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Private sector engagement in flood risk reduction and climate change adaptation –

Insights from manufacturing firms in Ho Chi Minh City, Vietnam

Geographie

Universität zu Köln

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Umschlagabbildung: Flooded street in Ho Chi Minh City. © Roxana Leitold

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List of abbreviations

ADB	Asian Development Bank
ADPC	Asian Disaster Preparedness Center
AMSL	Above mean sea level
CBD	Central business district
CFE-DM	Center for Excellence in Disaster Management & Humanitarian Assistance
CIEM	Central Institute for Economic Management
CSCNDPC	Central Steering Committee for Natural Disaster Prevention and Control
DECIDER	Decisions for Adaptive Pathway Design and the Integrative Development, Evaluation and Governance of Flood Risk Reduction Measures in Transforming Urban-Rural-Systems
DEM	Digital elevation model
DRM	Disaster risk management
FDI	Foreign direct investment
GDP	Gross domestic product
GIS	Geographic information system
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GSO	General Statistics Office of Vietnam
HCMC	Ho Chi Minh City
HIDS	People's Committee's HCMC Institute for Development Studies
ID	Identification number
IPCC	Intergovernmental Panel on Climate Change
JETRO	Japan External Trade Organization
MARD	Ministry of Agriculture and Rural Development
MNE	Multinational enterprise
MONRE	Ministry of Natural Resources and Environment

NDPC	Natural Disaster Prevention and Control
NGO	Non-governmental organization
NTP-RCC	National Target Programme to Respond to Climate Change
OECD	Organization for Economic Co-operation and Development
RCP	Representative concentration pathway
RRD	Red River Delta
RQ	Research question
SE	Southeast region
SIWRR	Southern Institute of Water Resources Research
SLR	Sea level rise
SME	Small and medium-sized enterprises
SMEDF	Small and Medium Enterprise Development Fund
SOE	State-owned enterprise
SRTM	Shuttle radar topography mission
SRV	Socialist Republic of Vietnam
TCFD	Task Force on Climate-related Financial Disclosures
UEL	University of Economics and Law
UN	United Nations
UNDP	United Nations Development Programme
USD	US Dollar
VCCI	Vietnam Chamber of Commerce and Industry
VEC	Vietnam Enterprise Census
VIF	Variance inflation factors
VND	Vietnamese Dong
VSIC	Vietnam Standard Industrial Classification
WACC	Center of Water Management and Climate Change
WEF	World Economic Forum

1 Introduction

Natural hazards are already among the main risks threatening humans and their environments in many regions of the world (Bloemen et al., 2018; Marfai et al., 2015; Nicholls et al., 2008). Recent scientific evidence predicts that climate change[1] will intensify the risk of natural hazards and bring about far-reaching environmental changes at global, regional, and local levels (Intergovernmental Panel on Climate Change [IPCC], 2014). Floods, sea-level rise, hurricanes, storm surges, and typhoons – all of these present compound future challenges for exposed populations, economic structures, and firm competitiveness.

The private economic sector is being confronted with challenges associated with these environmental changes (Goldstein et al., 2019). Estimates of economic losses are still subject to high degrees of uncertainty, but according to Burke et al. (2018), the costs of climate change (under a warming scenario of 3 °C) could lead to a global per capita decline in output of up to 25 % by 2100. Under this scenario, the costs and climate-related damages are unlikely to be spread evenly around the world or evenly throughout the economic sectors.

In particular, coastal cities in many emerging economies of the Global South,[2] such as those in Indonesia, Thailand, and Vietnam, have been identified as hotspots for future flood risks (Hanson et al., 2011; Hallegatte et al., 2013). With respect to the local economy, manufacturing firms are particularly exposed to the impacts of flooding as their activities are often concentrated in low-lying coastal areas (Asgary et al., 2012; Chaudhury et al., 2018; Marks and Thomalla, 2017; Neise and Revilla Diez, 2019). Moreover, the increasing frequency and severity of floods are embedded in complex transformation processes involving economic development, rapid urbanization, land-use changes, and political upheavals, situating firms in a multi-risk environment. Consequently, responding proactively to floods and the impending effects of climate change is one of the most pressing challenges for firms to ensure their competitiveness and survival in the long term, especially those operating in the Global South (Neise et al., 2018; Schaer, 2018).

[1] Notable among these are future sea level rise, and typhoons, as well as long-term changes in precipitation and temperature levels.
[2] In this dissertation, the term Global South refers to all low- and middle-income countries in Africa, Asia, Latin America, and the Caribbean (Mitlin and Satterthwaite, 2013).

Much scientific attention was given to impact assessment of floods at the macro-economic level before more recent studies began to address micro-economic and place-based impacts on firms (e.g., Haraguchi and Lall, 2015; Wedawatta et al., 2014). Damaged property, machinery and materials, power outages, and supply chain interruptions all result in lower business outputs, loss of market share and customers, and, in the long term, a reduction of jobs and tax revenues (Hallegatte, 2014). However, despite knowledge of flood impacts and prior achievements in risk reduction and adaptation research generally, the IPCC Assessment Report (2014) revealed a striking gap in existing scientific literature on private sector adaptation to floods. Many key issues remain unaddressed, particularly in relation to firms' prior flood adaptation efforts and how these relate to other business risks and complexities in firms' local environments (Linnenluecke et al., 2013; Verrest et al., 2020).

Furthermore, compared to large, often multinational companies, less is known about the flood response of small and medium-sized enterprises (SMEs[3]) although they play crucial roles in regional economic development through job and value creation (Asgary et al., 2020; Halkos et al., 2018). A few recent empirical studies have sought to address this knowledge gap on flood responses among SMEs (e.g., Halkos and Skouloudis, 2019; Marks and Thomalla, 2017; Neise et al., 2018; Neise and Revilla Diez, 2019; Pathak and Ahmad, 2018; Pathak and Ahmad, 2016). However, there is still no concise analytical framework for analyzing firms' decision-making processes for or against long-term adaptation. While the routines and dynamic capabilities of manufacturing SMEs have already been the analyzed for the development of adaptation strategies (e.g., Neise and Revilla Diez, 2019), little is known about the influence of individual attitudes among decision-makers and conditions in firms' external environments. Halkos et al. (2018) and Marks and Thomalla (2017) assume, for instance, that public flood risk management, institutional conditions, and local partnerships play decisive roles in developing firm adaptation strategies in the long run. Adaptation literature, which has so far mainly focused on entities such as private households, small farmers, and state organizations (e.g., Harvatt et al., 2011; Hulke and Revilla Diez, 2020; Porter et al., 2014; Toole et al., 2016; Tran et al., 2019), must therefore begin to improve

[3] In this dissertation, the classification of SMEs is based on the Vietnamese classification (Vietnamese Law 04/201/QH14-Law on Support for Small and Medium-sized Enterprises), which sets the limit for SMEs with 200 employees (including micro firms with less than 10 employees).

understanding of factors that influence firms' responses and activate their adaptive capacities (or not).

Despite this weak understanding of firm decision-making, strategies developed for (inter-)national scales (e.g., Sendai Framework for Disaster Risk Reduction 2015-2030) stress the importance of the private sector in enabling more integrated approaches to climate change adaptation. A rapidly evolving, forward-looking debate on adaptive governance has taken up this call and increasingly emphasizes the need to involve the private sector in future adaptation, especially given its financial resources, technological expertise, and organizational flexibility (e.g., Abe et al., 2019; Challies et al., 2016; Clark-Ginsberg, 2020; Renn and Klinke, 2013). However, the participation of smaller, local firms in collective adaptation is still limited (Pauw and Chan, 2018), and there is little empirical evidence on the conditions that determine their participation in multi-stakeholder initiatives. Yet, if we continue to turn a blind eye to SMEs' preferences for adaptation measures and their willingness and ability to participate, about 90 % of firms in the global economy will be excluded from the debate (The World Bank Group, 2020a).

Based on the conceptual and empirical gaps described above, this dissertation is structured so as to address the following research question: *How do small- and medium-sized manufacturing firms respond to floods, and which factors influence their decision to implement adaptation measures?* In answering this question, this dissertation has three broader research aims. First, it sets out to enrich adaptation literature with an integrated business perspective and conceptualize an analytical framework on the determinants of firm adaptation, including the role of adaptive capacities in decision-making. Second, it throws light on the link between experienced flood impacts and the specific responses of firms on a local scale. Third, it reflects on the role of firms in collective adaptation initiatives, taking into account the potentials and limits of SME engagement.

Towards these ends, the research for this dissertation employed a mixed-methods approach to assemble empirical evidence on manufacturing firms in flood-prone areas of Ho Chi Minh City (HCMC). As Vietnam's economic powerhouse, HCMC is facing manifold challenges due to considerable risks of flooding, which are likely to increase due to the dynamic interplay between climate change, ongoing urbanization, rapid economic growth, and other transformation processes (Bangalore et al., 2019; The

World Bank, 2019). HCMC provides an appropriate example of an expanding urban area in which manufacturing SMEs in particular are already impacted by floods. The findings of this case study provide crucial knowledge that is not only relevant in Vietnam but can also advance flood risk reduction and climate change adaptation in many other flood-prone areas in Southeast Asia and beyond.

The following seven chapters of this dissertation are structured as follows: Chapter 2 presents the state of the art in relevant literature on flood impacts, firm responses, and adaptive capacities. Based on the identified research gaps, the chapter summarizes the research framework and corollary questions guiding the dissertation. Chapter 3 details the mixed-methods approach for data collection as well as the context for the empirical analysis, first by presenting insights on disaster risk management (DRM) in Vietnam and then by assessing local flood risks faced by manufacturing firms in HCMC. Chapters 4, 5, and 6 present research articles that offer different analyses of the overall research question. These chapters have already been published or are under review in international peer-reviewed journals at the time of submission of this dissertation. Each chapter thus includes an individual introduction and conclusion as well as sections on theory, method, results, and a discussion. Chapter 4 develops a methodology to characterize overall exposure of manufacturing firms to future sea level rise (SLR) in HCMC. Chapter 5 focuses on flood impacts already experienced by firms and sheds light on the interplay between internal firm characteristics and external conditions that determine firms' decisions to undertake flood adaptation measures as they prepare for future flooding impacts. Based on those findings, Chapter 6 then describes scenario-based field experiments that examine the willingness and capacity of SMEs to participate in collective flood adaptation measures. Chapter 7, finally, discusses empirical results and theoretical contributions before deriving policy implications. Limitations of this study also are considered, as are recommendations for future research.

2 Conceptual framework: the perspective of firms in adaptation research

Little research addresses the extent to which and how firms prepare for the impacts of floods, although questions about adaptation action have been highlighted in recent scholarship on climate change (e.g., Agrawala et al., 2011; Averchenkova et al., 2016; Linnenluecke et al., 2013; Neise et al., 2018; Neise and Revilla Diez, 2019). The Sections 2.1 and 2.2 elaborate the state of the art in relevant literature dealing with flood impacts, responses, and adaptive capacities of firms, and set the stage for the research presented in this dissertation. Blind spots are identified in the literature that prevent decision-making in the face of current and future climate risks. Section 2.3 discusses the role of corporate behavior for risk adaptive governance (e.g., Challies et al., 2016; Chen et al., 2013; Clark-Ginsberg, 2020; Djalante et al., 2011) and multi-stakeholder initiatives (e.g., Pauw and Chan, 2018; Plummer et al., 2018; Renn and Klinke, 2013), and raises questions about the potentials and limits of private sector engagement for future risk reduction. Section 2.4 summarizes the integrated research framework and guiding sub-questions of this dissertation.

2.1 Impacts of floods

For more than two decades, the relationship between natural disasters, such as extreme floods, and economic development has been a central theme in development economics, economic geography and related disciplines (e.g., Albala-Bertrand, 1993; Kousky, 2014; Lazzaroni and van Bergeijk, 2014; Raschky, 2008). Various empirical studies and methodological approaches for measuring the socio-economic impacts of such extreme events have been developed, differing in terms of scale, research objectives (i.e., actors and sectors), and types of hazards.

As literature on the impacts of natural disasters tends to be macro-economic in nature, there is a large number of studies from cross-country and multi-event perspectives that calculate the economic costs of disasters and thus their influence on economic development (e.g., Crespo Cuaresma et al., 2008; Felbermayr and Gröschl, 2014; Hallegatte, 2014; Kahn, 2005; Lazzaroni and van Bergeijk, 2014). In wide-ranging debates about how to calculate such costs, there is no consensus on the long-term consequences of such disasters on economic development. Some publications even

highlight positive long-term effects of disasters on economic performance, assets, and employment growth from a cross-country perspective (Leiter et al., 2009; Skidmore and Toya, 2002). However, most econometric studies indicate that natural hazards have varying negative economic impacts in different local settings. Further, direct negative impacts are not evenly distributed among places, sectors, and actors (Elliott et al., 2019; Noy and Vu, 2010; Verrest et al., 2020).

Accordingly, a significant part of micro-economic and development research has analyzed the impact of natural disasters on communities, households, and individuals, as well as their exposure and vulnerability at the local level; meanwhile, firms have largely been neglected (e.g., Arouri et al., 2015; Balica et al., 2014; Clark et al., 1998; Noy and Vu, 2010). A seminal study by Tierney (1997) on business disruptions of 1,000 firms in Los Angeles after the Northridge Earthquake inaugurated a debate on the immediate and long-term effects of natural hazards on firms. Since then, several empirical studies addressing the whole spectrum of natural hazard impacts across different economic sectors and actors have come to the fore. Haraguchi and Lall (2015), for instance, investigate the impacts of the 2011 flood in Thailand on large multinational businesses in automotive and electronics industries, while Wedawatta et al. (2014) focus on impacts of the 2009 flood on small businesses located in Cockermouth, United Kingdom. These studies show that the manufacturing sector, in particular, bears the brunt of loss and damage due to its hard-to-change infrastructure and strong dependence on upstream supplier systems. Manufacturing firms suffer *short-term* and *direct impacts* such as property damage, the destruction of assets and stocks, business interruptions inside the flooded area, and electricity shortages, as well as *long-term* and *indirect impacts* that are more difficult to measure and tend to be neglected in impact research (Molinari and Handmer, 2011; Wedawatta et al., 2014). The findings of Wedawatta et al. (2014) show that firms not directly affected by flooding nevertheless experience a number of indirect and wider impacts, such as supply chain interruptions, postponed distribution, disrupted supply of raw material, or even the loss of market share and customers. These far-reaching impacts are usually not covered by insurance and can have negative business impacts for the future. SMEs in the Global South, particularly, are considered to be highly exposed to natural hazards (Chaudhury et al., 2018; Linnenluecke and Smith, 2018; Neise et al., 2019; Neise et al., 2018; Schaer, 2018; Verrest et al., 2020). Although they form the backbone of most

economies (Chatterjee et al., 2016; Chaudhuri, 2011) and play a vital role in local employment and income creation, they are commonly situated in a multi-risk environment, unprotected by publicly funded adaptation measures (Asgary et al., 2012; Pathak and Ahmad, 2016; Schaer, 2018). Highly localized scales of operation, fixed assets in single locations (Schaer, 2018), limited risk management capacities due to short-term planning and investment horizons (Chaudhury et al., 2018), and longer recovery periods after flood events (Asgary et al., 2012; Bahinipati et al., 2017) are factors that increase the exposure of SMEs to flood impacts compared to their larger multi-local and multi-national counterparts. Therefore, direct impacts such as flooded production sites pose a serious threat to their viability (Wedawatta and Ingirige, 2012). In this sense, Asgary and Naini (2011) argue that these direct and indirect impacts (i.e., supply chain interruptions) can lead to business closures in the short-term.

