26 cantons. The owners of buildings are obliged to insure buildings against natural catastrophes in 22 of 26 Swiss cantons. The penetration rate for natural disaster coverage is high with almost all buildings being insured against natural catastrophes and most households (estimated at 90% in 2014).
<b>Turkey</b>	Risks that may arise from fire, explosion, tsunami or landslide during and after an earthquake are covered under Mandatory Earthquake Insurance provided by Turkish Catastrophe Insurance Pool (TCIP) – a national catastrophe insurance pool.
<b>United States</b>	There are insurance pools for storm (and sometimes hail) risk, often limited to residential and commercial customers that have difficulty accessing private insurance markets, and sometimes are financially backed by the state government. California Earthquake Authority (CEA) provides catastrophic residential earthquake insurance. For floods, insurance is available through the National Flood Insurance Program (NFIP) which is subsidized by the government.
<b>UK</b>	Insurance companies and the Government worked together to develop a flood insurance scheme – known as Flood Re – to help support households at highest flood risk. In order to obtain a mortgage one is required to purchase property and liability insurance. Insurance for floods is offered as long as the Environment Agency continues plans in flood risk management and reduction measures.

Source: McAneney, McAneney, Musulin, Walker, & Crompton, 2016; OECD, 2015; Paudel, 2012; Swiss Re, 2010



The various schemes of insurance for disasters depend on arrangements between government and the insurance sector (Table 6). This is because of the inherent political framing of disasters as a part of civil protection. Green and Penning-RowSELL (2004) described the relationship between the two entities as either 'parasitic' or 'symbiotic' upon a continuum of time when analyzing flood insurance. Green and Penning-RowSELL explained that both entities have different concerns and different complementary strengths which can either produce an overall symbiosis or antagonism (2004: 519). Whether insurance and government relations are parasitic or symbiotic largely depends on questions of: who is profiting? Who is bearing the costs? And, whether prevention policies are in place to reduce the risk to the cost-bearer? In France, the levy paid by insurers to the state reinsurer for natural disasters funds many projects on prevention and mitigation, including risk assessments and public awareness. Thereby, the French Cat Nat public-private insurance-reinsurance scheme is not only centered around compensation but also reducing vulnerability. From this perspective, an important factor is the level of risk exposure, fiscal incentives and investments in prevention, and the overall socio-economic context of the country.

Governments may take varying roles in post disaster compensation efforts to victims, which may include the private sector or not. Several potential roles have been suggested (Sugarman, 2007), for example the state as insurer of last-resort, as in the case of France or providing subsidized insurance policies by partnering with the private sector. The United States has designed insurance pools within specific states based on natural hazards, for example in Florida there is the insurance pool for hurricanes, where the state acts as guarantor. The reason for these varying public-private partnerships are the problems that arise when evaluating governments as sole insurers and providers of disaster relief. Post disaster loans and grants confront policymakers with a question of justice and politics of budgetary concerns. Firstly, it means that taxpayers in general contribute and share the cost, which puts into question the allocation of resources and distribution. Secondly, due to budget constraints governments will have to shuffle funding from other public policy areas for the disaster (Paudel, 2012). And finally, if

governments always provide relief, it may contribute to disincentives for individuals to purchase insurance voluntarily because they will expect the same kind of help for future occurrences.

When large-scale disasters occur, governments tend to step in to provide financial assistance, whether through housing assistance programs (grants), aid and other types of relief and compensation. Expectations for government relief have been described as a form of distortion of the market under concepts of *charity hazard* and *societal legitimization* (Raschky & Weck-Hannemann, 2007). Expectations of government relief are part of society's view of legitimization in that political bodies have the obligation to restore social and economic order. Raschky and Weck-Hannemann (2007) presented this in the context of charity hazard as a form of moral hazard that intervenes in the supply and demand of private insurance. From a supply-side, insurers may choose to retreat from the market if deemed unprofitable as the demand decreases due to high expectations of government aid. In addition, that government financial assistance as charity hazard may result in market inefficiencies. Therefore, the political dimension of government aid is often a failure of allocation, and motivated by underlying policy decisions, most notable around times of elections and reelections (Raschky & Weck-Hannemann 2007: 9).

Several scholars provide a comprehensive comparative analysis between private and public insurance for disasters and the varying roles of government (Paudel, 2012; Priest, 1996). Analysis between the two rests on their relative capabilities to: reduce risk, aggregation, risk segregation and the control of moral hazard (Priest, 1996). The economics of government disaster relief presents some advantages in these capabilities. One advantage is that it can constrain the problem of adverse selection and increase the size of the insurance pool by mandating insurance. In addition, via command and control mechanisms surrounded building codes or urban planning policies, moral hazard may be reduced. This is an important component of insurance arrangements, because moral hazard risks that insurance doesn't provide incentives to reduce risks (Ehrlich & Becker, 1972). Some disaster scholars who have analyzed insurance arrangements in cross country comparative analysis, have tended to conclude that governments may be less effective as an

insurer for disasters (Kunreuther, 1996; Priest, 1996). Different arrangements, such as public private partnerships may be optimal, where some have commented on the success of such an approach in the French disaster insurance scheme (Michel-Kerjan, 2001).

Governments may take different roles in a framework for insurance against natural disaster risks. Executive bodies may intervene by introducing a mandate for compulsory property insurance to citizens as formulated in France based on solidarity. However, in other countries such as Germany, a similar method was under review but met with political rejection for a variety of reasons (Schwarze & Wagner, 2007). Schwarze and Wagner described the failure due to the political-economic context in Germany, in which a market-oriented design for compulsory flood insurance was rejected by finance ministers. The main reasons for opposition were because the scheme implied that the state would have to act as a guarantor for reinsurance in such a scheme. In addition, the plan presented a legal challenge in Germany, as it interfered with the notion of individual autonomy in having the right to choose certain commercial activity. This case aims to show that the market for insurance of disasters triggered by natural hazards, across public-private partnerships, different kinds of arrangements, and interests between private sector and government is complex and depends heavily on country-specific institutional and governance framework (centralized or Federal state) and risk exposure to different kinds of hazards.

Reviewing the literature on insurance for natural hazard induced disaster risks reveals that the context plays a significant role, which is determined by the risk portfolio of the country, politics and the role of governments. In addition, the relationships between insurance and the government has shed light on how insurance has a remarkable role as a risk manager in modern society and has suggested that the sector has increasing regulatory capabilities in the governance of risk (Ericson et al., 2003). As in the case of other financial markets, innovation and regulatory frameworks continue to change the scope and techniques of insurance for disasters. At the same time, insurance continues to draw attention in disaster

risk management literature because of these various challenges the market faces and has been proven to be an integral part of preparedness (OECD, 2015).

## Responsibilities in risk governance frameworks

Interest in responsibility emerges in the discourse about risks notably when causation is inquired about an incident. When something doesn't go right, *what* or *who* are the reasons behind it? In the literature on risk governance and the governance of disaster risk management, it has been suggested that the multitude of actors involved may result in complexity to establish and ensure accountability (Renn et al., 2011). At the same time, causation stimulates an inquiry about ownership of risk and responsibility for consequences of these events. The literature review on responsibility for the consequences of disasters highlights two critical points. Firstly, there is a methodological question on the attribution of disasters induced by natural hazards to human activities, as often discussed in the adaptation literature associating climate change patterns to anthropogenic sources (Stott et al., 2015). Even if the 'act of God' doctrine is obsolete there is still no legal framework that allows to systematically adjudge who is responsible for the consequences of these events (Arceneaux & Stein, 2006; Laut, 2018). Secondly, there are many kinds of responsibilities that are built into risk governance regimes, which makes attribution more complex. A review of risk-responsibilities offered in the risk management literature can offer insight into different kinds of responsibilities that are shaped by risk governance structures.

When disasters occur, the capacities of risk management and notions of risk prevention and mitigation are put into question. After Hurricane Katrina hit New Orleans criticism was made on the government for mismanaging the crisis but also led to investigations on the capacity of the levee system and in general the politics behind development in hazardous areas (see for example, Burby, 2006). The case showed that disasters including those stemming from the natural environment can be described as '...constructed through the responsibilities they engage' (Kermisch, 2010: 91) and these responsibilities tend to emerge following a major event that causes chaos, extensive damages and widespread disruption. Extreme events such as natural hazard triggered disasters test the capacities and capabilities

of risk governance structures, and in particular risk prevention and emergency response systems.

Responsibility is a concept with many different synonyms that arises in the risk governance literature. It has been suggested that the notion is rejected in the engineer's paradigm because the realist approach deals with risk as a technical output (i.e. probability) (Giddens, 1999). On the other hand, risk governance involves accountability mechanisms, where many state and non-state actors are in charge of managing risks, which imply responsibilities. In disciplines of anthropology and culture of risk studies, it has been suggested that the politics of risk and institutional framing of uncertainties in modern society structure a relationship between *risk and blame* in risk governance regimes (Douglas, 2013). Giddens (1999) described the nature of risk responsibility according to Beck's seminal on the 'risk society' (1992), where we live in a society besieged with manufactured risks and external uncertainties while in parallel ask for more accountability and ownership of those risks.

#### On attribution

Disasters otherwise deemed extreme events, are major events which give emergence to the links between risk and responsibility because informing causation is based on ideas of managing disaster risks prior to any negative effects. While the literature reviewed the links between vulnerability and disaster risks, as well as the complexity of governance schemes to reduce the consequences of disasters, there is an emerging question on responsibility. Linking responsibility to a particular stakeholder within a risk governance framework is complex because it calls for an explanation of cause-effect and therefore attribution. Giddens described this complexity as, 'Given the inherently ambiguous nature of most situations of manufactured risk, and the inherent reflexivity of these situations, responsibility can neither easily be attributed nor assumed' (1999: 8).

In the adaptation discourse attribution is a rising issue of interest because it seeks to make links between anthropogenic sources and the consequences of climatic

events, both extreme and slow-onset (Otto, James, & Allen, n.d.; Stott et al., 2015). Namely, in this context the link is made between the impact of past and present greenhouse gas emissions on local weather phenomenon (Stott et al., 2015). While scientific methodologies have been developed to attribute climatic risks to human-induced activities such as through the use of Probabilistic Event Attribution (PET), the question of allocating responsibility or liability is complex (Otto et al., n.d.). At this scale of risk attribution, where the cause-effect links are made between global emissions and local weather events, a climate litigation situation would be complex because it is not clear how to define the defendant and the plaintiff (Doelle & Seck, 2019). The parties in such a climate litigation could involve individuals, companies, states or non-state actors across multiple jurisdictions creating a complex landscape to allocate responsibility.

In the context of attributing the consequences of a disaster triggered by the environment to human activities, there is growing interest in the use of legal tools. This is explained by the growing work on attributing these events to human activities that influence or produce vulnerability and the legal responsibilities within risk governance frameworks. Differently than in the adaptation approach to attribution, the scale of disasters can be narrowed down to state, regional, local level activities and potentially adequate methods to equip legal systems to make links between the consequences and human activities. The argument is further reinforced by the legal evolution away from archaic concepts to define these events as 'acts of God' (Dodds, 2015; Fraley, 2009). While acknowledging that referring to disasters as 'acts of God' is obsolete, especially in the context of litigation, it is worth to discuss why this doctrine came to faces limitations.

Disasters that were once deemed 'natural disasters' related to events involving hazards of storms, earthquakes, and floods were also once deemed 'acts of God'—or *force majeure* based on the notion that they were unpredictable, unforeseeable and therefore exempted humans from liability. The doctrine was based on the idea that the cause of injury and destruction should be solely a natural force (e.g. 'sole proximate cause') and the court must rule on this exclusive and entire cause of injury with no human intervention either in active nor passive form (*negligence*)

(Faure, Jing, & Wibisana, 2014). In addition to absence of human agency or intervention, the doctrine requires that there is no aspect of foreseeability and for the magnitude of the force to be high (Dodds, 2015; Fraley, 2009).

The 'act of God' concept in disaster risk management literature and its application in the law clearly confront limitations, which has been acknowledged since early studies on disasters and responsibility such as the case of the Dale dike dam that collapsed in 1864 in Sheffield and killed a few hundreds of people (Binnie, 1978). Loimer & Guarnieri (1996) presented a historical account of how the 'act of God' argument by the 1800's was severely dismissed in court by judges and lawyers because events, even those triggered by natural forces imply human activities and in particular point issues of negligence. This is further explained by the association with accidents and the rise in safety legislation. Therefore, there is no ambiguity between superior forces and human induced accidents because science and the law place emphasis on the technical explanation of an event as linked to human intervention and negligence (Loimer & Guarnieri, 1996). However, the law does not clarify *who* is negligent and based on what criteria or standards.

Conceptually negligence supports the perspectives on disasters risks as no longer 'natural' because of the social, political and economic decisions that fashion disasters (Wijkam & Timberlake, 1984). In this case, 'act of God' is obsolete to explain disasters and the focus is on why and how vulnerable conditions came about as was discussed in the literature review on vulnerability. This perspective then implies that vulnerability is linked to negligence. For example, disasters reveal the limitations in prevention tools considered as *control mechanisms* and sheds light onto the issue of possible '*negligence*' for those in charge of carrying out risk management activities. These aspects appear in discussion on Hurricane Katrina when explaining the extent of consequences as stemming from problems with the levee system and poor crisis management decision-making (Burby, 2006; Colten, 2009)

Furthermore, foreseeability, another aspect determining *vis majeure* is no longer applicable because of data-gathering, catastrophe modeling and weather forecasting



capabilities. The help of early warnings provide margins of time for preparedness. However, recent cases reveal that there is still a complex relationship between negligence and foreseeability. In 2017 an investigation started on the Fukushima nuclear disaster accusing the executives of the plant for criminal negligence for not properly preparing the plant against possible natural hazard risks despite warnings (BBC, 2017). The result of the case is a nuclear meltdown triggered by earthquake and tsunami that led to contamination, environmental degradation and large-scale evacuations. The case is interesting because it involves a natural hazard that led to a technological disaster. Despite that the executives still face civil litigation, they were acquitted in the end on account of arguing the event was unforeseeable (Dooley, Yamamitsu, & Makiko, 2019). While predictability and foreseeability are disputed as non-applicable on account of capabilities of science and technology to model and forecast risks, negligence remains contested due to uncertainties in some cases. For example, a recent case explores the conditions of a cruise ship operator's liability for the deaths of tourists caused by a volcano exploding on White Island close to New Zealand during an excursion (Hals, 2019).

The argument of negligence against unanticipated or unprecedented disasters triggered by an environmental hazard discusses responsibility as pre-emptive. Therefore, the argument is based on the fact that something could have been done to prevent the level of adverse consequences but for some reason was not made. Then at which point in time is this link made and what evidence can be used for the argument? In the study of disaster risks and vulnerability, humans and nature interact in a dynamic space where risk conditions evolve rapidly. In addition to the temporal complexity, the risk governance literature refers to a variety of risk reduction and management policies and planning tools in place as well as actors responsible for their implementation, with growing emphasis on the community (Renn & Schweizer, 2009; Thaler & Levin-Keitel, 2016). Therefore, the governance landscape suggests multiple activities by varying actors and several frames of responsibilities. By moving away from the archaic 'act of God' doctrine and its normative framework, there is an interest to discuss different kinds of responsibilities that emerge in risk governance frameworks. This requires to better

define the criteria of responsibility and how they apply in cases of disasters where environmental hazards are involved.

#### Responsibilities in risk governance frameworks: risk-responsibility relationships

Risk governance involves many stakeholders with different capabilities and expertise to manage risks. It has been suggested that the shift from managing disaster risks, such as flood risk, to governance approaches, also known as integrated hazard management programs is marked by a shift in delivering government objectives and the diffusion of responsibility (Butler & Pidgeon, 2011). Butler and Pigeon (2011) conducted a study on flood risk management in the UK, following the 2007 floods, to identify the shift in approaches from hard engineering structures (flood defense strategy) to flood risk management (soft measures, nature based solutions, land use planning) and how this represents a 'deeper shifts in political rationalities' surrounding risk management. However, although there is understanding that shifts in governance redefine responsibilities and accountability, there is room to expand on which actors are involved and different kinds of responsibilities that emerge when disasters occur.

Shedding light on different forms of responsibilities in the governance framework may point to different pathways of linking cause-effect when large-scale events occur. Different kinds of responsibilities allocated across public authorities, private sector and the community are shaped by participatory risk governance structures, which has been especially emphasized in flood risk management (Renn & Schweizer, 2009; Wehn, Rusca, Evers, & Policy, 2015). Disasters then ask foremost about causality to inform responsibility. To help tackle this area of research, it could be useful to consider different typologies of responsibility found in the literature that make a conceptual link between risk-responsibility, cause-effect and attribution.

The relation between risk and responsibility are defined by agency because it is the result of decisions and actions. Risks as forms of responsibility are built into the very definition of risk (Rayner & Tansey, 2010), which proliferates with risk

management and risk regulation activities across organizations, institutions and governments. The continuous interaction between society and all the different kinds of risks and managing them, opens more perspectives to causation and varying forms of responsibility (Giddens, 1999).

Risk as a descriptive form contributes to rendering cause-effect relationships (Renn, 1998). From a social science perspective the normative approach to risk suggests involvement of human conduct. Managing risk means that, ‘{risk} also carries the implicit message to reduce undesirable effects through appropriate modification of the causes, or though less desirable, mitigation of the consequences’ (Renn & Rohrman, 2000: 14). Different typologies of risk-responsibilities emerge: *causal-responsibility*, *capacity-responsibility* and *liability-responsibility* (Kermisch, 2010). The typology is constructed based on assumptions of cause-effect that engage risk-responsibility relationships. Kermisch adopted definitions from Hart (2008) for each as follows:

- Causal-responsibility: the focus here is on *cause*, determined quasi-mechanically (i.e. the storm caused the plane to crash).
- Capacity-responsibility: refers to an agent and their capacity to understand, reason, and control their conduct under the assumption that they are responsible for their actions (i.e. if the pilot has a heart attack, he is not responsible for the plane crash).
- Liability-responsibility: responsibility is legal and is based on determining some kind of punishment. This entails who will explain the event, and who will pay compensation for damages.

### *Causal-responsibility*

Causal-responsibility as a quasi-mechanical form of causation is largely part of the technical approach to risk. This form applies to the general typology of disasters, denoting direct sources either technical, natural, man-made.

The first kind of responsibility deemed *causal* is about making correlations between object, events and consequences, and will not be the focus of the theoretical framework. Differently from capacity-responsibility, liability-responsibility is based on legal standards defined within a contract that determine

the conditions for when compensation for a 'risk' is triggered (Baker & Simon, 2002). We will focus on capacity-responsibility to make a distinction from liability as was discussed in the framework of insurance.

The other two, capacity-responsibility and liability-responsibility examine human conduct within a social and legal framework. They encompass social, cultural and legal constructions of risk and responsibility for disasters.

*Capacity-responsibility: distinguishing moral and professional*

Capacity-responsibility is concerned with individuals and their conduct. Capacity-responsibility refers to the consequences of human behavior that drive actions or in-action (negligence). It assumes that actions of persons are under their control, and that they are capable to reason and understand the possible consequences of ill-made decisions. This form of responsibility implies a dimension of consciousness and morality (moral responsibility) but also an added understanding of cause-effect. We may assume, that our first thoughts about responsibility is a form of *moral responsibility* in everyday life as a person (e.g. parent, child, citizen etc.), in which we care about the things that happen to us and others. In this way we are aware of risks to a certain extent and try to avoid those that may bring harm with best intention. However, capacity-responsibility should be further subdivided between the everyday moral responsibility of an individual and responsibilities that are determined by professional obligations.

Different forms of responsibility emerge that are differentiated from moral responsibility, especially in the context of risk and disasters (Bishop, 1991). Everybody may be assumed to have moral responsibility, but in the context of a professional role this may become more complex. Ensuring that activities do not result in death of colleagues, clients or citizens— means there is an additional moral responsibility to obtain information and prevent negative effects determined by the person's status and position. Bishop gave attention to this in his study on executives in organizations after disasters and differentiates *moral* and *professional responsibility*. The latter depends on a status in a company, and reviews if people

did their job well or failed. He described professional responsibility as, ‘when the outcome of a professional activity is of great concern to a person or people other than the person doing the activity’ (Bishop, 1991: 382). In this case, in-action to prevent damages or harm is not only defined as negligence, but now a professional negligence which is attributed to penalties in the law.

Differentiating between moral and professional responsibility in the context of disaster risks is determined by access to or availability of information on risks even under conditions of grave uncertainty. There is a question about risk culture in the organization, communication of risks, and biased judgments about probabilities which may guide improper actions. For example, Larmer (1996) reaction to Bishop’s work extended on his controversial argument about responsibility based on risk information, and direct or indirect access to it. Bishop’s argument was that executives can be held accountable when information needed to avert the disaster was available within the company, but not in their personal hands. This would mean that communication channels are not properly working within the organization culture surrounding risks. However, such an argument triggers a question of moral culpability for lacking information about risk under uncertain conditions, as disasters are low probability events.

Similar kinds of questions emerge in sociological studies on insurance that ask about moral risk and moral hazard situations. We may begin to gather some important elements to defining responsibilities as framed by causation and risks, which surfaces another risk governance aspect mentioned in the previous section on information and communication channels. In this context, these factors refer to availability of information and action or inaction.

Capacity-responsibility can be described as shaped by morals and may have different meaning depending on professional status. It reflects on internal responsibility and creates a link between the rationality behind the decisions people make and responsibility for those actions taken, especially when there are consequences. In some accidents these actions are more observable, such as error in management or miscommunication. For example, it may refer to the wrongly

interpreted information of tests made by employees before the BP oil spill. In situations of disasters involving natural hazards, human conduct may not be so obvious to the citizen or victim. Instead, these cases will inquire about pre-existing risk conditions to natural hazards and reflect on aspects such as building communities or critical infrastructure in hazard prone areas. These kinds of actions require further insight into the entire governance framework for managing risks across different institutions, organizations and actors as well as the variety of rules and policies put in place.

### *Insurance and liability*

Insurance is also an instrument for determining cause-effect and responsibility within the framework of liability and compensation. There are different insurance arrangements depending on the risk, which determine liability. Liability is central to third-party insurance, in which a person, a company or group may be held liable for damages, known as a *tortfeasor* (Miyazawa, 2015). When this tortfeasor is found of fault, they are liable and required to pay compensation to the victim. In the context of natural hazard disasters, first-party insurance works on the basis that a potential victim seeks coverage from insurance for the natural hazard. Seeking out policies is done before any damages occurs, and may be voluntary or mandatory depending on the legal framework and governance arrangements between the private and public sector for providing and accessing insurance for disasters (Faure & Bruggeman, 2008) .

Liability is a legal concept and implies an obligation that is framed by a legislative framework. Liability requires one to give an account and conduct is evaluated according to standards such as codes, regulations, or the law (Cornock, 2011). In this case liability is met with sanctions and penalties depending on cause-effect. Liability in disaster risk management is often attributed to financial responsibilities in the wake of disasters surrounding questions about who is going to pay for the costs and damages? Therefore homeowner insurance plays an important role in relieving individuals from liability in the case of a disaster and ensuring

compensation. However, in many cases, where insurance policies were not sought out, the government provides aid or assistance in various forms of state relief funds (Kousky, Michel-Kerjan, & Raschky, 2018). Some disaster events may require solidarity and national funds, for example this has been the case with terrorist attacks (e.g. 9/11 in the US) (Hadfield, 2008).

Liability is often discussed within the framework of private insurance and compensation. In order for this compensation to work, based on policies in the contract, causation is determined. The contract envisions different circumstances where responsibility is subject to the insured or not, and therefore if they are liable for compensation.

Ewald, (1991) relates this form of responsibility as the moral/reparation domain of insurance. Tom Baker furthers this moral attribute to human conduct by asking, ‘to what extent are those who suffer responsible for their condition?’ (Baker & McElrath, 1996). These kinds of questions are often framed in terms of moral hazard and how insurance liability can change or influence behavior. Insurance has been emphasized as an important tool in the preparedness phase of disaster risk management, also because it may influence behavior. In this case, financial compensation is associated with certain conduct and foresees any modification to behavior that may be influenced by this cushion of protection, discussed as moral hazard.

Liability is a form of legal responsibility determined by how causation is informed. Insurance arrangements By distinguishing capacity responsibility from liability, it gives rise to another type of responsibility that is not mentioned which is accountability. We will see that accountability is an important concept of responsibility in the rising governance perspective to managing risks which is different from responsibility and liability.

### *Accountability*

When disasters occur, financial compensation and liability, may not be the only form of ‘responsibly’ that victims seek out. Some victims may ask for more explanation for the event. For example, in his article, Hadfield (2008) investigated why certain individuals filed law-suits after 9/11 instead of opting for the fund that was created. His analyses offer insight into other values that may override financial compensation, such as the value of accountability in the sense of public judgment and assuring lessons learned of public officials (2008:5). Increasingly, large-scale events lead to investigations and formal sanctions deemed public *accountability* measures. Accountability is not only about penalties, but invokes the rule of law, and asks about the role of public authorities who have statutorily defined duties. This form asks about fulfillment of responsibilities. Natural disasters stir public and political accountability due to social and collective effects of the major event. Hilgartner (2007) referred to this as the politicization of disasters; because of massive disruption caused to citizen's social and economic life.

Across the responsibility types described, much of the risk governance literature furthers on the importance of responsibilities behind decision-making processes and policies towards risks by framing it as accountability. Accountability is a form of interpreting *responsibility*, but the two words are distinguished from one another conceptually and practically. A basic meaning is found in these two definitions: ‘calling to account for one’s actions by an authority’ (Mulgan, 2002: 555) and ‘the obligation to explain and justify conduct’ (Bovens, 2007: 450). Differently, responsibility is more inner-looking and gives a sense of morality and consciousness. It is also different from liability, which can be attributed to ramifications in the law (Cornock, 2011). Cornock defined accountability as a higher-level activity that requires the person responsible for a task to ‘give an account’ such as an explanation or reason for their action. It is external to the person and a formal obligation to justify one’s actions and the rationale behind them. The demands for accountability are driven by very different motives, they seek for public judgment, to expose what happened, who or what practices failed and to ensure lessons-learned.



Accountability is a comprehensive concept with different meaning for different people. Because it has this attractive quality, its use has expanded to many areas outside of its original sense (e.g. auditing or governments) (Mulgan, 2002a). These expansions are outside the scope of the paper, because the core meaning of the concept will be adopted which, in a very basic sense is described as: *the process of being called to account to some authority for one's actions* (Jones, 1992). How does this process look or work not only theoretically but rhetorically?

The term accountability has semantic ties to accounting, coming from bookkeepers who were keeping track of (e.g. a count) of itineraries and financial matters dating back to the 11<sup>th</sup> century (Dubnick, 2002). In this original sense the term relates to auditing activities pervasive as a current accountability measure for financial institutions and organizations (Power, 2007). These origins of accounting have expanded beyond auditing practices of internal and external methods of control to other areas, notably in political discourse where accountability addressed issues of power and control in democratic governance (Mulgan, 2002b). In this context, accountability was a method of controlling power in governments by having checks and balances in place to restrain self-interested motives. The motive was to ensure that public institutions would have a kind of control mechanism so that they continue to work for the needs and expectations of citizens. Thus, accountability relationships are found in several layers: between citizens and public office holders, between states and organizations, but also between internal units depending on hierarchical relationships.

There are few fundamental factors to accountability, firstly the externality function where judgment is made under a designated authority who is competent to assess if the conduct is acceptable or not. For adjudging the conduct, there should exist a broader framework of existing standards to which the conduct is comparable to. At core, in its original meaning and in practice, three characteristics have been outlined by Mulgan (2002a) on accountability, which are: it is *external*, it involves *social interaction and exchange*, and it *implies rights of authority*. Externality is fundamental, in that some kind of authority exists outside that the person or entity it is accountable to. He further described this as different kinds of 'forums' that the

agent addresses. It might be rather difficult to consider one accountable to themselves. The social mechanism is illustrated by the act of exchange between the forum and the accounted for. The two first characteristics are socially constructed by ways of standards and hierarchal relationships, because the authority is a symbolic need for legitimization. Legitimacy is based on having a 'right' to be accountable to, which represents a standard or position. Establishing this authoritative right is fundamental to initiating incentives to meet certain requirements, and therefore sets a status-quo. These three characteristics, externality, social exchange, and authority are the main dimensions of accountability.

Bovens (2007) suggested accountability as characterized by answers to set of questions to clarify the actors involved, information required and decision-making process. These questions are: 1) *To whom is the account to be rendered?* 2) *Who should render account?* 3) *About what is account to be rendered?* 4) *Why the actor feels compelled to render account?* (Bovens, 2007a). The answers to these three questions signify the relationships between actor and forum, processes of information gathering on conduct, investigation and judgment. All of these processes lead to a final outcome which may be formal or informal penalties and sanctions.

In conclusion, governance has emphasized risk management as part of the larger role of a 'regulatory state' (Majone, 1994), or in France described as the state and its *fonctions régaliennes* (Gilbert, 2002). Governance involves many stakeholders that manage and regulate risks, which has implications for risk-responsibility. As discussed here there emerge different kinds of responsibility that interprets cause and effect, such as liability and accountability. Although these concepts are sometimes used interchangeably, they are not synonyms. Each one can be distinguished, especially in the law when there are criteria and obligations involved. Responsibility for the risk of negative externalities is shaped ex-ante, however informed ex-post. When consequences do occur, there needs to be some kind of system in place, including standards and rules to allocate responsibility for the damages, however as the section explored, there are many different kinds of

responsibilities with different legal penalties. In the case of environmental disasters, these are yet to be defined.

## Chapter 4: Research Methods

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## Overview

This chapter presents the research methodology. The aim of this chapter is to explain the approaches used to analyze the data and justify why this method was adopted. A qualitative case study approach and interpretive methods were used to analyze the case. The attractive feature of this approach is in-depth analysis of a disaster that could capture the social, cultural, institutional and other contextual information that were important for the analysis. The thesis uses qualitative analysis by matching information collected on the case and theory from the literature on disaster risk management to shed light on drivers of risk and vulnerability to disaster risks and provide a critical reflection on how responsibilities are attributed in the aftermath of a disaster. These research methods and the limitations are analyzed. The chapter outlines the data collection process and the sources. It presents limitations to this process and how it influenced the research

### Qualitative case study approach

The thesis adopts a qualitative approach to study disasters and uses a case study analysis. The advantage of this methodology is that it allows in-depth analysis of a disaster and gives particular insight into the local exposure and vulnerability conditions. According to Yin (1998, 2012) this kind of method is useful especially if behavior cannot be manipulated and contextual conditions are relevant to the study. Although a comparative analysis would have allowed to test different variables and identify patterns, a single case study approach was chosen to gain a detailed understanding of the factors that increased exposure and vulnerability in particular place, which would allow to further explore how responsibilities were conceived and attributed in the aftermath based on information drawn from the trial. This narrow focus is one of the more practical ways to consistently apply concepts and build theories based on the literature supporting the analysis on the concepts of vulnerability, disasters, risk governance and risk-responsibilities.

The case study chosen for the thesis is the Xynthia storm in 2010, which triggered coastal flooding in the commune La Faute-sur-Mer on the western Atlantic coast of France. The case was chosen for three strategic reasons. Firstly, the local impact of the disaster allowed to gather and mobilize a rich set of information from different sources with an acute focus on a particular physical site and community. Secondly, when the research project started in 2013, the Xynthia disaster was still an important event in France. This importance of the event led to several reports, studies and news articles that were fruitful for the analysis. These various reflections could enrich an analysis on revisiting disaster risk management concepts and theories. Lastly, while the research was underway, the public trial started in 2014, which opened an opportunity to analyze a growing area of disaster risk management research on responsibility. Practical considerations were also made on feasibility of carrying out fieldwork and interviews in France.