Although the studies mentioned above provide valuable insights into flood impacts at local and individual levels, scholarship on the range of losses and damage suffered by SMEs in the Global South is still sparse. Existing studies usually deal with major disasters or flood hazards, overlooking the impacts of minor and local floods. Small floods are seen as a normal business risk and tend to compete for attention with other local economic and social risks (e.g., financial crises, competition, shortage of skilled workers, social instability). As they are still considered part of everyday life and not exceptional events or major risks, their economic and organizational impact is difficult to quantify (Arabindoo, 2016; Jha et al., 2012). However, some studies in recent years have shown that small-scale floods represent a recurrent and aggravating stressor, also owed to human interventions, responsible for the lack of technological and innovative development of local SMEs, thus threatening their long-term competitiveness (Halkos et al., 2018; Neise and Revilla Diez, 2019; Verrest et al., 2020).

2.2 Flood responses and adaptive capacities

Given the increasing threat posed by natural hazards such as floods (see Section 2.1), which is intensified by climate change and other transformation processes, the question of how firms respond to current and future risk situations arises. Research on risk reduction and climate change adaptation provides several valuable starting points for advancing our understanding of firms' flood responses, decision-making, and their underlying rationale.

In recent years, literature on natural hazards that are intensified and more frequent owed to anthropogenic climate change has spanned several disciplines and shifted the focus from vulnerability reduction to a more decision-oriented adaptation perspective (e.g., Adger et al., 2005; Grothmann and Patt, 2005; Ribot 2011; Wise et al., 2014). Vulnerability research largely implies a reactive and passive understanding in which the lack of adaptation is an important factor for shaping vulnerability of individuals or groups (Klein et al., 2003; Turner et al., 2003). In turn, adaptation has recently been understood as encompassing proactive measures for reducing vulnerabilities, focusing especially on learning processes and experiences (Folke, 2006). Adaptation thereby refers to socio-economic practices and adjustments toward the mitigation of current and anticipated negative environmental impacts and risks, while also taking advantage of beneficial opportunities (IPCC, 2019).

With regard to the integration of this generally-accepted definition in recent empirical research, there is an emerging consensus that human adaptation does not exclusively depend on climate and environmental conditions, but is also influenced by decision-making processes, the availability of potential adaptation options, and the institutional setting. Decisions to adapt, and the circumstances influencing and underlying such decisions, thus become a critical site for analysis (Pelling et al., 2015). For example, the implementation of adaptation measures is highly influenced by wider socio-economic transformations, institutional frameworks, and by underlying cultural and personal attitudes, perceptions and possibilities (Garschagen, 2014). This holds particularly true for transitioning countries like Vietnam, where ongoing trends toward economic liberalization and political transformation are influencing adaptation and decision-making across state, community, firm, household, and individual levels.

Along these same lines, an emerging body of literature has contributed to improved understanding of ongoing adaptation measures on the ground from different perspectives and implemented by different actors, with a strong focus on private households, small-scale farmers, state entities, and urban planning (Arouri et al., 2015; Balica et al., 2014; Downes et al., 2016; Downes and Storch, 2014; Duy et al., 2018; Garschagen, 2015; Hulke and Revilla Diez, 2020; Wise et al., 2014). Especially since the IPCC Fifth Assessment Report in 2014, research into how and under which circumstances firms adapt to floods is gaining increasing attention. The emerging body of literature concentrates on *"understanding the role and the need to engage businesses*

in adaptation given their potential to finance projects, develop technologies and innovative solutions […]", mostly referring to large enterprises with multinational operations (Averchenkova et al. 2016: 517). The focus on large enterprises as key actors in financing adaptation efforts provides only limited insight into adaptation initiatives at local levels in developing and transition countries, where SMEs are primarily located, and whose economic viability is most closely linked to people's well-being. Neise and Revilla Diez (2019) have taken important first steps in addressing the role of local firms by presenting a typology of strategies for how manufacturing firms in Indonesia respond to flood risks and environmental changes in their neighborhood field sites in Jakarta and Semarang. With regard to firms' routines and dynamic capabilities, they distinguish between reactive, proactive, relocation, surrendering, depending, and collaborative strategies, all of which differ in scope and scale, and can be pursued in a dynamic and overlapping manner. Reactive and short-term action is understood as *coping* or *resistance* (Garschagen, 2013) after or during the occurrence of a specific flood event. Firms endeavor to avoid direct flooding effects through reactive measures and thus secure their products and assets. Proactive adaptation strategies, by contrast, involve planning and managing future changes even before climate impacts are experienced (Adger et al., 2005), which is of great importance for business development and competitiveness. Proactive strategies drive long-term shifts in behavior and are defined "*as a process of mediating between sustaining and re-organising"* (Garschagen, 2013: 29). Neise and Revilla Diez (2019) and Linnenluecke et al. (2011) describe planning for the relocation of future production lines as the most drastic proactive adaptation strategy if the in situ adaptations are not sufficient.[4] Neise and Revilla Diez (2019) also point to firms' adaptive inactivity. Following their typology, an inactive and dependent strategy is characterized by firms' dependence on large scale infrastructural measures (e.g., dike systems), usually initiated and financed by state authorities, industrial parks, large business networks, international cooperation, or non-governmental organizations (NGOs). When firms lack appropriate competencies and financial resources, and are as a consequence overburdened by the simultaneous occurrence of floods and other business risks, they

[4] The categorization of proactive and reactive adaptation with explicit reference to spatial and temporal scale can be traced back to the early studies on climate change adaptation (e.g., Burton, 1996; Frankhauser et al., 1999; Grothmann and Patt, 2005) and is still used in the latest IPCC reports.

often either follow a *wait-and-see* strategy or even surrender and tolerate future business losses rather than invest in adaptation measures (Agrawala et al., 2011).

When analyzing firms' future-oriented risk reduction and adaptation actions, questions about the rationales underlying decision-making arise. As many firms already suffer from flood effects in their business life (see Section 2.1), firms' exposure, previous flood experience, and the individual degree of impacts are considered as key drivers for adaptation action (Averchenkova et al., 2016; Djalante et al., 2011; Kato and Charoenrat, 2018). But little is known about the actual efforts that firms put into adaptation measures, as well as what determines engagement in a proactive strategy, a reactive coping mechanism, or even inaction. Their decision-making for or against adaptation action largely remains a black box (Daddi et al., 2018; Linnenluecke et al., 2013). Thus, several scholars have called for better understanding of determinants that influence firm adaptation (Halkos et al., 2018; Halkos and Skouloudis, 2019; Krellenberg et al., 2014; Meinel and Schüle, 2018). Linnenluecke and Smith (2018: 24), in particular, conclude that adaptation literature still lacks in-depth analysis and *"coherent insights into the drivers, barriers and outcomes of adaptation efforts [...]"* to reduce small-scale flood impacts and identify effective solutions for more severe flood potentials in the future. They thus call for research that addresses the following research questions: What capacities do firms, especially in the Global South, have in order to adapt to natural hazards and climate change impacts? What internal and external factors facilitate and hamper adaptation, and what variations can be observed among different firm types (i.e., private, state-owned, foreign) and firm sizes (micro, small, medium, large)? These questions are of central interest in this dissertation (see Chapters 5 and 6) and relate to the concept of adaptive capacity for which a considerable number of definitions have been suggested (e.g., Gallopín, 2006; Garschagen, 2014; Gupta et al., 2010; IPCC, 2014). In climate change literature, *adaptive capacity* is commonly understood as *"the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences"* (IPCC, 2019: 678). Building adaptive capacity has a wide range of determinants focusing on financial, technical, and institutional constraints, depending on the context and focus of observation (Adger et al., 2003). Empirical studies at the household level, for example, usually use the five forms of capital, including physical, financial, human, social and environmental, for

structuring their analysis based on the sustainable livelihood framework (Garschagen, 2014).

So far, firms-specific adaptive capacities have not been at the forefront of analysis. However, we should critically think about different managerial, external, sectoral, and place-based influencing factors, since the adaptive capacity of a firm is generally determined *"by an array of factors which are neither independent nor mutually exclusive but a result of a combination of these factors"* (Abdul-Razak and Kruse, 2017: 106, based on McCarthy et al., 2001). First, firm-internal factors, such as size, business performance, and financial liquidity have been highlighted as most critical to their hazard responses (Agrawala et al., 2011; Halkos et al., 2018). Trinh and Thanh (2017), for example, stress that insufficient access to credit and technological skills pushes firms to adopt temporary coping measures rather than implementing effective long-term solutions. In the same line, Marks and Thomalla (2017) argue that the recovery of SMEs after the 2011 flood in Thailand was decelerated by a lack of insurance coverage and financial resources. Moreover, it is assumed that firms rely on their dynamic capabilities, including skills, knowledge, and organizational learning to adapt to changing business situations (Berkhout et al., 2006; Neise and Revilla Diez, 2019). Second, the role of managers' risk perceptions, including the division and understanding of responsibilities for addressing environmental changes or realizing proactive adaptation, have come to the fore (Mees, 2017; Meinel and Schüle, 2018; Linnenluecke et al., 2013; Ung et al., 2016). In particular, an unclear division of responsibilities could lead to ineffective adaptation management, and hamper the implementation of individual adaptation measures (Nalau et al., 2015). Third, the role of external conditions in the business environment, such as social networks, governmental support, and guidance, as well as regulatory frameworks should receive more attention (see Chapter 5). Lo et al. (2019) recently emphasize that adaptation measures are more likely to be taken when social capital is strong. The importance of social capital and social networks for building long-term adaptive capacity has been stressed since the 1980s (e.g., Adger, 2003; Aldrich, 2011; Bourdieu, 2012; Coleman, 1988; Marshall et al., 2012). At its core, social capital describes *"norms and networks that enable people to act collectively"* (Woolcock and Narayan 2000: 226). In particular, households and, as in this case, micro and small firms, which are closely embedded in their neighborhoods and institutional environments, pursue collective

adaptation strategies at different levels (Neise and Revilla Diez, 2019). This includes various forms of cooperation, ranging from bottom-up self-organization in small neighborhood networks and associations (mostly informal), to formal participation in government initiatives. Here, the role of the state in flood risk management as well as institutional conditions for firm adaptation are of particular interest, but still insufficiently understood for SMEs in transition countries like Vietnam. Research thus needs to investigate how flexible firms are in their decisions to operate within formal and informal local systems (see Chapter 6).

2.3 Adaptive governance and collaborative approaches

If the focus is shifted from individual and small-scale approaches to higher levels of analysis, then flood adaptation is increasingly seen as a matter of multi-actor responsibility, particularly in future-oriented climate debates. In developing countries and transition economies exposed to high risks of current and future flooding, the governments seem to be overburdened in financing large-scale flood protection and managing integrated flood adaptation strategies (Averchenkova et al., 2016; Bisaro et al., 2020). While adaptation to flood risks has long been seen as the exclusive responsibility of public authorities, recent policy trends highlight the importance of institutional arrangements, participatory approaches and multi-stakeholder initiatives for addressing the lack of public resources, capacity, and knowledge. The literature on adaptive governance therefore emphasizes a *"shift from government to governance […]"* (Clark-Ginsberg, 2020: 1), a less hierarchical and top-down administrative approach to flood adaptation, with more decentralized decision-making and better understanding between the different actors involved (Challies et al., 2016; Chen et al., 2013; Clark-Ginsberg, 2020; Djalante et al., 2011; Folke et al., 2005; Lebel et al., 2006). Such collaborative approaches on a broader inter-sectoral and inter-local scale are associated with positive outcomes. Pahl-Wostl (2009), Pauw and Chan (2018), and Verrest et al. (2020) argue that collective action by multiple local stakeholders based on the pooling of knowledge, the exchange of information, and the sharing of responsibilities and costs leads to more efficient and effective results in reducing flood risks. Moreover, high public acceptance and an increased ability to manage adaptation processes are highlighted as advantages (e.g., Djalante et al., 2011).

There is a broad consensus about firms' essential roles in multi-stakeholder collaborations, mainly due to their financial resources, but also their unique technological expertise and organizational flexibility (Plummer et al., 2018; Renn and Klinke, 2013). However, Verrest et al. (2020: 242) argue that the private sector is *"largely treated as a 'black box', obscuring much of the dynamics and diversity within the sector".* In contrast to multinational enterprises (MNEs), which are often overrepresented in adaptation efforts, SMEs have been shown to have limited participation in collective adaptation. Most initiatives do not involve SMEs as partners in formal agreements, nor do they explicitly target smaller local firms (Pauw and Chan, 2018). On the one hand, especially in developing countries, flood governance is still usually implemented in a top-down manner and driven by a few powerful actors, making it difficult for SMEs to get involved. On the other hand, most literature ignores the extent to which SMEs are actually willing to participate and contribute their capacities to collectively develop and implement adaptation measures. Although the idea of more intensively involving the private sector, and in particular SMEs, in collaborative adaptation measures is intuitively appealing, some key issues remain poorly understood: How should private sector involvement be encouraged in the face of this blind spot about decision-making processes for adaptation? What responsibilities could be assumed by local SMEs? And what collective adaptation strategies are preferred? Different approaches can be considered at this point, such as private sector financing of structural measures, the inclusion of community-based programs for knowledge sharing, and the joint development and implementation of soft measures. Moreover, the question arises if the same determining factors for individual adaptation are relevant for the collective engagement of SMEs, especially in light of the different business risks and limited resources of these different entities.

2.4 Integrated research framework and analytical questions

In response to the shortcomings and research gaps outlined above, this dissertation presents an integrated research framework for firm adaptation analysis (see Fig. 2-1), which forms the conceptual basis for the scientific papers presented in Chapters 4, 5, and 6. The framework uses insights into firms' adaptive capacities and the relevant determinants for individual and collective adaptation responses in order to emphasize the private sector potential for collaborative adaptation initiatives, and for

understanding the role and responsibilities of firms in flood adaptive governance systems. The framework focuses on the response of firms to flood events, their decision-making on the extent of adaptation action, and their engagement in long-term proactive measures or short-term reactive coping strategies. Firms' adaptation decisions can be examined at individual (Chapter 5) and collective levels (Chapter 6), although they overlap and are difficult to separate. The integrated research framework links the flood exposure of firms and directly experienced impacts with their responses. With a few exceptions (e.g., Agrawala et al., 2011; Weinhofer and Busch, 2013), the existing literature overlooks the role played by previous flood experience, as well as the degree of impacts (see Section 2.1), in informing flood-specific responses – thus discounting the role that responses to recurrent, minor floods can play in adapting to increased climate risks in the future. Further, the framework focuses on firms' different adaptive capacities and recognizes that adaptive capacity does not automatically translate into concrete adaptation measures. Rather, the question arises as to which determining factors on different scales (i.e., individual, internal, external) influence firms' flood responses and activate their adaptive capacity (or not).

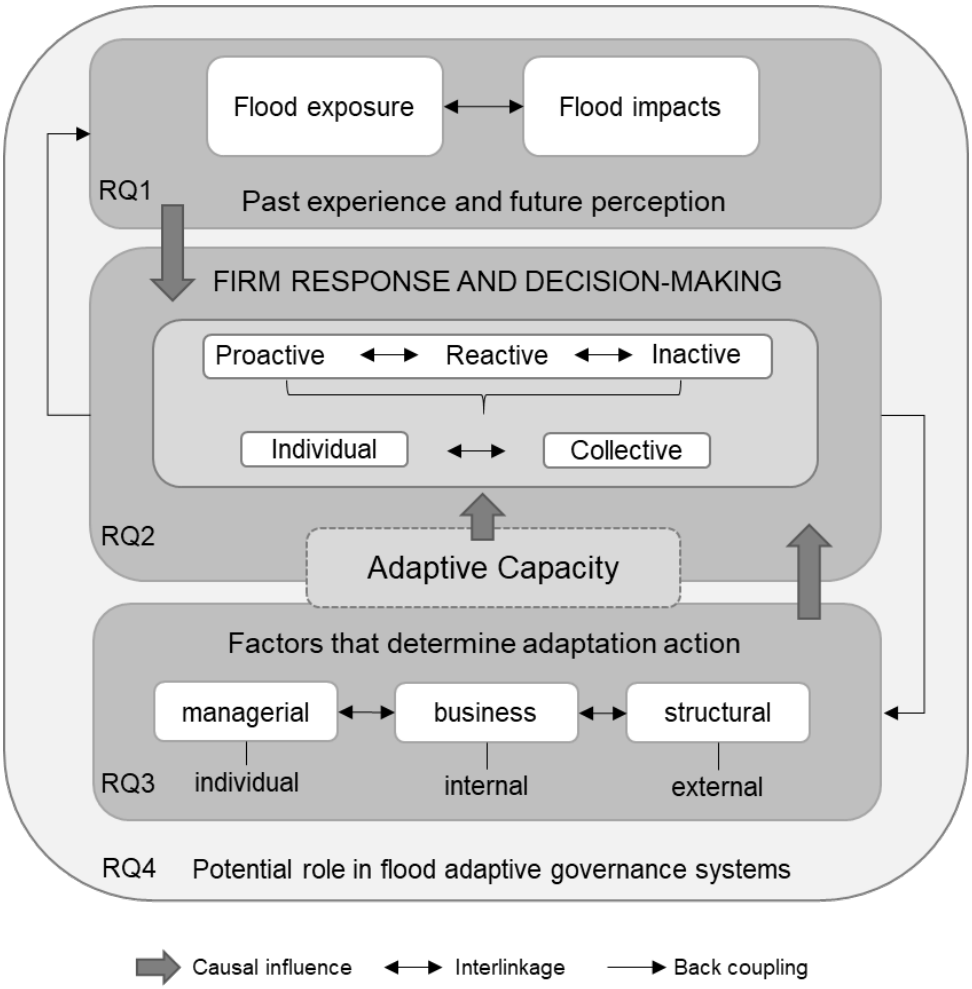


Fig. 2-1: Integrated research framework

Based on this framework, and to guide the empirical research for this dissertation, the following analytical corollary questions (RQs) are specified:

RQ 1: What flood impacts are manufacturing firms already experiencing now, and what is the extent of their projected exposure in the future?

RQ 2: Which adaptation strategies do firms apply and to what extent do their adaptive capacities differ?

RQ 3: Which internal and external factors determine firms' decision-making for implementing individual and collective adaptation measures?

RQ 4: What potential role could SMEs play in adapting to future flood risks and what mechanisms and designs might increase private sector engagement?

3 Research design

The empirical chapters of this dissertation (Chapters 4, 5, and 6) are scientific articles for publication, each containing a section on methodology, in which the particular research methods and data are explained in detail. This chapter describes the broader research design for this dissertation. First, relevant contextual information on the occurrence of natural hazards and DRM in Vietnam is offered, and a case study on flood risks for manufacturing firms in HCMC is presented. Second, the mixed-methods approach is described and its suitability for answering the analytical research questions specified just above is explained.

3.1 Setting the context: natural hazards in Vietnam

Vietnam is a rapidly developing country that is severely affected by a number of water-related natural hazards such as coastal storms, typhoons, tidal floods, and flash floods. Due to the country's location and topographical conditions, Vietnam's coastline that runs nearly 3,200 km, in particular, has experienced several destructive floods and storms in the last century (see Tab. 3-1).

Tab. 3-1: Occurrence of floods and storms in selected countries in Southeast Asia (SEA) between 2000 and 2019

	Flood and storm occurrences	Total people affected	Total damage ('000 USD)
Indonesia	140	6,408,935	7,309,633
Malaysia	45	876,844	1,419,000
The Philippines	257	143,722,849	21,017,450
Thailand	68	42,699,334	43,371,274
Vietnam	**134**	**34,622,087**	**12,235,109**

Source: Own calculation based on EM-DAT (2020)

Water-related natural hazards have had high socio-economic impacts, reflected in an estimated annual loss of between 1 and 1.5 % of the national gross domestic product (GDP) over the last two decades (The World Bank, 2019: 63). Moreover, Vietnam ranked 6th in the Germanwatch Global Climate Risk Index among those countries most effected by extreme weather events in the last 20 years (i.e., 1999-2018), specifically on measures such as fatalities and economic damage (Eckstein et al., 2019). For almost two decades, a number of studies have also identified Vietnam as one of the countries

most affected by the impacts of future climate change (Bangalore et al., 2019; Carew-Reid, 2008; Chaudhry and Ruysschaert, 2007; Dasgupta et al., 2009).

These studies project that socio-economic losses in Vietnam – currently 1.5 % of GDP – will increase to 3 % by 2050 and 7 % by 2100 (The World Bank 2019: 59). According to UNDP (2019: 15), the country has a 40 % chance of suffering economic losses of over USD 6.7 billion over the next 50 years, and a 20 % chance of over USD 8.1 billion losses. In particular, the delta regions along the coast, such as the Red River Delta (RRD), the Mekong Delta, and the low-lying Southeast region (SE), including HCMC, are likely to experience these losses. In 2017, almost 70 % of all firms in Vietnam concentrate the countrie's revenue in either the RRD or SE (General Statistics Office of Vietnam [GSO], 2017). Hence, there is a high risk that Vietnam's economic growth will be undermined if the effects of natural hazards and future climate change are not effectively addressed.

3.1.1 Disaster risk management and climate change adaptation strategies

To address the increasing risk to the population and to the economy, Vietnam has developed formal DRM policies at various administrative levels. The Ministry of Agriculture and Rural Development (MARD) is the coordinating body and implementing agency for responding to extreme weather events. For decades, the main focus of Vietnam's DRM approach has been on structural protection measures (i.e., dikes and embankments) and disaster relief (i.e., support for affected population) (Socialist Republic of Vietnam [SRV], 2001), with recent inclusion of ecosystem-based solutions. Most importantly, the National Strategy for Disaster Prevention, Response and Mitigation to 2020 and the accompanying Action Plan were introduced in 2007 with the aim of mobilizing resources to effectively implement disaster prevention, response, and mitigation through measures like sea dike systems and flood embankments (Center for Excellence in Disaster Management and Humanitarian Assistance [CFE-DM], 2018).

The Law on Natural Disaster Prevention and Control (NDPC, No. 33/2013/QH13), which was passed in June 2013 and came into force in May 2014, is the first stand-alone law on natural disasters in Vietnam to monitor and improve these guidelines. The law includes legal provisions and regulations for national, local, and municipal levels

and assigns roles and responsibilities to ministries, international stakeholders, and other key actors. Only recently, in 2018, the Office for the Central Steering Committee for Natural Disaster Prevention and Control (CSCNDPC) was established as an umbrella entity representing the main ministries and key disaster agencies. Its main task is to coordinate between ministries and agencies in order to facilitate decision-making on investments in disaster prevention and control at the national and provincial level. Since the Decision No. 460/QD-TTg (April 2019), CSCNDPC initially accepted the Vietnam Chamber of Commerce and Industry (VCCI) as a member of the Committee, representing the interests of firms and businesses (UNDP, 2019).

Regarding the formal responsibility of the private sector in DRM, Article 35 of the NDPC Law requires specific actions by so-called *economic organizations*. They are obliged to take initiatives to proactively protect their physical premises, production, and business activities, implement prevention and control plans and participate in awareness and training activities. Moreover, firms are obliged to contribute to the *Natural Disaster Prevention and Control Fund*, which is subject to government regulations. Their rights include compensation for supplies or equipment involved in emergency responses, and the possibility of investing in projects to prevent natural disasters that are in line with government planning.

Due to the significant risks Vietnam faces from the impacts of climate change, the Vietnamese government has also approved the *National Target Programme to Respond to Climate Change (NTP-RCC)* in 2008, which aims to develop adaptation and mitigation measures and integrate them into general planning processes (i.e., masterplans at all levels and sectoral planning) and socio-economic development (SRV, 2008). In addition to the government's efforts, a broad spectrum of international stakeholders such as international development agencies and NGOs (e.g., United Nations Development Program, The World Bank, Asian Development Bank [ADB], Asian Disaster Preparedness Center [ADPC], World Vision Vietnam, Deutsche Gesellschaft für Internationale Zusammenarbeit [GIZ], American Red Cross) has emerged in recent years to develop strategies for dealing with the impacts of climate change.

3.1.2 Flood risk of manufacturing firms in HCMC

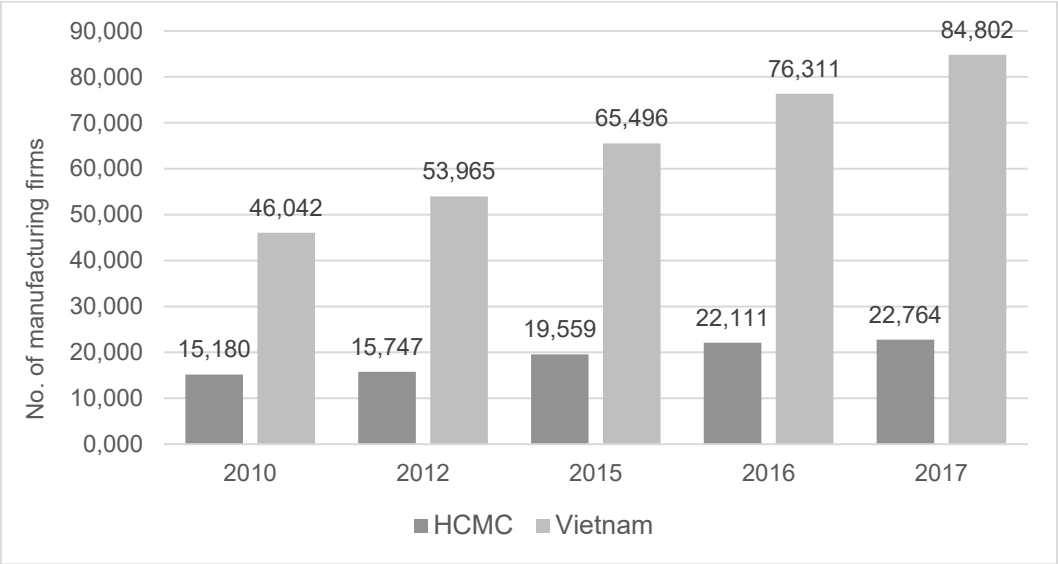
HCMC is an illustrative example of a city already facing manifold challenges due to regular flooding, which are projected to be aggravated by future climate change (Downes et al., 2016; Downes and Storch, 2014; Duy et al., 2018; Nicholls et al., 2007). The city is located in South Vietnam on the northeastern edge of the Mekong Delta and downstream of the Saigon-Dong Nai River. Apart from the city center, most of the surrounding districts are part of a complex river system and built on low-lying marshlands. According to a study by the ADB (2010: 2), about 40–45 % of HCMC is located below 1 m above mean sea level (AMSL). HCMC currently faces severe flooding events about once a year and half of the city is already regularly affected by flooding (Duy et al., 2018). Many districts in HCMC are projected to be exposed to future SLR by 2100, as major parts of the southern city are directly connected to the South China Sea (Scussolini et al., 2017). Further, HCMC has been identified as one of the 20 port cities worldwide which have both a high rate of population growth and a large number of exposed assets to SLR by 2070 (Hanson et al., 2011). According to the MONRE (2009), the sea level at the Vietnamese coast has already risen by about 20 cm over the last 50 years.