The aim of the thesis was to answer research questions about what happened in the disaster and propose some explanations for why the consequences were so high in a specific local area. More specifically, the research question deals with how such a past to present analysis of the disaster led to an informed a public trial to attribute responsibility for the consequences. Using this case study, the aim was to describe what happened and shed light onto i) how vulnerability is composed based on various factors and ii) how this information could inform responsibilities. More explicitly, a *descriptive* case study approach was employed (Yin, 2012), which is common for disaster studies that aim to use information on the case and build on existing theory. The case study approach was descriptive, in line with Yin's (2012) suggestion, because it is used to describe an intervention or phenomenon and the real life-context in which it occurred. Descriptive case studies are among the most common case studies especially in social sciences that seek to discuss a social phenomenon in context and various interactions. This approach falls in line with the common trend for disaster studies on using qualitative–process paradigm and theory building based on an idiosyncratic case (Buchanan & Denyer, 2012). The reason this approach in the field of disaster studies, is explained in part because of the unique context of this field of research,

*'What makes disaster research unique are the circumstances in which otherwise conventional methods are employed. Put differently, it is the context of research, not the methods of research that makes disaster research unique.'* (Stallings, 2002: 21)

In line with case research, the thesis uses a case study approach to build theory and test it, where particular interest is on the local context within a multi-level governance framework (Stallings, 2002). The local context should also capture social dynamics, behavior and perception, however the methodologies used for disaster studies faces similar challenges as in other areas of social sciences, such as analyzing social constructions, contextual situations, and changes in behavior and organizations (Stallings, 2007). In recognition of this challenge, an interpretive approach was advantageous to build on the theory that disasters are socially determined events. Therefore, the theoretical basis of the thesis, where disasters are conceptualized as a combination of natural hazard and vulnerability was important to deciding on an event-based approach. This single theory involves several components, with particular emphasis on understanding the interactions between the social and natural systems that create vulnerability, described as governance gaps, which can help better inform disaster risk reduction strategies.

As in most case study research, the aim was to understand the social context and interpretive methods to analyze several components of vulnerability. This called for a multi-disciplinary approach that could allow to integrate different approaches on disaster risk management and reduction research. A multi-disciplinary approach is argued to be important for disaster studies because it can break down the fragmentation of disaster research (Killian, 2002). However, it should be noted that emerging literature on adaptation to climate change and adaptive capacity as a component of vulnerability is not discussed, which would be an important area to pursue in further research and to support the integration of these two research streams. In recognition of this limitation, the aim of the thesis was to investigate the case and revisit conceptual frameworks in disaster risk management, with a focus on explaining the development of vulnerabilities and the attribution of

responsibilities. The research surveyed this conceptual level based on observations made and information collected (De Vaus, 2001).

Methods to study disasters tend to depend on retrospective designs to establish multi-level causality of extreme events and their consequences (Velimirovic, 1980). There are different phases of disasters that could be considered as before, during and after the event. Some may describe these events as the hazard cycle, characterized by temporal phases: mitigation, preparedness, response and recovery (Tierney et al., 2001). Since most disasters are studied retrospectively (Drabek, 1970) a narrative was chosen to organize information along a timeline that could help to infer path dependencies. Narrative lends itself to a qualitative enquiry in order to capture the rich data within stories (Mitchell & Egudo, 2003). This approach had the advantage of bringing together information gathered during field work and interviews, and organize it along a time line to capture a sequence of events before the disaster and what occurred in the years following. Narratives are also beneficial for the case study analysis adopted in the research project because they complement the interpretive approaches often used in social sciences (Mitchell & Egudo, 2003). In particular, the aim was to make links between governance gaps and drivers of risk as identified in the literature, and then how this could be used to attribute responsibilities across the risk governance framework.

The discourse on methods to study disasters suggests that the field benefits from a multi-disciplinary approach as was previously mentioned. This falls in line with a narrative inquiry deemed inherently multi-disciplinary. Qualitative research and narrative inquiry is not interested in prediction and control but in understanding a series of events, whereby several causations may be determined (Clandinin, 2006). The narrative was adopted to support theory-building and shift from a purely descriptive case study of the disaster event to explanatory, as suggested by disaster researchers,

*'The future of disaster research involves the transition from descriptive studies to explanatory studies {that} try to make sense out of the relationships observed in {descriptive} analytical studies ...'*

(Cisin and Clark 1962: 4, in Stallings, 2003)



Explanatory case-studies seeks to explain how and why a series of events occurred (Yin, 2012). It suggests causal paths from a variety of variables interacting over time. The Xynthia storm occurred in February 2010. However, information was gathered to understand the years before the disaster and in the years after the disaster. The methodology used seeks to answer both descriptive and explanatory questions: *what* is going on and *why*? These questions are brought forward in the analysis (**Error! Reference source not found.**), firstly by presenting the context, actors and events in the case study, and secondly, interpreting these variables along a timeline, which informs why the consequences were so high in a particular area and how the conceptualization of responsibilities evolve.

**Table 7 Descriptive and explanatory case study questions**

<b>Descriptive case study</b>	<b>Explanatory case study</b>
<b>Questions: What happened in the case?</b>	Questions: Why did this happen?
<b>Method</b>	Method
<b>Descriptive account, multidisciplinary theoretical basis</b>	Narrative inquiry
<b>Purpose</b>	Description of a series of events over time
<b>To define the significant variables: context, actors, and events.</b>	Purpose
	To understand path dependencies of the variables and their interactions over time and the role of different actors

A longitudinal analysis can be used to incorporate qualitative methods for complex causality. The reason is because the study of disasters is often done based on functional time phases and a spatial zone. While the time phases were discussed in the context of the natural hazard cycle (Tierney et al., 2001), the spatial zone is defined as the ‘impact zone’ and refers to the area where the danger and damage occurs. This method was attractive by allowing to use information from interviews and organize the content along a timeline for a very specific area. The aim of such an approach is to make conceptual links and determine path dependencies (correlations and causation) (Stallings, 2007). Multiple sources of information

opened up the possibility to establish several path dependencies that structure the event sequence. The result is to understand the conditions that contribute to the event.

A descriptive case study needs to be well informed by facts and data collected from a variety of sources. Researchers in this field of disasters usually adopt unconventional methods and designs, including the use of resources normally considered biased and unreliable. In recognition of this limitation, data on the case study was collected from different sources such as interviews, reports, observation and fieldwork on the site, to confirm or contrast information. The process of this data collection is described in the next section.

#### Data collection

Case studies need to be well informed and evidence should be drawn from multiple sources to provide a robust description of the event and the context. In this section, the process of data collection is described in order to present the different sources of information gathered on the Xynthia storm and consequences in La Faute-sur-Mer, as well as the trial that followed.

Primary and secondary sources were used to gather data on the case. This includes direct observations, interviews, official reports, administrative documents and scientific articles. These multiple sources allow for triangulation of evidence described as a process that merges independent sources that point to similar facts and give insight into the context (Mathison, 1988). The advantage of triangulating sources of evidence allows to establish converging lines of evidence, which will make findings as robust as possible (Mathison, 1988).

The next part describes the fieldwork visits, which includes observations and interactions with experts and inhabitants in the commune. It presents the interviews carried out and the kind of information gathered. Finally, a list of the main reports used to gather information on the case is provided. These documents inform the governance framework for disaster and flood risk management in France as well as

the legal process framing the public trial. These sources provide a comprehensive understanding of the case study and context.

### *Observations and fieldwork*

Primary sources were direct observations of the trial and a Fieldwork visit to the location of study. Four hearings were attended during the Xynthia storm trial in September and October 2014, which took place at Centre de Congrès les Atlantes in Les Sables d'Olonne north of La Faute-sur-Mer on the Atlantic coast. During these sessions discussions with other attendees and journalists documenting the case were carried out and notes were made on observations of the hearings. Recording the trial was not allowed, however a full transcription of all the hearings is available for public access<sup>13</sup>. In cases where information was missing from notes or trial sessions, these transcriptions were used in place.

Observation of the trial for data collection was important because of the particular atmosphere of the hearings. The trial was characterized tension, especially between the plaintiffs (Xynthia victims) and the defendants. The trial was also resourceful for understanding the governance of flood risk management in France as several public officials from different levels of government were asked to hearings where they described their positions and their roles surrounding flood risk management policies and implementation. Finally, the kinds of questions asked by both the jury and the lawyers representing both sides were very useful for the analysis. Many of the questions posed centered the role of risk information and communication across individuals, which was interesting to analyze given the literature on disaster risk management and insurance that discusses risk perception, moral hazard and information asymmetries.

To give a better understanding of the trials attended, the dates and descriptions of the hearings are listed in Table 8. The research benefited from participation to the hearings where all the civil parties shared their stories and experiences of the storm

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<sup>13</sup> Compte rendu des audiences par la Fédération Nationale des Victimes d'Attentats et d'Accidents Collectifs (FENVAC<sup>13</sup>) – SOS Catastrophes & Terrorisme (<http://xynthia.fenvac.org/>).

on the 24<sup>th</sup> September 2014. Following this day of hearings, a full transcript provided information on the physical history of the commune and the geomorphologic processes that shaped the terrain. The following five hearings attended between the 25<sup>th</sup> September and the 2<sup>nd</sup> October were important for the analysis, as these were full days of questioning public officials on their roles and responsibilities. This part of the trial allowed gathering information on the flood risk management framework in France, enriching the basis of understanding made from desktop research. In addition, these hearings were interesting to analyze using scientific literature review on how governance gaps can create higher exposure and vulnerabilities, confirming prevailing issues of poor planning, failures to implement zoning regulations and building in high risk areas. Although the literature provides empirical evidence of these ‘drivers of risk’, the trial confirmed how these gaps can occur along a chain of decision-making within a decentralized governance framework.

**Table 8 Hearings attended of the Xynthia trial**

Date	Trial hearings
<b>24 September 2014</b>	<p>Hearings of victims and relatives of victims to account for their experiences on the night when the Xynthia storm passed.</p> <p>Civil party speakers:</p> <p>Audition de M. Christophe LEMAIRE, partie civile.</p> <p>Audition de Mme Lise BENEZRA-GOLDBERG, partie civile.</p> <p>Audition de Mme Evangelia CHARNEAU, partie civile (épouse de Loïc CHARNEAU)</p> <p>Audition de Mme Liliane CHARNEAU-TURCAN, partie civile (sœur de Loïc CHARNEAU)</p> <p>Audition de M. Michel DUBOIS, partie civile</p> <p>Audition de M. Daniel DUBOIS, partie civile</p> <p>Audition de Mme Giselle ARNAULT, partie civile (compagne de Monsieur Lemaire</p> <p>Audition de Madame Françoise BEAUGET, partie civile</p> <p>Audition de Mme Mireille LOUINEAU, partie civile</p> <p>Audition de Jean-Loup ROUSSEAU, partie civile</p>
<b>25 September 2014</b>	<p>Le Tribunal est déplacé à la Faute-sur-Mer</p> <p>The tribunal moved to the site of La Faute-sur-Mer to allow for studying the geography of the commune and to see developments four years after the disaster.</p>

<b>29 September 2014</b>	The former prefect of the Vendée Department Audition de Monsieur Thierry LATASTE, Préfet de Vendée de juillet 2007 à janvier 2010 (aujourd'hui directeur de cabinet du Ministre de l'Intérieur)
<b>30 September 2014</b>	Head of the case, Mr. RAFFY gave an overview of the Xynthia storm, the verdict motivations and evidence. Audition du directeur d'enquête Monsieur RAFFY
<b>1 October 2014</b>	Description : Public authorities working in the Departmental level: Audition de Monsieur Jean-Louis DETENTE, responsable du service aménagement et urbanisme de la DDE. Audition de Robert SAINT-IGNAN, ancien ingénieur des travaux publics à la DDE de Vendée Audition de Stéphane RAISON, ancien chef du service maritime et des risques de la DDE de Vendée Audition de Loïc CARIO, chef de l'unité risque DDTM à l'époque des faits
<b>2 October 2014</b>	Audition de Stéphane MONTFORT, ancien chef de service du service instructeur de la DDE à la subdivision des Sables d'Olonne Audition de Monsieur Philippe CHABOT, Colonel chez les sapeurs-pompiers

## Fieldwork interviews

Fieldwork in La Faute-sur-Mer was carried out between 27 February and 2 March 2017. Fieldwork was important for the research because of two benefits. Firstly, it allowed understanding better the physical site of the case study. In this case, La Faute-sur-Mer is interesting to observe as it is surrounded by water and the proximity of the dikes to houses is apparent. To further an understanding of how exposure developed in the commune, the use of GIS imagery would have been useful to track changes in terrain and development. Another advantage to fieldwork was the ability to interact with local people that gave understanding on the divergent views of flood risk, the storm and responsibilities.



**Figure 4 The eastern dike at low tide and high tide, 28 February 2017.**





**Figure 5 La Faute-sur-Mer, the area behind the port where all the houses were demolished after Xynthia in 2016**

During fieldwork, semi-structured interviews were carried out with relevant stakeholders including public authorities in the municipal office, the president of the association for victims, members of the victim association, as well as local people. Interviews were carried out during field-work in February 2017 (Table 9). These interviews allowed to gather information on: i) the history of the commune ii) understanding of flood risk exposure and vulnerabilities iii) experiences with hazards iv) flood risk prevention policies and measures. Table 8 provides more details on these interviews including the dates they were carried out and the title of the organization. In the analysis of the thesis, references are made to these interviews, although they are left anonymous due to delicate matters in the case and preference of interviewees to leave personal opinions unnamed.

**Table 9 Interviews during Fieldwork visit**

<b>Date and location</b>	<b>Person and organisation</b>	<b>Subject</b>
<b>28 February 2017</b>	Mr. Renaud PINOIT President of AVIF	Review of AVIF, the association's origins and current activities.
<b>28 February 2017</b>	Resident of La Faute-sur-Mer	Confidential
<b>28 February 2017</b>	Treasurer of AVIF (victims)	Confidential
<b>01 March 2017</b>	Mr. Jean-François ETIENNE Chief town engineer of the commune La Faute-sur-Mer since 2010	A review of exposure and vulnerability of the commune before Xynthia and current flood risk management projects
<b>01 March 2017</b>	Discussion with persons responsible for the public consultation phase of the PPRL	The process of the public consultation phase and a review of files submitted analyzing flood risk of individual land plots
<b>01 March 2017</b>	Vice-president of AVIF (victim)	Confidential
<b>02 March 2017</b>	Resident of La Faute-sur-Mer since the 1990's	Confidential

The information collected from fieldwork interviews permitted to compile a comprehensive narrative of the Xynthia disaster. The interview with the town chief engineer of the commune, Mr. Etienne was particularly useful, as he had been working on flood risk management in the municipal council following Xynthia in 2010. This interview provided detailed information on the impact of the storm and particularities of the commune's exposure and vulnerability to flood risk. Questions during the interview pertained to the evolution of the flood risk map, risk zoning and a discussion on the latest version of the PPRI released in 2016. This interview also touched upon the levers and barriers to implementing flood risk zoning policies at the local level, as well as some concerns with the capacity of the dike.



The central focus of the municipal council during the time of fieldwork was on rebuilding the dike to meet new risk assessments and apply different engineering techniques to increase the structure's resilience over time to changing risk conditions including climate change concerns.

Travaux réalisés de 2010 à 2014 (hors travaux d'urgence)	
Secteurs	Digue EST secteurs E et H
Année de réalisation	2010
Coût TTC	2 020 000,00 €
Part communale	606 000,00 €

Travaux réalisés depuis 2014					TOTAL
Secteurs	Digue EST secteurs G I J	PLATIN et digue OUEST Secteur 3	Digue EST secteur F	Etudes et Maitrise d'œuvre	
Année de réalisation	2014	2015	2016	2013-2014	
Coût TTC	2 434 800,00 €	1 390 800,00 €	247 728,48 €	461 360,00 €	
Part communale	425 684,00 €	359 058,00 €	63 484,55 €	119 108,00 €	
Travaux restants					TOTAL
Secteurs	Digue EST secteurs BCD	Digue OUEST Secteurs 1 et 2	Digue Vieilles Maisons	Etudes et Maitrise d'œuvre	
Coût TTC	525 051,42 €	1 229 772,48 €	669 934,62 €	276 000,00 €	
Part communale	134 553,18 €	315 149,69 €	171 681,91 €	69 724,00 €	

**Figure 6 Costs for rebuilding protection measures**

Source: Commune de La Faute sur Mer, Les enjeux de l'après Xynthia, 1 décembre 2016

While visiting the municipal council, the public consultation phase for the latest PPRI and PPRL was underway. During this phase of the PPRI/L, which lasts about five months, inhabitants are encouraged to visit the municipality to review the flood risk map, flood risk zones and consult the status of their properties. The persons who oversee this public consultation phase of the PPRI are not local people from the commune because the aim is to ensure that the process is neutral. A visit to this public consultation allowed to gather in-depth information on the challenges with implementing this flood risk policy. An analysis of the files, letters and personal statements from local homeowners showed concerns about the zoning and

urban regulations. The main concerns expressed in these letters were on the restrictions applied to plots of land in high flood risk areas such as prohibition to build additional constructions and requirements for modifications such as a refuge zone or a second story. The files submitted by residents included a list of precise questions pertaining to their plot including a map with topographical data that individuals received by hiring private engineering consulting firms.

Visitors to the municipal council during the consultation phase were local homeowners but also local people from the sister commune across the estuary Lay, L'Aguillon-sur-Mer. This shows interest of local people to compare maps and interest in the risk zoning process. Discussions with visitors allowed to gain an understanding on the tensions of the zoning process, especially on validity of the risk assessments. In particular, homeowners were curious as to why neighboring houses could have different risk levels. Other questions inquired about the criteria applied to high risk and to medium risk zones? Local people were very much concerned with the zoning and regulations because they felt it puts restrictions on their future investments as many purchased land for retirement.

Differently from meeting with the municipal council, the interviews with victims gave insight onto the experiences people have when they face disasters. The victims of the storm shared emotional stories and trauma. As a researcher, my aim during these interviews was to stay neutral, especially when discussing the trial. Interacting with this personal side of the case brought to life the research and gave insight into the culture and history of the commune as well as perception of the event and responsibility.

Some photos are presented from the fieldwork that were taken during 28 February and 01 March 2017. **Error! Reference source not found.** shows the dike that was reconstructed behind the port along the estuary at high tide and low tide. Figure 7, 8, 9 and 10 are photos from the visit to the municipal council during the public consultation phase, which includes hazard maps accessible to local inhabitants and several letters and files on personal cases of individuals that asked for reviews of their properties.

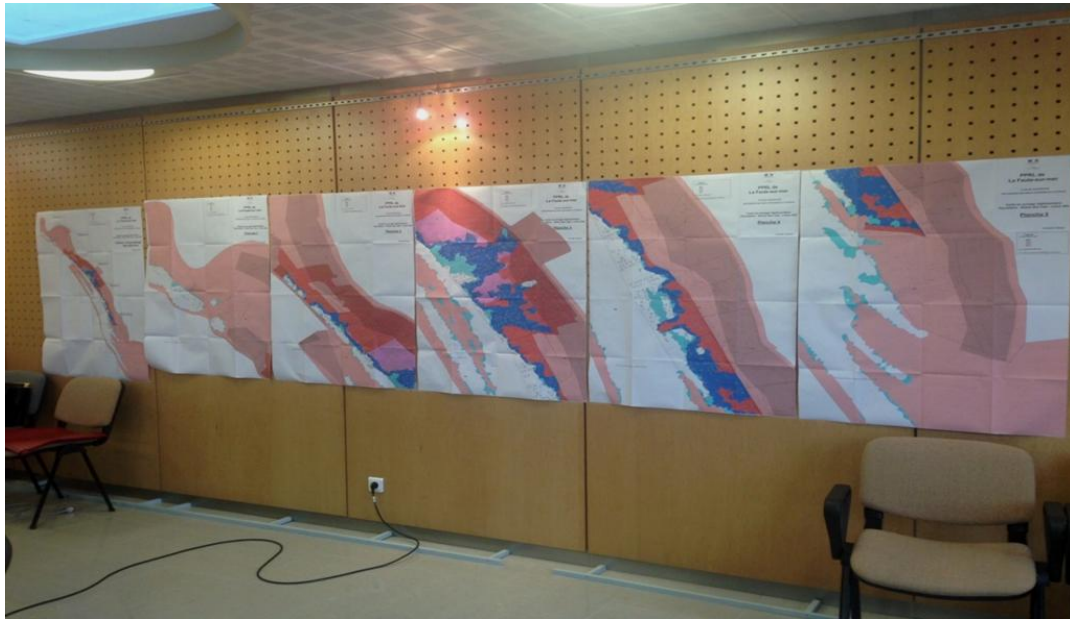


Figure 7 Public consultation phase for the PPRL 01 March 2017, located at the municipal office La Faute-sur-Mer.

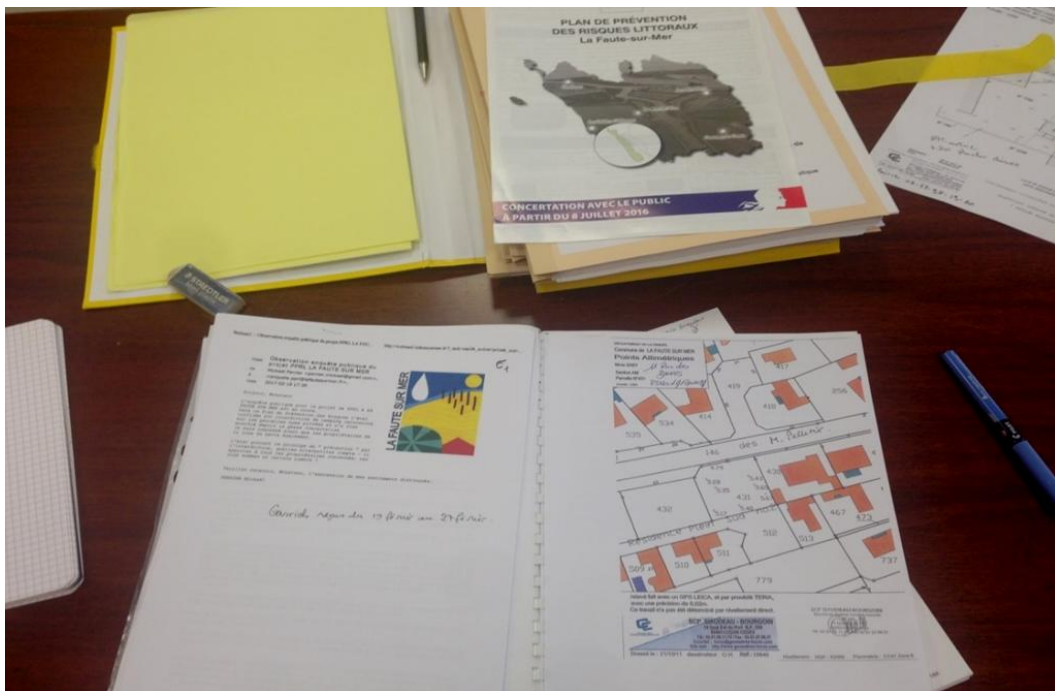


Figure 8 Public consultation phase for the PPRL 01 March 2017, located at the municipal office La Faute-sur-Mer.



Figure 9 Public consultation phase for the PPRL 01 March 2017, located at the municipal office La Faute-sur-Mer.

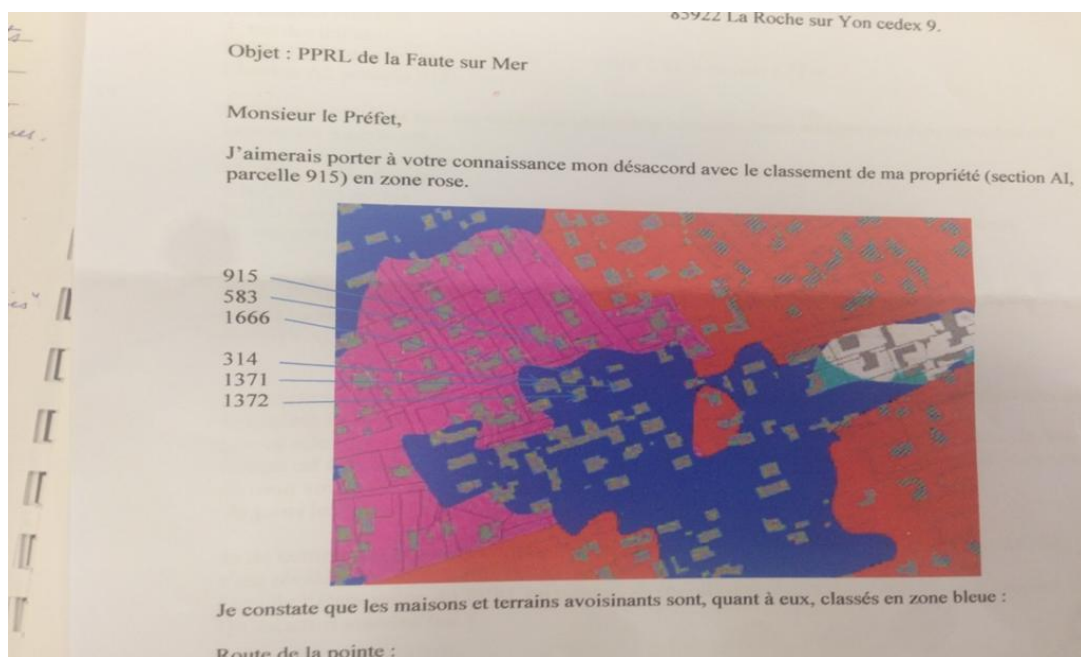


Figure 10 Public consultation phase for the PPRL 01 March 2017, located at the municipal office La Faute-sur-Mer

To provide a more comprehensive analysis of the case study it would have been better to interview local people who also own temporary houses. There are limitations with having information from just one part of the commune, mainly those who are retired and live there all year long. Gaining the perspective of local people who were not there at the time of the storm could give a better understanding of risk perception, their story of living in the commune and choosing the place and views on responsibilities for the consequences of the storm and flooding. This information may have reinforced or contrasted the views of non-secondary homeowners in the commune. In addition, it would have been useful to interview the mayor and lawyers involved in the trial. However, due to time constraints and the level of French at the time of the research, only a few interviews were carried out.

#### Additional interviews

Additional interviews were carried out with different stakeholders working on disaster risk management (Table 10). For more general information on disaster risk management and in France, interviews and email correspondences were conducted with reinsurance companies, natural catastrophe modeling firms and public official. The interviews were semi-structured and lasted between one and three hours.

**Table 10 Interviews with disaster risk management experts**

Date and location	Person and organisation	Subject
15 April 2014	Magistrat à la Cour des comptes	Xynthia case: why the Cour des Comptes decided to choose the case for a report (2012), the issue of inefficient cost and public budget spending, especially the expropriation of houses.
16 July 2014	Chief Economist and personal adviser of the chairman	Reinsurance for natural disaster risks, internal modeling capabilities, CAT bonds, study of dependencies/interdependencies of natural disasters.



<b>22 July, 2014</b>	INHESJ, Ecole Militaire	Operations in crisis situations, strategy and response. Natural disasters are not a priority for this agency.
<b>24 October, 2014</b>	Munich Re's Risk Trading Unit	Cat Bonds, in particular the risk of wind-storms in Europe (high costs and difficulty to model) which are a growing hazard in the reinsurance market.
<b>29 January, 2015</b>	Former secretary of the Scientific Committee of the Association Française pour la Prévention des Catastrophes Naturelles (AFPCN)	Xynthia case and trial. Has a secondary house in Les Moutiers en Retz, north of La Faute-sur-Mer
<b>2 December 2015</b>	SENIOR Manager, Research and client services	Nat cat modeling firms, The OASIS platform

Interviews with reinsurance companies Munich Re and Scor helped gain information on disaster risk financing with a perspective on France's insurance arrangements for disaster risk (the Cat Nat scheme). These interviews dealt with how reinsurance assesses different kinds of disaster risks and potential problems that may occur in the future of this market. The discussion evaluated the role of governments as reinsurers (e.g. France) in comparison to the private market. Private reinsurers are considerably weighting on the advantages of using cat bonds as an alternative risk transfer mechanism. Growing interest of governments in this market may increase this financial tool for financing disaster risks.

An interview was carried out with the Chief Economist at the reinsurance company Scor, located in Paris. This person was in charge of advising the Chairman and providing an economist point of view to projects. This interview pointed to particular interest about France's public-private reinsurance scheme and the phenomenon of 'systemic moral hazard'. From a reinsurer's perspective, this kind of arrangement develops a system in which costs are covered and guaranteed under the principle of solidarity, however there is a risk that it creates a lack of incentives to invest in mitigation and flood risk prevention. Thus, the context of France's public-private partnerships insurance arrangements for disaster risk was compared to the private reinsurance sector.

Other institutions were interviewed working on disasters, crisis and risk management in France that provided additional resources of information. One interview was held with an official in the Institut National des Hautes Études de la Sécurité et de la Justice. This government department works on evaluating different areas of risk under conditions of security and justice. They deal with a range of risks from radicalization, terrorism, racism, drug trafficking and natural hazards. This department is more engaged with national crises and emergency response and gave insight into the governance framework. Another interview was held with a former member of the Federal Aviation Association, and director of Centre for the Study of Air Navigation (CENA). Although the interviewees professional career was outside of disaster risk management, they took particular interest in the Xynthia case with comprehensive research on documents and meetings about flood risk management in France, and in particular an analysis of the Xynthia storm.

The Cour des Comptes (Court of Auditors) was interviewed based on a follow-up report made in 2012 about state activities post-Xynthia. This independent body has financial jurisdiction under the administrative order in France to assess legality of State accounts. The Cour des Comptes study evaluated the state budget that was allocated to post-disaster funding following Xynthia. It provides a thorough documentation on financing after the Xynthia storm through insurance and reinsurance, and state funds, as well as investigation of flood risk management processes. The interview with the magistrate (counselor) who is also an ecological specialist explored potential problems in the insurance and reinsurance arrangements for flood risk in France. In addition, that such a financing option based on solidarity leads to expectations of state obligations to take care of its citizens, even those who choose to live in high risk areas. Furthermore, information was gathered on state decisions after the storm to expropriate houses bringing into question how the state budget is allocated or these kinds of events and the use of public budgets.

### *Reports and documents*

Several reports and documents were used to collect data. These range from official public reports, administrative documents, the transcription of the trial, and official flood risk management documents for the commune. The benefit of these documents is that they provided a comprehensive analysis of the consequences of the Xynthia storm and give insight into the legislation guiding the national flood risk management policies in France.

The main reports used to gather information on the case included:

- Three senatorial reports from 2010 led by Senator Anziani:
  - *Rapport d'information fait au nom de la mission commune d'information sur les conséquences de la tempête Xynthia* ;
  - *'Xynthia: une culture du risque pour éviter de nouveaux drames'* ;
  - *Rapport d'information fait au nom de la mission commune d'information sur les conséquences de la tempête Xynthia*.
- Cour de Comptes report (2012), *Lesson from the 2010 floods on the Atlantic coast (Xynthia) and in the Var*.
- Report by the Ministry of Ecology, Sustainable Development and Energy (Le Ministère de l'Ecologie, du Développement durable et de l'Energie (**MEDDE**)) (May 2010), led by Catherine Bersani and colleagues. titled, *Tempête Xynthia : retour d'expérience, évaluation et propositions d'action*.
- Risk prevention plan documents:
  - Information on flood risk policies and regulatory documents are found on the relevant government websites online, such as DRIEE Ile-de-France (*Direction Régionale et Interdépartementale de l'Environnement et de l'Énergie*) at <http://www.driee.ile-de-france.developpement-durable.gouv.fr/>;
  - The PPRI file and flood hazard map for La Faute-sur-Mer from 2007 was provided by the municipality during fieldwork
  - Study on the system of protection against flood risk for the commune La Faute-sur-Mer (Système de protection contre la mer de la commune de la Faute sur Mer - Étude de Danger), carried out by the private consulting firm BRL ingénierie, from July 2015.
  - Public file on the background and regulations for the PPRL for La Faute-sur-Mer (Note de Présentation et Règlement - *Plan de Prévention des Risques Littoraux*, La Faute sur Mer, Projet n° 3 - Enquête Publique).



- Study called by the Departmental Direction for the Territories and the Sea in the Vendée (Direction Départementale des Territoires et de la Mer de la Vendée) Study on natural hazards in the 'South of Vendée and in the Poitevin marsh' Phase 1 Report: Analysis of the site, May 2013 (ETUDE DES ALEAS NATURELS SUR LE « SUD VENDÉE ET MARAIS POITEVIN » Rapport de phase 1 : Analyse préalable du site) [http://www.Vendée.gouv.fr/IMG/pdf/Rapport\\_Phase\\_1\\_cle25328c.pdf](http://www.Vendée.gouv.fr/IMG/pdf/Rapport_Phase_1_cle25328c.pdf)

Together these documents provided information for the relevant legislations and regulations pertaining to flood risk management in France, including those applicable to the ownership and maintenance of dikes, flood prevention, land use and urban development in flood hazard areas. Documents provided by the municipality of La Faute-sur-Mer during fieldwork helped to understand phases of the history of development, different stages of carrying out flood risk documents, including flood hazard maps and the evolution of the expropriation zone following the Xynthia disaster. Recent reports made by the commune showed efforts to rebuild a positive identity and attract tourism with new development projects underway, notably turning the area where houses were expropriated into a golf course.

## Methods

The research is anchored in two research questions presented in the previous section on: 1) What are the leading governance gaps that contribute to vulnerable conditions? How do these vulnerability components interact in complex systems and explain the consequences of disasters? 2) How to define and attribute responsibilities for disasters? What is the role of public trials to allocate responsibility? The first question aims to identify the different components of vulnerability in the commune La Faute-sur-Mer to flood risk, which is analyzed over time and reflective of governance gaps. In addition, the analysis aims to shed light on important concepts in studies on disaster risk management such as, socio-ecological systems in terms of urbanization and the interactive space between the

natural system and build environment. It also surveys the 'the levee effect', culture of risk, risk perception and the role of insurance and fiscal incentives to prevent risks. The second research question seeks to unravel the role of public trials to attribute responsibility for disasters. It draws from the first analysis where governance gaps also shed light on responsibilities in a risk governance framework that can help to define and attribute accountability, liability and responsibility for the consequences of disasters. To survey these research themes, the case study of the Xynthia storm and public trial was analyzed.

Based on the data collected described in the previous section, textual analysis was carried out to make links between different sources of information. The data was organized based on disciplines that seemed to be pertinent to the literature used for the thesis, which includes management (social), economic, and legal. The information was organized along a timeline to track different events before the Xynthia storm and after, that could help to identify changes in risk management, economic tools on risk (insurance and funding) and legal (accountability mechanisms) that could help to inform path dependencies on vulnerability and attribution of responsibility for the disaster. The two figures are presented **Error! Reference source not found.** and **Error! Reference source not found.** These figures map out a timeline of the data gathered on the case that could help identify interconnections and guide the analysis on the evolution of vulnerabilities before the storm and the evolution of responsibilities in the aftermath with the public trial and most recent discussions.

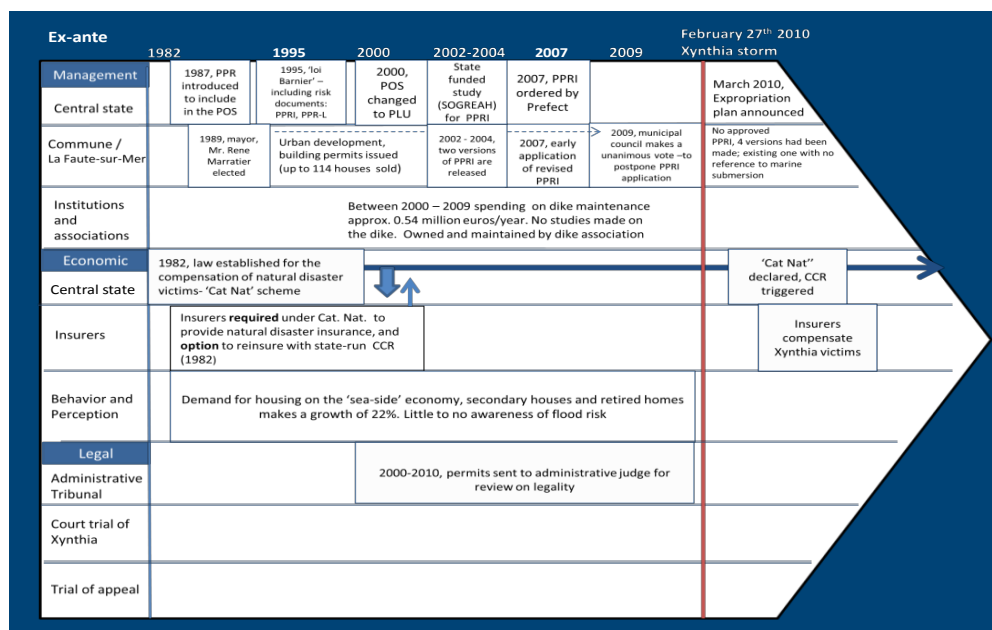


Figure 11 Xynthia storm timeline: before 2010

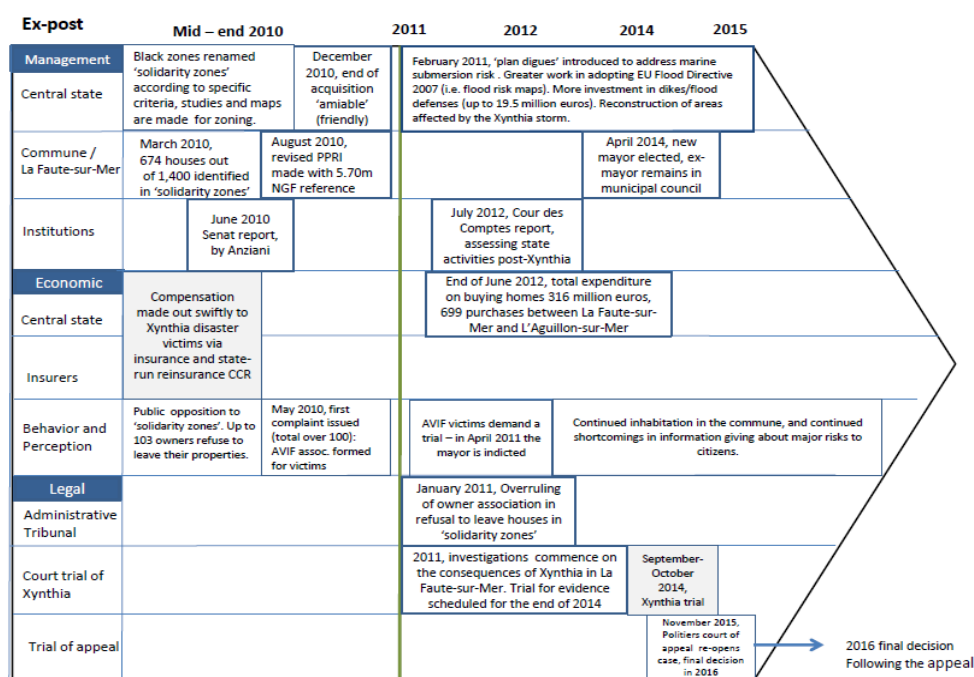


Figure 12 Xynthia storm timeline: after 2010

These methods could give insight into the causality of extreme events by indicating drivers of risk. It is suggested that disasters stem from a combination and interaction of numerous factors, at different levels of analysis over time (Rasmussen, 1997). Differently from positivist assumptions about cause and effect, qualitative studies on disasters usually points to contextual significance of the event and correlations (Leveson, 2004). This context forms the disaster conditions (i.e. pre-existing risk conditions), which includes social processes (political, cultural, economic and more). To be more exact, the processes are defined as components of vulnerability that influence the physical-, natural-, environment and behavior (some of which may have not been considered in the causal chain). All of these play an important role in the analysis of the case. Stallings (2003) referred to this disaster research method as ‘conjunctural reasoning’, because it shifts from determining causation through linear and reductionist processes to evaluating systemic factors that combine over time. Such an approach to analyzing disasters sheds light on the complexity of defining and attributing responsibility for disasters, given the systemic nature of these complex events.

## Summary

This chapter gave an overview of the methods used for the thesis. In particular, it described the qualitative case study approach and an event based study using the Xynthia storm disaster. This section also clarified the boundaries of the case study site, where analysis focuses on the localized impact of the disaster in La Faute-sur-Mer. In addition, the period of the case study was mentioned, where the analysis covers before and after impact of the storm. The chapter also described the data collected from various sources such as interviews, fieldwork and observations. The chapter discussed how this information was analyzed interpretatively to make a descriptive analysis of the case study to inform different components of vulnerability and the evolution of conceptualizing responsibilities, which is the focus of the next sections. While the methods chosen for the thesis present some limitations, this chapter aimed to explain why case study research was chosen and its advantages to revisit concepts and theories that frame the current disaster risk management literature.

## Chapter 5: Analyzing the historical roots of vulnerability of La Faute-sur-Mer: identifying governance gaps

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## Overview

This chapter presents a narrative of the case study to explain the leading drivers of exposure and vulnerability in the commune La Faute-sur-Mer to flood risk. The narrative of the history of the commune dates back to land transformation in the 18<sup>th</sup> century until the Xynthia storm in 2010. As suggested in the literature on vulnerability, the analysis looks at the role of biophysical changes, decisions on land-use and urban planning, the socio-economic conditions and demographics as well as risk prevention policies within a multi level governance structure (See Chapter 3: Literature Review). The literature provides understanding of vulnerability trends to flood risk as caused by rapid changes to the built-environment and socio-cultural context, with developments in land-use, population increase and ecosystem evolutions (Plate, 2002). The Xynthia case study discusses these different components of vulnerability and their evolution over time by focusing on governance. It sheds light on governance gaps that resulted in higher exposure and vulnerability levels. It is inspired by a methodology on analyzing vulnerability used by Magnan and Duvat described as 'trajectories of vulnerability' (2018). In the analysis, emphasis is on governance gaps in the flood risk management framework in France.

The precedent chapter on research methods presented the sources of information collected on the case study of the Xynthia storm and its consequences in La Faute-sur-Mer. To inform this narrative and analysis on the history of vulnerability in the commune, information was drawn from interviews with scientific experts, members of the municipal council, inhabitants of the commune and members of the association for victims. In addition, official reports, transcriptions of the public trial in 2014, articles and fieldwork observations (2017) provided complimentary information. The chapter brings together this data collected on the Xynthia storm's impact in La Faute-sur-Mer and concludes with a timeline illustrating significant events before the storm to explain the leading components that shaped vulnerability over time.

### The history of the terrain of La Faute-sur-Mer – ‘La Presqu’île’ and early settlement

The commune La Faute-sur-Mer is located in the southern part of the Vendée Department on the western Atlantic coast of France and covers a surface area of seven kilometers squared (Pigeon, 2012). The western side of the commune runs along eight kilometers of a sandy beach and large dunes that eventually terminate into a natural reserve at the tip of the peninsula called the Pointe d’Arçay. The eastern side faces the estuary Lay, across from which is the sister commune L’Aiguillon-sur-Mer. As La Faute-sur-Mer rests between two waterfronts, the nickname it has adopted is *La Presqu’île* (translated as 'almost an island') (Figure 14). The history of the terrain where the commune is situated is rather recent because the area was once under water. A series of smaller islands merged overtime due to currents carrying sand. This same current continues to slowly modify the terrain.



**Figure 13 Map of France and location of La Faute-sur-Mer in the Vendée Department**

Source : google.maps (<https://www.google.fr/maps/@47.3415377,-5.33562,1177141m/data=!3m1!1e3>)





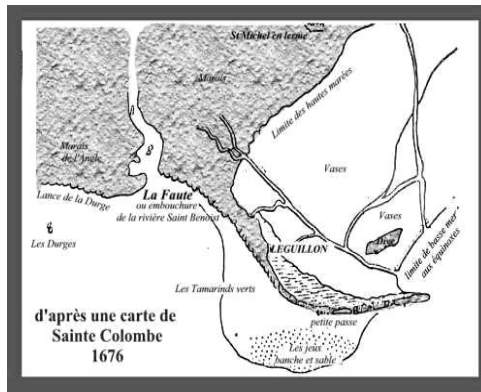
**Figure 14 Recent local poster of the commune, La Faute-sur-Mer**

Maps dating back to 1720 show that where La Faute-sur-Mer is located today was under the Atlantic ocean. Professor Sauzeau, a geographer specialized in the history of coastal land formations presented the peculiar history of the terrain at the start of the Xynthia trial (Hearing, 16 September 2014). The land is continuously taking shape due to the currents that carry sediment. Sauzeau remarks,

*‘There is something unique in this village, we are dealing with rapid dynamics of the implementation of the topography’*

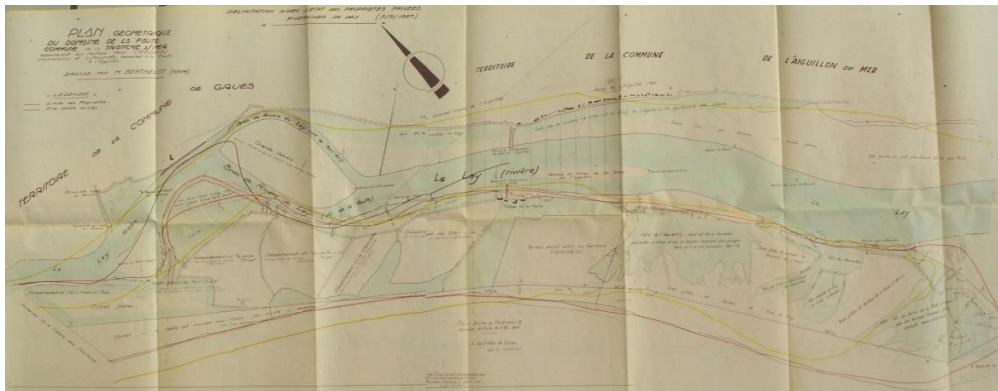
(Hearing, 16 September 2014).

Year zero of the commune’s land can be traced back to 1794 in archives, yet many land formations have since modified (Figure 15). During the 19th century the coastal current that crosses the Atlantic carried sand from the north to the south gradually expanding the land where La Faut-sur-Mer is located today, at a rapid rhythm of about 30,000 m<sup>2</sup> every ten years. The same current continues to change the tip of the peninsula (See photos of the modifications of the the point d’Arcay) (Hearing, 16 September 2014).

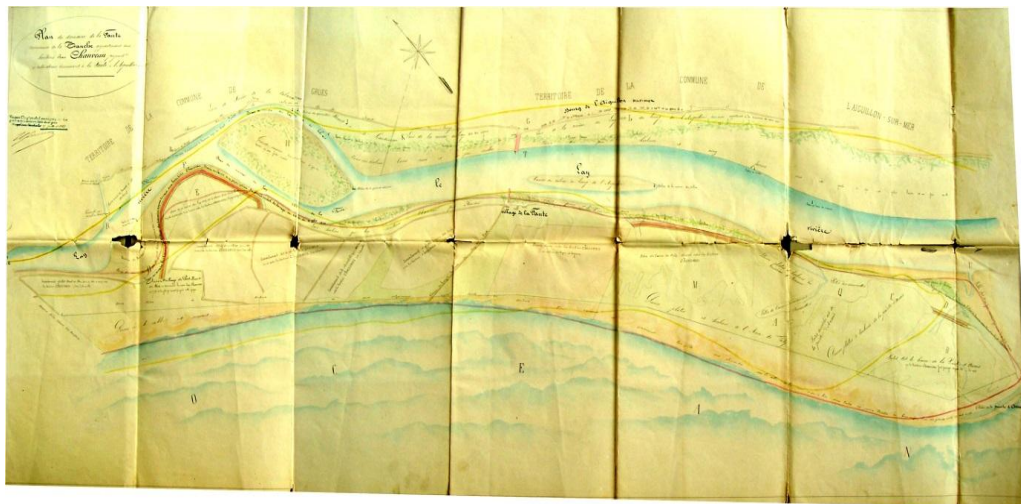


**Figure 15 Map of the area La Faute-sur-Mer 1676**

During the early 1800's, the first family to settle in the area beared the name Chauveau and built houses on the inner dunes, with the estuary Lay flowing on both sides (Hearing, Sauzeau, 16 September 2014). Originally, constructions were built on higher topographical areas farther from the sea, while the lower land areas were used for agriculture (Vinet, Defosse, et al., 2012). In order to make more land available for cultivation, a series of low-level dikes were constructed to push back the estuary. This is a first instance of human interventions in the natural environment, that dates back to the 1800's. Although ocean currents brought sedimentation and formed the island where La Faute-sur-Mer is located today, using methods of reclamation transformed the coastline (Vinet et al., 2012) . A series of maps from different periods shows how the terrain has transformed over the centuries (Figure 16 and 17). The map from 1864 and another map (year unknown) show how the islands merged to form a peninsula where La Faute-sur-Mer is located now.



**Figure 16 Map of La Faute-sur-Mer 1864**



**Figure 17 Map of La Faute-sur-Mer, year unknown**

In the early 20th century a shift took place from using the land for agriculture to contemporary objectives, namely tourism (Vinet et al., 2012). The commune became a development project for the tourism economy and secondary houses either for vacation or retirement purposes. These new constructions predominately absorbed the lower grounds that would allow closer access to the sea. In the 1920's writings by Mr. Louis Chevrier describe La Faute as a popular swimming location and emerging resort site for visitors to enjoy the sea (hearing, 16 September 2014). Aerial images from the 1920's show the beginning of development in the commune

(Figure 18). At this time much of the area was still used for agricultural. During this early phase of development a degree of flood prevention was installed with the construction of a dike in 1937. The dike controls the fluctuation of the tide protecting the inland community, thereby incereasing attractiveness of the space for settlement. This pointed to another human intervention in the natural environment by installing a protective structural measure. It also shows that there was knowledge of flood risk in the area.



**Figure 18 Aerial photo of La Faute-sur-Mer in the 1920's**

Reports following the storm stated that although Xynthia had an exceptional meteorological character, the consequences were exacerbated by a vulnerable coastline (Anziani, 2010b). Vulnerability of the coastline occurs because of several contributing factors in the natural ecosystem because of these dynamic and geomorphologically complex systems that evolve over time (Pethick & Crooks, 2002). Contributing factors including the natural mobility of the coastline, such as

the movement of estuaries and the dunes with tides, waves, winds, and flora progressively, in addition to extreme weather events that can cause severe erosion. Natural forces along the coast contributed to continual modifications of the tip of the peninsula (Point d'Arcay). Tides accumulated sediment from erosion along this peninsula that has been studied by natural scientists and geographers.

Anthropogenic forces contributed to the vulnerability of the coastline. Activities like pumping and draining water, digging, and modifying beach-line natural barriers increase vulnerability levels. Similarly, the reclamation of land using dikes and levees also interfered with natural processes and increased vulnerability to inland flooding (Vinet et al., 2012). A receding coastline and erosion have presented an even more critical situation along the western coast that was hit by Xynthia (25% of the coastline has receded in France, 25.9% of the eroded coastlines were urbanized areas, artificially created and developed) (Anziani, 2010a).

The parts of the coast where the Xynthia storm triggered storm surge and flooding was commented on as an 'artificialized space' in reference to the use of structural measures to keep the water out once settlement started in the area (Anziani, 2010a; Vinet, Defosse, et al., 2012). The idea of the commune as an artificial space points to the role of human activities that have modified the land largely to suit settlement. Thanks to the installation of various structural measures over time, including low lying dikes dating back to the 1800's, riprap and gabions, and the construction of a dike in 1937, these interventions led to important changes in the ecosystem and coastline of this area, explaining the attraction for development and increased exposure to flood risk (Vinet, Defosse, et al., 2012). Much of the literature on vulnerability along the coast discusses the role of structural protection measures that influence land formations, and in particular effects on erosion or accumulation of sedimentation (Duvat et al., 2017). Interviews discussing the commune's geography and modifications, suggested that over time 'nature is taking back its place' (Interview, anonymous).

Originally La Faute-sur-Mer was attractive for settlement because the land was fertile for cultivation, yet in modern history would present many opportunities for urbanisation and tourism. In 1953 La Faute was officially declared a separate commune (separation from La Tranche-sur-Mer), which would make it the 307<sup>th</sup> and one of the youngest communes in the Vendée (commune's website, <http://www.lafautesurmer.net/historique-de-la-commune/>).

During the 1960's and the 1970's development expanded and the cost of land rose in parallel. The price of plots of land in the 1950's was about 500 francs/m<sup>2</sup>. The price continued to steadily rise over the years to €12 /m<sup>2</sup> (approximately the 1980's), and by the 2000's was no less than €300/m<sup>2</sup> (Interview, February 2017). The 1970's were important development years for La Faute-sur-Mer, and what Sauzeau referred to as, *'the desire for the shore and the rise of the sea-side economy'*. The price for land in this area was affordable and attracted a population with enough purchasing power to obtain a residency on the sea-front. At the same time the commune's local administration responded positively by gaining economic benefits from tourism and local commerce. Sauzeau commented that the rapid rhythm of construction was supported by the commune's ease for issuing building permits.

*'For these communes (seaside), there is a right to draw the deliverance of building permits. We minimize the constraints for obtaining them'*

(Hearing, 16 September, 2014).

The Vendée department is the second most popular area for French vacationers after the Var (Interview, February 2019). The coast from La Faute-sur-Mer to the north western town La Tranche-sur-Mer covers 11 km of continuous camp sites situated along sandy beaches. The region and in particular the commune is a popular sea-side resort for people seeking an affordable second home or a quiet place for retirement. How is it that such a paradise was developed in a high flood risk prone area? The next part delves into the governance gaps that had cascading effects on increased exposure and vulnerability in the commune to coastal flood risk. In particular the governance gaps point to issues with land use and urban

planning policies in flood hazard areas, the impact of structural protection measures, risk culture, and the role of insurance and incentives.

#### Governance gap one: flood risk regulations on urban development

To analyze the increase of exposure and vulnerability of La Faute-sur-Mer caused by aggressive development, we look into the role of flood risk management policies and regulations in regard to spatial planning (land use and urbanization). In the municipality, there appears to have been a series of gaps in the time between the implementation of flood risk management policies and the development of the commune, which led to a high growth of constructions in a flood risk prone area. Between the 1950's and 1980's, the population grew two-fold, from 390 inhabitants in 1953 to 690 in the year 1982 (INSEE, 2018). In the 50 years before the Xynthia storm in 2010, the population of La Faute-sur-Mer almost tripled (Vinet, Defossez, et al., 2012). During this period, many new dwellings were constructed. Sauzeau commented that urbanization was driven by 'the shore of desire', which contributed to 450 new dwellings between 1990 and 2000, and from 2000 to 2010 about 250 dwelling per year (hearing, 16 September, 2014). In 1950 300 plots of land were built in La Faute-sur-Mer, while in 2010 there were 2 121 urbanized plots (Vinet, Defossez, et al., 2012).

Intensive development conflicted with land use and urban planning regulations in areas where hazards are known. In the 1990's important regulations were introduced in the French flood risk management framework with a particular focus on controlling urbanization in flood risk areas. During this time, while development in the commune continued to grow rapidly, France implemented a national flood risk management strategy that reinforced the role of urban planning regulations and risk zoning methods to constrict building areas in order to reduce the exposure of houses and long-lived assets to flood risk. In 1995, the Risk Prevention Plan for Floods (*Plan de Prévention du Risques des Inondations* – PPRI) was put into force. For communes located on the coast and at risk to marine

flooding or coastal surge, the Coastal Risk Prevention Plan (*Plan de Prevention des Risques Littoraux* (PPRL)) was required in addition to the PPRI.

The PPRI was implemented on the 2<sup>nd</sup> of February 1995 under the Environmental Law ('Loi Barnier'), and codified in Article L.562-1 in order to replace existing flood prevention procedures (Rasse & Rasse, 2014). The state created this new flood risk management policy framework to better ensure national coherency and standards to address flood risk across all communes. This was a positive sign in establishing an effective governance framework to ensure consistent implementation of flood risk policies at the local level. The PPRI serves to control urbanization and reduce the vulnerability of existing populations and assets at risk to floods by first ordering a flood risk and vulnerability assessment. The PPRI is ordered by the state and then the prefect of the regional *département* communicates the order to the local level. The municipal council is required to draw up a version and have it approved by the prefect (préfet). The role of the local level is important to ensure the PPRI is approved and implemented. In this way flood risk governance functions on a top down and decentralized approach, where the local level is responsible for implementation.

The PPRI is composed of three essential documents and steps:

- A report identifying the flood risk and a study of the impact it may have on the population and infrastructure, both at present and in the future. This aims to identify the risk, hazard and vulnerability levels. Often times, risk studies are outsourced to private consulting firms subcontracted by the state.
- A regulatory map illustrating risk zones. These maps should be scaled between 1/10,000 and the 1/5,000 and show both the zones according to actual risk level and the zones in which new development could increase the risk or create new risks. The map is meant to be easy to read for end-users and standardized based on color codes for different risk levels. The colors define areas across three types: a zone where building is allowed (*constructible*), a zone where building constructions is allowed under certain conditions, and non-building zone. The motivations for implementing the PPRI/PPR-Land zoning maps came from insurance groups in France, who were insecure about their level of risk exposure across France and wanted to restrict further development in floodplains (interview).



- When completed, the risk study incorporates several regulations regarding urban development. A set of regulations that specifies the rules for each zone based on risk level. It should include defining the rules for putting in place any project, and measures of prevention and protection.

These three factors are reproduced in a parallel document pertaining to coastal communes at risk to flooding, called the Risk Prevention for the Coast (*Plan de Prévention des Risques Littoraux, PPRL*). Once the risk study and map are finalized, they are transferred to the municipal council for a public consultation (*enquête publique*) phase that lasts six weeks. During this phase, members of the community are invited to share concerns and comments. This practice aims to increase participatory processes in flood risk governance and involve the community to increase risk awareness and preparedness.

Despite these efforts by the central state to implement flood risk management policies to better identify flood risk areas and control urbanization, several issues surfaced when the Xynthia storm triggered coastal flooding in La Faute-sur-Mer. The PPRI was a major issue under investigation in the aftermath of the disaster and a topic of inquiry during the trial. There were a few reasons for why the PPRI became a central piece of evidence for the investigation. Firstly, urban development and the issuing of building permits in the few decades before the storm contradicted regulatory constraints and zoning established in the commune's PPRI. Secondly, there were several versions of the PPRI made for La Faute-sur-Mer, that resulted in delays and modifications. In particular, modifications were made that reduced areas in red categorized as high-risk non-building zones. However, these changes in zoning were made with no reference to a study or change in risk level.

The story of the PPRI revealed several problems and diverging interests, between technical studies on risks and urban development that could support the growth of the local economy. In 2001, the first PPRI was prescribed by the prefect of the region for the commune La Faute-sur-Mer. Since this first call to carry out a PPRI, between 2002 and the final version adopted in 2007, four versions were released

revealing several inconsistencies. The first version presented in 2002 was financed by the central state that subcontracted the private firm, Grenoble Company for Studies and Hydraulic Applications (Société Grenobloise d'Études et d'Applications Hydrauliques (SOGREAH)) to carry out a risk and vulnerability assessment. At this initial stage of preparing the PPRI, the study showed most of the commune in red zones, signaling a high-risk level and prohibiting further constructions (in French '*zone non-constructible*'). During the trial for the Xynthia storm, the chairperson of the jury presented the PPRI from 2002 and referenced the doctrine of the state on hazard zoning regulations stating that, '*when the coastal flood ('submersion') height exceeds one meter or when current speed exceeds half a meter per second, the area must be classified as a high risk zone*' (Hearing, 29 September 2014). For this purpose, the state regulation on high flood risk zoning specifies the risk level. According to the study, the commune La Faute-sur-Mer, especially the area behind the dike was designated as a high-risk zone.

At the trial, the person responsible for development and urbanization at the Department level (DDE) was asked by the jury to comment on this study for the PPRI, and stated,

*'The hazard map from July 2002 classified "high risk" for the whole of the La Faute-sur-Mer basin (lower grounds in the 'cuvette'), this would make it possible to classify a large part of the commune as a non-buildable zone and would also freeze all possibility of development outside the flood zone'*

(Hearing, 1 October 2014).

The initial version of the PPRI in 2002 was transferred to the municipal council for a consultation phase. This process is required in order to engage the local administration and community in participatory governance practices. The document called for major reforms around land-use in the commune. In addition, it pushed for reinforcement works on the dike. In 2004 after the PPRI had gone through this consultation phase, there were several hesitations with moving it forward on the part of local authorities because it restricted development in a large part of the commune. It is also not clear what the role of the community in this consultation process was and if they were concerned with the impact the PPRI

would have on development or rather implications on the value of their properties. The result of the PPRI showing La Faute-sur-Mer in a high-risk zone led to demands by the municipal council for a reassessment. Shortly after, another PPRI version was presented in the same year with a new map that had been modified reducing areas marked red (outlawing any new constructions) to blue where constructions are allowed under certain conditions. The only part left red referred to the 50 meters strip behind the dike. The president of the jury asked about the basis for these modifications in the Xynthia trial,

*'Who arbitrated this choice to limit the non-building zone to 50 meters behind the dike while the topographical data had not changed?'*

The representative from the departmental level of government (*Directions Départementales de l'Équipement* (DDE)) responded that the modifications were based on the dike, *'It was the confidence in the dike which led us to take up these elements'*. When asked about the dike and any studies that could be referenced to confirm its capacity, it was assumed by parties that it was in *'good'* condition. When asked the same question about the changes to the zoning, the former engineer for public works at the departmental level (DDE) responded,

*'The studies of SOGREAH are a technical document that defines the parameters. What we do after is an urbanization document; they are two different things'*

(Hearing, 1 October 2014).

This reaction presents an interesting element that should be discussed in risk management on the interaction between technical risk studies and local knowledge that have implications on urban development. Acerra & Sauzeau (2012) presented this discourse in reference to the age of digitalization, characterized by technical experts, E-engineers interacting with local elected officials and technical services, that together was a driving factor of urbanization during the 1980's, where local knowledge of risks was devalued and forgotten, especially in many coastal areas. Nevertheless, a change in hazard zoning at the municipal level requires investigation and approval at the prefectural level. The question was why the

prefect did not take note of such inconsistencies. In response to these inconsistencies, the prefect stated during the trial that,

*‘The Vendée region has 69 municipalities affected by the risk of this type (flooding). There are 240 km of coastline; therefore, there are places where serious problems can occur...France has 69 communes and 36,000 mayors. The basis on which to implement these risk regulations are limited, and rely heavily on availability, willingness and mayors. We cannot rely on the state to be present everywhere; it must rely on local intermediaries such as municipalities’.*

(Hearing, 29 September 2014).

In 2006, the final project of the PPRI was issued which included the map generated from 2004 illustrating a reduction in high-risk areas deemed non-buildable zones. When submitting the final PPRI version to the prefect, the mayor wrote a letter communicating that he felt, *‘Let down about the risk zoning and building regulations’* (letter presented in trial). During the consultation phase, the municipal council commented on the effects that zoning regulations would have for the local economy because urban development would be severely limited. The president of the jury asked the former engineer of the DDE for confirmation about the PPRI project in 2004 and the consultations at the municipality. He responded,

*‘It is not a presentation, it is a consultation. The needs of the communes must be taken into account’.*

When asked about what needs exactly, the response was,

*‘I do not remember exactly, but the development needs, surely’*

(Hearing, 1 October 2014)

The delays for implementing regulations on development based on flood risk maps reflects time-lines to carry out policies across a multi-level government and decentralized risk governance structure. In this case, the chain of decision-making from the central state, to the prefect, departmental and finally at the commune level allowed for delays because of the various consultation phases. The PPRI is a centrally administered policy that is based on decentralized implementation. In the governance framework, consultations are in place to allow flexibility for locally tailored solutions. However, Larrue and colleagues (2016) described the strategy of

prevention in France's governance scheme as part of a broader planning culture that creates tensions between dynamics of centralization and decentralization. While participatory processes are considered aspects of good risk governance frameworks (Thaler & Levin-Keitel, 2016)., they rely on risk communication and dialogue to facilitate the acceptability of all stakeholders on risk reduction planning and measures. However, in many cases the PPRI is seen as putting constraints on development thereby creating tensions between central state policy objectives and local interests (Beucher & Rode, 2009).

With all the delays to pass the PPRI, the prefect urged an early application in 2007 of whatever existed at that point. The reasoning behind this action was related to concerns about the lengthy time it was taking to implement a PPRI since it was first prescribed in 2001. Under early application, three years are permitted until full implementation of the regulations within the document is required. This would mean that approval was anticipated in 2010. In order to have the approval by the prefect, it would require that the requests made to the commune for modifications to meet regulations would be complete. The former prefect of the Vendée region, who served from July 2007 to January 2010 (now Chief of Staff of the Ministry of the Interior), said during the trial that his role was to implement the process of the PPRI. This includes ensuring that planning authorizations in the commune respect the regulations. The prefect at the time attested that letters were sent to the mayor of La Faute-sur-Mer to put pressure for making additional studies on the vulnerability and reinforcement needs for the dike.