The increased urban flood risk in HCMC can be attributed to heavy rainfall due to storm surges (pluvial flooding), high tides (tidal flooding), and upstream water discharges (fluvial flooding). These natural risks are exacerbated by uncontrolled urban expansion and poorly connected infrastructure since the beginning of the 21st century, two factors which have been identified as key flood risk multipliers leading to a reduction in water regulation capacity, drainage capacity, water permeability, and land subsidence (Storch and Downes, 2011; The World Bank, 2019).

Since the government's political renovation and economic liberalization policies (Doi Moi) in 1986, HCMC has been rapidly expanding and spreading to the outskirts of the city. The population increased from 3.5 million in 1976 to 8.4 million in 2016 (GSO, 2020). Parallel to this population growth, the economic structure of the city has changed, accompanied by an ongoing process of rapid industrialization. From a record low of USD 6.29 billion in 1989, the national GDP of Vietnam reached an all-time high in 2019 (USD 261.92 billion at current USD exchange rates) and has doubled from 2010 (The World Bank Group, 2020b). At present, the HCMC region generates almost 40 % of GDP (Katzschner et al., 2016). This considerable economic growth has been set in

motion by the transition from a state-planned to a market-oriented economy, and continues to be driven by massive flows of foreign direct investment (FDI), a general modernization of industry, and the rapid emergence of private firms, particularly in HCMC (Bloomberg, 2015; Mishra, 2011). Private firms in the manufacturing sector, ranging from metal production and food processing to light industries, such as clothing and textile production, play a decisive role in HCMC's remarkable economic development and in providing jobs for the growing population (see Tab. 3-2).

Tab. 3-2: Development of manufacturing firms in HCMC and Vietnam



Source: GSO (2017, 2016, 2015, 2012, 2010)

At the same time, however, the manufacturing sector is at the forefront in terms of losses and damage from floods in HCMC. First, this labor-intensive industry is equipped with a hard-to-change infrastructure. Manufacturing firms located in the western parts of the city (e.g., in the districts Binh Chanh and Binh Tan) are particularly affected by pluvial flooding during the rainy season from April to November. This surface inundation is due to blocked waterways and an inadequate drainage system. Firms located close to the Saigon river (e.g., in District 7, District 2 and Binh Thanh) are exposed to tidal and fluvial flooding, often exacerbated by releases from the upstream water reservoir and thus by increased water levels in the river (Duy et al., 2018). Additionally, manufacturing firms are often pushed to (re-)locate to the outskirts of HCMC. These areas are often already low-lying and flood prone (Katzschner et al., 2016).

Second, almost 96 % of the manufacturing firms are SMEs (see Tab. 3-3), facing additional challenges within an institutional setting that is still biased in favor of large state-owned enterprises (SOEs) and multinational firms (Nguyen et al., 2013; Revilla Diez, 2016). According to the Japan External Trade Organization (JETRO, 2017), SMEs in HCMC receive ineffective support from the government and a lack of financial accessibility to solve flood problems on their own (see Chapters 5 and 6). Most of the large SOEs and multinational firms are located in industrial zones and parks protected from the current floods. By contrast, smaller firms outside these industrial areas with private flood protection infrastructure are still at risk, and will especially be so in the future.

Tab. 3-3: Number and percentage of manufacturing firms in HCMC and Vietnam according to firm size

	HCMC		Vietnam	
	no.	%	no.	%
Small (< 50 employees)	20,460	89,9	70,286	82,9
Medium (50 - 200 employees)	1,504	6,6	9,095	10,7
Large (> 200 employees)	800	3,5	5,421	6,4
	22,764	**100**	**84,802**	**100**

Source: Own calculation based on GSO (2017)

Third, despite the changes made to flood risk management over the last decade, urban and economic planning in HCMC did not take sufficient account of current and future flood risks (Duy et al., 2018; Katzschner et al., 2016). On a small-scale level, the city's administration has developed plans for and begun to implement huge infrastructure projects to reduce flood risk over the last 15 years (Lempert et al., 2013). First and foremost, the *Flood Prevention Planning 1547* will be soon completed. This project was approved by the MARD in 2015 and aims to build a ring dike with tidal sluice gates and embankments close to the Saigon river to control tidal flooding. To date, six out of eight sluices are under construction as well as a seven-kilometer ring dike along District 7. In addition, existing projects such as the dredging of canals, the improvement of drainage systems, and the creation of reservoirs have been accelerated (Duy et al., 2018). However, some experts question the actual effectiveness of these flood protection strategies. A study by Scussolini et al. (2017) shows, for example, that while the construction of a ring dike protects the inner city from flooding, it increases the

risks in other, more rural districts. Moreover, the public sector is suffering from a lack of financial and human resources, and is characterized by a rather hierarchical planning system coupled with a fragmented stakeholder spectrum (Birkmann et al., 2014; Garschagen, 2013; van Etten, 2007). To this day, as which the state's general national orientation, HCMC prefers hard infrastructure solutions. Despite efforts made in the NTP-RCC, researchers argue that flood requirements and climate change responses are insufficiently considered in spatial planning decisions (Gravert and Wiechmann, 2016).

In summary, HCMC requires a greater commitment to flood adaptation strategies aiming at long-term solutions. The link between economic development and flood risk prevention is of particular interest and contributes to the motivation for this dissertation. Here, private engagement, for example, of local manufacturing firms, could promote knowledge and financial capacity, especially for future small-scale flood adaptation strategies in industrialized areas.

3.2 Mixed-methods approach: data collection and analysis

In order to gain an in-depth understanding of firms' exposure and responses to floods, and in particular to understand the determining factors for their decision-making, this study follows a mixed-methods approach (Kelle, 2014). This approach has been divided into three survey and an analysis phases consisting of the mapping of manufacturing firms, the identification of future flood-exposed areas, exploratory meetings and expert interviews, semi-structured interviews, and scenario-based field experiments (Fig. 3-1).

Since this dissertation is embedded in a broader German-Vietnamese research project, entitled *DECisions for Adaptive Pathway Design and the Integrative Development, Evaluation and Governance of Flood Risk Reduction Measures in Transforming Urban-Rural-Systems (DECIDER)*, several project meetings and discussions with experts on the future risks of climate disasters, urban growth, and socio-economic upheaval were crucial for obtaining feedback on both methods and the interpretation of results.

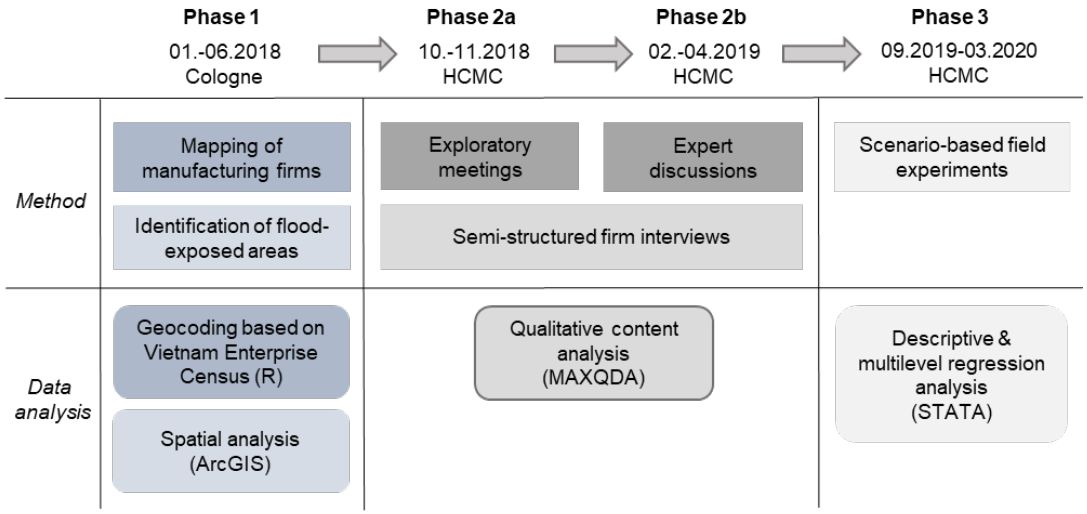


Fig. 3-1: Overview of research phases, methods, and data analysis

In a first step, I combined the projection of future SLR in HCMC with the spatial distribution of manufacturing firms to get an overview of firm exposure to future SLR (see Section 3.2.1). In a second step, these insights were used to identify smaller case study areas for further analysis. In these areas, qualitative semi-structured interviews with firms and expert interviews were conducted in order to understand how, why and under which conditions firms prepare for flood impacts (see Section 3.2.2). In a third step, the data obtained from scenario-based interviews were analyzed quantitatively to investigate collective action rationales and determinants (see Section 3.2.3, for an overview see Fig. 3-2). The development of the methods thus builds on each other and the results are systematically triangulated.

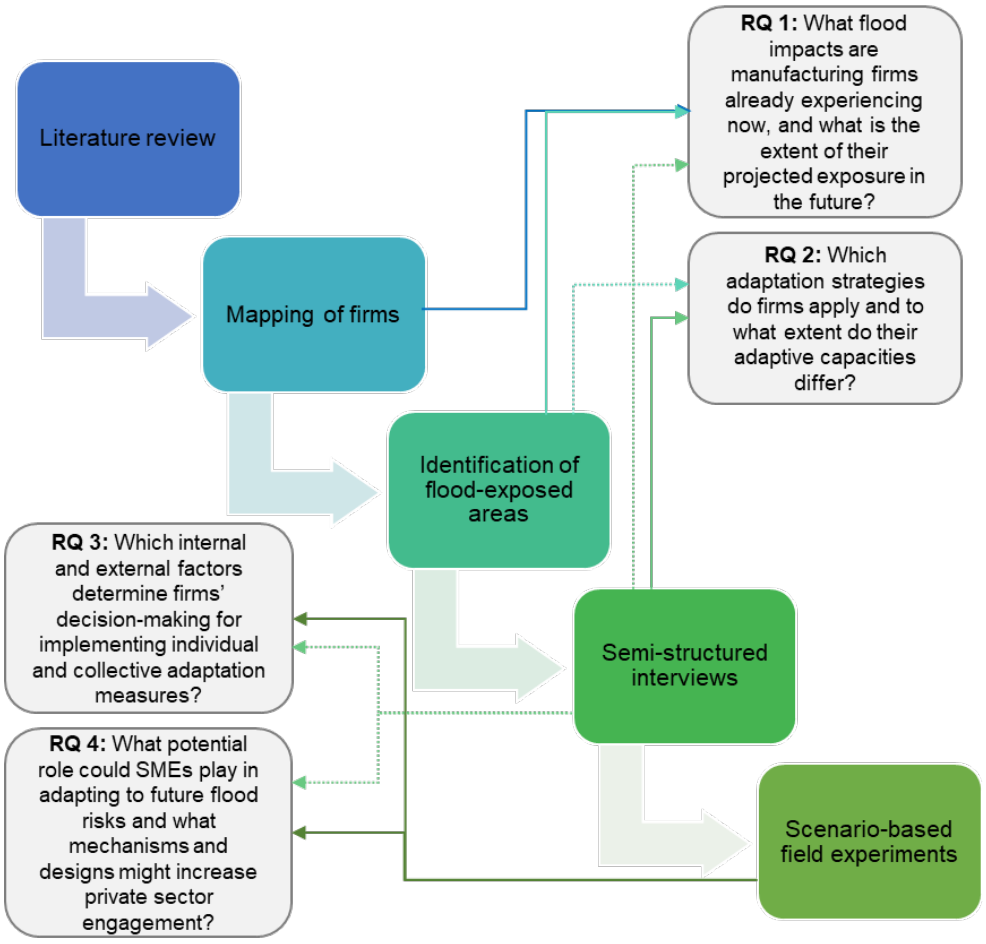


Fig. 3-2: Methods used to answer the analytical research questions

3.2.1 Mapping of firms and identification of flood-exposed areas

The mapping of manufacturing firms and the combination of this geographic information with potential inundation areas due to SLR is useful for acquiring an adequate overview of firms' exposure to future floods in HCMC (see Chapter 4). For this approach, the *exposure to floods* is based on Balica et al. (2012: 79), who define exposure as *"the predisposition of a system to be disrupted by a flooding event due to its location in the same area of influence"*.

For the mapping of firms, their addresses from the Vietnam Enterprise Census Survey (VEC) of 2005 and 2015 were converted into geographic coordinates using the Google Maps Geocoding API. The VEC is a data set at the micro firm level, which is carried out nationwide by the GSO. It contains detailed information from the previous year on the location, business sector, type of ownership, turnover, net profits, employment, assets, and capital stock of registered enterprises in Vietnam. In order to relate the

geographic location of firms to future SLR projections, an elevation-based analysis was carried out in ArcGIS. A free digital elevation model (SRTM 3.0) of HCMC provides the essential topographic information, and for the SLR simulation an amplitude based on the predictions RCP 4.5 and RCP 8.5 of the IPCC (2014) was used. As this dissertation aims to ensure the transferability of results to political developments in Vietnam in general, and HCMC in particular, a scenario (i.e., 50 cm SLR with a tidal maximum of 150 cm) was defined that is consistent with the official SLR projections of the Vietnamese government and more recent studies on HCMC (e.g., Downes and Storch, 2014; Scussolini et al., 2017).

The results of this methodology (see Chapter 4) provide a general overview of future exposure to SLR, as defined above, and thus help to answer RQ1. However, due to the limitations of a basic elevation model (Elkhrachy, 2017; Hu et al., 2017; Santillan and Makinano-Santillan, 2016; Storch and Downes, 2011) and significant uncertainties about the assumed SLR, the results do not allow for statements at the local level.[5] Rather, it is necessary to go beyond future projections and define specific areas with a current flood risk to understand the extent to which manufacturing firms are already impacted by recurring floods and actively prepare for them. Therefore, I also analyzed news articles and recent publications on floods in HCMC and used information about the last severe flood event in HCMC in November 2018, provided by the Steering Center of the Urban Flood Control Program in HCMC. Subsequently, I also checked local densities of manufacturing firms based on mapping of the VEC and different lists of firm and industrial park locations provided by the VCCI. The results of this analysis were used to select smaller case study areas.

During a first field trip to HCMC from early October to mid November 2018, some possible case study areas were visited and finally discussed with various experts (e.g., public authorities, district leaders, business associations, and scientific partners, above all) in exploratory meetings. Accordingly, Tab. 3-4 lists the selected local areas for the semi-structured interviews and scenario-based field experiments.