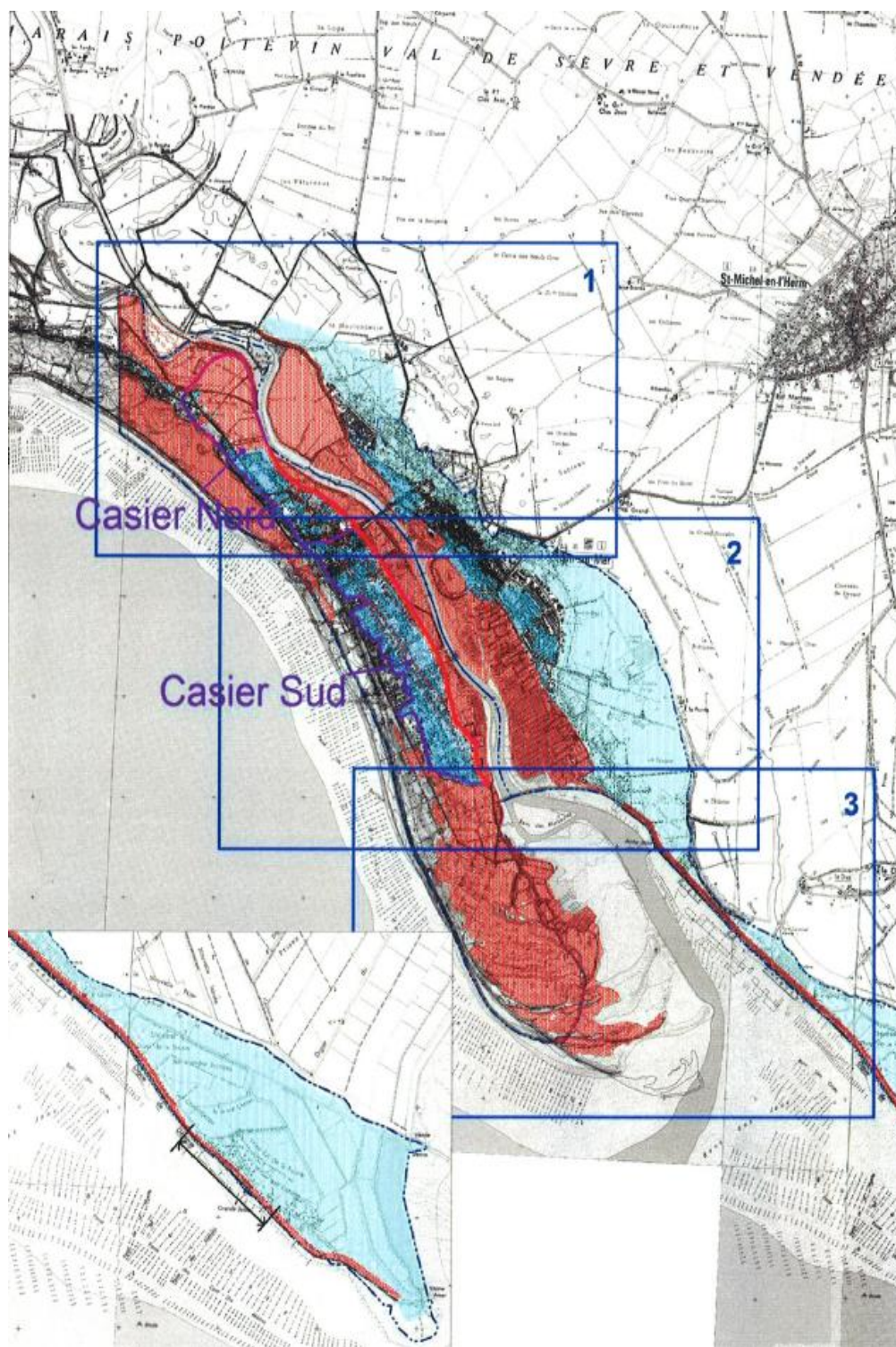





Figure 19 PPRI for La Faute-sur-Mer in 2007



## Commune de la Faute sur Mer

### EXTRAITS CARTOGRAPHIQUES Plan de zonage des mesures d'opposabilité immédiate de certaines dispositions du projet de PPRI de l'estuaire du Lay approuvé le 8 juin 2007

#### Légende

-  Zone bleu clair : Zone constructible sous conditions (en bordure du marais)
-  Zone bleu foncé : Zone constructible sous conditions
-  Zone rouge : Zone inconstructible sauf sous conditions pour travaux spécifiques

#### DESCRIPTIF SOMMAIRE DU RISQUE

L'estuaire de la rivière Le Lay est soumis à des risques d'inondation fluviale et de submersion marine.

Le Lay, formé par Le Petit Lay et Le Grand Lay, se jette dans l'océan Atlantique dans la baie de l'Aiguillon après un parcours de 80 km. Il connaît régulièrement des crues importantes, les épisodes de crues se produisant généralement durant la période hivernale.

L'estuaire de la rivière Le Lay est concerné par un plan de prévention des risques prescrit le 29 novembre 2001 qui établit les risques pour les communes de La Faute sur Mer et L'Aiguillon sur Mer.

##### 1. Nature et caractéristiques de la crue

Le Lay a connu de nombreuses crues dont celles de 1960, 1969, 1977, 1979 (bassin haut du Petit Lay), 1982 et 1983.

La cote de référence retenue pour déterminer les aléas et les zones inondables tient compte de l'influence des eaux marines et de la crue du Lay :

- l'aléa submersion marine est qualifié par le niveau de marée exceptionnel, les surcotes météo-océaniques et la surélévation, atténuée par l'estuaire, du niveau lié à la houle ;
- l'aléa inondation pour les éléments fluviaux correspond à une crue centennale du Lay. Cet aléa influence peu le niveau d'eau dans l'estuaire du Lay en raison de l'écrêtement dû aux débordements et au stockage très important dans le marais.

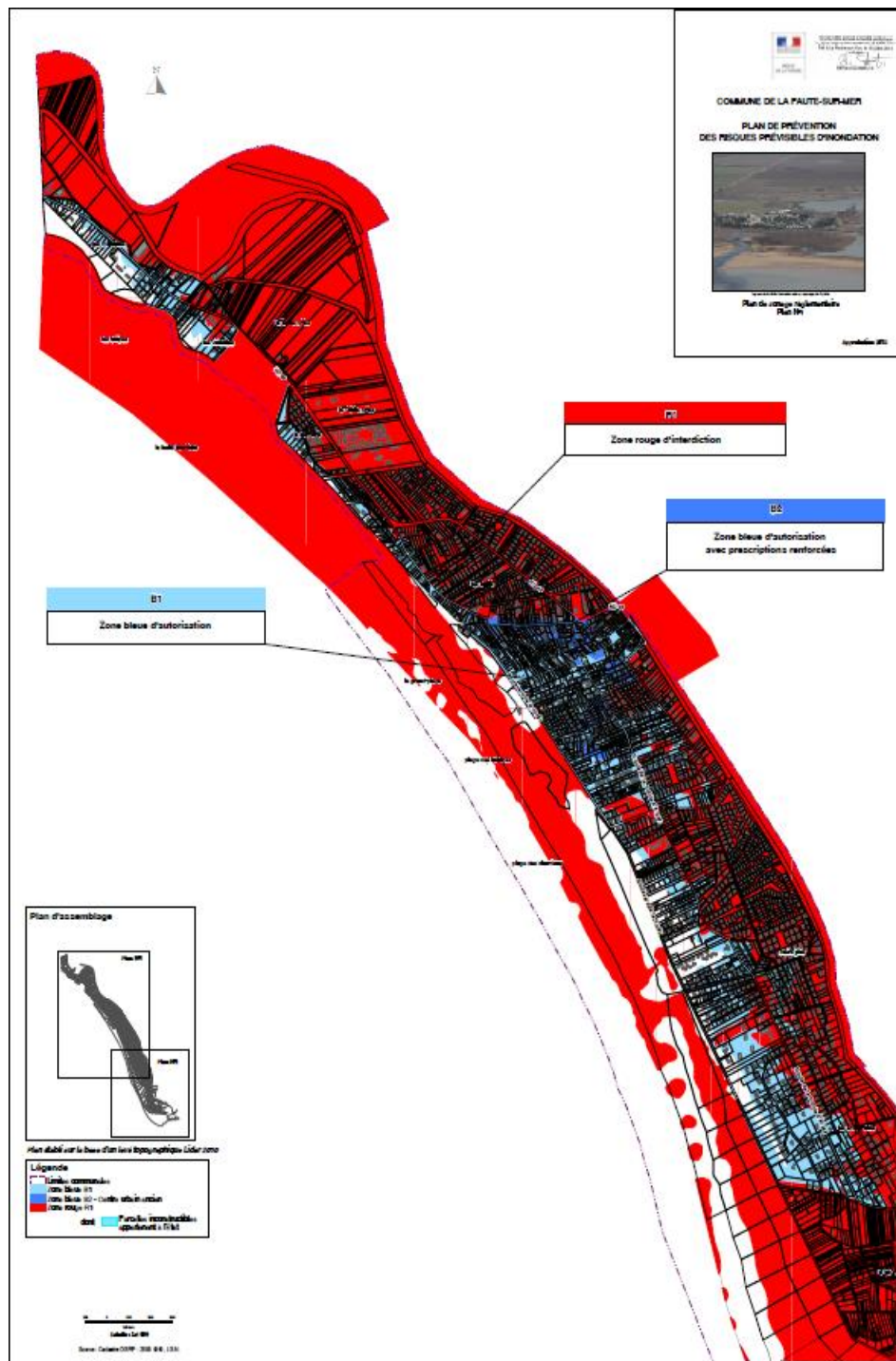
##### 2. Intensité et qualification de la crue

Les niveaux d'aléas d'inondation et de submersion marine sont définis comme suit :

- aléa faible : hauteur de submersion < 0,5 m et vitesse d'écoulement < 0,5 m/s
- aléa moyen à fort : hauteur de submersion comprise entre 0,5 m et 1 m et vitesse < 0,5 m/s
- aléa fort : hauteur de submersion > 1 m et/ou vitesse d'écoulement > 0,5 m/s

Figure 20 Legend for the PPRI regulatory zoning map 2007







In 2008 the municipal council with the mayor in lead contacted the prefect to express concerns about the interdictions posed by the PPRI. The letter requested further diagnostics and help from the state (trial evidence). During these years the risk map released in 2007 was used for assessing building permit issuances (Figure 19 and 21). This risk map from 2007 showed a slight increase of red areas as non-building zone in the sister town across the estuary L'Aguillon-sur-Mer and some additional areas in La Faute-sur-Mer. The document also modified the safety building code to 20 cm above ground level for new constructions in La Faute-sur-Mer. These changes were claimed to have been made according to further assessment of the dike, which changed vulnerability levels.

The 2007 risk map was argued to have been modified due to additional studies, but it was difficult to find concrete evidence for this during the trial. Instead, the arguments for modifications were said to be based on the '*objectivity of science*', because it incorporated the capacity of the dike. The judge overruled this comment, stating, '*The objectivity of science debate was overruled on account of subjective decisions indicating signs of mere neglect*' (Hearing, 1 October, 2014).

On the part of civil defense, it was argued to have been due to a '*conflict of interests*' as stated by the civil defense lawyer Mrs. Lepage. Elected officials in the commune were accused of economic interests to expand urbanization in the commune. Despite all the efforts to make studies, consultations and implement the PPRI in the commune, in 2010 when the Xynthia storm struck, La Faute-sur-Mer still did not have an approved version. These issues lead to investigate the PPRI in other flood risk areas for comparison. Follow up reports in late 2010 revealed that many of these risk plan prevention documents (PPR, PPRI) had not been adopted. Either they were just prescribed or are in the process of being studied. Concerning the PPRI for floods, according to the report in 2010 by Senator Anziani, out of total 10 102 communes identified that are required to have this document, less than 50% were in the phase of being prescribed and 112 still under study (Table 11). More recently, a study by La Fabrique Ecologique on coastal zones in France showed

that it takes on average a commune six years to implement a PPRI (Madelenat, 2019).

**Table 11 PPR phases from the study Anziani, 2010**

Type of PPR	Prescribed	Under study	Approved	Total
All risks	4228	187	7755	12170
Flooding	3395	112	6595	10102

The hearings during the Xynthia trial revealed that several municipalities rarely have a PPRI in place. This delay was questioned in the trial:

Mr. Seban (*Partie civile, civil party*):

*‘You indicated that only 46 PPRs had been adopted across 864 coastal communes, about 5%. For Faute-sur-Mer, it took 12 years to develop one, what do you think?’*

Mr. Anziani (*Senateur, Senator*):

*‘In the Senate, we were surprised by the slow development of a PPR/PPRI. This question was studied, and a schedule should be imposed with penalties in case of delay’.*

On account of the housing development in flood risk areas and the delays to implement a PPRI, the governance gap on controlling urbanization in flood risk areas pointed to issues with a top down policy making approach and decentralized implementation. In addition, while the consultation phases reflect ‘good governance’ aspects, including inclusiveness and participation, they also led to loopholes, where economic interests of the municipality challenged technical risk documents that would restrict development and reduce exposure in the community.

Governance gap two: a complex landscape of urbanization policies

The PPRI is a principle flood risk management document because it contains zoning regulations. However, land-use planning in France includes other policies

and regulations, which have accumulated over time resulting in a complex governance framework. The issuance of building permits must comply with the national laws on urbanization and in particular, Article L. 421-6 refers to this and the regulatory requirements for land-use. Two documents are important, the *Plan d'Occupation des Sols* (POS) (Plan of Land-use) or the *Plan Local d'Urbanisme* (PLU) (Plan of Local Urbanization). In places at risk to certain hazards, there are other kinds of regulatory planning documents required such as the *Directive Territoriale d'Aménagement* (DTA) (Territorial Directive for Land-use). Even if the license is in accordance to the documents, there are further exceptions in the case additional laws are applicable regarding the location of the commune, such as the Law of the Coast (*Loi Littoral*). Together, with the progressive development of new policies, including those on climate change adaptation and sustainable development, it is important to ensure coherency and compatablitiy across these land use policies.

The main urban planning document is the POS. Since first implementation in 1967, the POS was renewed in 2000 to a new document called the *Plan Local d'Urbanisme* (Plan of Local Urbanization). Similarly, as in the case of the PPRI there were lags of time to update these documents in the communes affected by Xynthia. In the Vendée and Charente-Maritime departments, the urban planning document in communes were outdated and most were never modified from a POS to a PLU. In the Vendée out of the total 33 coastal towns, 10 fell under the rules of the revised PLU, while 23 under a POS. Out of these 23 under a POS, seven were made over 15 years ago. The POS of La Faute-sur-Mer dated back to 1984 (Pigeon, 2012) and showed most of the area as permitted for building in the short term with no information about marine flood risks. Outdated documents pertaining to land use and urbanization can be misleading as they do not take into account rapid changes in spatial planning that can increase exposure and vulnerability. At the same time, these documents are used to review the issuance of building permits, which can lead to higher exposure levels.

The coastline is largely an artificial space, with increased vulnerability due to urban planning and structural protection measures that interfere with natural physical

processes of the ocean. In the 20 years before the Xynthia disaster, it was revealed that many houses were built along the coast in areas at risk to flooding (Genovese & Przyluski, 2013). The situation presented unlawful development and weaknesses in the governance structure, as land use planning is subject to building and zoning regulations based on the Act on Environmental Protection of 1995. The Act requires communes at risk to floods to use the PPRI as complimentary to the POS. However, the shortfall of this law is that in many cases the PPRI had not been implemented or confronted delays as was described in the case of La Faute-sur-Mer in the last section. Therefore, the role of the POS to control urban planning was important in this commune.

The POS, which communicates regulations on urban planning and building codes should have been coordinated with the PPRI, as urban structures posed higher risk in La Faute-sur-Mer to flood risk. This increased exposure was found due to, 'Of the 676 homes listed, 444 are single story (60%), while only 6% contain one or more floors' (Vinet, Lumbroso, et al., 2012). The predominance of bungalow properties can be explained by urban planning, historical trends in architecture and social demand. Firstly, the urban planning and land use documents (POS) dated back to 1984 and had encouraged low constructions limited to 9 meters (Vinet, Defosse, et al., 2012). Reasons behind this decision were to maintain aesthetics of the coastal landscape and urban trends. Historical trends in architecture indicate that from the 1950's to the 1960's, most houses were built on the ground level with one floor level (Kolen et al., 2013). In the 1960's to 1970's first floors were elevated, which reduced some vulnerability to flood risk. In the 1990's until the 2000's there was a reemergence of building on the ground floor with modern bungalow-type constructions (Kolen et al., 2010). A study made by Vinet, Lumbroso and colleagues (2012) showed that 32 people corresponding to 85% of deaths in La Faute-sur-Mer caused by Xynthia were in these kinds of bungalow construction types,

*'the night of the Xynthia storm, no person was found dead in a house built before 1960, so the oldest homes are the most secure....in 1990 2000 there were 450 new constructions, and then from 2000 to 2010, about 250 dwellings per year'.*

(Sauzeau referring to the study made by Vinet et al., 2012).

Another factor explaining the development of single-story houses is social demand. Year round residents are mainly retirees, while vacation homes are used during the summer. Factors such as limited mobility on account of age and the socio-economic context characterized by modest incomes, did not encourage a larger dwelling or an additional floor. The relationship between the risk of death caused by flooding and the height of water are correlated as found in the case of La Faute-sur-Mer (Jonkman & Penning-Rowsell, 2008).

As a result, the Xynthia trial focused on the various documents that regulate urban planning. There are cases in which the construction of new dwellings was subject to the regulations in the PPRI, hence these served as evidence in the trial for illegal practices of urban development. In addition, there were several other documents such as the POS, now PLU that set out regulations on housing types and materials, which included building codes and aimed to maintain a coherency of style. Together, this created several time lags due to the introduction of new policies within a complex landscape of multiple urban planning rules. With rapid changes in the physical environment, it would be important to regularly update land use and urban planning documents and ensure consistency between all the policies associated to spatial planning.

#### Governance gap three: on structural protection measures

Prevention in flood risk management uses structural, non-structural and semi-structural measures (Jha et al., 2012; Vinet, 2018). In France, to address coastal flood risks, the use of planning policies to designate risk zoning and non-buildable areas is a main tool to reduce exposure and vulnerability as discussed in the last section. In addition, there are many structural defense mechanisms in place, such as groynes, dikes, riprap and breakwaters as well as protected areas to ensure ecosystem services. Early installations of these structures can be traced back to the middle ages and steadily became a widespread practice to address erosion and coastal flood risk (Deboudt, 2010). Structural protection measures are allocated

public funding via the 'Barnier Fund' that is financed by taxes on home insurance against disaster risks (Larrue et al., 2016).

Disaster risk management research suggests that structural risk reduction measures influence a physical space, which includes disruptions to natural physical processes such as the movement of sediments and has implications on decisions to build in an area (Foster & Giegengack, 2011). Many insights have been drawn from the case of the state of Louisiana, and in particular the impact of the levees on the Mississippi delta and increased urban development in floodplains in the New Orleans area (Colten, 2009). Similarly, studies in the Netherlands have also contributed to analyzing urbanization in floodplains that are protected by structural measures (Baan & Klijn, 2004). Structures such as sea walls, dams, dikes and levees can undermine the risk in an area by giving a false sense of safety. In addition, they need constant monitoring and maintenance, which requires a governance and organizational structure to ensure necessary works are carried out and funding is available (Slomp & De Vries, 2017). These various factors are presented to explain the role of the dike as a driver of vulnerability in La Faute-sur-Mer.

After the flooding in La Faute-sur-Mer, the dike was investigated. During the passage of the storm marine overflow overtopped the dike and subsequently floodwaters were trapped in the commune (Interview, February 2017). At several parts of the dike the earth embankments gave way and some dikes were submerged (Vinet, Defossez, et al., 2012). The dike was revealed to be in poor condition, lacking maintenance and too low for the risk levels of marine flooding. How did it come that such an important protection system was in many ways neglected? Reports following the Xynthia storm disclosed several issues about the dike including ownership problems, lack of maintenance and hardly any scientific studies on its capacity (Anziani, 2010a; Cour des Comptes, 2012).

Here we highlight two governance issues related to the dike. Firstly, the 'levee effect' (Burby, 2006; Laska & Morrow, 2006) which explains the negative side effects of hard protection structures because they can encourage development in

hazardous areas. Secondly, an outdated legal framework on ownership and maintenance, which created the risk of these measures to become forgotten and ineffective against changing risks levels. This highlights the need for risk governance frameworks to identify contradictory or incompatible risk policies that can be drivers of risk.

The dike in La Faute-sur-Mer is a structural prevention measure that reduces the risk of flooding and exposure. It was first installed in 1937 along the Lay estuary. After the storm, analysis of the dike showed that its capacity was insufficient for the risk level of Xynthia and had a hydraulic load level that occurs once every 100 years (Kolen et al., 2010). The dike was investigated because all 29 deaths occurred in dwellings within 400 meters behind it (Vinet, Lumbroso, et al., 2012). Even more, the urgency of the situation revealed a systematic problem with dikes. Reports following the Xynthia disaster showed that up to 1000 kilometers of dikes across France are considered to be unsafe or subject to failure such as overtopping (Cour des Comptes, 2012). After storms in 1999 the region, several dikes failed in the Vendée department and a plan was put in place to restore and raise dikes by one meter (Kolen et al., 2013). Despite knowledge of the poor condition of dikes in the region, there was very little information on the maintenance or reinforcement of the dike in La Faute-sur-Mer. At the same time, there was a growing exposure rate of houses to flood risk in the commune due to urbanization trends.

In coastal and riverine flood prone areas, the role of structural measures on a false sense of safety plays a significant role in vulnerability because of the morphologies that take place naturally and from human activities. Prevention and mitigation structures are widely used to manage flood risk including basins, dams, dikes and levees. There are a range of problems with relying on these kinds of defense mechanisms, notably a behavioral adjustment known as the 'levee effect' where developments are encouraged in floodplains (Burby, 2006). The levee effects is an important component to vulnerability because it contributes to a myopia of natural hazards, which can have cascading effects on gaps in risk governance (Kunreuther & Michel-Kerjan, 2010). When Hurricane Katrina triggered flooding in New Orleans, many residents had high confidence in the levee system, and yet this

mechanism required attention and reinforcement works (Colten, 2005). In La Faute-sur-Mer the dike lowered the perception of flood risk among local residents, which was mentioned by both civil parties and local authorities during the Xynthia trial. The trial also revealed that local public officials had high confidence in its capacity when the PPRI study was under way, because flood risk maps were adjusted based on the structure. Therefore, the dike had important implications on local politics in which short term urban planning was preferred to support economic growth.

Structural measures require constant maintenance and in some cases may lead to more catastrophic effects in the case of failure (Crichton, 2008). Dikes, seawalls and dams function only as good as they are maintained over the years. This requires a clear set of responsibilities on the regular evaluation of these structural measures and funding schemes. In France, owners of these structures are a patchwork of multiple entities and public-private partnerships. Partnerships are often considered a sign of good governance, because they mobilize actors, expertise and resources (Thaler & Levin-Keitel, 2016). However, it is important, that if ownership is delegated across several organizations, there are clear roles and responsibilities for regular maintenance. The dike in La Faute-sur-Mer faced an overall lack of maintenance mainly because of fragmented ownership and rules stemming from an outdated legal framework.

The problem in the case of the dike La Faute-sur-Mer was that ownership and rules on maintenance were governed by an outdated legal framework dating back to 1807 (Anziani, 2010b). This law delegated the responsibility of dike maintenance to owners of the land, which over time spread across a multiplicity of entities ranging across the state, territorial collectives, associations, unions, the commune and private individuals. In La Faute-sur-Mer, a local association owned the dike that dates back to the first families who settled in the area. Ownership progressively passed down throughout the years along a chain of local landowners (Interviews, February 2016). These owners are obliged by law to carry out maintenance, security and control (Anziani, 2010b). The state is in charge of



overseeing that the owner properly executes these responsibilities with regular inspections.

Despite legislation in place on the ownership and maintenance of dikes, a plethora of arrangements across France resulted in several gaps and uncertainties. Reports after Xynthia stated that in many cases owners of dikes could not be traced (Cour des Comptes, 2012). Studies after Xynthia showed that France had up to 13 000 km of dikes and flood defences, 1 300 km of which were sea dikes, and for 3 000 km of these flood defences no owner was known (Kolen et al., 2010). In 2012, a study made by the independent accounting body, the Cour des Comptes (2012) found that 95% of the total length of sea flood defences and sea walls along the coast of the departments that were hit by the storm had no trace of ownership, management or maintenance.

At the same time, throughout the years the number of obligations required of dike owners had increased, many of which were not adhered to resulting in an important structural protection measure in La Faute-sur-Mer lacking any risk assessments and maintenance. In 2007, a decree was implemented to ensure that these structures are assessed, monitored and maintained and assigned the Ministry of Ecology (*Ministère de l'Environnement, de l'Énergie et de la Mer*) the role to supervise this inspection and maintenance (Larrue et al., 2016). However, the law of 1807 on ownership of structural measures was not addressed at this time, which led to a mismatch in the governance system even though there were binding laws in place. The hearing on 3 October at the Xynthia trial addressed the complex framework for the management of dikes,

*'This system is the result of history...these are complicated issues, determining who owns the dike (public or private), who will manage it, who will pay for the work to be done...these are complex issues'*

(Hearing, 3 October 2014).

As a result, risk governance should consider any changes to policies and take into account existing legislation that may be contradictory or forgotten. In the case of La Faute-sur-Mer, responsibilities for the managing the dike were neglected. The

Association of the Marais du Lay was responsible for maintenance, yet it was claimed that this association was inactive or non-existent based on a hearing with the departmental Director at the time of the storm (*Directions Départementales de l'Équipement* (DDE) (Hearing, 3 October 2014). Studies existed since the early 2000's indicating dangerous conditions of the dike such as the risk of breaking and overflow, especially in the case of an extreme weather event. A document from 2002 revealed that along with the preliminary hazard and zoning information, a contingency plan should have been implemented for monitoring and controlling the dike if a storm warning is issued (Hearing, 1 October 2014). This had not been carried out during the storm in 2010.

Before the Xynthia storm struck, the dike was already a point of interest according to interviews with local people. Local people experienced difficulty to make contact with the dike association and reached out to the prefect at the departmental level to bring attention to the dike (Interview, 28 February 2017). Due to the governance framework on ownership, there was a lack of accountability for the dike that resulted in unclear organizational responsibilities to carry out assessments and mobilize resources for necessary reinforcement works.

Structural measures do not only require clear organizational structures for accountability but also funding schemes. The studies on dikes after Xynthia (Cour des Comptes, 2012) showed that where owners could be identified, many did not have the will, the knowledge or financial means necessary to carry out maintenance. Before the disaster local people paid a yearly tax on the dike of about €12 per year, which was little in terms of the work that needed to be done. In order to fund the reinforcement works needed, the prefect would have to make a request to the state for additional funds. During the trial, the jury asked the prefect if there was information on the dike and any kind of request for funds. The prefect responded that he was aware of concerns for the dike in the period between 2000 and 2006, and there was available state financing of 50% (Hearing, 3 October 2014). In France, the state can offer to intervene with help on funding and in some cases claim ownership of structural protection measures. In 2003, the adoption of the Action Programmes for Flood Prevention (PAPI) introduced the principle of

integrated flood risk management and co-financing mechanisms between the state and the local level (Larrue et al., 2016). However, reports showed that on account of limited state budgets, a contribution to invest in dike work was limited at a maximum of 50%, where the other half is left to the local commune and associations (Anziani, 2010a). During these years, there had been some recalibration of the dike pointing to 2003. Following this period funding dropped below 25%. In 2007, the prefect issued a study on dikes in the Vendée region. Due to several stakeholders involved in the management of dikes and budgetary constraints, this process only started in early 2010. In 2009, a project proposal and an application for a grant were submitted to heighten the dike, yet the process was slow. These various problems related to accountability stem from the need to create an alignment of responsibilities and tasks in risk management, and also address budget lines to enable investments in dike maintenance as both of these issues are often discussed in the disaster risk management literature concerning limitations of structural protection measures (Crichton, 2008).

The dike led to increased exposure and vulnerability of houses in the community. Due to similar situations, for example in the Netherlands where several areas are located below sea-level, a new technique for managing flood risk has been implemented that emphasizes 'living with water' (Baan & Klijn, 2004; van Slobbe et al., 2013). In this case, structural measures are put in place while at the same time leaving space to let water in. Therefore, relying on flood defense infrastructure especially on the coast such as dikes, sea walls and levees requires constant monitoring and evaluations of the structure and surrounding environment (erosion of cliffs and dunes, deterioration of the coastal ecosystem) and careful attention to the cascading effects they may have on exposure and vulnerability.

Governance gap four: absence of risk culture

An analysis of vulnerability should consider social aspects which includes demographics, risk perception and 'risk culture' (Meur-Férec, Flanquart,

Hellequin, & Rulleau, 2010). The notion of *risk culture* in the French risk governance framework (in French, *culture du risque*) is often described as an aspect of risk knowledge and preparedness. It relates to institutional risk management arrangements, risk information sharing and a general risk awareness (Quenault, 2015), and, 'implies that the individual considers himself master of what happens to him, thanks to the implementation of an instrumental rationality, by abandoning all 'superstitious' beliefs relating to luck or fate' (Peretti-Watel, 2005). In the case study, demographic trends and socio-economic conditions of La Faute-sur-Mer are also factors important to understand the history of vulnerability and in particular, shed light onto the notion of what risk culture means in the context of flood risk governance in France in coastal communities. The high turnover rate of the coastal community is also comprised of a majority of secondary homeowners, which did not facilitate a collective memory about risks nor social cohesion. These factors reduced information sharing and risk perception, with implications on obstacles for building a risk culture, explored as a component of vulnerability in this section.

La Faute-sur-Mer is a small town that relies on tourism and a real estate market for secondary vacation homes. The commune does not have any large industry or infrastructure, except for some small oyster farming and fisheries. The socio-economic conditions of the commune are modest, comprised of middle-income families and bungalow style houses. Local people who call themselves *Fautaise* are few. In 1954 there were only 390 inhabitants, and the highest count is in 2006 with roughly 1,000 (INSEE, 2018). The population size coincides with seasonal fluctuations, because dwellings are predominately used as vacation homes during the summer periods. It is estimated that up to 87% of the houses in La Faute-sur-Mer are used as second homes (Vinet, Defossez, et al., 2012). During vacation periods the number of inhabitants grows exponentially, sometimes up to three-fold. Fieldwork was carried out off-season in February 2017 and most of the commerce and attractions were closed. However, local people and the tourist office assured that starting from April and on throughout the summer period the town would receive many visitors. This difference between the population size during high

season and off-season creates a risk of few instances to build community networks and cohesion. In addition, disaster risks such as storms and coastal flooding tend to become dismissed as a majority of the population only live in the area during the summer when there is a low risk of winter cyclones and related hazards (storm surge).

In addition to seasonal population fluctuations, the demographics of retired year-long residents are unique to several coastal communities, including La Faute-sur-Mer. The literature on vulnerability suggests that some segments of the population are more vulnerable to disasters, such as the elderly (for example see, Ngo, 2001; Rapaport, Manuel, Krawchenko, & Keefe, 2015). A majority of inhabitants in La Faute-sur-Mer who live year-round are retirees. Persons aged over 74 years only made up 15.8% of the population, while the median age of the population of coastal communities affected by Xynthia was 52 years in 2010 (Vinet, Boissier, & Defossez, 2011). In 2018, data shows that 56% of the population was between 60-75 years and older (INSEE, 2018). The age factor discussed in vulnerability is relevant for explaining the consequences of Xynthia, whereby 75% of the victims were people aged over 60 and mainly women (Vinet et al., 2011). Xynthia triggered flash flooding during the night while most of the commune was sleeping and mobility issues posed problems.

Demographic trends including seasonal fluctuations and a high turnover partly explain vulnerability. There is also the role that experience with hazards plays in risk perception (Meur-Férec et al., 2010). A the lack of any reference event in La Faute-sur-Mer contributed to an absence of a '*culture of risk*'. Marine flooding in the area was documented in 1924, 1940 and 1957, however these occurred before an explosive growth in development in the area which could make them easy to forget (Vinet, Defossez, et al., 2012). There is documentation of yearly harsh winter storms on the Atlantic coast that caused storm surge. Storm Martin in 1999 hit Charente-Maritime and had higher wind levels than Xynthia and more recently in 2009, storm Klaus crossed La Rochelle (a bit south of the commune) (Hamdi, Bardet, Duluc, & Rebour, 2015). These cyclones are characterized by strong winds, rain and high waves, which can increase the risk of coastal surges depending on a

combination of factors (barometric pressure, high tides, tidal coefficient) (Adam et al., 2016). The commune's high turnover since the 1960's meant that only some of the commune's population might have experienced the storms in 1999 and 2009. Interviews carried out by the geographer historian Seauzeau showed that the memories of any large-scale events were absent from local people, even the strong storms in the last 20 years, *'It should be emphasized that between 1924 and 1957 there were many events, but the populations have very few memories of this'* (Hearing, 16 September 2014).