[5] Chapter 4 provides a detailed description of the methodology applied, its strengths and weaknesses.

Tab. 3-4: Selected local areas for semi-structured interviews and scenario-based field experiments[6]

District	Commune	Flood source	Locational information
Quận Bình Chánh	Xã Tân Kiên, Xã Phong Phú	Pluvial and fluvial	Canal areas with high density of exposed SMEs (peri-urban)
Quận Bình Tân	Phường Bình Hưng Hòa, Phường Bình Trị Đông A, Phường An Lạc, Phường An Lạc A	Pluvial and fluvial	Canal areas with high density of exposed SMEs
Quận Thủ Đức	Phường Tam Bình, Phường Hiệp Bình Phước	Tidal and fluvial	Riparian and canal areas close to the Saigon river with high density of exposed SMEs
Quận Bình Thạnh	Phường 25	Tidal and fluvial	Riparian areas close to the Saigon river, new urban developments and infrastructure, high density of exposed SMEs
Quận 2	Phường Cát Lái	Tidal and fluvial	Riparian and canal areas close to the Saigon river, Cat Lai Industrial Zone 2
Quận 7	Phường Tân Thuận Đông, Phường Tân Kiểng, Phường Phú Thuận	Tidal and fluvial	Riparian areas close to the Saigon river with small industrial sites, Tan Thuan Export Processing Zone with foreign firms
Huyện Nhà Bè	Xã Hiệp Phước	Tidal and fluvial	Riparian and canal areas close to the Saigon river, Hiep Phuoc Industrial Park (peri-urban)
Quận Gò Vấp	Phường 10, Phường 17	Pluvial	Elevated urban areas with small industrial sites
Quận Tân Bình	Phường 02, Phường 14	Pluvial	Elevated urban areas with small industrial sites
Quận Tân Phú	Phường Tân Quý	Pluvial	Elevated urban areas with small industrial sites
Huyện Hóc Môn	Xã Bà Điểm	Pluvial	Elevated urban areas with small industrial sites

Source: Author's analysis

[6] In Table 3-4 and Fig. 3-3 the original Vietnamese spelling is used. For the rest of this dissertation, the English spelling is used for the sake of clarity.

3.2.2 Expert discussions and semi-structured interviews

During the first (research phase 2a) and second (research phase 2b) field phase in Vietnam, an exploratory and qualitative approach was applied. Initially, eleven expert discussions were conducted with selected experts from public stakeholders (e.g., People's Committee Steering Center of the Urban Flood Control Program; People's Committee's HCMC Institute for Development Studies [HIDS]), scientific institutions (Southern Institute of Water Resources Research [SIWRR]; Center of Water Management and Climate Change [WACC]), development agencies (GIZ), and representatives of business associations (Delegation of German Industry and Commerce Vietnam; VCCI; SME Promotion Center). The aim of these discussions was to gain general local knowledge on the flooding situation in HCMC and its impacts on the private sector.

Based on this initial knowledge, and an empirical study conducted with firms in Indonesia by Neise and Revilla Diez (2019), I developed a semi-structured questionnaire together with Vietnamese co-researchers, [7] to obtain a detailed understanding of the experienced impacts of floods on business processes (RQ1), how firms prepare for it, and what adaptation strategies they pursue (RQ2). Moreover, I aimed to grasp the factors determining firms' decisions to implement adaptation measures (RQ3).

From October to November 2018, and February to April 2019, a total of 30 semi-structured interviews with 10 micro or small firms, 11 medium-sized firms and 9 large firms[8] were conducted in the case study regions (see Fig. 3-3). In order to identify differences in the adaptive capacities of firms, and thus their flood response, a broad spectrum of firm sizes and main business sectors were considered. The respondents were firm leaders, as strategic decisions in Vietnam, and especially among SMEs, are generally still organized in a hierarchical and top-down manner. The firms for the interviews were identified along the lists of firms already mentioned in Section 3.2.1.

[7] The colleagues which supported the interviews and field experiments on site are Vietnamese native-speaker associated with the Centre for Economic and Financial Research, University of Economics and Law (UEL), Vietnam National University.
[8] Annex A provides the list of all firm interviews and the interview guideline.

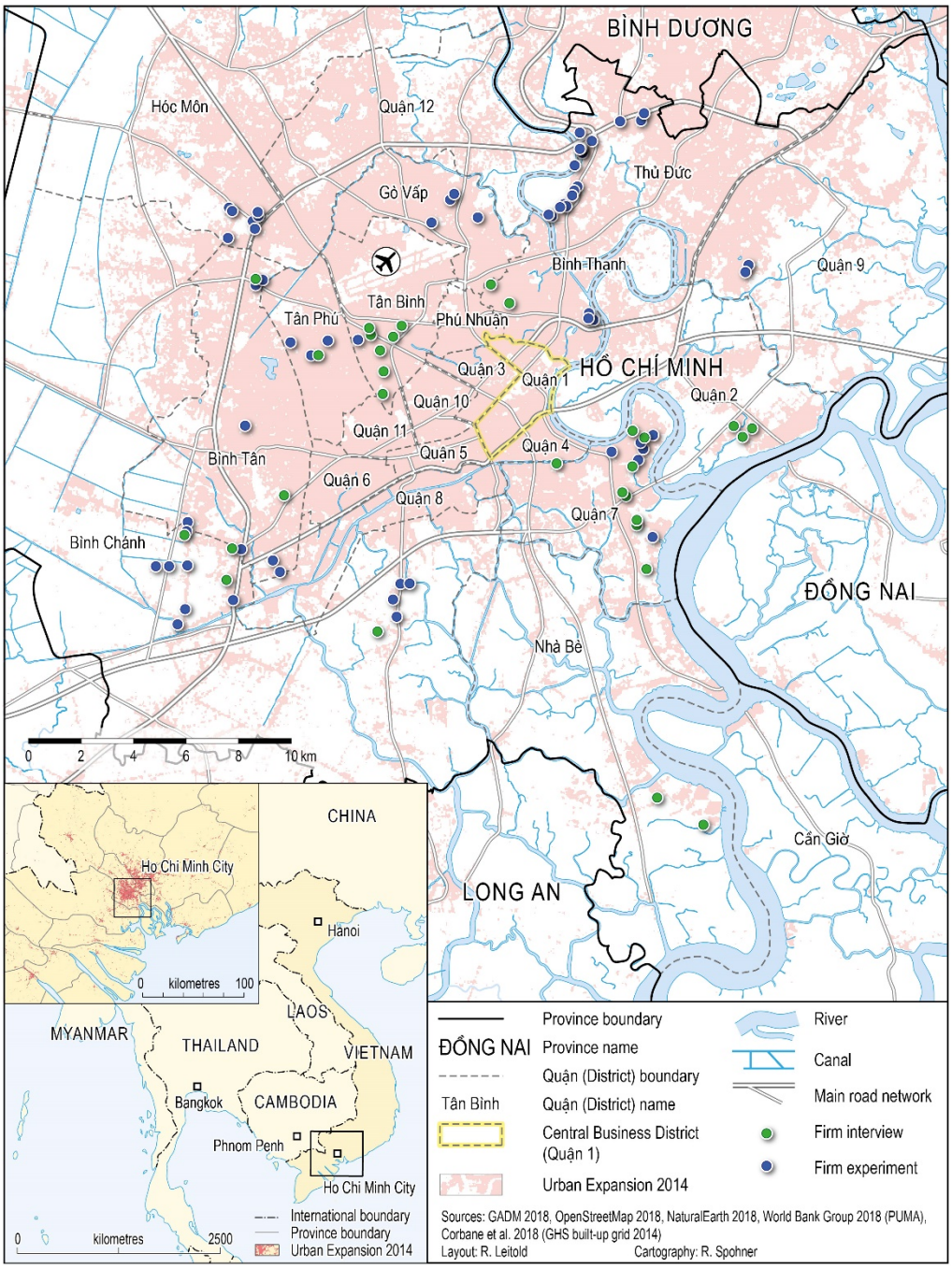


Fig. 3-3: Locations of firm interviews and scenario-based field experiments

The sample was stratified by firm size, but the firms within each stratum were selected at random. Accordingly, the number of medium and large firms interviewed is greater than their relative occurrence (see Tab. 3-3). For each interview, the Vietnamese co-researchers organized an appointment in advance by telephone, e-mail, or letter. Before an appointment was made, the suitable interviewees were asked whether the company had experienced flooding in the last five years. In addition, the Central Institute for Economic Management (CIEM) Vietnam, based in Hanoi, provided an official

document containing general information about the questionnaire and the permission to interview, which we were able to hand over to the respective respondent. The semi-structured interviews were conducted together with at least two Vietnamese co-researchers per interview in order to avoid language and cultural barriers and misunderstandings. Prior to the interviews, the respondents were informed that they should not feel obliged to answer the questions. In addition, the interviewer asked for permission to record the interview and assured that the statements would be kept anonymous and confidential. The interviews lasted between 25 and 55 minutes, were translated to me on site and, if allowed, voice recorded. Based on the respective audio files or handwritten notes in Vietnamese, the statements were then transcribed and paraphrased in English. Whenever possible, we also visited the firms' production facilities and had the decision-makers explain, for example, exactly how flood water gets into the building and what measures were taken for prevention.

The same guidelines were used during the interviews, but due to their semi-structured form, respondents were able to provide additional comments and information in between questions and explicitly at the end of the interview (Bernard, 2017; Helfferich, 2011). The guideline consisted of five broad thematic blocks. The first asked for general information about the economic situation of firms (e.g., number of employees, establishment, ownership, sales, production sites). The second block related to perceptions of (future) flood risks and impacts, while the third block asked about individual adaptation procedures, strategic plans, and factors influencing companies' decisions. The fourth block dealt with firms' knowledge of collective initiatives, such as collaborations in their neighborhood, with public authorities or NGOs. Finally, the fifth block consisted of questions on respondents' assessments of the institutional setting (e.g., regulation procedures, infrastructure, laws and permits) and local risk management systems. After the last severe flood event in November 2018, specific questions about this event and its effects were added to the questionnaire for the second field phase in 2019. The complete interview guideline is available in Appendix A.

For the empirical analysis in Chapter 5, a structured content analysis technique was applied (Mayring, 2015). First, I collected the adaptation measures that have been implemented and those planned for the future. Second, I grouped the reported flood impacts into categories defined by the UNISDR (2013) (i.e., direct, indirect, and wider impacts) and correlated them with the intensity and nature of the response. Third, I

deductively tested criteria of internal and external factors influencing adaptive behavior and added additional factors that emerged inductively. All empirical material was coded and analyzed in the software MAXQDA.

3.2.3 Scenario-based field experiments

In the third field phase, scenario-based field experiments were used to collect primary data on the willingness of firms to participate financially in different collective flood adaptation measures. The aim of this method was to identify the relevant determinants for decision-making by firm leaders and to draw conclusions about the mechanisms that might encourage SME participation collective adaptation (RQ3 and RQ4).

To identify future behavior in relation to environmental stressors such as flooding from a methodological standpoint, a variety of approaches have been developed. Early in the adaptation debate, Adger et al. (2005) and Preston et al. (2011) emphasize the widespread lack of clarity about how human action determines the selection, success, or failure of adaptation options. However, still few modelling approaches take into account both human decisions, their preference for adaptation measures, and determinants that influence adaptive behavior (Haer et al., 2017; Holman et al., 2019; SREX and IPCC, 2012). Moreover, there is still a need for innovative epistemological studies focusing on hypothetical what-if analyses or experimental designs (as proposed by Croson et al., 2007; Delmas and Aragon-Correa, 2016) for creating and evaluating adaptation options and testing effective strategies for encouraging collective behavior. Conducting scenario-based field experiments is a novel methodological approach for filling this gap (Neise et al., 2019).

A scenario-based field experiment consists of a public-good game with different scenarios in a field environment using vignette designs.[9] As they are conducted in a real and familiar environment, field experiments allow a deep understanding of the external and contextual factors that influence the willingness of firms to participate in collective actions (Ehmke and Shogren, 2009). In total, scenario-based field experiments with 63 decision-makers of manufacturing firms with fewer than 250 employees[10] were conducted between September 2019 and March 2020 (see Fig. 3-3).

[9] Chapter 6 provides a deciphered explanation and conceptual background information of the method.
[10] For the experiments we included a few firms with more than 200 but less than 250 employees according to the EU definition of SMEs.

The first selection process was similar to the process used for the semi-structured interviews (see Section 3.2.2). Since some firm owners were initially quite reluctant to participate in the experiments due to confidentiality concerns and the availability of time, the VCCI and local district officers in the case study areas supported the Vietnamese colleagues with additional internal SME lists and contact details. Prior to the survey period, five co-researchers from the University of Economics and Law (UEL) were trained in two kick-off sessions in which the background of the study, the methodology, and the different scenarios were explained in detail. Subsequently, the standardized scenarios were tested in a one-week pre-test. After slight revisions, the scenario-based field experiments were conducted together with the co-researchers and the results discussed directly afterward. Before the experiment, the participant was assured that all answers would be kept anonymous and confidential. The given answers were collected in Vietnamese and transferred into an English version of the questionnaire. Afterwards, I coded the resulting answers as numbers and entered them into an English Excel file.

The scenario-based field experiments consisted of two parts.[11] First, a small survey was conducted to collect firm-related information to develop independent variables on the hypotheses presented in Chapter 6 (Aguinis and Bradley, 2014; Atzmüller and Steiner, 2010). The survey contained information on firm characteristics, flood exposure, adaptation measures, neighborhood relations, and the institutional environment. Second, a one-shot public-good game with 20 scenarios was played one time with each participant to determine the general preference for adaptation measures and the conditions under which they are willing to invest part of their budget. Public-good games try to explain why collective action initiatives sometimes succeed or fail. The rationale behind the game relies on the mechanism of voluntary contributions, which examines the participant's individual contribution to a public good and examines whether the participant is willing to contribute or prefers to rely on the contributions of others (Chaudhuri and Paichayontvijit, 2006; Ones and Putterman, 2007). Typically, flood adaptation measures are so-called *discrete public goods* with provision points, which means that they require a certain contribution (i.e., threshold value) from different actors in order to be realized. Therefore, the public-good game followed the logic that if the provision point is not reached, a money-back guarantee is applied and

[11] Annex A provides the SME survey.

the contribution of each actor in the experiment is refunded (Groothuis and Whitehead, 2009).