Based on this data, there was a lack of memory of any coastal flooding in La Faute-sur-Mer and surrounding area because flood events were merely events documented in archives but did not contribute to experience or knowledge of risks (McEwen & Holmes, 2017). These recent storms also did not result in any major damage, which makes them easy to forget. Few reference events combined with a lack of collectivity in the commune because of the high turn over rate resulted in a lower risk perception. This context of the community gives insight into categories of remembering and forgetting natural hazards described by McEwen and Holmes as 'active forgetting' and 'active remembering' (2017: 148). 'Active remembering' can be facilitated by local activism and groups such as associations to maintain a 'social remembering' of flood hazards by continually sharing stories (McEwen & Holmes, 2017).

The absence or presence of a *culture of risk* in the area is difficult to evaluate after Xynthia because research was carried out after the disaster. This means that there was availability of risk information, thereby reference is made to the availability heuristic for risk association and perception (Tversky & Kahneman, 1974). In addition, there are various views on the meaning of the concept. Some refer to risk culture as a form of resilience that, 'represents the acceptance of living with risk and reducing vulnerability to risk, or adapting to the threat' (Scarwell et al., 2006: 156 in Quenalt, 2015). From this perspective, risk culture denotes a level of participation in decision-making and 'acceptability of risks' (Barquet & Cumiskey, 2018). Others look at the meaning of culture in the context of risk, which implies development over time and across shared values, community beliefs and

information networks (Douglas & Wildavsky, 1983). A sociological perspective on risk culture refers to a set of beliefs and ideas about risk based on framing described as the social construction of risk (Tierney, 2014). Framing of risks refer to information channeling and should consider how risk is framed politically by national policies and then translated at the local level where experiences with hazards and community dynamics play a role (Cornia et al., 2016).

Given these different approaches, the absence of a risk culture in La Faute-sur-Mer is often discussed in the context of a lack of awareness about risks and gaps in risk governance (Interview, February 2017). A solution to rectify this absence of risk awareness would be risk communication channels. The social construction of risk suggests to look at the role of institutions and politics that communicate risk and dangers to citizens, which lead to certain ‘frames’ (i.e. conceptual lenses) that influence how individuals make sense of risk (Paton, 2003). In France, the emphasis on flood risk prevention strategy using urban planning and hazard maps is based on technical documents drawn up by private consulting firms to guide risk-informed decision-making. At the same time, the regulations and objectives of flood risk reduction are defined by policies designed at the central state level. For local level elected officials and inhabitants, hazard maps can become contentious because they are reflective of the politics behind the central state on general objectives in flood risk prevention applied across all communes (Beucher & Rode, 2009). The state has recognized this by putting in place a public consultation phase of risk studies and zoning in hopes of facilitating local participation. The idea is to merge this gap between risk policies and communities through a dialogue that could be part of building a ‘risk culture’.

Research on risk governance has considered the role of influential political and social actors in elevating or decreasing feelings of danger and how this impacts risk perception and risk culture (Peretti-Watel, 2005). In the French flood risk management framework, the local level government plays a central role in communicating local risks (such as natural hazards). La Faute-sur-Mer is vulnerable to fire, floods and earthquakes, as documented in the commune’s risk

prevention plans, the *Plan Prevention du Risque (PPR)*. The PPR was implemented by French government in 1987 in order to ensure that natural hazards are taken into account in urban planning decisions (they are referred to in the urban planning documents, under article L 121-10 code of urbanization) and support risk communication tools. In addition, there is the Municipal Information Document on Major Hazards (*Document d'information communal sur les risques majeur* (DICRIM) introduced in 1990 to inform the local population of natural hazards. However, this document and the PPR played a limited role in risk communication in La Faute-sur-Mer and even more, had no influence over risk culture building.

Another tool for the local administration to communicate risks was the PPRI and the associated public consultation phase. However, the trial showed that some members of the municipal council and inhabitants felt that the zoning regulations in the PPRI were merely a politicization of flood risk to legitimize urban planning constraints (Interview, February 2017). The result of this perception towards flood risk policies is a large fragmentation between ‘experts’ associated with flood risk prevention administered by the central state and the ‘laymen’ within the local community (see Revet & Langumier, 2015). Therefore, there is interest in discussing the relationship between risk policies, framing and communication channels that could determine risk culture. Risk culture is also about collective behavior and attitudes towards risk, which depends largely on how risk is communicated and perceived, relying on how information is shared over time.

In the case study, exploring the notion of risk culture asks if people were more aware of flood risk would they have been more prepared or more willing to take on the risks? Risk culture relates to traditions and social interactions around hazards built over time, in which memory of risks plays an important role. Growing work in disaster risk management considers how local activities are a critical factor in building preparedness because social capital and networks provide various resources on disaster risks including information sharing (Aldrich & Meyer, 2014). It does not conclude that public authorities do not have a responsibility to communicate risks. Instead, it highlights the role of social arrangements and sharing in ‘active remembering’ that facilitates risk awareness (McEwen &



Holmes, 2017). Some demographics require different kinds of risk communication tools to facilitate participation in community preparedness. For example, research on the Western coast of France showed that retired communities respond better to pamphlets (Laganier, 2006).

Although a useful and attractive term in disaster risk management, risk culture can describe a community that lacks awareness about risks and preparedness to a disaster or is more willing to accept the risks. Based on the case study analysis, risk culture refers to the former, in which the role of memory and collective knowledge accumulated over time is associated to a better preparedness to disasters. In order to address this component of vulnerability, risk communication should have been carefully evaluated, especially paying particular attention to the turnover rate, demographics and seasonal population changes in the commune. Relying on public consultation phases of the PPRI document and risk map failed to increase awareness and risk perception. Therefore, complementary communication channels should have been implemented, such as trainings and seminars.

#### Governance gap five: insurance and lack of incentives

Another driver of exposure and vulnerability in the commune is a discussion on insurance, because it has an integral role to play in the governance of flood risk management in France. Insurance is often discussed as an important instrument in the governance of managing disaster risks by providing financial preparedness to facilitate compensation to victims (OECD, 2015). In addition, insurance has been analyzed as a potential instrument that can create fiscal incentives, especially in prevention at the individual level (Kunreuther, 1996) or depending on how it is arranged with the state, can incentivize public investments in risk reduction (Green & Penning-Rowsell, 2004; Huber, 2004; Bruggeman, Faure, & Fiore, 2010; Paudel, 2012; Surminski & Thieken, 2017). Studies on insurance for disaster risks have suggested barriers to this instrument, such as a general unwillingness to purchase it voluntarily by households (Kunreuther, 1996); and on account of uncertainties either insurance unwilling to offer coverage for the risk or the risk of

adverse selection (Paudel, 2012). Against this backdrop, insurance and government have taken varying arrangements to address insurance for disaster risks, which has depended on country contexts of market availability, the risk profile (different hazards), and the institutional set up (Green & Penning-Rowsell, 2004; Surminski & Thieken, 2017). The insurance scheme in France for disasters triggered by natural hazards is particular and sheds insight onto a component of vulnerability in La Faute-sur-Mer, which deals with incentives and urban development in risk zones.

In France, insurance is one of the main features of disaster risk management, in which recovery and compensation is reinforced by the state through collective risk pooling and a state backed reinsurance. The French 'Cat Nat' scheme combines private insurance, a state-funded reinsurer CCR (*Caisse Centrale de Réassurance*) and the government (Treasury) in a public private partnership to address natural hazards (Dumas et al. 2005). The program relies on constitutional guarantees founded on the principle of national solidarity for disasters. In 1982, the French government introduced the law on Compensation for Victims of Natural disasters (*Loi n° 82-600 du 13 juillet 1982 relative à l'indemnisation des victimes de catastrophes naturelles*) (CCR, 2015). The initiative was pushed forward following a series of flooding events (1977, 1980, and 1981-82) and risk assessments that showed the potentially high costs of an earthquake in Nice in the south of France (Michel-Kerjan, 2001).

The state plays an important role in this public private insurance-reinsurance scheme, which calls into question the allocation of funds across a country with very different exposure profiles across regions. Insurance companies are required to participate in the Cat Nat scheme by offering insurance against disaster risks at a flat rate set by the state Treasury. In turn, for the requirement to offer insurance, insurers are eligible for a state non-limited guarantee of reinsurance through the public reinsurer. Reinsuring with the CCR is not obligatory, however under this scheme the government acts as a lender of last resort, meaning 'it will pay until virtually bankrupt' (Michel-Kerjan, 2001). Insurers pay a tax of 12% on premiums to Cat Nat that funds the 'Barnier Fund', which is the main public engine funding

prevention projects. Therefore, compensation and prevention financing are part of the Cat Nat scheme. However, exposure to disaster risks varies and studies show that, '80% of départements have paid more in contributions than they have received as compensation, while 5% of départements have been paid three times the amount of their contributions' (Larrue et al., 2016: 30). For example, just in the case of coastal risks, between 1982 et 2009, the departments Pyrénées Atlantiques et la Gironde were involved in more than 1,000 Cat Nat requests (Deboudt, 2010).

The Cat Nat schemes covers all properties against disaster risks, which means that deciding on what events are covered by the CCR is a political decision. In order to activate the state-run reinsurance, it requires that the president or prefecture (*préfecture*) of the departments in the French territory affected officially declares the event as a 'natural disaster' (*'catastrophe naturelle'*). This is a politicized decision-making process. Therefore, discussions in 1999 raised the added premium for the Cat Nat and included revisions to more stringent requirements for declaring a state of natural catastrophe specifically in the event of a drought (OECD, 2006). It also modified rules to ensure that communes have specific risk management plans in place in order to be eligible in the wake of a major event (OECD, 2006). This last point, however is questionable as in the case of Xynthia, as the reinsurance mechanism was activated to address the costs in La Faute-sur-Mer (and other eligible areas) impacted by Xynthia, yet the commune did not have a PPRI nor an up to date emergency plan (*Plan Sauvegarde de Commune* (PSC) as required by the state.

Insurance has been considered to offer advantages in reducing flood risk according to information capabilities and incentive structures (Crichton, 2008). Information-gathering capabilities on risks offer a competitive advantage. By leveraging on these capabilities, it can create fiscal incentives such as discouraging development in floodplains and high-risk coastal areas and communicating flood risk levels to residents via premiums. Michel-Kerjan (2001) wrote that the French Cat Nat system allows insurers more information-gathering capabilities because they can share risk information. Since premiums are flat, insurance groups are pooled

together. Insurer groups, such as the French Federation of Insurers (FFSA<sup>14</sup>) and Group of Insurers (GEMA<sup>15</sup>) gather regularly at conferences and share information on disaster risk exposure, portfolio management and potential disaster costs. However, when it comes to using this information to construct fiscal incentives against development in flood risk areas, or promote state-run prevention projects, there is some uncertainty. Policies on zoning and building restrictions using flood risk information is the role of the central state, with responsibilities of implementation at the local level. Therefore, it is not clear what the role of insurance is as a technology of risk information within this governance framework.

The Cat Nat set-up results in no real insurance market, because competition is unlikely due to flat premiums and natural hazard disaster risk is bundled into overall coverage for the property. This gives emergence to two questions. Firstly, are individuals properly informed about their risk level since flat premiums do not reflect actual risk levels? Secondly, does it create a lack of incentives to invest in prevention since there is a guaranteed compensation? When reviewing the potential advantages that insurance can offer to incentivize risk reduction in the case study, it appears that there are several shortcomings. However, the scheme does offer several advantages in comparison to other public/public-private partnership insurance schemes for disasters or purely private market frameworks. These will be discussed.

Property insurance against flood risk is bundled with other hazards under the French Cat Nat scheme. The advantage to this mandate is that insurers have access to a wide risk pool between high risk and low risk profiles and market penetration is almost at 100% (Larrue et al., 2016). In this way, the program has overcome challenges of willingness to purchase insurance voluntarily by making it mandatory. However, one of the risks this scheme can create is moral hazard. Studies in behavioral economics on insurance have explored the internal risk of

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<sup>14</sup> FFSA, La Fédération Française de l'Assurance brings together insurance and reinsurance companies operating in France.

<sup>15</sup> GEMA (Groupement des entreprises mutuelles d'assurance) is a professional union, created in 1964, which includes French and Belgian mutual insurance companies.

moral hazard where insurance can modify individual's motives to prevent loss, described as, 'the tendency for insurance against loss to reduce incentives to prevent or minimize the cost of loss' (Baker & McElrath, 1996). The disadvantage to bundling risks is that the insurance sector faces difficulty to create fiscal incentives for property owners to either avoid living in high flood prone areas or incentivize installation of risk reduction measures by leveraging on premium pricing.

Studies following Xynthia and the trial revealed that that insurance did not play any significant role in communicating risk when individuals bought houses or filed for a building permit in La Faute-sur-Mer. Flood risk was not clearly stated in leasing agreements, nor communicated when building permits were issued (hearings during the trial). During the Xynthia trial, the jury questioned civil parties about their decisions for living in the commune. In particular if the person had knowledge about flood risk, would they have bought the land or constructed their property there? Most plaintiffs responded that this kind of information would have changed their decision-making processes. It is important to consider that these responses were coming just four years after the storm struck the commune and while victims were fighting a judicial case for personalized compensation. Therefore, it may be assumed that the person assessing likelihood of such a rare event had higher perceptions of the risk by recalling the experience. The notion of the *availability heuristic* is the idea that people assess likelihood of risk according to how available an event is in the mind (Tversky & Kahneman, 1974).

Public and private financial implications in flood risk management surfaces two important roles, on compensation and on financing protection (risk prevention and mitigation) (Huber, 2004; Crichton, 2008; Paudel, 2012). Since compensation is relatively guaranteed by the Cat Nat system, it would be important to reduce exposure to risks by ensuring that adequate investments are allocated to prevention measures and to avoid 'systemic moral hazard' (Huber, 2004). Huber (2004) described systemic moral hazard as a situation when 'lax' behavior towards risk reduction stems from insurance arrangements and impacts all parties, including the state, different levels of government, the private sector insurance and individual

households. This is explained because the state is accountable following a major disaster so the costs are valued in the aftermath, and not in prevention. To this purpose the best case scenario is when nothing happens, and in the case something does, emergency management and reconstructions can justify the use of public funding. The mandatory insurance scheme set up by the Cat Nat means that insurers have access to a large pool and will most likely be able to cope with the costs of disasters.

There are positive aspects to the public-private partnership for insurance against disasters in France. The reinsurer CCR engages in risk modeling and flood risk assessments across France. One of the ways it actively aims to reduce exposure is discussions with policymakers on flood risk management strategy and prevention. In particular, this is done around the allocation of funds from the 'Barnier fund' (financed by the insurance levy) for prevention projects. For example, the PAPI combines public and private actors in project proposals for integrated flood risk management that can be financed by the fund. However, budgets for prevention will most likely be allocated to projects surrounding densely populated areas, for example the PAPI for the Ile-de-France Seine et Marne, the state largely contributes to a fund (almost 50%) of €133 million along with other stakeholders (e.g. basin managers) (OECD, 2014).

Risk governance often discusses the role of the state as 'risk manager', because in some way or another it will have to intervene in the financing of the costs (Paudel, 2012). In 2005 the state called for a comprehensive review of the Cat Nat scheme. The investigations resulted in giving more leverage to insurance groups on assessing risk and negotiating the premium amounts paid to the state-reinsurer.

Despite reviews and some modifications, the system is still subject to critique because of the high investments allocated to risk reduction and prevention projects against natural hazards in France. More recently in December 2016, the independent court of auditors (*Cour des Comptes*) issued a correspondence to the ministries in charge of territorial development and finances to call a review for the state funding scheme for the prevention of major natural risks and overall

management of the public ‘Barnier fund’ (Cour des Comptes, 2016). The correspondence explains that state funding in this area has considerably increased in the last years:

*‘It’s expenditure, limited to €10 million per year up to 2004, reached €100 million in 2007 and amounted to €158 million in 2014 due to a regularly expanded field of intervention. Financed by a levy on the additional premiums paid by insured persons under the natural disaster guarantee, the FPRNM has become the main source of funding for the policy for the prevention of natural hazards. The Court considers this de-budgetization of ordinary State expenditure to be debatable.’*

–Cour des Comptes, 2016 (March)

The Cours des Comptes inquiry into the Cat Nat scheme and associated funds (*Fonds de Prévention des Risques Naturels Majeurs*, FPRNM) shows that public spending is very high for the prevention and mitigation of risks. In 2019, amendments were carried out again on the Cat Nat by raising taxes with the reinsurer to increase spending power towards risk prevention from €127 million to €180 million (Assemblée Nationale, 2019). To ensure there is a stable financing mechanism, the Cat Nat has showed a positive trend towards contributions from mandatory insurance policies against natural hazards.

The decentralized governance approach adopted in France to manage flood risks relies on implementation at the local level, including the management of prevention and risk reduction. The case study of the Xynthia storm revealed that many defense structures across communes in France were inadequately maintained (Cour des Comptes, 2012). Therefore, insurance has space to intervene, especially at the local level by reinforcing risk communication and bringing attention to areas where exposure is high and reinforcements are needed for existing structural protection measures. For example, coordinating urban planning policies, risk zoning and real estate practices with insurance is critical for such a governance structure to be effective.

The French Cat Nat public-private insurance-reinsurance scheme is positively reviewed for making compensation efficient and rapid (Interview, February 2017),

however the arrangement should inquire about risk communication tools surrounding the purchasing of properties in risk areas as well as on how to structure incentives to invest in prevention. Even after the lessons obtained following the Xynthia disaster, a recent report showed that development and demand for properties along the coast in France remains high, despite issues of coastal retreat, flood risk exposure and erosion, that will be exacerbated by climate change patterns (Madelenat, 2019)

### Interactions between the components of vulnerability and a timeline of the disaster

Retrospective analysis used by many disaster risk scholars aims to fine-tune what are the leading components of vulnerability that can explain the high consequences of a disaster (Przyluski & Hallegatte, 2012). In this chapter, the Xynthia storm case study was analyzed based on governance gaps that led to higher vulnerability conditions in the commune La Faute-sur-Mer. Exposure and vulnerability to the risk of coastal floods was shaped from a variety of factors that reinforced each other over time. In particular, the analysis looked at failed anticipatory flood risk management in the commune, non-adherence of urban planning regulations based on hazard zoning, lack of maintenance and assessments of important prevention measures (the dike) and a decreased perception of disaster risk across inhabitants and local officials, often termed as an absence of a '*culture of risk*'. All of the specific aspects of the case were discussed within the context of France's flood risk governance framework and the relevant policies and regulations in place to reduce the consequences of floods.

This research can help develop a method to study disasters, proposed here as 'disaster episodes' to identify before and after periods of a disaster with specific attention on the underlying drivers of risk. Gaining a better understanding of these drivers and how they reinforce each other can help to identify methods to reduce and plan for future disaster risks.



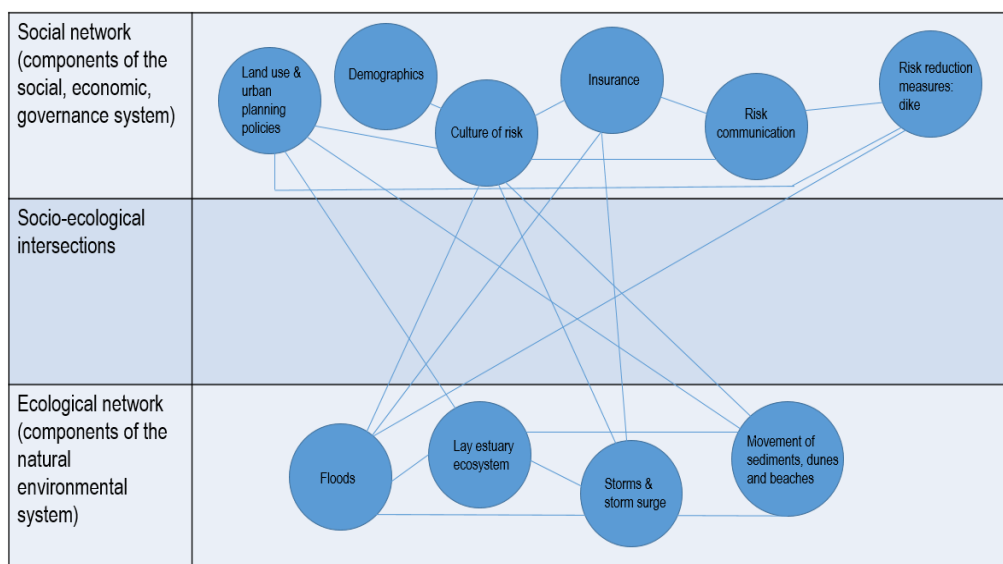
Firstly, spatial planning uncoordinated with flood risk management policies was observed as a driver of risk. Urban development in flood prone areas led to higher exposure of houses in the commune. In addition, this push for development undermined natural hazards over time and created gaps between flood risk maps and regulating urban development. Furthermore, vulnerability was influenced highly by structural protection measures (dikes and seawalls) that reduced the perception of danger, known as the 'levee effect'. The management of dynamic coastlines requires taking into account natural evolutions and human activities within spatial and temporal scales. The temporal problem reveals that since no events occurred where damages were high, the perception of risk decreased and a cascading effect was further urban development in areas at risk to flooding in the commune.

The Xynthia storm exposed several gaps in flood risk management policies and urban development within this small commune that had particular demographics, including age (retirees) and a high turnover. The demographic trends contributed to an absence of risk culture, which refers to a lack of preparedness to disaster risks. The commune has a history of attracting temporary residents for vacation homes and has a high turnover, which did not allow to facilitate information sharing, especially the participation and exchange of knowledge of the hazard among community members. Culture is something developed over time and requires social networks, resources and participatory processes. Therefore, the analysis on social vulnerability gave emergence to the important role of risk communication and perception as part of building a risk culture, which is relevant to strengthening sense-making around disaster preparedness. It also refers to a key component of community coping capacity in the face of disasters.

Another component of vulnerability analyzed referred to the role of insurance and fiscal incentives to invest in risk reduction and mitigation measures. The public private Cat Nat insurance scheme in France shed light on the advantages to this solidarity approach. However, it discussed also some potential side effects of the unlimited guarantee provided by the state reinsurance. While the scheme has succeeded to overcome several challenges faced by both private and public

insurance markets for disasters, there arises a question about incentive structures to invest in prevention across all parties involved in the Cat Nat framework. Households require incentives to invest in their own risk reduction measures, because all hazards are bundled into property insurance where risk is priced at a flat rate. At the same time, there is a question of incentive structures in place for other stakeholders to restrict development in flood prone areas, including real estate, commercial developers, and the state if there is a guarantee for compensation when disasters occur. Within this governance structure, there is a question of responsibilities across government, households, insurance and real estate market, especially due to urban pressure along the coast, which is at high risk to disasters.

The different components of vulnerability culminated in a series of errors which led to grave consequences of the Xynthia storm in this commune. The interdependencies of these components reflect the complexity of risk governance in France, and more generally can open discussion on governance structures within different countries.



**Figure 22 Socio-ecological system represented by the case study Xynthia storm, inspired by Barnes et al., 2017**

The analysis points to an important interaction between evolving natural systems and human activities in a coastal commune that led to higher vulnerability levels. Figure 22 presents this interaction using the normative framework on socio-ecological systems (SES) inspired by Barnes and colleagues (2017). Using this framework, the social network encompasses social, economic and governance (policies, risk reduction measures) aspects and the ecological network refers to the environment such as the estuary and coastal ecosystem, as well as the natural hazards (flood, storm surge). These two systems interact in socio-ecological networks, and the intersections are the drivers of risk. While research on SES contributes to understanding of adaptive capacities and which networks support resilience (Barnes et al., 2017; Cinner & Barnes, 2019), this framework provides a useful approach to synthesize the vulnerabilities discussed in this chapter and the intricate relationship between the environmental and human system.

## Summary

The Xynthia storm offers a narrative compiled from a variety of sources and perspectives. The issues raised in the Xynthia disaster case refer to several activities across different dates. For a synthesis the timeline of events is provided in the table (**Error! Reference source not found.**). The table begins in the 1940's and concludes in 2017 during the final year of research. It is divided between disaster alerts, which are events that signal risks across four periods. The table also represents different categories of activities across social, risk management, economic and legal. These disciplinary divisions are important elements in the next chapter, which will look at the question of responsibility for disasters and how it evolved in the case study

**Table 12 Time line of vulnerability and following events: the Xynthia storm in the commune La Faute-sur-Mer**

Period*	Key moments (social, disaster alert, risk management, legal)	Key activities during this time period
<b>PERIOD 1</b>	1920's SOCIAL	Tourism began in the commune La Faute-sur-Mer during summer periods
	1928 Disaster alert	Slight coastal flooding and coastline retreat
	1937 RISK MANAGEMENT	A dike was constructed in La Faute-sur-Mer
	1940 DISASTER ALERT	A tsunami hit the Vendée region that caused slight material damage and killed some livestock. La Faute-sur-Mer was slightly affected.
	1941	Coastal flooding/ overflow Damage to protection measures
<b>PERIOD 2</b>	1957 DISASTER ALERT	Coastal erosion
	1950's-1960's SOCIAL	Development and urbanization started to take place, mainly houses were bought as second vacation homes. Bungalow style houses were built on the ground level with no second story; and later some houses were built with first floors and elevated.
	1967 RISK MANAGEMENT	POS (Plan d'Occupation de Sols) created to guide urban planning and enforce building codes across communes in France.
	1982 ECONOMIC	Law established for the compensation of victims to natural disasters. The creation of the Cat. Nat. solidarity scheme that entailed mandatory insurance for natural disaster risks.
	1984-1989 RISK MANAGEMENT	POS was implemented for La Faute-sur-Mer (urban planning document).
	1987	1987 PPR (Plan Prévention du Risques) added to POS (then PLU) to take into account natural risks in urban planning ( article L 121-10 of the code on urbanization)
	1989 DISASTER ALERT	Slight marine submersion documented in l'Aiguillon-sur-Mer and la Faute-sur-Mer
	1990's SOCIAL	From 1990's to 2000, 450 new dwellings were built. During this time period there was a reemergence of building houses on the ground floor with modern bungalow-type structures.
	1995 RISK MANAGEMENT	PPRI and PPR-L were implemented in France to frame land use planning and set building and zoning regulations in the Act on Environmental Protection under the 'loi Barnier'.
	1999	Storms Lothar and Martin crossed the region; little

	DISASTER ALERT	<p>damage occurred in the commune, however storm dynamics were very strong, including higher winds than Xynthia.</p> <p>From 2000-2010 about 250 dwellings were built per year in the commune.</p> <p>The Plan Sauvegarde de Commune (PSC) was created, which is the general plan of security for the commune and emergency response.</p> <p>Flood Action Programme implemented (PAPI) to engage public and private actors in integrated flood risk management, including on the financing and management of structural protection measures.</p> <p>2001: Prefectural order of a PPRI for La Faute-sur-Mer</p> <p>2007: there was a call for an 'early approval' of the PPRI for La Faute-sur-Mer with a hazard zoning map that indicated blue areas (constructible) and red areas (non-building zones). No micro-topography was applied to the risk study, making areas at low zones, with 2-3 m NGF behind the dike labeled as a 'blue area' despite the high risk levels to flooding.</p> <p>Implementation of Decree on the maintenance of dikes</p> <p>2004-2009: Correspondences were carried out between the mayor of La Faute-sur-Mer and the prefect regarding the hazard mapping.</p> <p>2009: Municipal council of La Faute-sur-Mer unanimously voted to postpone the implementation of the PPRI up to 3 months because of restraints it would make on building in areas.</p>
<b>PERIOD</b> <b>3</b>	2000's SOCIAL 2000-2009 RISK MANAGEMENT	
	2010 27-28th February DISASTER	<p>Xynthia storm passed through France.</p> <p>Consequences: Housing loss, infrastructure damage, agricultural loss, disruption to power networks and 29 deaths in the commune La Faute-sur-Mer.</p>
<b>PERIOD</b> <b>4</b>	2010-2015 ECONOMIC- LIABILITY TRIGGERED	<p>Black zones (Solidarity zones) were declared as part of a state-led expropriation project of highly exposed houses along the coast, in areas that were impacted by Xynthia. However, the costs to expropriate the houses outweighed the cost of rebuilding the future dike.</p> <p>Compensation was made from the Cat Nat. and expropriation of houses was funded by the 'Barnier fund'.</p> <p>2015: Administrative Tribunal of Nantes was opened concerning the expropriation of houses:</p>

<p>2010 – 2017 SOCIAL – COLLECTIVE ACTION and ACCOUNTABILITY</p>	<p>2010: Association of victims (AVIF) was formed. The Public prosecutor asks if victims wish to make complaints. A file of investigation is opened for the case, a total of 40 complaints were issued.</p> <p>2014: Xynthia trial began and first sentences were issued to five individuals condemned for the consequences of 29 deaths in La Faute-sur-Mer.</p> <p>2015: Court of Appeal of Poitiers was opened, to review the Xynthia case. The judgment led to a reduction of sentences of those accused including acquitting.</p> <p>The public prosecutor asked the judges to condemn: in solidarity the State, the commune and l'Association Syndicale de la Vallée du Lay (ASVL) to pay the insurance group, Crédit Mutuel a sum of €1, 491, 038, 53.</p>
<p>2010-2017 REVIEWING DISASTER RISK MANAGEMENT</p>	<p>2017: Victims continued to seek compensation for social loss.</p> <p>2010 Rapid Submersion Plan (Plan Submersion Rapide (PSR)) introduced to address the following hazards: coastal flooding, flash floods, ruptures of fluvial or maritime dikes.</p> <p>Three reports were issued by the Senate; under the direction Senator Anziani (2010). Reports showed that out of 864 coastal municipalities only 5% had an approved PPRI PPRI did not include marine submersion as a risk There was an outdated legal framework managing the dike.</p> <p>Regarding La Faute-sur-Mer and communes affected by Xynthia There was a problem of the Illegal issuing of building permits in risk areas Houses were mainly one-story with no refuge or 2<sup>nd</sup> story in high risk areas.</p> <p>Cours des Comptes report 2012: Few owners of dikes were known across flood defenses in France. Criticism made on the state's spending on the expropriation project.</p> <p>2010-2011: Revised PPRI made for La Faute-sur-Mer with a reference level of 5.70 m NGF. This is based on 4.70 highest water level rise occurred during Xynthia, with an added meter to take into account global warming and sea level rise.</p> <p>2011-2012: PSC created, using multiple</p>

	communication tools.
	2012-2013: study of flood risk, vulnerability and the dike was carried out in La Faute-sur-Mer
	2015: La Faute-sur-Mer approved a PLU
	2013-2017: Reconstruction was carried out and works on the series of dikes along the estuary.
	2016: PPRL ordered for La Faute-sur-Mer Study of hazards and risk made by the consulting group BRL Engineering
	2017: Public consultation phase of updated PPRL

*The time line is divided between four periods, distinguished by disaster alerts or occurrences. These events are reminders of the risk of flooding in the area. Different activities are also categorized across the themes of risk management, social, economic, and legal.*

## Chapter 6: Attributing responsibilities for disasters: the Xynthia storm trial

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## Overview

The question framing this chapter of the thesis asks about how to define and attribute responsibilities for disasters and in particular, what are the role of public trials to assign responsibility for the consequences? It uses a case study analysis of the Xynthia trial in 2014 following coastal floods that killed 29 victims in La Faute-sur-Mer. To this purpose, the chapter presents the methods used by the trial to inform judgment on causality and responsibility, which was determined by actions or in-action to properly manage risks (*negligence*) and examines the role of risk information and communication channels. The analysis draws from a theoretical framework on the relationship between risk and responsibility, and the different forms of responsibility that emerge in risk governance frameworks such as *liability* and public *accountability*. While these concepts can appear as synonymes and redundant, the Xynthia trial and other trials for disasters that are presented in this chapter for comparative analysis, failed to convict individuals. This shows that there are types of responsibility to consider, and their alignments to actors in risk governance frameworks are relevant for such an analysis. Most notably, there is a question about whether legal tools are equipped to systematically adjudge these complex events. This chapter deals with this complex question about responsibility for disasters using the case study analysis of the Xynthia storm and trial.

The Xynthia case study invites an interesting question on an important research stream on disasters concerning responsibility for the consequences of these events, and in particular, what role trials can play. The Xynthia public criminal trial in 2014 convicted five individuals for the death of 29 victims who drowned in storm induced coastal flooding. The defendants were mainly locally elected persons or persons directly involved in urban planning who were accused of issuing illegal building permits and promoting development in flood risk zones. Evidence brought forward for the accusations included delayed implementation of regulatory urban

planning documents, multiple versions of flood hazard maps, a conflict of interests to promote development in risk zones, and a lack of communication channels in place about flood risk in the commune that should have increased awareness of inhabitants.