Four scenario cards were carefully designed according to the principles of vignette studies to show them to the participants. They provided descriptions of realistic but hypothetical situations that illustrate the scenario to the respondents and ensure that they can understand and assess the scenario situation (Neise et al., 2019). In order to contextualize realistic scenarios for the experiments, findings from semi-structured interviews, expert discussions and local flood adaptation strategies were taken into account. The draft scenarios were previously developed and discussed at the University of Cologne and reviewed by Vietnamese experts from the UEL. Additionally, several visits to flood-prone industrial sites provided an overview of the local environment.

In total, the experiments generated 1,260 observations (63 experiments multiplied by 20 scenarios) for data processing. After finishing the data cleaning, I analyzed the data with the statistical program STATA 13. Regarding data analysis, it is important to note that the individual observations are nested within characteristics at higher levels, as each respondent answered 20 scenarios. More specifically, the assessment of each scenario is determined by the individual characteristics of the respondent (e.g., feeling of responsibility) and the firm (e.g., flood exposure, competitiveness, cooperation and support), and the spatial context (e.g., amount of SOEs or FDIs in the neighborhood). To deal with the interdependent structure in hierarchical data, multi-level approaches can be used (Rabe-Hesketh and Skrondal, 2008). Here, to use hierarchical random effect models is an innovative approach to estimate the effects of different levels simultaneously. By contrast, the use of ordinary least squares regression, for example, would lead to spatial autocorrelation and violation of the assumption of independence (Hox et al., 2017). In order to consider factors influencing the willingness of firms to participate in collective adaptation measures on a scenario, firm, and spatial level, I used a three-level binary-logistic regression for data analysis. The decision for this method was based on the above argumentation and followed suggestions of Neise et al. (2019), Park et al. (2012), and Sohns and Revilla Diez (2018).

4 Exposure of manufacturing firms to future sea level rise in Ho Chi Minh City, Vietnam

Leitold, R., and Revilla Diez, J. (2019). Exposure of manufacturing firms to future sea level rise in Ho Chi Minh City, Vietnam. In: Journal of Maps, 15 (1), 13-20. https://doi.org/10.1080/17445647.2018.1548385

Abstract:

Ho Chi Minh City (HCMC) is facing notably high levels in current and future flooding. Simultaneously, the ongoing process of rapid industrialization is characterized by the strong emergence of manufacturing firms within the urban area. As manufacturing firms are at the frontline regarding damage caused by flooding, which is often neglected in risk analyses, we argue that the assessment of firms' exposure to flooding is essential for implementing an integrative flood risk governance. Hence, this study maps manufacturing firms in HCMC, using geocoding based on the Vietnam Enterprise Census (2005, 2015), and assesses whether they are exposed to future sea level rise. The maps developed visualize the expansion of manufacturing firms from 2005 to 2015 and the spatial distribution of firms exposed to future sea level rise in HCMC. Our results reveal that particularly domestic, private micro firms in labor-intensive industries, which represent the backbone of the local economy, are exposed, threatening their competitiveness and viability.

Keywords:

Ho Chi Minh City, Vietnam, manufacturing firms, exposure, floods, future sea level rise

4.1 Introduction

Many coastal cities are experiencing growing exposure to natural phenomena including sea level rise, heavy rainfall, and storm surges (Chan, Chuah, Ziegler, Dąbrowski, & Varis, 2018). As the latest IPCC report (2014) postulates, particularly the risk of flooding in coastal megacities is rapidly rising. Ho Chi Minh City (HCMC), the largest city and economic powerhouse of Vietnam, provides an appropriate example for a location facing manifold challenges due to its notably high levels in current and future flood exposure and projected sea level rise (SLR) (ADB, 2010; Downes et al., 2016; Downes & Storch, 2014; Duy, Chapman, Tight, Linh, & Thuong, 2018; Nicholls et al., 2007). Additionally, the city is confronted with an ongoing process of rapid industrialization closely related to the government's political renovation policy and economic liberalization reforms (Doi Moi) since 1986 (Revilla Diez, 2016). Multiple local effects are induced by Vietnam's transition from a state-planned to a market-oriented economy, e.g., the strong emergence of private firms since 2000 and the considerable growth of small- and medium enterprises (SMEs, including micro enterprises). As firms are already frequently located in flood-prone areas on the fringe of the city and are equipped with hard-to-change and immovable infrastructure, particularly firms in the manufacturing sector are at the frontline in terms of loss and damage caused by flooding (Neise, Revilla Diez, & Garschagen, 2018). Recently, there has been extensive research on the impact of flooding in HCMC (Arouri, Nguyen, & Youssef, 2015; Balica, Dinh, Popescu, Vo, & Pham, 2014; Dang & Kumar, 2017; Downes et al., 2016; Downes & Storch, 2014; Duy et al., 2018), mostly focusing on the impact of flooding on communities and households and risk-adapted land use planning. However, little research exists on firms' exposure to future SLR inundation, although political frameworks such as the Sendai Framework for Disaster Risk Reduction 2015–2030 highlight firms and businesses as important actors for implementing an integrative and effective flood risk governance. Generally, private sector contribution is still rare, not adequately consulted and mostly realized by large multinational firms (BTU Cottbus & TU Dortmund, 2013; Neise & Revilla Diez, 2018). Therefore, there is a growing need to assist decision makers, policy makers, administrative bodies, and other stakeholders on firms' exposure to projected SLR in order to facilitate future adaptation efforts in HCMC's urban area. Against this background, this study's approach aims to:

(1) Assess the number and expansion of manufacturing firms in HCMC from 2005 to 2015;
(2) Identify future inundation areas in HCMC;
(3) Reveal the spatial distribution of all manufacturing firms exposed to future SLR and identify firms' specifics due to firm type, main business activity, and staff headcount in HCMC.

In order to assess these three empirical aspects, this study has developed a threefold methodology (1) mapping firms by geocoding, (2) revealing an initial estimate of future inundation areas by using SLR projections, and (3) displaying geocoded firms within inundation areas. In recent years, several techniques and methods in geographical information systems (GIS) have been developed that aimed to analyze and visualize exposure to environmental hazards (Kalogirou & Chalkias, 2014). As maps are an important medium to visualize spatial analysis, this study presents a *Main Map* of likely flood-exposed manufacturing firms that are located in future inundation areas and, thus, adds significant value to research and policy implication on flood exposure in HCMC, Vietnam.

4.2 Study area – Ho Chi Minh City, Vietnam

HCMC is situated in the southern part of Vietnam on the north-eastern edge of the Mekong River Delta and downstream of the Saigon-Dong Nai River. Major parts of the city are built on low-lying marshlands, being part of a complex river delta which makes the city extremely sensitive to various flood sources. Nowadays, more than 50 % of the city is regularly affected by flooding caused by high tides, heavy rainfall, and storm surges (Duy et al., 2018). As the southern parts of the city are directly connected to the East Sea, many districts (Quans) are projected to be exposed to SLR by 2070 (Hanson et al., 2011). About 60 % of the main city is located below 1.5 m above mean sea level, nearly 40–45 % of the land cover is 0–1 m and 15–20 % is 1–2 m in elevation (ADB, 2010). Over the past 50 years, the sea level has increased by about 20 cm (MONRE, 2009) and is expected to continue rising (see Section 4.3.2).

Along with the SLR, the issues of substantial urbanization and socio-economic dynamics in HCMC over the last 20 years can be identified as crucial multipliers of flood risk and are expected to continue in the future (Storch & Downes, 2011). HCMC

is the economic center of Vietnam and a logistic hub in South East Asia (SEA), well connected to domestic and international markets. The economic structure of the city has been changing since Doi Moi policy in 1986. Vietnam's transition from a planned to a market economy was and still is driven by economic liberalization and, thus, massive Foreign Direct Investment (FDI) flows and an overall modernization of industry accompanied by the emergence of the private sector (Bloomberg, 2015; Mishra, 2011; Waibel, 2009). Since then, about 350,000 private companies are operating in a range of sectors from food processing, light manufacturing like garment and textile production, and sophisticated financial services in Vietnam (Bai, Jayachandran, Malesky, & Olken, 2017).

The national Gross Domestic Product (GDP) reached about 200 bn USD (at current USD rates) in 2016 (The World Bank, 2016). To date, the HCMC region generates almost 40 % of the country's GDP and accounts for around 70 % of its export revenue growing rate (Katzschner, Schwartze, Thanh, & Schmidt, 2016). The economic development of HCMC is notably attributed to the city's location and its attraction for the labor force (Duy, Chapman, Tight, Linh, & Thuong, 2018). Moreover, FDI has been encouraged through a series of laws, policies, and investments, primary distributed within the Southeast region including HCMC. Particularly the Southeast offers a more market-friendly business environment which has fostered faster economic growth (Nguyen & Revilla Diez, 2017). This economic growth is borne by SMEs which continue to play a major role and represent 96 % of all manufacturing firms in HCMC (VEC, 2005, 2015). Although the SMEs sector is a key driver in the Vietnamese economy, it is facing additional challenges with an institutional setting that is biased in favor of larger firms such as multinational and state-owned firms (Nguyen, Le, & Bryant, 2013; Revilla Diez, 2016). In comparison to large firms, SMEs in Vietnam generally encounter an ineffective support from the government, a lack of financial accessibility and limited business capacity (JETRO, 2017). Moreover, poor strategic plans to achieve long-term goals may strengthen the exposure to future SLR inundation as SMEs often follow short-term plans and catch up temporary opportunities (Trinh & Thanh, 2017).

Despite the remarkable economic development, the economic planning in HCMC does not sufficiently consider topographic conditions. The economic infrastructure and industrial zones are continuously started up in and relocated to highly flood-exposed

urbanizing zones such as wetlands and low elevated areas, which has presumably intensified forthcoming inundation (Katzschner et al., 2016). The industry in these areas often consists of firms in the labor-intensive manufacturing and processing sector, requiring significant numbers of manufacturing workers. Thus, the labor market has surged around these emerging industrial zones, which induce mostly young men and women from rural areas to migrate often large distances to HCMC (Arnold & Pickles, 2011; Seo & Kwon, 2017; Waibel, 2009). Over 70 % of these migrants are between 15 and 30 years old (Seo & Kwon, 2017). Additionally, workers from household businesses formally registered their businesses or started self-employed micro firms after Doi Moi (McCaig & Pavcnik, 2013). Thus the competitiveness and viability of many manufacturing firms is closely connected to peoples' livelihoods.

4.3 Data and methodological workflow

As this research seeks to indicate future tendencies of flood exposure by combining projected inundation areas with the location of firms, three steps of analysis need to be applied in order to prepare a suitable dataset and comprehensive maps (see Fig. 4-1). The methodological approach is based on the understanding of exposure by Balica, Wright, and van der Meulen (2012) who define exposure to flooding as *"the predisposition of a system to be disrupted by a flooding event due to its location in the same area of influence"*. Thus, in the case of manufacturing firms in HCMC, exposure to flooding is defined by the location of firms and the predisposition of future inundation in this area due to SLR. The Vietnam Enterprise Census Survey (VEC) of 2005 and 2015 is a micro firm-level data set and provides detailed information on characteristics like the location of firms, legal ownership, business sector, labor information, as well as business results such as turnover and capital resources of registered enterprises in Vietnam. The VEC is nationwide conducted by the General Statistical Office of Vietnam (GSO) and collects information of the preceding year. Due to the census, we use the 2007 Vietnam Standard Industrial Classification (VSIC) system to define 'manufacturing & processing industries' (for a classification of the business activities of 'manufacturing & processing' firms see Fig. 4-2).

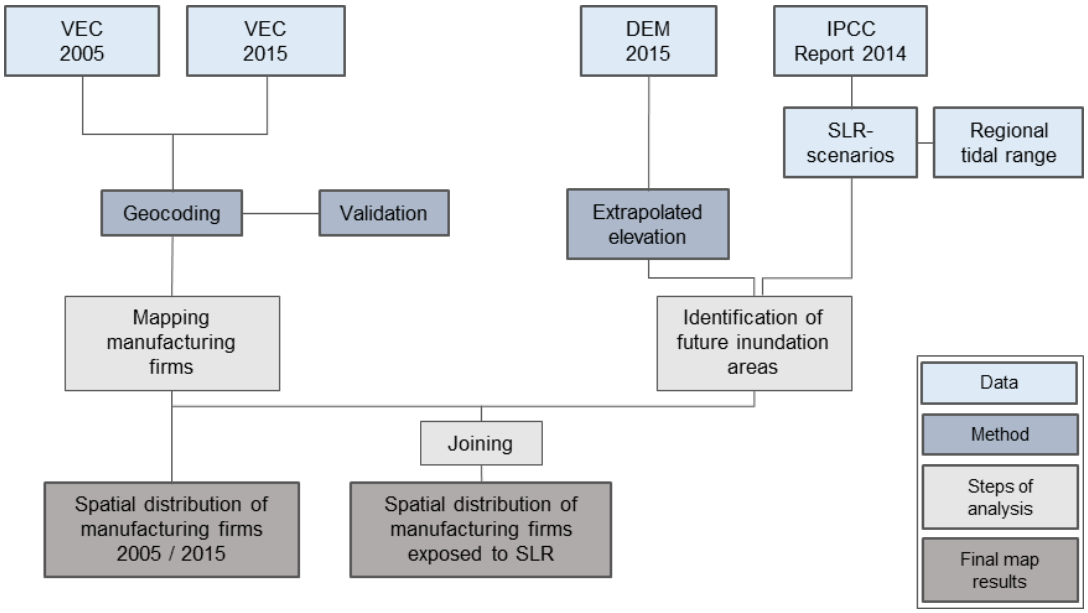


Fig. 4-1: Methodological workflow

Source: Authors

4.3.1 Mapping manufacturing firms by geocoding

In a first step, we map manufacturing firms in HCMC by addresses on the basis of the VEC, 2015. In order to convert the addresses from text into geographic coordinates (latitude and longitude), we used Google Maps Geocoding API. Generally, the process of translating an address into the best matching geographic coordinates includes parsing the input addresses into different components (Zandbergen, 2008). In our case, we divided the addresses by information on the country, street name, and building number. The geocoding was conducted with the package 'ggmap' in RStudio (3.4.3.). As an output, the addresses of 89.5 % (117,655) of a total of 131,500 firms in 2015 were found and turned into geographic coordinates. Based on this output, we validated the data to the best of our knowledge on both the macro- and micro-level. First, we checked that about 70 % of the geocoded addresses are located within the same district compared to the district code of the census. We verified that a large share of the remaining firms is situated close to the administrative border of districts. Second, we implemented a visual ground truthing. Therefore, we used the information from the census on a firm's location within an industrial park (yes/no) and compared it with satellite data on a sample basis. Third, we randomly validated the given email addresses of the firms with their location published on their websites.