Adjudicating responsibility for disasters that involve a natural hazard means an individual or a group of individuals are found guilty for the consequences because of errors or failures in risk management decisions. From this perspective the analysis builds on the previous chapter, where vulnerable conditions to disaster risks stem from various components in the natural-, built- environment and institutional, socio-economic, and culture context. This is explained by the trial's focus on determining exposure and vulnerability as shaped by social and organizational risk management processes. In particular, the focus of the trial and evidence brought forward in hearings was on failures in governance arrangements within a multi-level flood risk management framework in France.

The Xynthia criminal trial was initiated by investigations by the public prosecutor and collective action by the association for victims, called *Association des Victimes des Inondations de La Faute-sur-Mer et de ses Environs* (AVIF). This association could be considered as an emergent group that formed after the disaster (Majchrzak, Jarvenpaa, & Hollingshead, 2007) that first took on activities to help provide immediate relief to victims. The association later developed into a formal organization to carry out activities surrounding support and coordination of victims who participated in the Xynthia disaster trial. In this chapter, the analysis looks at the role of this association and other parties in the trial to survey how responsibilities evolved from the beginning of the trial in 2014 until the end of the research for this thesis in 2019.

The argument for legal action in the case of Xynthia is that building communities in hazardous areas puts people's lives at risk and requires those in charge (public authorities) of overseeing land use and urban development to be held accountable. Some described the process of the trial as an *assessment* that was important to restore *public accountability* and the conditions of acceptable public management

of flood risk (Scarwell, 2017). The trial was a way to examine causation and responsibility for the consequences of the flooding, or as Quenault described an opportunity to,

*'..question the process of framing, from the 'putting one at risk' to the 'assigning causation' of the disaster, which will lead to interpret how 'risk taking' engages the responsibility of local actors and calls for a denial of risk to promote a culture of resilience in civil society' (2015: 3)*

In this way, the trial shifted the focus from the risk of the natural hazard to one that evaluates the social construction of vulnerability and injustice (Lauta, 2014). Environmental injustice is the study of disasters reveals how the law and regulation of the environment perpetuate societal inequalities (Colten, 2007). The case of Xynthia did not examine social inequality and environmental management at a systemic scale as suggested by Colten (2007). Instead, the Xynthia trial applied a narrow focus on attributing consequences of the flooding to local land use decisions, a communal history of exposure and injustice framed by errors in the governance framework for disaster risk management in France.

Assigning blame after a disaster can be subjective, described as, 'the process of 'putting in question' (otherwise known as blaming) seeks to assign responsibilities, and this justified and necessary process, where the psychological reconstruction of victims, will be eminently subjective' (Quenault, 2016: 2). Therefore, further analysis of the proceedings of the Xynthia trial such as the verdict motivations and evidence used can shed light on how the law and lawyers can better prepare to attribute responsibility for disasters and provide relief to victims. The latter refers to the limitations in tort law as focused on methods of compensation 'to make people whole' after disasters (Ratner in Miyazawa, 2015: 120). Nevertheless, public trials are important tools to establish and reinforce accountability in risk governance structures that can also provide relief to victims, either in compensation or symbolically by making the public aware of the gaps in risk management policies. However, the legal tools will have to address the potential for subjective inference and the argument of uncertainties surrounding disaster risks when the legal process requires criteria and standards to clarify how attribution is informed.

To cope with this complex landscape of responsibilities and their alignment, the analysis of the trial in 2014 in this chapter sheds light on different responsibilities in risk governance frameworks. Risk governance involves a variety of risk management tasks across different administrative levels assigned to a range of stakeholders with expertise. Moreover, it increasingly includes bottom up participatory channels to involve the community with the aim of incorporating local needs and acceptability in risk management practices. Therefore, how responsibilities are perceived by different stakeholders within this governance structure can be shaped by different frames of risk. In the analysis, these different lines of responsibility are referred to as risk and responsibility relationships, which are drawn from the risk governance literature and distinguished here as: capacity-responsibility, professional responsibility, liability, and accountability. These responsibility types have different legal ramifications and will be presented in how they emerge and evolve in the case study.

#### A trial for disasters involving natural hazards: positioning the Xynthia trial

Disasters triggered by natural hazards are increasingly investigated and brought to court where individuals are convicted for the consequences. This is especially the case when the economic and human toll is high and when crisis management is carried out poorly. What are the main characteristics of these trials for disasters involving a natural hazard and what kind of evidence is used to infer the attribution of responsibility for the consequences? A comparative analysis of different trials allows to identify some common and different features. The investigations tend to look at conditions before the disaster event with particular attention on the availability of risk information, communication channels and actions carried out or more importantly, those that were not taken to reduce the risk preemptively. These factors are important for the analysis of the Xynthia trial in which we return to typologies of responsibility (liability and accountability) and the notion of professional negligence as discussed in the literature review on risk-responsibilities in governance structures (Chapter 3).

The Xynthia trial is not the only case of a criminal trial for a disaster involving a natural hazard. Other trials have taken place in recent years in different countries involving a variety of natural hazards that are helpful to position the analysis of the case study. Two trials are presented for comparison, the L'Aquila trial in Italy for the earthquake in 2009, and the Fukushima Daiichi trial for the triple disaster and cascading effects on the nuclear power plant in Japan in 2011. The aim of this comparative analysis is to identify common traits and differences concerning the verdict motivations, evidence provided in the trial and who the defendants were within the risk governance framework. The analysis considers how disasters are treated either similarly or differently in these trials.

On the 6th of April 2009 the earthquake in L'Aquila resulted in 309 deaths (Imperiale & Vanclay, 2019). The disaster led to investigations in 2010 and the conviction of seven persons (three seismologists, a volcanologist, two seismic engineers and the former head of Italy's civil protection service) for involuntary homicide because of improperly communicating the risk of earthquakes to the local population (Alexander, 2014; Cartlidge, 2015; Cocco et al., 2015). There existed many studies on seismic hazard in the region and the local population was aware of the risk. A few days before the earthquake in 2009, the National Commission on Major Risks (*Commissione sui Grandi Rischi*) met to review the risk of earthquakes and risk communication tools. However, the main evidence used in the trial was the miscommunication of the degree of risk to local people in L'Aquila from these functionaries, who were later accused of 'involuntary manslaughter'. This is explained because warnings were made by local civil servants following foreshocks that occurred during the night, however they did not raise high concern. Local people have the habit to leave their homes after foreshocks because of the danger of buildings collapsing. Following foreshocks many residents returned to their houses and died in the rubble when the 6.3 magnitude tremor hit the region at 3:32 in the morning (Ray, 2011). This failure to communicate risks to the local population led to investigations, the conviction of seven functionaries and a trial. In addition to the political motives behind the L'Aquila trial, a question surfaced on

the role of scientists in risk governance and if they can be held responsible for disaster events (Cartlidge, 2015).

The Fukushima Daiichi disaster in 2011 is another example of a disaster that initiated a judicial review in 2015 and trial in June 2017. The disaster involved a tsunami that led to the failure of the nuclear power plant and cascading effects on exposure of people and the environment to toxins (Funabashi & Kitazawa, 2015). The trial charged three former executives of the operator of the destroyed nuclear power plant, Tokyo Electric Power TEPCO with professional negligence. Prosecutors alleged that there were studies of tsunami risk communicated to the plant and these executives had this knowledge, yet the information was ignored (BBC, 2017). A Japanese parliament report from 2012 commented that the disaster was entirely ‘man-made’, because it could have been foreseen and prevented, and the effects mitigated by human response (BBC, 2017). Investigations of the disaster and its consequences outlined a series of errors, including regulatory weaknesses and negligence to address the risk (IAEA, 2015). In this case, the trial attributed responsibility (criminal liability) to these executives for the consequences of the meltdown of three reactors in the nuclear power plant and cascading effects such as exposure of people and the environment to toxins. Responsibility was assigned to the executives of the plant, who should have been firstly, aware of tsunami risk because of available risk information and secondly, implemented proper risk reduction and mitigation measures, but failed to do so.

Differently from the L’Aquila and the Daiichi Fukushima trials, the Xynthia trial focused on the municipality's decisions about land-use and urban planning in flood risk zones in the years before the storm that led to a higher exposure of people and their assets. This trial highlighted that scientific evidence of the risk was presented in the commune’s flood hazard maps and yet, zoning regulations were changed due to subjective interpretations of the risk and confidence in the dike's capacity to withstand a major event (storm and coastal surge). The illegal issuing of building permits in high flood risk areas served as the main evidence in the trial, because it put people's lives at risk. The verdict motivations and evidence will be further presented in this chapter.

The L'Aquila, Xynthia and Fukushima disasters involved different kinds of natural hazards and resulted in different scales of consequences. Furthermore, the trials for these events occurred in different cultural and socio-political contexts with their own distinctive disaster risk management governance frameworks. The main difference across these examples are the positions of the persons convicted: functionaries specialized in seismic hazard science and civil protection services (L'Aquila), executives of the nuclear power plant (Daiichi Fukushima) and local authorities in charge of land use and urban planning (Xynthia). There are various factors that explain why different stakeholders within risk governance frameworks were convicted in these trials. One explanation could be linked to emergency management and how decisions made in the immediate aftermath highlighted 'wrong-doings' (errors) and initiated pathways to attribute responsibility.

The aftermath of disasters are key moments where quick actions need to be made. In this context, timeliness is critical and a clear and strategic vision needs to be designed, which explains why a command-and-control approach is often adopted (Imperiale & Vanclay, 2019). This approach, as Imperiale and Vanclay (2019) explored in the case of Italy after the L'Aquila earthquake has been criticized for being rigid and inflexible to take into account social dimensions of disasters. This is explained because after the L'Aquila earthquake, the Italian government decided to employ fire, police, emergency and military personnel and mark out restricted red zones, where many local people found the extent of military presence absurd (Imperiale & Vanclay, 2019). As a result, this response created gaps between bottom up local participation and top down disaster management structures. This gap created tensions between different parties and gave emergence to demands for responsibility for the deaths caused by the earthquake.

Similarly to the L'Aquila case, emergency management after the Fukushima disaster was considered by scholars and practitioners as poorly carried out (Aoki & Rothwell, 2013; Funabashi & Kitazawa, 2015). Reviews of emergency management of the disaster highlighted communication gaps between the nuclear industry and government, including uncoordinated response and overall misjudged risk about nuclear power plants and tsunami risk (Aoki & Rothwell, 2013). These

reviews pointed to the cascading effects of exposing people and the environment to toxins, which was attributed to the failure of executives of the plant to carry out their responsibilities to manage risks. Therefore, these cascading effects led to the conviction of the executives of the plant in the trial.

Similar to the other cases, reviews of the Xynthia storm and coastal flooding also pointed to failures in preparedness measures and emergency management (Kolen et al., 2010). These reviews showed issues with early warning about flood risk along the coast and delayed response to the flooding in La Faute-sur-Mer. An interview with a local inhabitant of the commune during fieldwork commented on the delay for teams to arrive to the situation,

*The storm and flooding struck at 3h00, but the helicopters didn't come until 11h00. There were no communication measures across persons to get help'*

(Interview in La Faute-sur-Mer, February 2017).

Despite these gaps in issuing proper early warnings and activating quick response measures, attention after the disaster focused on the exposure of people and houses to coastal flood risk. This aspect of the disaster was highlighted even more by the state's rapid decision after Xynthia to limit the exposure of houses in high flood risk zones along the coast by implementing an expropriation project. In this project, the state ordered flood risk maps to be drawn up and the implementation of a buyout program. To go forward with the project, a public study was made using geo-localization observations for 240km along the coast. Based on this information 'solidarity zones'<sup>16</sup> were drawn out, indicating houses that were to be acquired by the state. Within the solidarity zone there were perimeters indicating the status *Déclaration d'Utilité Publique* (DUP). DUP is an administrative procedure under

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<sup>16</sup> Before the zones were renamed 'solidarity zones' they were claimed as 'black zones'. The name was changed to symbolize state solidarity with natural disasters. In order for a zone to be labeled a solidarity zone, the area in question had to meet two of the following criteria: a) a risk of flooding level higher than 1 meter; b) the property had a distance less than 110 meters from the dike to take account possible wave phenomenon in case of rupture of the dike; c) there is a risk of a hydrologic phenomenon in which velocity and waves can be very strong and rise quickly; where the houses were destroyed and rebuilding them with a refuge is very difficult; d) where the area is a coherent and homogeneous whole, and does not create urban spread-out.



French law which allows the expropriation of private property for public utility, in which the person is subject to a 'just' indemnity. These zones were made according to flood risk heights and velocities, distances of houses from the dike, risks of marine submersion, and where houses were considered to be 'lost' in which rebuilding them would be too costly. In the department Charente-Maritime, the prefecture issued 19 maps indicating solidarity zones, which included areas that had not been flooded by Xynthia. The result of this decision led to 20% of La Faute-sur-Mer deconstructed which included the expropriation of 500 houses at a cost of €540 million (MEDDE, 2017).

The impact of expropriating and demolishing houses in La Faute-sur-Mer was high for such a small commune. The program triggered controversy. People responded with questions about the intervention, such as: *'Why, are there other solutions? Are there intermediary solutions?'* (Interviews with local people in La Faute-sur-Mer, February 2017). One of the problems with the solidarity zone was the variety of individual cases involved that had different experiences of the Xynthia storm, and yet all the properties were bundled together in a circled area entitled 'solidarity zone'. Within this zone, there were people who survived the disaster and were willing to have their houses expropriated, while others who were being forced even if they were affected very little by flooding. Some residents located inside the solidarity zone did not experience any water damage from the storm. Due to these disparities, tensions surrounded the scientific basis to these zones. An interview in February 2017 with the President of the association for victims (AVIF) of the Xynthia storm, commented that the tensions on this matter called for collective action. The association that formed to help victims (AVIF) started to defend people and criticize the solidarity zone,

*'AVIF helped to defend cases, such as those who were asked to have their houses demolished, but their houses were not in the correct sector. They put like three-fourths of the commune in this solidarity zone, in which people were forced to move'.* (Interview, February 2017)

In response to the expropriation plan, many local people thought, *'Ok there should be a solidarity zone, because there are dangerous areas, but it doesn't mean all of them'* (Interview, 28 February 2017). By defending cases and having the support of the commune, the zone was re-made in April and again in September 2010. However, this decision on drawing up flood risk maps quickly based on coarse topographical data created a separation between local people and the central state, where the entire governance framework for flood risk management was put into question, which fueled mistrust (interview, February 2017). It further highlighted the central component of the Xynthia trial, which was on the high exposure of people and houses in flood risk zones and the conviction of local administrative members in charge of urban planning in the trial.

In all three cases where disasters triggered trials (L'Aquila, Fukushima Daiichi and Xynthia), decision-making in the immediate aftermath pointed to the area of focus on risk management failures and responsibilities. Therefore, decisions made in the immediate aftermath of a disaster could set the pathway of conceptualizing and attributing responsibilities.

In addition, a point of interest in these three trials presented is the difference in defendants. While the motives for the trial used similar evidence regarding risk information and communication before the event, the convicted persons were different. The L'Aquila trial focused on risk communication (Alexander, 2014), where scientific arguments were used in the verdict motivations to accuse public functionaries involved in research (Cocco et al., 2015). The executives of the Fukushima Daiichi nuclear power were accused of professional negligence based on evidence that showed tsunami risk information was available and yet no prevention or mitigation actions were carried out. Similarly, to the Xynthia trial, flood hazard maps, risk information and illegal issuing of building permits were used as evidence to show that risk information was available yet not adhered to leading to exposure of people to disaster risk. What is common across these cases is the role of risk information used in the trial and the determinatio of action or inaction (negligence) to reduce risk.

To position the Xynthia trial in comparison to the other trials, the common trends are identified as: 1) the role of risk information and risk communication, 2) subsequent actions or in-action based on available risk knowledge, and 3) collective action for the process of public judgment to assign responsibility for the consequences. In order to further examine the Xynthia trial and why certain local authorities were convicted, it is important to identify the stakeholders involved in the trial and their roles and responsibilities in the risk governance framework in France, which will be described in the next section.

#### Stakeholders in the Xynthia trial

As was discussed in the previous section, the Xynthia trial is not the only criminal trial that has taken place for disasters involving a natural hazard. However, different stakeholders were involved in the trials for L'Aquila, Xynthia and Fukushima. This suggests that each disaster is treated differently giving importance to the uniqueness of the event and the legal basis to convicting persons within the risk governance framework. In this section, the actors involved in the Xynthia trial are described in order to map out the relationships between the defendants and the role of the association for victims. The roles of stakeholders were important in the trial, as it helped to inform the verdict motivations and analyze the evidence brought forward to attribute responsibility.

The defendants in the trial were persons who held positions in the municipal council of La Faute-sur-Mer. Some parties were directly involved in urban planning, while others were responsible for communicating risks to local people. The plaintiffs were civil parties consisting of about 121 persons, all of whom were members of the association for victims (AVIF) that formed after the Xynthia disaster.

France's flood risk management framework allocates responsibilities amongst different tiers of government (central, regional and local level). This multi-level governance framework is based on decentralization that began in the 1980's. The framework gives autonomy and delegates important risk management tasks to

regional authorities and municipalities, in order to open channels for risk management processes to take into account local knowledge and interests. The result of this framework has been described as a ‘fragmented landscape’ leading to the responsibilities at each level of authority to become ‘watered down’ (OECD, 2014a). Along this chain of decision-making, there is a question of resources to manage risk. Gilbert (2003) discussed the configuration of actors managing risk as formed by hierarchies and interdependencies, and depending on the arrangements in place, actors have at disposal certain resources and technologies which define and model the risk problem. The numerous amounts of communes across France (36,000) portray a variety of hazard and vulnerability profiles. To this purpose, the access to important resources may be limited, including funding schemes, technology and information on risks.

The Xynthia trial occurred in a particular context, where the French state guarantees collective security and in many ways presents a sense of mastery over risk management and the prevention of crises (Gilbert, 2002). However, the multi-level and decentralized risk governance framework involves a chain of decision-making, which can lead to fragmentation and unclear responsibilities. Therefore, within this framework, we identify the defendants in the trial within the pyramid of disaster and flood risk management policymaking and implementation.

#### The defendants: mapping out their *relations*

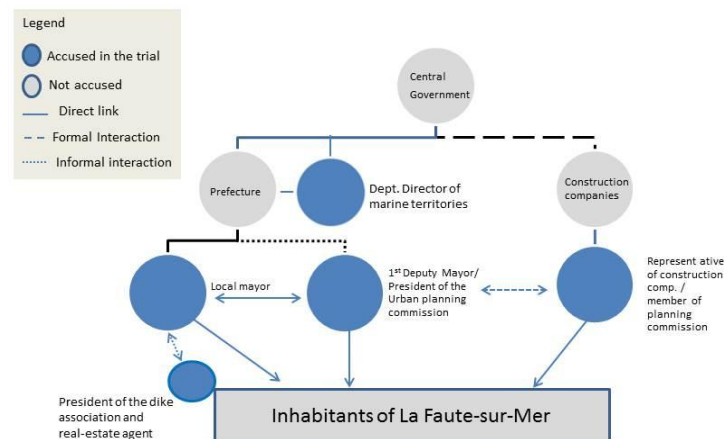
The trial for the Xynthia storm accused five individuals (Mr. René Maratier, Mrs. Francoise Babin, Mr. Philippe Babin, Mr. Patrick Maslin, and Mr. Alain Jacobsoone). Three of the defendants held positions in public office, one at the departmental level and two in the municipality. One was the owner of a construction company that built many houses in the commune and the other was president of the association for managing dikes who was also involved in real estate.

The central focus of the trial was on the mayor Mr. Maratier, which drew political and media attention. Mr. Maratier had been serving office from 1989 until the Xynthia disaster in 2010. Under statute, the mayor is responsible for the protection of residents in the commune, which includes the duty to communicate risks. Mayors are also responsible for issuing building permits that should adhere to regulations on urban planning in hazard prone areas, where restrictions are made in high-risk zones. Working alongside the mayor and a defendant in the trial was the first deputy mayor and president of the urban planning commission, Mrs. Babin. She had served office in the similar timeframe as the mayor and was responsible for overseeing development projects. In parallel to her work in the municipal council, she had a career in real estate. Due to involvement in these dual activities, the trial inquired about a 'conflict of interests' as the cost of land and housing had risen substantially during her years in office. Both the mayor and the president of the urban planning commission were investigated on account of decision-making on urban planning and the issuing of building permits in high flood risk zones.

The third public authority convicted was the deputy regional Departmental Director of Marine Territories (DDTM) of the Vendée department, Alain Jacobsoone. This position entailed the responsibility of overseeing the conditions of the dike and estuary. As he worked at the departmental level, tasks involved overseeing water management and risk conditions across the region. At this level of government, the priority is to oversee that risk policies designed at the central state level are put into action across the municipalities within the region. Therefore, investigations on the Xynthia storm looked into the poor status of the dike. The dike had undergone little maintenance and lack of studies, for which Mr. Jacobsoone was accused of not properly overseeing. In this case, several correspondences were referred to in the trial that could provide information on what knowledge was known on the dike in the period between 2001 and 2009, and how the department and the municipal council were coordinating flood risk management policies and implementation.

The defendant Patrick Maslin was representing two construction companies, which built several houses in the commune over the years prior to the disaster, including some in flood risk areas. The problems with the houses were that they didn't fall

under safety building codes found in the commune's urban planning documents. In addition, Mr. Maslin had access to flood risk information because he was also an active member in the municipal council.



**Figure 23 Mapping the actors in the Xynthia trial**

The final defendant presented here was Mr. Babin, who had served as president of the local association for managing the dike and in parallel worked in real estate. He is also the son of Mrs. Babin, another defendant in the trial. Given his position overmanaging the dike, Mr. Babin was accused of not properly overseeing the conditions of the dike during the night of the storm, which could have signaled warnings of overtopping and initiated evacuations in the area.

A majority of the defendants had a significant role in decision-making on local urban planning and had access to flood risk information. Mrs. Babin is the mother of Mr. Babin who has a long history of family in the area working in real estate. The only person not directly involved in decision-making about development in the commune was Mr. Jacobsoone (DDTM), who was in charge of the local estuary and dike at the departmental level.

Under statute, the mayor and the first deputy had legal responsibilities to manage risks in the commune. These two defendants had the professional role to oversee urban development and circulate documents on risk information to inhabitants. In

addition, the mayor was responsible for issuing building permits. The other defendants were brought to court based on actions such as selling land or building in hazard prone areas. What is interesting is the close interconnections between these actors (See the actor-map of the Xynthia trial for relationship links between the defendants in Figure 23). Figure 23 presents the persons in the trial and their relationship to one another. The darker circles indicate the defendants in the trial, while the gray circles are those who were not accused in the trial yet are participants in the flood risk management framework given the multi-level and participatory risk governance model adopted in France. The different kinds of lines indicate the nature of the link between the actors, either through direct laws, formal interaction through policies and regulations which imply professional obligations, or informal interactions that can be found through various correspondences and municipal meetings.

The prefecture and Departmental Director of Marine Territories were delegated responsibilities to oversee local risk management activities. The mayor had a duty to protect inhabitants and communicate risk via a variety of documents, such as the *Document d'information communal sur les risques majeurs* (DICRM) and the *Plans de Prévention des Risques* (PPR), which communicates all hazards in the commune including technological risks. Concerning flood risk, the mayor should have had at disposal the *Plan de Prévention des Risques Inondation* (PPRI), and urban planning documents such as the *Plan Local d'Urbanisme* (PLU), formerly the *Plan d'Occupation des Sols* (POS) modified in 2006. The president of the planning commission regularly interacted with the mayor to oversee development and that new constructions fell under regulations in urban planning documents. Both had an important role in discussing the PPRI with other municipal council members during consultation phases. There was also formal interaction between the representative of the two construction companies and the municipal council. Finally, the president of the association for dikes had certain obligations for monitoring the dike, by assigning responsibilities to a person that should have been carrying out daily checks. The president of the association for dikes also had

interactions with the mayor in regard to these duties, but was not a formal member of the municipal council.

The actor map illustrates clear links between the different parties in the trial as well as their relative positions in the overall governance framework of flood risk management in France. Due to these various interconnections between the defendants, the trial reveals important local dynamics and signs of miscommunication of risk information. This was highlighted on account of issues of urban development in flood risk zones. In this case, the top down structure of policy making and decentralized implementation of risk policies in France has created gaps in governance. These gaps were central themes in the trial, because supporting evidence convicted local authorities of professional negligence and criminal liability.

*The plaintiffs: an emergent group turned into a victim association*

The plaintiffs of the Xynthia trial were victims of the storm who were either present in the commune when flooding occurred or had members of their family who died during the disaster. Victims of natural disasters are usually placed in categories depending on varying degrees of loss. There are those who experience material damage and economic loss, such as businesses, their homes, other types of property and those who experience human loss. It is assumed that victims are not heterogeneous, even if they experience the same flood event because the effects vary on a scale of impact and how it is measured (Lamond, 2011). Individuals faced different degrees of impact from the Xynthia storm. Along the path of the storm wide-spread damage occurred affecting agricultural areas, as well as several communities and economic sectors including fisheries and oyster farms. In total, there were 47 fatalities across France. The Xynthia trial did not investigate the deaths of all victims in France. The focus of the trial was on the experience of inhabitants in the single commune La Faute-sur-Mer and investigated the cause of 29 fatalities behind the local dike during the night of the storm.



Each plaintiff will not be introduced for brevity. There were about 40 civil party hearings during the trial. Out of the five weeks of the trial, one was given to the plaintiffs. Each plaintiff shared their story and provided a detailed account of their experience during the storm and their history of settlement in the commune. In addition, many shared their experiences of interactions over the years with the municipality and their relationship with the mayor and local administration. A majority of the plaintiffs were retirees, who had moved to the commune in the last thirty years. The children of victims had also come to represent their case.

The focus here is on the role of the association for victims (*Association des Victimes des Inondations de La Faute-sur-Mer et de ses Environs* - AVIF), and the self-organization and collective action taken by the plaintiffs to support each other and push forward with a trial. One of the most important entities in the Xynthia case is this association of victims, because it gained political and strategic power to push for a public case and investigations.

After the storm, a momentum of collectivity formed between victims, and many inhabitants became members of AVIF, which helped to reinforce efforts to investigate responsibility in the trial. AVIF was created one month after the Xynthia disaster, on the 3<sup>rd</sup> of April 2010. The president of the association in 2017, Mr. Renaud Pinoit was not directly affected by the storm but had been in La Faute-sur-Mer when the flooding occurred. He moved to the commune with his wife in the 1980's from the Paris region to have an affordable place by the sea-side and a quiet environment. When they woke up the morning of the 28<sup>th</sup> of February, they didn't realize what had happened until they went out of their house and noticed the area in the cuvette ('basin') flooded. After the storm, immediate relief was needed, which led to the creation of the association:

*'As we were not affected directly, we began immediately to help others. Many efforts were needed: cleaning the houses, resettlement, problems of insurance, lost documents, and drivers licenses etc. So we understood that we have to organize ourselves immediately'*

(Interview, February 2017).

The beginnings of this association reflects similar characteristics of emergent groups discussed in the sociology of disasters (Majchrzak et al., 2007). Emergent groups form after disasters and participate in emergency response. Participants can be volunteers, emergency workers, businesses, churches, government agencies and in some cases affected persons, 'affected persons, organizations, and communities are the first to help themselves after disaster impact' (Drabek & McEntire, 2003: 99), as was the case in Xynthia. There are no clear rules and membership, as these groups are known for their fluidity and adaptability to coordinate different expertise, knowledge and resources after a disaster (Majchrzak et al., 2007). These are similar attributes to AVIF before it formalized into an official association one month after Xynthia.

When the association was established officially it had about 800 members, almost the totality of the commune. The association's main activities at this time were on helping inhabitants understand the solidarity zone and the expropriation project enacted by the state. In April when the zone was declared by the state and houses were selected for expropriation, several individuals asked the association to help defend their cases, because some did not want to give up their properties. During this time, the association gained a strategic and political power, especially in cases dealing with insurance for resettlement.

*'There were insurers not in agreement with people (they didn't want to insure properties in high flood risk areas). The association gained some political power, and a strategic power – so that when we called insurance it was easier to find an agreement'.*

(Interview, February 2017).

AVIF's political importance by representing collective action between victims of the disaster in the small commune created a pathway towards bringing into question the responsibility for the deaths. Shortly after the disaster, the state procurer visited the commune surveying the possibility for a judicial investigation. During this visit, the prosecutor asked if people wanted to make formal complaints. By November 2010, forty complaints were issued by both members of AVIF and non-members. AVIF had an important role by helping members to write up their

complaints in detail and compile them together as evidence for the case. In addition, during this time Mrs. Lepage a well-known lawyer who works on environmental cases in Paris met with the association to ask to represent their case.

After the expropriation project and zoning was managed, many people left the association. Those who remained wanted to defend the case of the victims and participated in the trial, which took place in September and October 2014. In 2017 AVIF still had 250 members. Some of these members were met with during fieldwork visits. Discussions with them revealed regular interactions between members and the civil lawyer and their personal commitment to investigating the specific technicalities of the French legislation that could help them to defend their case. The objectives of the trial were not only to restore accountability of flood risk management but pursue a line of separate compensation that would be unique to the plaintiffs that lost family due to flooding in the commune.

#### Analyzing the verdict motivations

In this section, the accusations and evidence for the verdict are presented, which includes important definitions in the law. The notion of negligence appears to be central theme in the verdict motivations for the Xynthia trial but brings into question the matter of voluntary and involuntary conduct.

The Xynthia trial was a criminal court but followed civil procedures. This is explained because the defendants were tried for having committed a criminal offence and the criminal court has the jurisdiction to allocate penalties or prison. Civil courts have the jurisdiction to decide disputes between private persons. When a person causes injury to another in the course of a criminal offense, the outcome takes the form of a remission when possible or the allocation of penalties for damages. In the trial for Xynthia, civil proceedings meant that victims could be actively involved in the trial and not just passive witnesses of the proceedings. Therefore, the civilian judge could rule on civilian interests, in this case the victims and reparation for their traumatic experiences and human losses caused by the Xynthia disaster.

Two accusations were made under the criminal code and penal code: *involuntary homicide*<sup>17</sup> and *the risk caused to others*<sup>18</sup>. The first accusation on involuntary homicide is based on evaluating a causal link between the conduct and the harm. Depending on how cause is characterized, fault is determined accordingly. In French law causation is described based on a dual system to recognize both *intentional* and *unintentional* circumstances. Fault can be determined in the form of *negligence*, applicable if the person accused holds statutorily defined duties. The second accusation, the risk caused to others considers if the individual behaved in a risky way and the result of behavior. The *behavior* (i.e. taking the risk) is voluntary, but the *result* in actual damage to life or physical integrity is not. Prevention is an important aspect in this accusation, because it deems that the offence occurs before any preventative measures are taken. If there is no result of the 'risky' action, there are still penalties. For example, driving under the influence whether or not an accident has occurred is penalized. Yet if there are damages, for example a car crash, the penalties are adjusted accordingly to the gravity of the consequences.

Evidence brought forward to inform causation for the consequences of the flooding were based on decision-making that favored urban development despite having in place flood risk management policies and regulations, including a hazard map that indicated areas as non-constructible and in high risk. In French law '*force majeure*' includes the law of negligence as a passive form of human intervention in the consequences of natural hazard induced disasters. If evidence is found in the case of *voluntary in-action*, it deems the consequences as caused by human conduct and assigns responsibility accordingly. Negligence is not a legal concept and is borrowed and used in the law for cases on legal liability and responsibility. For a conduct to be considered negligent there must be a 'duty of care', hence a legal responsibility that was not adhered to. This is explained as, 'negligence involves derivative responsibility: people are responsible for negligent harming because they are responsible for a breach of a duty of care' (Raz, 2010: 14). The positions of

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<sup>17</sup> Homicide is defined in article 221-6 of the Criminal Code.

<sup>18</sup> Risk caused to others is defined in article 223-1 of the Penal Code.

public office holders involve a ‘duty of care’ as defined under statute to ensure accountability behind decisions and actions carried out. If this is breached, the persons can be convicted of professional negligence as was applied in the trial.

The law of competence and responsibility for the deliverance of building permits falls under the duties of the local mayor. Despite this legality, reports following Xynthia examined the complex division of responsibility for the deliverance of building permits (Anziani, 2010b). The document on land-use planning defined by the municipal council (PLU) determines the conditions of the permit. Extra measures should be taken if the commune has in place a PPRI. An initial review is made on the permit and in the case of doubt, it is delegated to the prefecture at the departmental level for further review. Across all the communes in France, 80% of building permits are forwarded to the prefect for a review before deliverance (Anziani, 2010a). However, the mayor makes the final decision for approval depending on the review by the prefect. In most cases the mayor follows the ruling by the prefect because the legality of the permit is controlled by this layer of government and in the case of litigation the mayor is responsible. The mayor in the trial had been serving office for twenty years before the storm and the evidence brought against him was the issuance of several illegal building permits that did not follow flood hazard zoning regulations, which was argued to be evidence of professional negligence.

Negligence in this case should be reviewed within the broader legal framework on urban development regulations and flood risk management policies. Reports after the storm showed that there was in general a situation of weak control of legality in the area of building permit issuance (Anziani, 2010a; Bersani, Dumas, et al., 2010). For example, in the case the prefect disagrees with authorizations for urbanization issued by the mayor, the judgment is referred to an administrative judge. According to the senatorial report from 2010, this appeared to be a prevalent problem in two departments hits by the storm, Charente-Maritime and Vendée. Many of the authorizations referred to for a review continued building while investigations were underway. In Charente-Maritime, thirty cases were deferred to the judge and

twenty-eight of those continued building during the investigation. In the Vendée out of eighteen referred, only six paused construction until the final judgment. Weakness of enforcement and oversight resulted in existing constructions in high risk areas. However, there are several entities involved in this framework including buyers, real estate agents, the municipality, the departmental prefecture, and construction companies, which puts into question the rule of law, transparency and decision-making within this risk governance framework, that also aims to reduce risk by addressing urban pressure in vulnerable areas.

The mayor has an important role to communicate risks to the commune, which the trial showed was not properly done and part of ‘putting others at risk’ (the second accusation). This led to a series of other issues surrounding the improper fulfillment of putting in place the flood prevention document (PPRI) for the commune and inconsistent risk information in the flood hazard map. There were four versions of the PPRI made within ten years and one was still not approved by the prefect when the Xynthia storm hit in 2010. The trial discussed the complex situation with implementing this document due to the chain of decision-making across levels of administration. It involved the consulting firm that made the scientific study hired by the central state, the prefecture of the department that prescribed this policy, and the mayor and the first deputy mayor including the municipal council in charge of overseeing public consultation and implementation. The president of the urban planning commission was considered to be an active agent in the consequences of the Xynthia storm flooding because of her parallel duties in the municipal council and working as a real estate agent in the commune. This led to accusations in the trial of a ‘conflict of interest’ caused by voluntary negligence on account of not properly overseeing urban development according to regulatory policies in the PPRI. Therefore, negligence in this case assumes the availability of risk information that contradicted development that had been approved in the commune.

The other three defendants were the president of the association for dikes (also a real estate agent), a representative of two construction companies that were

building houses in the commune who was also a member of the urban planning commission in the municipal council, and the Director of the Department for Marine Territories. Each one of these defendants had duties that required a minimum level of information about flood risk. Since evidence in the trial pointed to gaps in using risk information to inform their duties, the trial determined this failure as professional negligence, because it put people's lives at risk.

The event was described as unique and extraordinary, yet foreseeability was debated because of the evidence provided on available flood risk information in the commune (Feuillet & Chauveau, 2012). In addition, a review of the event and reflection on risk governance led to consider a series of errors in the chain of risk management decision-making. This should be considered within the overall flood risk governance framework in France and how responsibilities are allocated across different stakeholders.

#### Outcomes of the Xynthia trial

The Xynthia trial in Les Sables d'Olonne in the fall of 2014 lasted five weeks and was closely followed by the public. It was covered by media and journalists attended hearings. The result of the trial led to a first verdict announced on 12<sup>th</sup> December, 2014 that allocated fines and prison sentences to four persons convicted (Table 13).

**Table 13 First verdict sentences of the Xynthia trial**

Defendant's role	Sentence
<b>Mayor</b>	4 years prison (minimum of 2 years to be spent in prison)
<b>President of the planning commission</b>	2 years of prison and a fine of €75,000
<b>Real estate agent and president of the association of dikes</b>	18 months of prison
<b>Owner of construction companies</b>	A fine of €30,000

A year after the trial, an appeal was made in November 2016, which led to modifications of the first penalties, either by reducing them or acquitting the defendants. The appeal was then referred to an administrative tribunal, where insurance sued the commune, the association for managing the local dike and the state to pay a sum of €1.5 million. This situation resulted in on-going questions about the possibility to create a separate fund to compensate victims that experienced human loss in La Faute-sur-Mer. While the Xynthia trial centered on five individuals in the municipality (members of the municipal council and non-members) as well as an official at the departmental level, the case shifted perspective by positioning the commune as liable along with the central state as one entity using evidence of failures to implement flood risk management policies. Here the question of multi-level governance returns highlighting the importance of responsibility alignment.

While the trial in Les Sables d'Olonne was a highly publicized event, the progressions of the Xynthia case were not followed in close detail by media and journalists. Different phases of the trial present an evolution of conceptualizing and attributing responsibility, notably allowing to transfer responsibility from one party to another. The next part revisits different kinds of risk responsibility relationships in the Xynthia case study over time to classify steps in this evolution. The interest in discussing the evolution of defining and attributing responsibilities for disasters is because in all three disaster trial cases (L'Aquila, Daiichi Fukushima and Xynthia), over time the verdicts were challenged and the defendants either had penalties reduced or they were acquitted (see Table 14). It would be important to identify potential limitations to treating disaster responsibility in trials.

**Table 14 Trials for disasters (L'Aquila, Xynthia, Fukushima) and outcomes**

<b>Trial</b>	<b>First outcome</b>	<b>Proceeding outcome</b>
<b>L'Aquila</b>	Six years of jail	Six out of seven defendants were acquitted in 2014, one person had the sentence reduced to two years of prison
<b>Xynthia</b>	Penalties and prison sentences	Reduced sentences and acquittal
<b>Fukushima</b>	Acquitted, criminal liability	On-going trial to determine civil litigation in September 2019

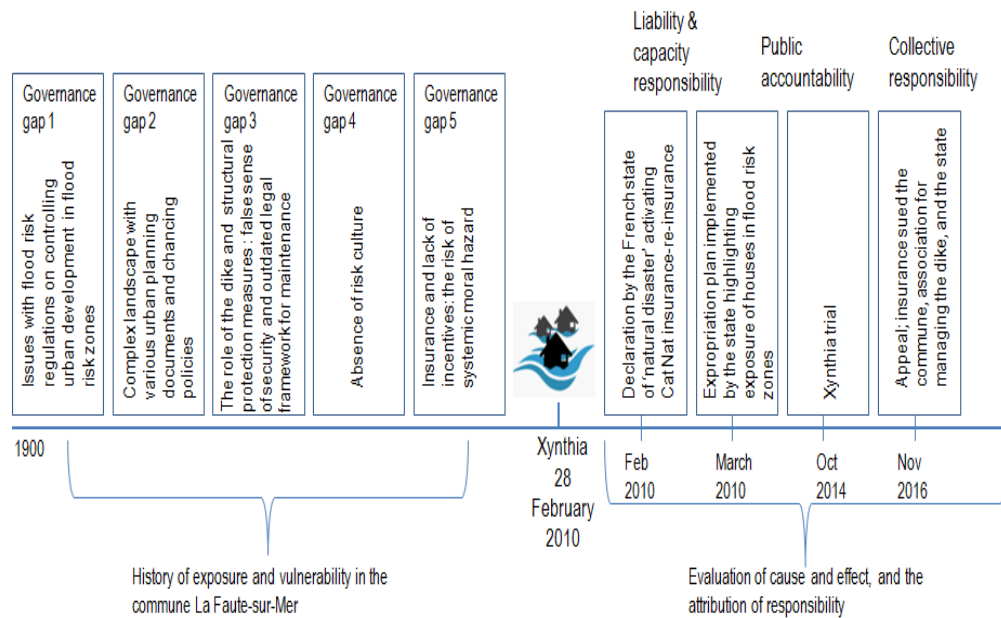


## The evolution of conceptualizing and attributing responsibilities

Responsibility is discussed in the Xynthia case study based on information gathered on the trial, including analysis of the transcriptions, observation of hearings and interviews carried out with local people and journalists. To put the trial into context, a review of responsibilities of each defendant in the French flood risk governance framework was provided. The evidence used in the verdict motivations on *involuntary homicide* and *putting others at risk* was also presented. The arguments in the trial were based on evidence supporting professional negligence derived from civic duties of individuals working in public office that have responsibilities to oversee the implementation of flood risk management policies in relation to risk-informed land use and urban development restrictions. Analyzing the consequences of disasters based on vulnerability conditions reveals a complex system of several components caused by governance gaps over time, as presented in Chapter 5. This complexity may explain why the law faces challenges to determine cause effect and attribute responsibility. This is because the verdict of the Xynthia trial was challenged based on the argument of uncertainties. The analysis reflects on different forms of responsibility in the case study to explain why the verdict and appeal occurred.

A typology used for analysis sets three types of responsibility that were discussed in the literature on risk-responsibility relationships: *capacity-responsibility*, *accountability* and *liability*, and proposes an additional form that is described as a *collective responsibility*. The typology is organized across four analytical dimensions inspired by Pellizzoni (2004: 548). Based on the case study analysis, it is argued that responsibility is increasingly shifted from individual responsibility and liability, to a demand for public accountability, which is reflective of risk governance frameworks surrounding complex disasters that are caused by a multitude of factors (see Chapter 5) (Figure 24). The complexity of attributing responsibility (or public accountability) for disasters through the process of a trial however, has resulted in appeals and the consequential diffusion of responsibility. Therefore, the law and relevant legal tools are not yet fully equipped to treat

disasters (of natural origins) systematically because there are multiple ways to define and attribute responsibility for the event and provide relief to victims.



**Figure 24 Timeline of Xynthia: governance gaps, vulnerability and attribution of responsibilities**

Four responsibility types are presetned in the analysis: capacity-responsibility, liability, accountability and collective responsibility. The first three are briefly explained followed by analysis of how they occur in the case study, which leads to consider an emerging kind of responsibility discussed in disaster risk governance deemed collective responsibility (Scarwell, 2017) or shared responsibility (Singh-Peterson, Salmon, Baldwin, & Goode, 2015). This kind of responsibility has not yet been clearly defined in the literature. In the thesis, the case study analysis of the Xynthia storm suggests that collective responsibility is the result of the diffusion of responsibility that also emphasizes the role of communities in disaster risk management. Collective responsibility is explained by the growing emphasis on building resilience, where disaster risk governance emphasizes community

participation and local adaptive capacities in managing, preparing and coping with natural hazards and disaster risks.

Capacity responsibility (1) refers to human conduct and looks at the agent and their capacity to control their conduct under the assumption that they are responsible for their actions. A large part of this kind of responsibility is also intertwined with moral responsibility, because one can reflect on how their conduct could pose potential risks to themselves and others. Depending on the actions taken or when an adverse event and damage occurs, the conduct and consequences are evaluated to determine liability.

Liability (2) is a first appraisal of responsibility, which assesses the damages. It is a form of responsibility within a legal contract that deals with conduct in the form of obligations. These legal obligations pertain to codes of conduct, regulations or clauses in the liability contract which entails who will explain the conduct or event, and who will pay compensation for damages. In most cases following disasters, liability is a first form of appraisal to determine material damages and the associated conduct to explain those damages. The objective of this appraisal is to assess the costs and relevant compensation, penalties and sanctions given the legal contract pre-defining liability agreements.

Liability faces limitations in the case of large-scale disasters because collective consequences trigger a demand for explanations and public judgment. These events defined by their low-probability and high-consequences draw attention because they impact a large segment of society where compensation may be neither sufficient nor suitable for the victims on account of the loss they experience. The demands for accountability follow any kind of liability arrangements (individual insurance) and are driven by a collective demand for explanations. This demand is about ensuring the accountability of risk governance and relevant risk management policies.

Accountability (3) is framed upon three conditions: (1) public judgment and the use of a public trial, (2) the consequences imply legal penalties such as sanctions, penalties or prison, and (3) a forum is needed to assess the actions of the person

held accountable to which standards should exist (Bovens, 2007a; Mulgan, 2002a). The first two conditions accountability define cause and effect based on actions and fault, which in the case study led to consider professional negligence. The third aspect points to the collectivity of the process, both in demands and in assessment found with the forum. Accountability is an external process for judgment and asks for individuals to ‘give an account’ to the forum. The defendants in the case were asked to explain their rationale behind their decisions surrounding urban development in flood risk zones.

At first instance before the disaster, all individuals including inhabitants and local authorities had an individual responsibility referred to as capacity-responsibility. This kind of responsibility in the context of natural hazards and disaster risk depends highly on the information available to the individual. Having more information on risk exposure may influence conduct, such as seeking out insurance, choosing how to build properties or actively gaining a better understanding of available prevention and mitigation measures. Several biases and judgment errors surrounding low-probability disasters may influence capacity-responsibility because conduct may fall in line with a false sense of security or myopia (Kunreuther & Michel-Kerjan, 2010; Collenteur et al., 2015). In the case of Xynthia, the trial revealed that the level of risk awareness and perception of flood risk varied across parties, including at different tiers of government between the departmental and commune level, as well as across inhabitants.

If we consider capacity-responsibility of inhabitants living in La Faute-sur-Mer, one asks the question if people are responsible for their awareness about risks where they live. There are several factors that influence preferences about where to live, the kinds of houses desired and available resources to attain information about risks when settling. In the case of disasters involving natural hazards, it is often assumed that moral hazard is not applicable, because no one can control the consequences of these events (Paudel, 2012) such as those living in La Faute-sur-Mer at the time of the Xynthia storm. However, risk information is an important factor in the verdict motivations and was used to attribute responsibility for the consequences to local public authorities. As we see later, this is because

professional responsibility also characterizes the responsibility of local authorities, defined as 'duty of care'. In addition, inhabitants were questioned on their level of risk knowledge to discern if it was either communicated by the municipality or in leasing agreements.

Risk information was a central piece of evidence in the trial but pertained to its availability in the municipality and how public authorities made decisions surrounding flood risk management. The basis for the legal argument is on the statutory duty of these public servants to be informed about risks and communicate them to the local community. To put some pressure on culpability for being informed or not about risks, what if inhabitants had been fully aware and evidence showed that they were communicated their risk exposure to floods? Would this have changed responsibility in the trial? Perhaps attention would have shifted to capacity-responsibility and lack of individual conduct to take appropriate preparedness measures. The trial created a clear division between the five condemned public authorities and the victims, and their responsibilities surrounding risk information and awareness.

There is a need to distinguish individual conduct and capacity-responsibility as dependent on the status of the person. The local mayor and other public office holders have certain legal duties under statute and so legal obligations give new meaning to responsibility. Therefore, professional responsibility requires these persons to be informed about risk and conduct should reflect this knowledge. Duties surrounding risk communication and implementation of flood risk management policies applied to urban development were found to be shortsighted and subject to a 'conflict of interest'.

To this purpose, professional negligence and misconduct explain the failure to fulfill certain duties around flood risk management policy implementation, and therefore why local public authorities and those working in the municipal council were convicted. Modifications to the flood hazard map and failure to apply strict rules on issuing of building permits that adhere to urban regulations were central arguments in the verdict motivations. The main argument is that these

responsibilities are formed before any event occurs, because they are preventative measures. Therefore, they are assessed based on accessibility of risk information. The decentralization of flood risk policymaking and implementation in France means that local public office holders are delegated several responsibilities. There is a question of oversight from the central state or departmental level, and the capabilities and resources to fulfill certain tasks at the local level within this decentralized governance framework. Therefore, the question is not about responsibility for information and communication, but what is done with the information. Then this reasoning of assigning responsibility should take into account oversight mechanisms and any potential conflicts or limitations.

After disasters occur, to address the material damages such as loss of housing stock, there is a question of liability and compensation in cases where insurance markets exist. Liability is determined by what actions led to the consequences and attributes who is liable under legal obligations, which is agreed upon before any event. This part of liability is referred to as, 'Being responsible for some act or state (such as the damage the act caused) is part of only one kind of liability-generating condition' (Raz, 2010: 4). Persons who faced material damage by the Xynthia storm were deemed not liable and were compensated by insurance, which was said to be effective and timely (Interview, February 2017). It should be noted that this process was separate from the line of compensation sought by the association for victims in the Xynthia trial to address human loss. Therefore, in the case study compensation for material damages surfaced quickly in the aftermath thanks to the Cat Nat public private insurance-reinsurance scheme for disasters in France.

The process of compensation for material damages caused by disasters in France brings the focus of the analysis on the Cat Nat insurance-resinsurance scheme for disasters. In particular, two points surface. Firstly, the concept of solidarity supporting the diversified risk pool and, secondly, the politicized process of declaring disasters as 'natural' that become the responsibility of the wider public. The French insurance system for disaster risks is framed by solidarity, which can take for granted the risk pool. On the positive side, the high market penetration of this mechanism ensures reserves to provide victims compensation to cope with

events. However, in the case of a major disaster liability is off-set and the scheme highlights disasters as a political item. This is because in order for the CCR to be activated, the disaster needs to be politically declared as ‘a natural disaster’ by the prefecture or a higher up public authority. By doing so, the state assumes liability through the state-run insurance-reinsurance scheme and relieves responsibility from other actors, including municipalities and individual households situated in risk areas.

Given this insurance arrangement for disasters, capacity and responsibility should be reassessed because it assumes that preventive actions were carried out to reduce exposure and risks. Returning to capacity-responsibility brings interest onto behavior and choice within the context of the insurance scheme for disasters and the risk of moral hazard. In particular, there is question about the role of financial incentives to reduce risk. The cushion of guaranteed compensation provided by the French Cat Nat system opens a space for modified behavior systemically. As everybody knows that they will be covered for these kinds of events, there is a risk of information gaps and modified behaviors across institutions, insurers, developers, the real estate market and individuals in a situation described as ‘systemic moral hazard’ (Huber, 2004). Systemic moral hazard was described as a component of contributing to vulnerability in Chapter 5. While the French Cat Nat scheme has been successful in overcoming several other challenges faced by purely private or other public private partnerships of insurance for disasters (see Paudel, 2012 on comparative analysis between public and private insurance schemes for disasters), there is a question about incentives and preventative action to reduce risk exposure and vulnerability. Moreover, it discusses how liability is defined for disasters and attributed depending on the insurance scheme, where in this case it is absorbed the French public as a whole. When conceptualizing risk-responsibility relationships, liability is intricately intertwined with capacity responsibility because the terms of the contract determine who will compensate, under what conditions and it takes into account actions or negligence, and even potential situations of moral hazard.

In the case of the Xynthia storm, the Cat Nat insurance scheme served as the first form of appraisal for material damages. The procedure of activating the scheme was also symbolic because it communicated causation as it deemed the event as 'natural'. Insurer groups carried out a first appraisal of the damages and allocated compensation for properties affected by the Xynthia storm (1,480 M € insured losses). In this first instance, human conduct was excluded from the evaluation of cause and effect and the focus was on Xynthia as a 'natural disaster'. The political decision made by the state to declare the event officially as a *catastrophe naturelle* (Cat Nat) triggered the state-run reinsurance *Caisse Centrale de Reassurance* (CCR). This political declaration further signaled the disaster as a purely natural force and did not highlight the role of human activities including risk prevention policies. Upon the declaration, several funds could be activated to help allocate relief to individuals and economic sectors such as agricultural and fisheries that suffered losses from the effects of the storm and floods. All these various forms of compensation through insurance and relevant state funds asserted that individuals were not liable for the consequences of disasters that involved a natural hazard. Or rather, given the solidarity approach to the insurance scheme, everybody is involved as households across France contribute to the collective risk pool.

This labeling of the Xynthia storm and coastal flooding as a 'natural disaster' was further highlighted by the expropriation project that shortly followed the disaster. This buyout program led by the state was based on drawing up solidarity zones using a quick analysis of topographical data to define houses located in high-risk areas. The objective of the state was to reduce exposure along the coast. Such a reaction from the state draws parallels with the use of the precautionary approach in risk regulation (O'Riordan & Cameron, 1994), as scientific evidence for this decision was unclear and proceedings for the project were enacted rapidly. The expropriation project also triggered a question about the allocation of public resources and mistrust between local people and the central state (Cour des Comptes, 2012). In this phase of the disaster assessment, the emphasis was made on the natural phenomenon, which made a clear division between what was induced by nature and human. At this stage of the disaster, the state provided



support to victims relieving any individuals from responsibility, including itself in terms of risk governance errors and failures.

While the responsibility form of liability addressed immediate material damages through the Cat Nat compensation scheme and state funds, victims of the Xynthia disaster deemed this type of 'responsibilization' of the consequences as limited. In particular, victims of the disaster demanded responsibility for the human loss, which evolved into a demand for public accountability as well as individualized compensation.

A collective demand made by victims and with the support of AVIF focused on seeking explanations and for someone 'to give an account' for the consequences of the event. The focus of this demand was on gaps in the flood risk management policy framework. To this purpose, liability and compensation for material damage faced limitations, and what is described in the literature as 'aggregated compensation' after disasters (Miyazawa, 2015), failed to provide the relief to victims who lost a family member in the flooding. The political and media attention on the case also facilitated larger interest in this call for public accountability. In addition, the tensions surrounding the expropriation project of highly exposed houses highlighted the role of land use and urban planning policies in the risk governance framework as well as how the public budget on risk prevention is spent.

The Xynthia trial was driven by a collective demand for public accountability, where victims called for a public judgment and carved a pathway for a personalized compensation to cope with human loss. The concept of accountability has been an important in public policy literature that describes the relationship between public office holders and their duties to citizens (Mulgan, 2002a). Accountability has dimensions of seeking, 'transparency, liability, controllability, responsibility, responsiveness' (Koppell, 2005). The collective efforts carried out by the association for victims helped to make the case public. In this second phase of evaluation, investigations of the case shifted from causation and liability to a

demand for accountability, where ‘capacity-responsibility’ re-emerged to evaluate the consequences of this disaster no longer deemed as ‘natural’.

Accountability is considered to be based on three assumptions: i) externality, ii) social exchange, and iii) rights of authority (Mulgan, 2000). The first aspect of accountability requires a forum to which the person is accountable to. The Xynthia trial was pushed by inhabitants and victims in La Faute-sur-Mer. With official organization and support from AVIF, they were able to define a forum. The forum in this case was interesting because it was represented by the victims who demanded explanations. However, victims cannot make judgment and the jury assessed the case drawing on French legislation and flood risk management policies and an analysis of the history of exposure in the commune over an extended period of time. Social exchange in this case was the judicial review and the use of criminal law and civil proceedings. The aim was to clarify the actions (i.e. conduct) by different persons and to evaluate their actions, with specific attention to negligence, which contributed to higher exposure and vulnerability in the commune.

Law is a social construct with particular reasoning of responsibility and penalties, described as, ‘The law uses the concepts of responsibility and of negligence and assigns certain consequences to being responsible’ (Raz, 2010). When it comes to the causation for disasters, those responsible for managing risk are investigated especially when people's lives are put at risk. In the case of extremely rare disasters there is a question about risk and uncertainties, availability of information and voluntary or involuntary action or in-action. Using the law in a trial to determine accountability puts forward questions such as, who is to be targeted as accountable? Under which criteria and standards of conduct? And who is the forum the person is to be accountable to? In addition, what time periods are assessed to examine risk governance and the cause of exposure and vulnerability of a place? Risk regulations and risk policies are often slower to develop and implement than the rate at which risks develop and evolve. Accountability for the consequences of disasters in the case of Xynthia allocated responsibility to individuals directly in charge of local flood risk management either by overseeing urban planning or

communicating risk. The question is about how far back one should go to determine cause and effect by analyzing the development of exposure and vulnerability of a place.

During the Xynthia trial, the senator Anziani had been following the case and led the compilation of two important reports that review the disaster (Anziani, 2010a, 2010b). During the trial a presentation made by this Senator discussed in particular the long chain of decision-making and failures of multiple responsibilities to manage risks in the French governance framework. The five persons convicted in the municipality and at the departmental level were a component of a larger governance framework for managing flood hazards, which makes the question of 'who is responsible' more complex.

Disaster risk management activities and policies are revisited after a major event and opens a space for lessons-learning (Chauveau et al., 2017). During this phase, the aim is to strengthen risk management capabilities and promote activities to better reduce risk, exposure and vulnerability and foster preparedness. In the case of Xynthia, a new phase emerged characterized with the reallocation of responsibility, notably making the commune responsible. In November 2016, an appeal reviewed the first charges of the defendants, many of which were reduced and led to defendants being acquitted. The case also grew in complexity when the local insurance group *credit mutuelle* rejected to cover the mayor because they claimed to only insure their clients (Interview, February 2017). The result was that insurance filed a suit against the municipal council and won, where La Faute-sur-Mer was penalized €1.5 million to pay to the insurance group. As this sum is large for such a small commune, the state was condemned 'in solidarity', meaning the local commune and the state were considered as the same entity.

Collective responsibility (4) is the final form of responsibility discussed in the case. It is shaped by collective capacity-responsibility that has evolved because of new input on risk information and awareness made known by a forensic analysis of the disaster led by the trial, in which exposure and vulnerability were linked to a history of errors in decision-making. The argument for the emergence of collective

responsibility is based on significantly diverging views on attributing responsibility with the appeal in 2015 that reduced the first penalties and acquitted the five individuals in the trial. Most importantly, collective responsibility is argued to occur when responsibility has been transferred so many times from one entity to another, it become diffused. This is reflected upon as a result of the insurance group suing the commune and the state ('in solidarity' as described in French) for the consequences of the disaster.

Collective responsibility emerges with the French flood risk management strategy that is emphasizing 'building resilience', which is meant to foster local ownership of risk and their social acceptability (Laganier, 2006). This framing of the flood risk management strategy centers upon multi-stakeholder engagement and in particular, the role of the local level as part of integrated hazard management. The Prevention Action Programs for Floods (*Programmes d'Actions de Prevention des Inondations* (PAPI)) implemented in 2002 promotes integrated flood risk management, which aims to coordinate actors and across sectors (urban planning, water management, flood risk management) and at the local level (Guillier, Larrue, & Nussbaum, 2016). Guillier and colleagues (2016) questioned effectiveness of the operationally of the PAPI policy instrument in France and implementation at the territorial level, finding that coordination has improved. At the same time, following Xynthia, the Rapid Submersion Plan (*Plan Submersion Rapide, PSR*) was implemented in 2010 (MEDDTL, 2011). This policy contributes to flood risk assessments, with particular attention to coastal flooding, flash floods, ruptures of fluvial or maritime dikes. The PAPI and the PSR outline actions to be undertaken by actors to reduce risk, under a larger umbrella of the national flood risk management plan (*Plans de Gestion du Risques Inondation* (PGRI)) (MEDDTL, 2011).

Against this backdrop, the policies of integrated flood risk management aim to increase coordination across actors and facilitate the allocation of state funding for prevention. The Barnier fund can provide funding for PAPI arrangements from 20% to 100% depending on eligibility (Guillier et al., 2016). These integrated frameworks also aim to address drivers of risk by coordinating actors across sectors

and policies (urban planning, water management, structural prevention project management). However, they do not address the issue of responsibility when a disaster strikes or define accountability mechanisms. While innovative integrated frameworks assume accountability mechanisms, for example by creating links between funding and prevention measures, and implications of local actors and risk ownership (e.g. dike maintenance), the question surfaces as to whether this also results in diffused responsibilities across a multitude of actors, in which accountability is difficult to attribute when a disaster happens.

Seven years after Xynthia in La Faute-sur-Mer, the municipality has facilitated the participation of the local community in flood risk management. Inhabitants were invited to be more involved in public consultation phases of the PPRI/PPRL and to learn more about the hazard zoning and relevant regulations. Fieldwork visits during this consultation period revealed some resistance on the part of locals to these measures because of the implications on property values and restrictions to developments. The goal of the municipality was to oversee activities that could make the commune more aware of flood risk and increase overall resilience. At the same time, participation is interlinked with responsibilities.

It was not the purpose of the analysis, to judge whether the trial was correct or not, or to give an opinion on the outcome. Instead, it sheds light on how we may revisit responsibilities for disasters. Given the complexity of different disasters and the evolution of responsibilities, there is room for more research on this topic and in particular on trials to attribute responsibility of the consequences of these events. Due to the different phases analyzed in the case study, it may be concluded that legal tools are not yet equipped to systematically define and attribute responsibility and attributing it for complex disasters.

## Summary

This part revisited different forms of risk-responsibilities by analyzing the Xynthia storm case study and trial. In Chapter 5, interconnected variables caused by governance gaps contributed to exposure and vulnerability as presented in the first

analysis of the thesis. The trial focused the role of decision-making and failed risk reduction policies surrounding urban development. In the case of Xynthia, the criminal trial for the consequences was about the role of public judgment and adjudicating responsibility to meet accountability demands by victims. In order to determine responsibility, the case shed light into gaps in the flood risk governance structure in France.

Despite these evolutions of the case that led to re-examining evidence as a basis to verdict motivations in the appeal process, victims of the Xynthia trial continued to search for arrangements that would open compensation paths to address their personal loss in the disaster. In particular, victims hoped to find a compensation vehicle through a private fund attached to a minister. An example of such a fund is the case of victims who were trapped in a bar that caught on fire in 2016 in France (Kergel, 2019). With the fire incident as a precedent, the motive is to find a financial agreement involving the central state as a representative of the case and for the cause, as expressed by an interviewee during fieldwork in La Faute-sur-Mer (Interview, February 2017). The interviewee expressed the following reasoning:

*‘We hope the same will happen in our case. It was shown that the commune committed errors, which was revealed in the trial. And the ex-mayor was condemned also because he made bad choices. And so the idea now is, instead of attacking the state, because the commune is a part of the state, is to find a financial arrangement for how much to be reimbursed on the part of victims’*

In December 2016, discussions were held on the case between lawyers of both parties, the association and the commune concerning the possibility for a compensation tool for victims that would be deemed separate from the material damage they faced. The interviewee from the victim association commented that the absence of the state resulted in incomplete discussions because the state has the highest financial means by stating that a second step was needed to progress the case, *‘And now the second step, is to have the presence of the state, with a minister to be able to make an arrangement with everybody at the table’* (Interview, February 2017). The importance of involving a representative at the ministerial level for AVIF was to be able to open up a relief fund to compensate for human loss.

From this perspective, the importance for the victims is this separation, which opens an important discussion on the moral responsibility of protecting lives from disasters and the financial responsibility or liability to compensate, should there be negligence as was discussed in the case.

The process of the Xynthia trial in 2014 and on-going discussions in 2017 show that determining responsibility for the disaster has gone through different phases. These phases were important for the analysis, whereby the first appraisal attributed the event as purely natural and focused on material damaged, and largely the work of insurance and state reinsurance schemes to determine compensation. Limitations to settling the disaster through liability for material damage stemmed from collective demands by victims demanding further explanations of the disaster and to specifically address human loss. The call for a criminal trial was to establish accountability for the disaster and more largely brought to light accountability of the risk governance regime in France. This demand represented an important move to associate the consequences of the disaster with individual conduct and gaps in risk governance (the failure to adhere to regulatory restrictions on urban development in hazard-prone areas). However, in the years that followed, an appeal reduced the initial sentences and acquitted the defendants.

As the verdict was challenged based on uncertainties, it reveals the limitations of legal tools within this framework of disasters to cope with risks and uncertainties in risk governance structures upon attributing responsibility. The appeal is an important evolution of the case, because it led to revisiting evidence and the verdict motivations, ultimately deciding that the commune along with the association for managing the dike were now liable for the consequences. These new elements in the case show that the law is still unprepared to deal with disasters and provide relief to victims, especially where uncertainty and the criteria of uncertainty is to be debated and defined when framing disaster risks in the law. The thesis argues that the result of these decisions in the case study has given emergence to 'collective responsibility', which is the result of the diffusion of responsibility across various actors. This shared responsibility appears to support the framing of the governance of disaster risk reduction as one of collectively building resilience. While the thesis

recognizes the importance of participatory governance frameworks, there is a question of informed and effective risk management, the complexity of the history of vulnerability and the need for an alignment of responsibility in the context of disasters, which opens new arenas for the development of appropriate attribution tools.