After the validation, we identified firms that where either established before 2005 or between 2005 and 2015 as reference years by merging the Vietnam Census datasets of 2005 and 2015. The final results of the development and spatial distribution of manufacturing firms in HCMC are presented in the Main Map (Map 1).

4.3.2 Identifying future inundation areas by SLR projection

In a second step, we carried out an elevation-based Geographic Information Systems (GIS) analysis in order to reveal the future SLR in HCMC. In hydrological modeling, GIS is often used to conduct flooding projection models and to analyze multi-source spatial data (Gallegos, Schubert, & Sanders, 2009; Merwade, Cook, & Coonrod, 2008). In the absence of an appropriate hydrological model, we used a free of charge digital elevation model (DEM) derived via Shuttle Radar Topography Mission (SRTM) 3.0 (2015, horizontal resolution of 30 meters) of HCMC to provide a basis to attain essential topographical information for SLR projection. As the SLR will probably increase the intensity, duration, and area of future flooding (ADB, 2010), the results of elevation modeling are used to prepare a future inundation map.

The official projection of the SLR used by the Vietnamese government is 75 cm by 2100 (MONRE, 2009), but the planning parameter used by the National Target Programme to Respond to Climate Change is 100 cm SLR by 2100 based on IPCC A1F1 emission scenario (Nicholls et al., 2007). This also corresponds with the RCP 8.5 (range of 52–98, 74 cm mean SLR) predictions of the newest IPCC report in 2014. However, in consideration to the large uncertainties of the assumed SLR, our analysis contains one amplitude of SLR based on the RCP 4.5 and RCP 8.5 scenario which have already been used for SLR simulation in HCMC by Scussolini et al. (2017). In order to ensure the transferability of our findings to policy development in Vietnam, we define a scenario with a rise of 50 cm respectively and combine it with a current tidal maximum of 150 cm, following Downes and Storch (2014).

In a third step, we join the location of manufacturing firms in 2015 with the SLR simulation to reveal the spatial distribution of exposed firms. In order to differentiate between the firm size, we use the definition of SMEs formulated by the recently established Vietnamese Law 04/2017/QH14-Law on Support for Small- and Medium-sized Enterprises (National Assembly of Vietnam, 2017) which is based on the staff

headcount (see Tab 4-2) and the total turnover of the preceding year of firms which should not exceed VND 300 billion. The final results are presented in the *Main Map* (Map 2).

4.3.3 Data limitation

Regarding our methodology, some limitations in data and operationalization should be mentioned. First, the SLR has to be understood as one of many factors for exposure to flooding. Due to Phi (2013) and Duy et al. (2018), the exposure to flooding of HCMC is not only increased by the SLR, but also by manifold and self-enhancing processes. Data on e.g. pluvial and fluvial flooding, flood water velocity, and flood duration would be a valuable supplementary to generate a comprehensive hydrological model. Moreover, due to the difficulty in acquiring spatially accurate data, the impact of observed land subsidence (e.g. Erban, Gorelick, & Zebker, 2014; Minh, Trung, & Toan, 2015) and flood protection measures in HCMC could not be included in this study.

Second, analyses based on digital elevation models derived via SRTM generally imply limitations due to the vertical resolution level (Elkhrachy, 2017; Hu, Peng, Hou, & Shan, 2017). As Storch and Downes (2011) have already pointed out, the known accuracy problems of SRTM data in built-up land distort the assessment results. Recent studies on localized assessment of DEM's quality and accuracy reveal that the root mean square error ranges from five to eight meters in different land-cover classes (Elkhrachy, 2017; Santillan & Makinano-Santillan, 2016). In north-eastern Philippines, for example, it ranges from 5.91 m (for built up land) to 10.42 m (for bushland) (Santillan & Makinano-Santillan 2016). Testing for uncertainties as using check points obtained by GPS observation or using a geomorphology-based approach (see Tran, Raghavan, Masumoto, Vinayaraj, & Yonezawa, 2014) to improve the resolution of data is reasonable but costly in terms of time and effort. Against this background, we work with original SRTM data, being aware of limitations due to accuracy and reliability. As we are operating with a projection of 200 cm above mean sea level (AMSL), a vertical resolution between five and eight meters is rather coarse. Thus, we are commonly talking about areas and firms likely exposed to future SLR and provide an initial estimate of future SLR inundation.

Third, it is important to recognize that merely 89.5 % of firms' addresses could be localized by geocoding. The coarse validation of the referenced addresses indicates that our data is more reliable for revealing spatial patterns rather than accurate, micro-scale analysis. Additionally, it has to be mentioned that our analysis is based on the given information of the census. We were not able to eliminate errors occurring during data collection. We assume that the census does not observe some of the very small and self-employed micro firms that for example are not officially registered.

4.4 Results and observations

Due to the overall economic growth of HCMC, it is observed that the number of manufacturing firms in HCMC increased considerably in total from 6,405 in 2005– 19,680 in 2015 (+207 %). The comparison of firm identification numbers (IDs) within the datasets from 2005 and 2015 reveals that only 2,986 firms can be found both in 2005 and 2015. This suggests that 53 % (3,419) of the manufacturing firms have been closed, consolidated, or changed business or products. However, 13,275 of 19,680 firms in 2015 have been newly established, relocated or changed fundamentally as they were given a new firm ID during the period of observation.

Following the recently established Vietnamese definition of SMEs, 96 % of manufacturing firms in HCMC can be defined as SMEs, which consist of micro firms (64 %) and small- and medium firms (32 %). Due to the number of employees, 4 % of all manufacturing firms are considered as large firms. In respect of the firms' turnover, only 2 % of all firms are defined as large firms with a total turnover of more than VND 300 billion. The greatest share of the manufacturing firms is domestic and private owned (86 %), and 13 % are either state-owned enterprises (SOE) or firms partially shared by state sector with still existing linkages to state authorities. Only 1 % of the manufacturing firms is defined as foreign firms (incl. FDI).

Regarding the main business activity of manufacturing firms in HCMC, garment production (14 %) has the highest share of the total amount of firms in 2015, followed by the production from prefabricated metal (13 %), the production from rubber and plastic (8 %), and the production of food (7 %) which all have increased in importance. The emergence of manufacturing firms is primarily concentrated within the inner city and in the north, east and parts of the southern urban fringe (see *Main Map* (Map 1)).

Based on the assumption of 2 m AMSL, the total area of inundation is 45 % (about 975,807 km^2) of HCMC province, whereby we have not distinguished between built-up and non-built-up areas. It could be assumed that the share of inundated industrial built-up areas would be minor. However, the projected inundation is concentrated in some hotspot areas mainly of lower elevation and situated circularly around the city center. Due to the percentage of the inundated area (inundated area/total area), the highest inundated districts are the western districts Binh Tan (51 %) and Binh Chanh (58 %) and the districts Quan 2 (58 %) and Quan 7 (52 %), located east of the central business district (CBD). Situated close to the river in the south of HCMC, about 50 % of the area of Nha Be will also be inundated by future flooding.

The GIS analysis indicates that about 15.7 % (2,441 firms) of the total geocoded manufacturing firms in 2015 are located in future inundation areas. 80 % of the exposed firms were established after 2005. Concerning the spatial distribution of the exposed firms in HCMC, the *Main Map* (Map 2) clearly shows that some districts likely exposed to flooding also have a high concentration of firms. Overall, two hotspots of exposed firms could be identified. First, situated close to the city center, the western districts Binh Tan, Quan 6, and Tan Phu with respectively in total 633, 105 and 122 exposed firms have the highest number and density of exposed firms per km^2. Second, closely situated to the Saigon River (Song Sai Gon), the eastern districts Binh Thanh, Thu Duc, and Quan 7 with respectively 191, 252 and 159 exposed firms have a high number of total exposed firms, although the density of firms is rather minor (see Tab. 4-1).

Tab. 4-1: Highly exposed districts by an inundation of 2 m AMSL

Name of district	Density of exposed firms (no. exposed firms/km²)	Exposed firms (total no.)	Inundation area (km²)	Inundation area (%)
Quan 6	15.0	105	1.3	19.3
Binh Tan	12.2	633	26.7	51.3
Binh Thanh	9.2	191	8.0	38.7
Tan Phu	7.6	122	2.5	15.7
Thu Duc	5.3	252	17.8	37.2
Quan 8	5.0	94	6.3	33.1
Quan 7	4.5	159	18.6	52.0

The analysis reveals that more than half (53 %) of the future flood-exposed firms are located in only five of 24 districts in HCMC, creating a belt around the city center. To some extent, the exposed firms are located within areas that are characterized by high inmigration rates, such as Thu Duc and Binh Tan. These districts registered high rates of population growth, respectively, + 64 % and + 58 % from 1999 to 2005 (GSO, 2010). Whereas manufacturing firms located around the city's core of Quan 1 (mainly Quan 3, Quan 4, Quan 5, Quan 10, Quan 11, Phu Nuan, Tan Binh) are less exposed to future flooding due to SLR. Only 74 of a total of 3,851 manufacturing firms within those districts are exposed to flooding, which amounts to 2 %.

Regarding the size of firms by staff headcount, the largest share of the 2,441 exposed manufacturing firms ranges from micro- (59 %) to small- and medium (36 %) firms (see Tab. 4-2). It is expected that the number of micro firms not reached by the census, particularly informal and self-employed firms, is much higher. Additionally, 106 large firms with in total 65,612 employees are located within areas of future inundation.

Although the highest share of turnover is also generated by large firms, SMEs contribute to 30 % of the total turnover and engage 37 % of total employees (see Tab. 4-2). Generally, the exposed firms in HCMC are economically and socially important, employing 104,100 persons who might be severely affected by the viability of firms.

Tab. 4-2: Manufacturing firms exposed to future SLR according to firm size

Size	Exposed firms (no.)	Total turnover of firms (million VND)	Total employees of firms (no.)
Micro (1-9)	1,445	3,587,486	5,359
Small (10-49)	691	9,181,878	14,719
Medium (50-200)	199	14,746,158	18,410
Large (200+)	106	66,641,324	65,612
Total	*2,441*	*94,156,846*	*104,100*

Concerning the type of firm, similar to the total share of manufacturing firms in HCMC, 86 % of the exposed firms are domestic and private owned (2,094). 13 % are SOE or at least partially shared by the state sector (338) and only 1 % (9) of the exposed firms is foreign. Regarding the main business activity of exposed firms, production from prefabricated metal (16 %) represents the highest share, followed by the production from rubber and plastic (11 %) and garment (11 %, see Fig. 4-2)

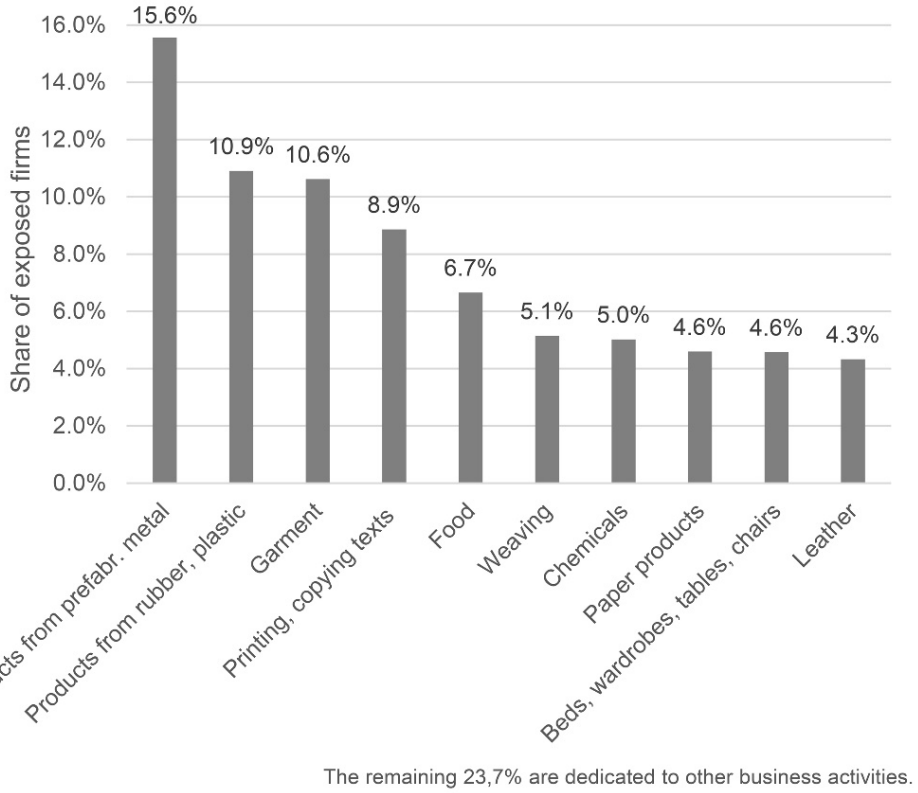


Fig. 4-2: Share of manufacturing firms exposed to future SLR according to business activity

Source: Authors, calculated from VEC, 2015

4.5 Conclusions and outlook

The *Main Map* presented in this study documents both the spatial distribution and development of manufacturing firms from 2005 to 2015 and future flood-exposed firms due to SLR inundation within the urban area of HCMC. We demonstrated that the ongoing process of rapid industrialization in HCMC is characterized by a strong increase in manufacturing firms within the last decade. This increase is spatially spread over the city and induces people to migrate from rural areas to HCMC, e.g., to Thu Duc and Binh Tan, in order to find employment particularly within the manufacturing and processing sector. Several of the manufacturing firms are located in two hotspot areas in the western and eastern districts that will probably experience inundation due to SLR in the future. At this point, the analysis shows that domestic, private owned micro and small firms which are engaged in labor-intensive industries like the production from prefabricated metal, rubber, plastic, and garment represent the largest share of the exposed firms. Due to manifold reasons, e.g., limited access to finance and capital resources, limited capabilities and lack of experience, particularly micro and small firms seem to be overwhelmed with the implementation of individual, long-term adaptation measures or the relocation of business premises. Accordingly, future flooding endangers their competitiveness, and many jobs within the manufacturing sector are threatened, affecting directly peoples' livelihoods.