## Chapter 7: Concluding remarks and discussion

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## Overview

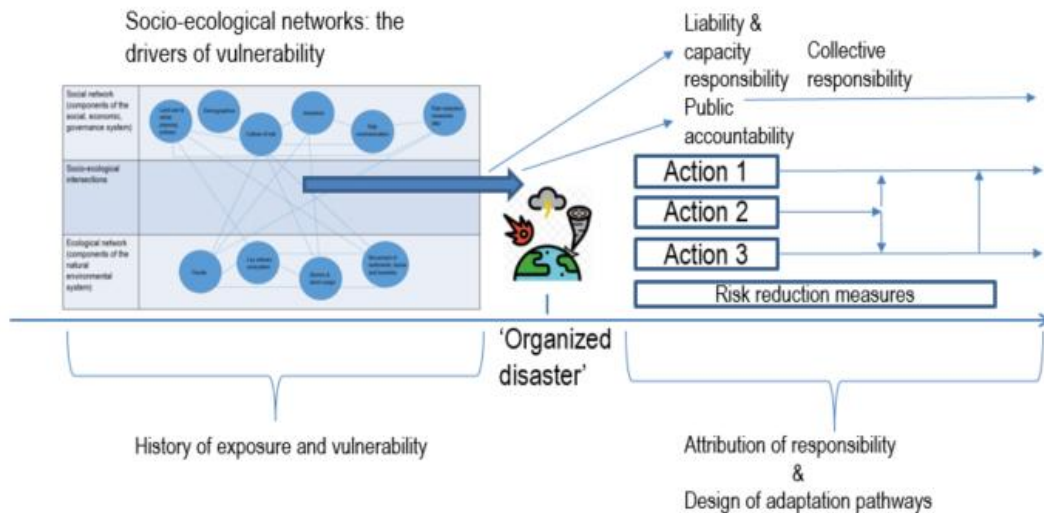
The purpose of this thesis was to revisit the Xynthia disaster in 2010 to explore vulnerability of the commune La Faute-sur-Mer and the process for attributing responsibility for the consequences. The thesis used this case study analysis to reveal the relationships between dynamic components of vulnerability stemming from socio-cultural characteristics of a place and institutional arrangements in a multi-level risk governance structure. The analysis thus aimed to identify the relationships between governance gaps (poor land-use planning and development decisions in risk areas, levers to the implementation of flood risk management policies at the local level, risk culture and perception and insurance schemes for disaster risk) that lead to vulnerability trends over time. At the same time, the case study analysis focused on the public trial in the aftermath of the disaster in 2014, to explore the process of defining and attributing responsibility to individuals for the consequences of disasters that involve a natural hazard. These two research themes were enriched by an analytical framework on the institutional and organizational processes that shape vulnerability and risk-responsibility relationships, which was presented in the literature review (Chapter 3). To deepen these areas of research - on the social features of "not so natural" disasters and the attribution of responsibility for the consequences - two questions framed the thesis:

- 1) What are the governance gaps that contribute to vulnerable conditions? How do the identified components of vulnerability interact in complex systems and explain the consequences of disasters?
- 2) How and why does the definition and attribution of responsibilities for the consequences of disasters evolve? What is the role of public trials to attribute responsibility for these kinds of events (disasters that involve a natural hazard)?

The final chapter organizes the conclusions of the analyses in Chapter 5 and Chapter 6 that refer to (i) risk governance gaps reinforce components of

vulnerability that are highly interconnected and interdependent in socio-ecological systems and (ii) the complexity to define and attribute responsibility for the consequences of disasters leads to the diffusion of responsibility that is ultimately collective.

The analysis on vulnerability provided insights onto the significance of governance gaps as drivers of risk over time, thereby providing insight into decentralized risk governance structures, as the case in France. This retrospective method of surveying vulnerability in disaster research has been a traditional approach and carried out for several other disasters such as Hurricane Katrina and the Fukushima triple disaster (for example, see Duvat & Magnan, 2014). Therefore, the purpose of conducting this analysis was to provide a basis for the second research theme on responsibility. Tracking vulnerability over time helped to understand the evolution of defining and attributing responsibility for the consequences of disasters, as it showed that there are several risk-responsibility relationships embedded in risk governance frameworks. However, the analysis came to the conclusion that responsibility in the end for disasters risks tends to spread out, where this is lack of legal and accountability instruments to systematically assign responsibility for these events. Therefore, while tracking vulnerability according to governance gaps is a robust methodology to study disasters, as explored in the thesis, the notion of accountability as central to governance regimes remains absent from this process. As the Xynthia trial showed, while someone should be held responsible for the consequences of disasters, inclusive risk governance strategies framed by building resilience presents the potential for too many lines of responsibilities, where no one is legally responsible in the end.



**Figure 25 From vulnerability analysis to informing risk reduction actions**

These conclusions open potential paths for further research on disasters (Figure 25). Firstly, research on exploring the dynamic interaction between multiple components of vulnerability in complex socio-ecological systems could further develop on how these interconnections over time lead to 'organized disasters'. This means that, similar to the studies on accidents in complex socio-technical systems (e.g. Pidgeon, 1997; Turner, 1994), the governance of disaster risk management should be flexible enough to incorporate normal errors, where a degree of vulnerability is inherent to the system. This inspires more research on forward-looking methods, such as how to build resilience and adapt dynamic socio-ecological systems over time with notable emerging interests on the role of adaptive capacities as potential for adaptation and the 'adaptation pathways' decision-making methodology. The question on how to increase adaptive capacity in the face of extreme climate events is at the heart of the climate change adaptation and disaster risk reduction research nexus. This area of research benefits from a 'forensic analysis' of disasters to identify components of vulnerability that

can help inform risk reduction actions in the future under different kinds of global warming scenarios. Complementary to this first research stream is also the call for more studies on the relationship between the governance of building resilience and risk-responsibilities across multiple actors. In particular, pathways should include more work on defining responsibilities - often framed as 'risk ownership' - especially over time, and further research on attribution. Developing this research could provide tools and methods on how governance structures should be better equipped to systematically treat responsibility for disasters that involve a natural hazard. Moreover, there is a question about how legal tools could be developed to treat disasters and ensure relief to victims.

This chapter also considers the limitations of the thesis and concludes with a few final comments on how the case study analysis could inform policies in disaster risk management.

### [Vulnerabilities to disaster risks: revisiting the Xynthia coastal disaster](#)

The present thesis was designed to study vulnerability to disasters. In particular, the case study analysis of the Xynthia storm explored governance gaps that led to higher exposure and vulnerability conditions, otherwise referred to in the literature as 'drivers of risk' (Cardona et al., 2012). The concept of vulnerability was presented in the literature review and various definitions helped shape the analytical framework. More specifically, these pioneering works from the 2000's helped to identify components across the natural ecosystem, built-environment and socio-economic context within risk governance frameworks that contribute to higher vulnerability levels. The analysis also showed how other factors play a role in shaping vulnerability over time such as behavior, risk perception and demographics complementing the findings of other studies on vulnerability (Burby, 2006; Cutter, 2006; Meur-Férec et al., 2010).

The findings of this investigation complement those of earlier studies on the identification and characterization of different drivers of risk. Governance gaps in

the case study focused on delayed risk-informed urban planning and more generally, the complexity of the risk management and urban planning policy landscape driven by the central government yet slow to implement at the local level. This sheds light on decentralized governance structures and potential barriers to managing risks. In France risk policy making is driven at the central level and relies on a chain of decision-making across a multi-level administrative structure for decentralized planning and implementation. There are varying sets of responsibilities across this tiered governance structure, where communication and coordination mechanisms are important for effectiveness. Participation has been a driving force in the building resilience motive of recent years to create risk ownership across stakeholders (local, associations, private sector, community). While bottom up mechanisms are in place, such as in the case of urban planning - where the PLU is decided by the municipality - tensions arise between central state regulations and local interests. Moreover, the prescription of central state risk policies (PPRI, PPRL, PPR) take precedence, thereby challenging the municipal level of authority to decide on urban planning.

The importance of the PPRI was discussed thoroughly in the case study analysis as the main document regulating urban development in flood risk zones. However, local actors could see this prescriptive policy as pressure from the central state challenging other interests, especially because hazard zoning constrains development. Therefore, the analysis sheds light on risks in decentralized risk governance and the challenges of trade-offs in risk management. A priority for effective disaster risk reduction relies on coordination between top down and bottom up arrangements. It reinforces the idea in the literature that stakeholder acceptability and consensus set the foundation for effective risk management (Cinner & Barnes, 2019; Losada et al., 2019).

Within this participatory governance framework, the analysis explored the meaning of risk culture, which refers to local community risk perception and engagement in risk management for reducing vulnerability. Risk culture is a central component of risk management strategies in France, especially in the area of natural hazards management because it surrounds the importance of raising awareness, information

transparency and community channels in building resilience across social and natural systems. Associations across territorial collectivities (*collectivité territoriale*) stress the role of risk culture for preparing to live with the risk of flooding, shaping the main message, '*Vivre avec les inondations: Développer la culture du risque et repenser nos espaces*' (Living with floods: Developing a risk culture and rethinking our spaces) (France Nature Environnement, 2018).

The analysis in the thesis explored risk culture through the aspect of demographics, which is often suggested as a characteristic of social vulnerability to disasters in the literature. While race or socio-economic data were not highlighted, the interest in the study was on the problems associated with the high turnover rate characterizing coastal communities. In particular, obstacles to building a risk culture were explained because a majority of the population owned second houses used for summer vacation periods, thereby creating little interest or awareness about the risk of winter cyclones or community participation in flood risk management policies (such as the PPRI consultation process). Instead, inhabitants who live in the commune throughout the entire year are mostly retirees, which is often considered as a segment of the population that is more vulnerable to disasters in the literature (Ngo, 2001). The main findings referred to the implications on these demographics on a lack of participation in flood risk management, which led to gaps in information sharing (e.g. telling stories over time as in river basin communities) and social networks, as an inherent part of building a risk culture. The thesis showed that risk culture is attributed to a lack of awareness about risks and preparedness for disasters, where learning processes (e.g. experiences with disasters and iterative learning) are key contributing factors. Such findings compliment studies on the role of social capital, culture and tradition in reducing vulnerability and adapting to disaster risk (Aldrich & Meyer, 2014).

The findings of the thesis provided insight into the significance of insurance mechanisms against disaster risks in the governance of disaster risk management by looking at the French Cat Nat scheme. While the solidarity principle shaping the Cat Nat Scheme has overcome several barriers faced by insurance arrangements for disasters risk (across options proposed by private, public or through partnerships)

as discussed in the literature (e.g. Kunreuther, 1984; Crichton, 2008; OECD, 2015; Paudel, 2012), there is a question about how this arrangement in France constructs or limits incentives, especially in financing prevention (i.e. the risk of moral hazard). This is explained because disaster risk insurance is mandatory and bundled with a range of hazards such as fire, which creates a diversified risk cushion, high penetration and an efficient mechanism for compensation for material damage. However, there is a question about the role of insurers as no real market exists and if there is a risk of lack of fiscal incentives to invest in prevention across stakeholders, described as systemic moral hazard (see Huber, 2002). These insights raise questions about the nature of different arrangements for disaster insurance, in particular the role of the state and private sector, and how to put in place governance arrangements that will systematically provide incentives for stakeholders to engage in risk reduction activities. The role of insurance in disaster risk management will continue to be important, especially with critical questions on who has responsibility to invest in prevention and provide post-disaster compensation. This is on the rise with growing demand of liability turned to private companies, such as the energy company (Pacific Gas and Electricity) in California facing blame for ageing distribution networks trigger major wildfires.

This retrospective design to study vulnerability to disasters adds to the body of research on good governance arrangements for effective disaster risk management and reduction. In-depth case studies are valuable to further identify context-specific drivers of risk and their interactions to inform appropriate policy tools. In so far that the thesis shows the importance of context specific history of hazard and vulnerability, there is caution with promoting a one size fits all governance approach or principles to account for diverse cultural and traditional contexts.

#### ‘Organized disasters’ in complex socio-ecological systems

Considerably more work will need to be done to characterize the interactions of vulnerability components in complex systems and survey the role of governance arrangements to reduce these drivers of vulnerability. In particular, it would be



valuable to consider feedback loops within the socio-ecological system that leads to 'organized disasters'. Organized disasters refer to the perfect conditions in which disasters are realized because vulnerability components reinforced each other over time. The easiest example to put forward as relevant for many cases is the role of structural protection measures on increased urbanization in risk-prone areas and effects on decreased risk perception (Burby, 2006; Colten, 2009).

Drawing from studies on industrial accidents or disasters in complex socio-technical systems could contribute to the study on dynamic vulnerabilities within socio-ecological systems. This is because there are many parallels to be drawn between these two complex systems, notably the role of technology, decision-making (governance) and the normalcy of errors. In the organizational accident literature, it is suggested that social and technical components are tightly interconnected in complex systems and therefore errors such as miscommunication, technical errors or biased risk management decisions are coupled and lead to accidents (for example, see Perrow, 1984). These cornerstones of accidents theory (interconnectedness and normal errors) in complex socio-technical accidents enrich the exploration of vulnerability in socio-ecological systems, by providing important material to better understand the social network.

This field of work has been applied to disaster that involve a natural hazard and lead to industrial accidents. For example, in 2011, Perrow continued his seminal work on *normal accidents* in organizations (1984) by writing on the Fukushima triple disaster, in his article titled 'The Inevitability of Accidents' (2011). He wrote:

*'Nothing is perfect, no matter how hard people try to make things work, and in the industrial arena there will always be failures of design, components, or procedures'* (Perrow, 2011: 1)

Such a statement surfaces the importance of flexibility in governance arrangements for disaster risk management to allow for feedback loops and learning processes. If we consider that even risk management techniques such as urban planning and land use restrictions in flood risk zones face limitations, then disaster risk reduction should be designed with the flexibility to account for failures whether in the social, ecological or technical system and incorporate iterative learning mechanisms. From

this perspective, a disaster like the case of Xynthia where vulnerability was so intricately shaped by different factors over time could be considered as an 'organized disasters'. Organized gives the notion of controllability or rationality behind design or an implemented action, while disasters in contradiction imply some kind of chaos or out of control event.

'Organized disasters' presented in the research is inspired by the literature on the social construction of vulnerabilities and accidents in socio-technical systems. A range of works use organizational theory to analyze various accidents (e.g. Chernobyl, Bhopal, Deepwater Horizon) from the bottom-up or top-down approach (Perrow, 1984, 1995; Turner, 1978b; Leveson et al., 2009). The approach to accidents from this perspective shed light on disasters having origins from an accumulation of interrelated components that interact overtime. By studying their interaction, these studies insist on identifying a series of failures and errors, some of which are referred to as 'normal deviants'. Drawing from these perspectives on accidents in complex organizational structures can enrich studies on building resilience in socio-ecological systems to capture various relations and interactions between different system elements that contribute to vulnerability and disaster risks (Gunderson, 2010).

#### Moving forward: from dynamic vulnerability and governance gaps to adaptation pathways

Disaster risk management research discusses building resilience, reducing vulnerability and adapting (Birkmann, 2006). These research framings propose methods to analyze disasters and reduce their consequences in the future. There is increasing interest on the use of adaptation pathways to apply a forward looking plan to manage and reduce risks, notably climate related risks using different climate change scenarios and expiration dates ('tipping points') of different risk reduction options (Djalante, Holley, Thomalla, & Carnegie, 2013; Hassnoot, Kwakkel, Walker, & ter Maat, 2013; Magnan & Duvat, 2016). Adaptation pathways is a decision-making tool and a methodology explored to help plan a series of risk reduction options over time under uncertainties (Hassnoot et al.,

2013). While climate change will exacerbate natural hazards (slow onset and extreme onset) different scenarios could have varying impacts. Studies by the IPCC and OECD particularly highlight coastal areas as most vulnerable to a range of hazards (e.g. sea level rise, flooding, erosion) and tropical cyclones (high winds and waves, coastal surges) (OECD, 2019; Oppenheimer & Bruce, 2017). In recognition of climate change intensifying some kinds of disasters, an evaluation of the effectiveness of risk reduction options benefits from long term perspectives that ask about how the social and ecological system can adapt using different kinds of global warming scenarios.

Adaptation pathways inform dynamic policy making by evaluating different kinds of risk reduction options over time and their expiration of effectiveness in terms of tipping points (Hassnoot et al., 2013). The value of retrospective studies on vulnerability to identify drivers of risk helps to better inform risk reduction actions in the future to avoid path dependencies and lock-in effects, which create vulnerable conditions or lead to mal-adaptation. These dynamics and feedback loops, are also present in the idea of 'organized disasters' previously described, which requires to identify, characterize and determine the relationship between drivers of risk (the system components). The thesis focused on one set of components, under the theme governance gaps, which is particularly important in contributing to the adaptation pathways approach. This is because it can help to identify enabling conditions or barriers for implementing risk reduction in the short term and potentially in the long-term towards building resilience and adapting. Drawing from the analysis, adaptation pathways should foremost focus on the role of legislation and regulatory tools around urban development and land use planning as the method to reduce risk in areas that are already highly exposed and their effectiveness in decentralized risk governance structures.

In addition, the analysis considered the negative side effects of structural protection measures, where adaptation pathways cope with uncertainties of this risk reduction effectiveness over time. This is especially important in dynamic zones such as coastal areas because wetlands, marines and dune systems change and human interventions can create cascading effects (e.g. such as blocking sediment

movement). Then it could be necessary to consider in the future options such as managed retreat and or relocation policies in places that are at high risk to coastal disasters such as the commune La Faute-sur-Mer.

In order to think about one or a combination of risk reduction options, governance arrangements will be significant in thinking about and designing long term plans and therefore central to informing and designing adaptation pathways as a methodology and tool to address disaster risks. This is because the analysis showed that risk reduction policies are effective in so far as the right governance arrangements are in place. For example, the need for coordination, consensus building, risk acceptability framing, mobilizing risk prevention financing and defining accountability mechanisms should be part of designing pathways.

### Attributing responsibility for disasters: the Xynthia trial

The thesis also analyzed responsibility for disasters through a case study analysis of the Xynthia disaster public trial in 2014. The analysis of the public trial aimed to explain the process for criminalizing local authorities in the commune for the human consequences of the disaster. In particular, the analysis explored the evolution of defining and attributing responsibility across different phases (verdict motivations (2010-2014), first sentences (2014), appeal (2016) and post-appeal until 2018). Evolution refers to the transferring of responsibility from one party to another across these different phases just mentioned. Analyzing the evolution of responsibilities was informed by risk-responsibility relationships (capacity responsibility, professional responsibility, liability and accountability) as different responsibilities embedded in risk governance frameworks.

First, the case study was positioned in comparison to other disaster trials. There are a few other cases of trials for disasters such as the L'Aquila earthquake and Fukushima Daiichi trials that provide insight into the main factors behind verdict motivations. This comparative analysis allowed to determine that the role of risk information to determine negligence in terms of inaction to prevent risks served as the main evidence for verdict motivations. In the case of Xynthia, the trial found guilty persons in the municipal council for the illegal issuing of building permits in flood risk areas while having hazard maps and relevant regulations on restricting any kind of developments in such areas. Therefore, the main argument was *negligence* on account of availability of risk information and the issue of 'a conflict of interest'. Similar to other trials the concept of negligence was important for determining inactions that led to people's lives put at risk.

The interest for carrying out research on this public trial is because the attribution of responsibility went through different phases. The analysis looked at these different phases by exploring risk-responsibility relationships in risk governance frameworks, which includes capacity responsibility, liability and accountability. The analysis furthered on the typology of responsibility types and how they manifested in the case. This was explained by liability as the first form of appraisal

because when Xynthia passed, the state declared it officially as a natural disaster (*catastrophe naturelle*) to activate the public reinsurance program. This declaration made the disaster a political item and designated the event as purely natural thereby separating human conduct from causation. Insurance and a variety of state funds provided compensation for material damages, whereby liability was triggered. However, victims of the Xynthia storm who faced human loss in La Faute-sur-Mer mobilized into an association and triggered a demand for accountability. The analysis showed how this move pushed forward by collective actions meant that liability reached its limitations. Instead, victims who suffered human loss called for a public judgment and additional relief.

The trial was an accountability mechanism. In the first outcome in 2014, the trial found guilty public officials due to gaps in revised flood hazard maps which decreased flood risk areas and at the same time the illegal development of dwellings in high risk zones. It also found guilty persons involved in the business of construction for not adhering to building standards and individuals responsible for overseeing the dike because it was not properly maintained. However, in the following years the case was re-opened as the individuals convicted filed an appeal in 2016. Arguments for the appeal were grounded in the many uncertainties when managing disaster risks. The appeal led to reductions of the initial sentences and another evolution of responsibility, where it was transferred from the local officials to the commune as an entity and the association for managing dikes (as part of the commune) with the state in solidarity. At this phase of the case, insurance sued the commune an amount of €1.5 million. The analysis showed how this new phase led to a diffusion of responsibility that was collective and shared across all individuals.

These various phases of assigning responsibility in the case study, shows that attribution is complex for disasters because vulnerability is built over time and influenced by many factors. While the use of criminal trials is a step forward to restoring public accountability in risk governance frameworks, there is room to formalize the standards that will be used to treat disasters in trials. Even if we agree that the 'act of God' defense is no longer valid, there is still a question about how responsibilities for the consequences (mainly human) are assigned for these events

and according to what standards. This is not to say that each disaster should be treated the same, because they are unique events. However, the legal tools used to define and attribute responsibility for disasters should be to some extent consistent to ensure that victims receive appropriate forms of relief.

Towards the governance of building inclusive resilience: developing tools to attribute responsibility for disasters

The governance of disaster risk management and reduction emphasizes the importance of building resilience (Tierney, 2014). It describes risk reduction as successful by making the ecosystem, economy, infrastructure and community be able to withstand, cope and recover from a disaster (not necessarily to how it was before). Growing emphasis on the role of social networks and community participation in the disaster risk management framework is part of this rising approach to building resilience, which has implications on responsibilities. This perspective further highlights the role of communities within the governance framework and the added value of community resources and networks as a coping capacity to natural hazards (Aldrich & Meyer, 2015).

The governance approach of building resilience examines the role of local measures in preparedness and vulnerability reduction as part of *adaptive capacity* to a dynamic risk environment (Nelson et al., 2007). Therefore people-centered and community-based approaches to adaptation highlight raising awareness about disaster risk, communication of risks, and building a 'risk culture'. Nevertheless, scholars note that there are many factors to include in a community based approach to adaptation such as changes in local dynamics, legislation, policies and market trends (Allen, 2003). While these positive points for increasing adaptive capacity and building resilience have been described, it is not clear what this means for community responsibility in the disaster risk governance framework.

With a shift away from the state as the only risk manager, the participatory approach to the governance of building resilience should avoid the diffusion of responsibilities across all stakeholders. While inclusiveness and participatory

governance frameworks are good initiatives because they take into account local issues, they should also ask about the clear assignment of responsibilities and accountability mechanisms. Even if attribution of multi-factorial causation is complex it doesn't mean that no one should be held responsible (Lauta, 2018). While disasters become more an object of the law with cases in Chile, Japan, USA and Philippines as discussed by Lauta - it is not clear how responsibility is distributed (2018).

In conclusion, the emergence of trials for disasters provides a method of defining and attributing responsibility. This process calls for further research, especially as building resilience and the role of communities continues to be an important part of disaster risk management and adaptation policies. Moving forward with adaptation pathways as mentioned in the first research theme, the research on disasters should also explore the distribution of responsibility.



## Limitations

The limitations to the research are presented in this section. As with most disaster studies, a limitation to the research project is that the analysis was made after the event occurred, which limited the ability to make hypotheses. Furthermore, the research relied on existing studies and theories in the literature to explain the pre-existing risk conditions and determine the drivers of vulnerability. Based on the information gathered the analysis explored path dependencies between different components of vulnerabilities, where the drivers of risk were analyzed as stemming from governance gaps.

Different methods would have also been appropriate to deepen the analysis of vulnerability over time, such as the use of GIS technology and maps that help to identify changes in the physical terrain and the trajectory of housing developments. Other aspects of the analysis focused on the role of behavior, choice, risk perception and risk culture in shaping vulnerability. Analyses were made from inferences using information from interviews, transcriptions of the trial and the literature on decision-making under risk and uncertainty as well as on sociological approaches to risk and culture. The use of a survey and interviews with more stakeholders could have made findings more robust on the topic of risk perception and risk culture. Given the general limitations of studying disasters using information after the event to infer pre-disaster conditions, mixed methods could have been useful to explain the drivers of risk.

Another challenge when studying disasters retrospectively is informing causation and multi-factorial agency over time. The analysis on linking governance gaps to vulnerabilities to explain causation involves multiple factors that change at different horizons of time and have different levels of influence on contributing to exposure and vulnerability. Some of the factors discussed in the analysis were on decision-making about spatial planning, the complex landscape of urban planning policies, the insurance market and the demographics of the community. However, multi-level and multi-criteria assessment to derive complex causation could benefit

from sophisticated models or feedback looping software to visualize interactions between components. Modeling techniques (e.g. Loopy software for causal loop diagrams or Vensim stock and flow models) could have been useful to discuss complex systems thinking for vulnerability and resilience in the thesis. Future research could employ more methods to develop causation models for case studies of disasters that would be informative for complex systems thinking. Applications of a systems approach can clarify components of systems, analysis of vulnerability by grouping elements, identifying their bounds, functions and interactions. A systems approach could help capture the complexity of the system and contribute to the research on building resilience and adaptive governance approaches (for example, see Folke, 2006).

The methods in the thesis adopt a qualitative single case study approach, which could be strengthened by using complimentary methods. Other research methods such as comparative analysis with other cases in different countries or hazards could be fruitful for an analysis on the history of vulnerability. The advantages of a comparative analysis allows to fine-tune similarities and differences, especially highlighting different governance structures and what measures are effective in reducing risks and what are the challenges for their design and implementation. A comparative analysis could have been interesting if carried out with other cases of coastal flooding or even other kinds of natural hazards such as wildfires. This would help to identify the enabling conditions for effective disaster risk reduction options.

The literature explored for the thesis may present a set of limitations as they were selected to frame the analysis by focusing on the social characteristics of disasters (vulnerability caused by governance gaps). Other literature on disaster studies could have provided a complimentary or alternative approach to analyze the case study. For example, disaster research on resilience could give different insight and conclusions on the case study of the Xynthia storm. Resilience provides different perspectives to dynamics of socio-ecological systems. Another point of departure could have been drawing from the climate change adaptation literature, which presents interesting reflections on adaptive capacities, especially in the face of

shock events. Drawing from studies on the dynamics of socio-ecological systems and adaptive capacities to build resilience could be interesting to further the study on vulnerability in the context of climatic extremes and climate change. Current international developments with the work agenda of the United Nations Framework Convention on Climate Change (UNFCCC) and the International Panel for Climate Change (IPCC) bring increased interest on the role of climate change patterns on hazards, including slow onset and extremes, and the implications for disaster risk management practices. In addition, climate change adaptation is exploring attribution science and climate litigation tools. This area could bring interesting insight into the discussion of responsibility as explored in the thesis.

#### Final comments

The research revisits the 2010 Xynthia storm that triggered coastal marine flooding in the commune La Faute-sur-Mer located on the western coast of France. This disaster had large-scale impacts on the community with high human loss and material damages. The aim of the research was to explore through this case study analysis 1) vulnerability conditions that are socially constructed over time and the associated governance gaps, and 2) unravel the complexity of the attribution of responsibility for the consequences of disasters, specifically through an analysis of the public trial. The relevance of this thesis sheds light on disasters risk management and in particular on the significance of governance for effective policies.

A priority in disaster risk management is to ensure appropriate systems, methods, and support are in place to reduce vulnerability to disaster risks. Researchers have the opportunity to contribute to this field of knowledge by drawing information from comprehensive case study analysis. In-depth studies allow to identify and characterize these components of vulnerability across the social, built and ecological environment and explore their interactions. Moving forward, the interactions between these components provide important information on the role of associated governance arrangements that can be the drivers of risk. Forward

looking approaches to reduce risk, such as presented by the adaptation pathways methodology could benefit from insights on governance for effective risk reduction policy design and implementation. In conclusion, this thesis calls for future research on the enabling conditions for reducing vulnerability, building resilience and adaptive capacities against climate risks and disasters.

Another focus of the research was on responsibility for the consequences of disasters, with a focus on large-scale events that involve a natural hazard. In particular, the research presented different types of responsibility such as liability and accountability to allow to consider different approaches and methodologies to determine cause-effect and attribution, which are embedded in complex risk governance frameworks. The point of this research scope was to show that, although participatory governance approaches improve awareness and can mobilize expertise, the emphasis on local communities in building resilience calls for clarity on the lines of accountability in these risk governance regimes. While more stakeholders get involved in integrated approaches to manage hazards, risk ownership will be a key component.

Moreover, disasters that involve a natural hazards and are treated in trials to determine individual responsibility for the consequences as in the case study present an important research scope. While the trial could be an important public accountability mechanism in risk governance, there is a question about their consistent application across disaster cases and if they can meet the demands of victims. So far trials for disasters have succeeded to make known the failures of risk governance, however they have failed to meet the demands of victims for relief. It is not to say that nobody should be held responsible, however the standards and processes to attribute responsibility through criminal trials should be clarified. Public trials, criminal trials and or law-suits for disasters will continue to be a method to treat disasters and provide relief to victims. A stream of work for future disaster researchers questions about who is or should be responsible and according to what standards?



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**Titre :** Revisiter la tempête de Xynthia et les inondations côtières en France : explorer les vulnérabilités aux risques des catastrophes et l'attribution de la responsabilité pour les conséquences

**Mots clés :** risque de catastrophe, gouvernance, vulnérabilité, responsabilité

**Résumé :** La thèse revisite la catastrophe de la tempête de Xynthia de 2010 et le procès public qui a suivi en 2014 pour explorer i) les conditions spécifiques de vulnérabilité au risque d'inondation côtière dans la commune de La Faute-sur-Mer (côte Atlantique de la France) et ii) le processus d'attribution de la responsabilité des conséquences de la catastrophe. Une analyse d'études de cas explore les relations entre les composantes dynamiques de la vulnérabilité identifiées et caractérisées comme provenant de divers dispositifs sociaux et institutionnels au sein d'une structure de gouvernance des risques décentralisée en France. L'analyse se concentre sur les faiblesses de gouvernance dans les décisions d'aménagement et développement du territoire dans une zone à risque, les défis de la mise en œuvre des politiques de gestion des risques d'inondation au niveau local, le rôle de la communauté (sensibilisation, culture du risque et participation à des modèles de gouvernance inclusifs) et des incitations liées au régime français d'assurance-réassurance "Cat Nat" pour les risques de catastrophes.

Dans le même temps, cette première analyse fournit une base importante pour explorer le deuxième thème de recherche sur l'attribution de la responsabilité des conséquences de la catastrophe, en particulier concernant les pertes humaines. Cette analyse se concentre sur le procès public qui a eu lieu en 2014, où les autorités locales ont été accusées d'homicide involontaire pour la mort des 29 habitants qui se sont noyés chez eux à La Faute-sur-Mer pendant la nuit de la tempête. Sur la base du déroulement du procès et de l'évolution de ce cas d'étude entre 2014 à 2017, l'analyse explore l'ensemble des enjeux pour définir et attribuer aux individus la responsabilité des conséquences des catastrophes déclenchées par un aléa naturel. Ces deux thèmes de recherche sur (i) la vulnérabilité associée aux faiblesses de gouvernance des risques et (ii) l'attribution de la responsabilité des conséquences des catastrophes, ceux-ci sont enrichis par un cadre analytique sur les processus institutionnels et organisationnels qui façonnent la vulnérabilité et les relations responsabilités-risques, qui est présenté dans une revue de la littérature.

**Title :** Exploring vulnerability to disaster risks and attributing responsibilities for the consequences: revisiting the Xynthia storm coastal floods and public trial in France

**Keywords :** disaster risk, governance, vulnerability, responsibility

**Abstract :** The thesis revisits the Xynthia storm disaster in 2010 and the public trial that followed in 2014 to explore i) the conditions of vulnerability to the risk of coastal flooding in the municipality of La Faute-sur-Mer (Atlantic coast of France) and ii) the process of attributing responsibility for the consequences of the disaster. A case study analysis identifies risk governance gaps that have shaped vulnerability conditions in the commune. It explores the relationships between dynamic components of vulnerability stemming from social and institutional arrangements within a decentralized risk governance structure in France. This first analysis provides an important basis for examining the second research theme on the attribution of responsibility for the consequences of the disaster, in particular regarding the loss of life. This analysis focuses on the public trial that took place in 2014, where local authorities were charged with involuntary homicide for the deaths of 29 residents who drowned from coastal

flooding in their homes in La Faute-sur-Mer. Based on the court proceedings and the evolution of the case study between 2014 and 2017, the analysis sheds light on issues confronted by the legal process to define and attribute responsibility to individuals for the consequences of disasters that involve a natural hazard. These two research themes on i) vulnerability associated with gaps in risk governance arrangements and (ii) attribution of responsibility for the consequences of disasters, are informed by an analytical framework on the social, institutional and organizational processes that shape vulnerability and risk-responsibility relationships presented in a literature review. Finally, the thesis discusses results from the case study analysis and proposes research opportunities on forward looking approaches to reduce disaster risk and implications on the allocation of responsibilities in participatory governance frameworks.