Against this background, our analysis revealed that the exposure of firms to SLR inundation is still an underemphasized but important issue, often neglected by policy makers and even scientific discourse. This paper underlines an initial estimate of future exposure to future SLR of manufacturing firms in urban HCMC and, thus, provides useful information for both the private sector (e.g., firm owners and stakeholders) and public administration in terms of future planning policies and the support of long-term adaptation measures. Following Katzschner et al. (2016), all relevant national and local governmental agencies support the process of relocating industrial factories from inner city districts to the urban fringe. Regarding this policy agenda, our findings emphasize the importance of keeping the issue of flood exposure and the protection of relocated firms in mind.

Furthermore, the findings could be used for public discussion on the impact of potential SLR as the increasing intensity and frequency of flooding are generally seen as a barrier to future prospects and the economic development of the city. This study provides a

first step of flood analysis and represents a promising methodology for further investigations which should focus on estimating eventual losses by SLR inundation according to production specifics and suitable adaptation strategies.

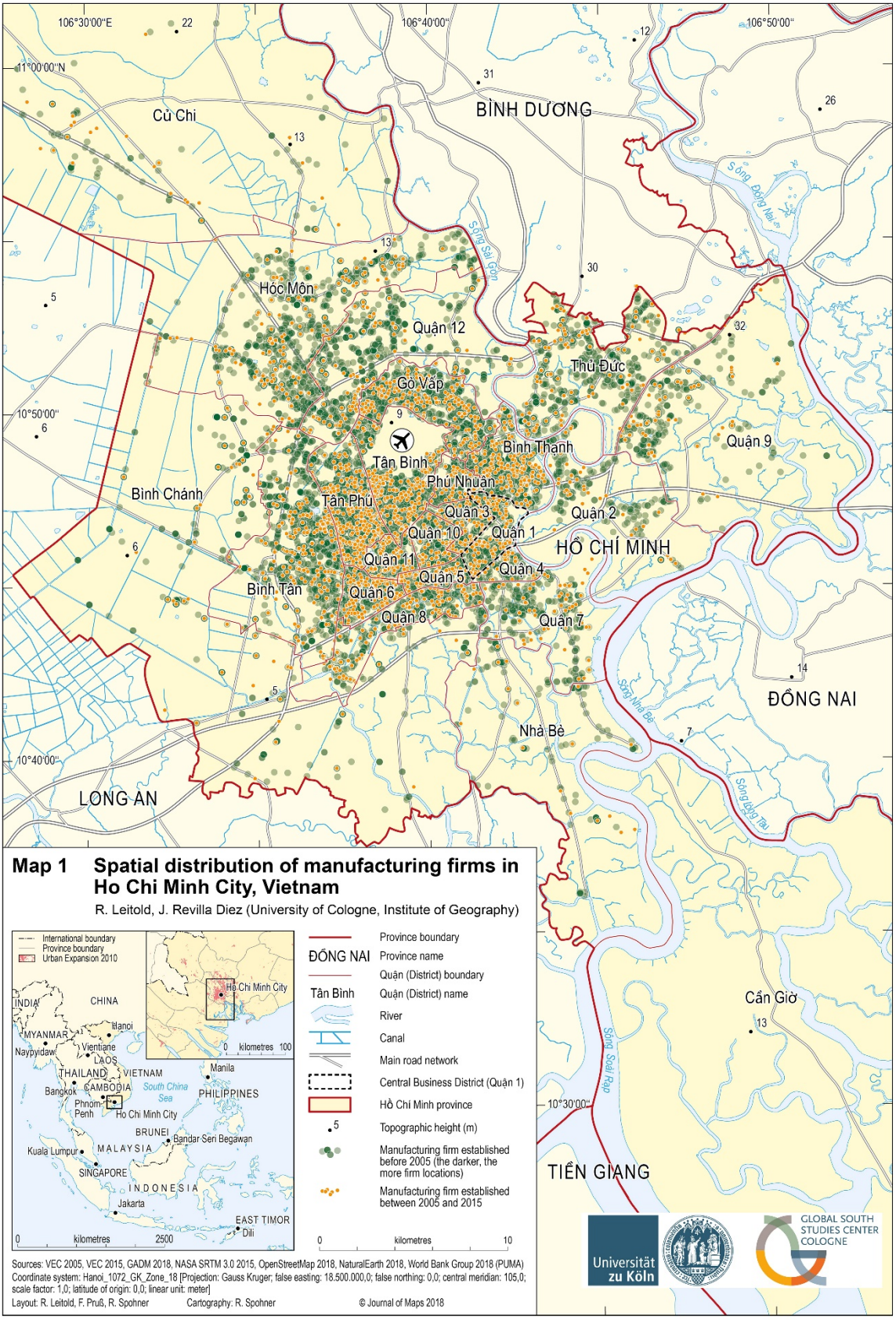
Summarizing the methodology implemented, our research processed a dataset of firms in HCMC which offers different opportunities for further spatial analysis on the exposure of firms to environmental hazards. As our data is currently limited by lacking a comprehensive hydrological model, supplementary data on flooding indices could easily be combined with the geocoded dataset in order to estimate the exposure to recurring and present-day flood events. Moreover, by mapping firms on the basis of the VEC dataset, we are prospectively able to conduct various kinds of spatial analyses to answer scientific questions due to other natural hazards besides the issue of flooding.

Software

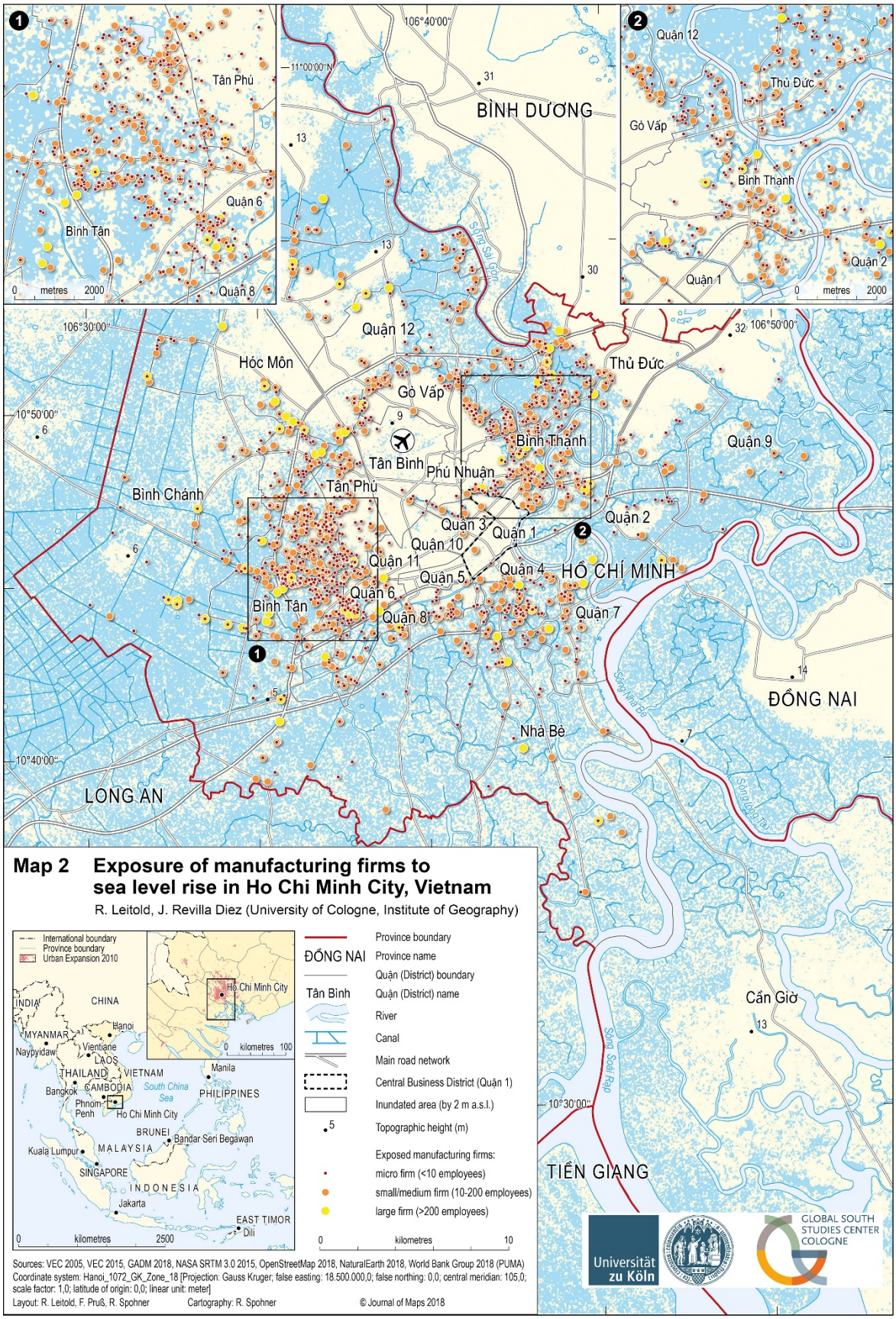
We used Google Maps Geocoding API for the geocoding of the Census data. The 'ggmap' package in RStudio (3.4.3.) was used for further data processing and calculation. The production of the final map was performed with ArcGIS (10.5) by ESRI and Adobe Illustrator CC with MAPublisher (10.1) extension.

Supplemental material: Main Map

Map 1: Spatial distribution of manufacturing firms in Ho Chi Minh City, Vietnam



Map 2: Exposure of manufacturing firms to sea level rise in Ho Chi Minh City, Vietnam



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5 Flood risk reduction and climate change adaptation of manufacturing firms: global knowledge gaps and lessons from Ho Chi Minh City

Leitold, R., Garschagen, M., Tran, V., & Revilla Diez, J. Flood risk reduction and climate change adaptation of manufacturing firms: global knowledge gaps and lessons from Ho Chi Minh City.

This is the author's original manuscript of the submitted article.

Abstract:

Flooding poses continuous stress to small- and medium-sized enterprises (SMEs) particularly in transition economies which depend on their firms' performance but might not yet have fully developed flood protection infrastructure. Yet, detailed knowledge on whether and how firms take adaptation action against flood hazards and which barriers might persist is surprisingly thin. We respond to this blind spot by offering an empirical analysis on manufacturing firms in Ho Chi Minh City (HCMC), one of the front lines of future environmental risk. Drawing on qualitative interviews, our study has two main aims: first, to understand if adaptive action occurs more intensively amongst firms with high direct impacts, and second, to shed light on other internal firm characteristics and external conditions that determine the decision of firms to take flood adaptation measures. We find that the majority of firms cope reactively to prevent severe effects of flooding. Interestingly, experience with past events and a high impact do not automatically lead to long-term strategic adaptation. A lack of business capabilities and financial capacity combined with an insufficient support system largely hampers proactive adaptation. This leads to increased exposure and self-reinforcing effects which quickly endanger the future business viability of firms. Future research on adaptation to climate change should seek to improve the understanding particularly of adaptive capacities amongst SMEs which are very different from international corporations.

Keywords:
Adaptation strategies, climate change, flood risk reduction, manufacturing firms, Ho Chi Minh City, Vietnam

5.1 Introduction

Disasters and climate change risks are a growing concern for business leaders around the world. According to the latest edition of the World Economic Forum's annual Global Risks Survey drawn on feedback from business leaders and other high-level decision-makers, the top three global risks in terms of likelihood and impact are extreme whether events, the failure of climate action for mitigation and adaptation, and natural disasters (World Economic Forum, 2020). The urgency of environmental risks has thus clearly overtaken business leaders' other concerns, including economic, geopolitical, technological, and societal concerns.

Yet, despite this risk assessment by top-level business leaders, the detailed knowledge about the environmental and climate risks faced by the private sector is surprisingly thin. The Global Assessment Report on Disaster Risk Reduction of 2013 which focused on economic risks and the private sector impacts from disasters differentiates conceptually between direct losses (i.e., the destruction of assets and stocks), indirect losses (i.e., business interruptions due to direct losses or supply chain interruptions), wider impacts (i.e., other consequences such as loss of market share or clients), and macroeconomic effects (i.e., all of the above and their effect on business performance) (UNISDR, 2013). However, estimates on disaster losses are scarce and characterized by high uncertainty, even with respect to past direct and indirect losses, let alone the future. Estimates on the costs of climate change by the end of the century range from only a few percentage points of GDP reduction up to a 25 % decrease in global per capita output by 2100 under a 3 °C warming scenario (Burke et al., 2018). However, apart from macro-economic modelling, damage or loss projections on firm level – and by different types of firms – are in short supply. Data is particularly scarce in developing countries and transition economies as well as on small- and medium-sized companies, in contrast to large corporations.

Even less is known about the ways in which corporations do or can adapt to these risks, particularly also with an eye towards upcoming climate change risks (Averchenkova et

al., 2016). While the surging body of climate change adaptation literature has been focusing strongly on the adaptation of entities such as private households, state organizations, or small-scale farmers, firms and especially small- and medium-sized firms offside the big global corporations tend to be neglected by the adaptation literature (Averchenkova et al., 2016). This is a surprising and pressing gap given that in most economies private investment contributes the lion's share of overall investment – hence shaping the assets exposed in future disasters – and that corporations make up for major parts of the economy. Studies looking into the reporting of 1600 adaptation strategies of corporations which are now requested to disclose their climate activities under the new Climate-related Financial Disclosures (TCFD) mechanisms found severe blind spots within the firms' current treatment of climate risks and adaptation (Goldstein et al., 2019). Also the last Assessment Report of the IPCC has revealed a strong gap in the existing scientific knowledge on firm-level adaptation to climate change hazards (IPCC, 2014).

This paper aims to help closing this gap. In order to understand whether and how firms are adapting to natural hazards and which barriers might persist, we offer an empirical analysis on one of the front lines of environmental risk and alleged adaptation: We focus on manufacturing firms in Ho Chi Minh City, an increasingly flood-prone city which is highly exposed not only to current flooding, but also to climate change hazards in the future. We focus on manufacturing firms because in contrast to the service sector or other companies, this sector is amongst the sectors with the highest potential impacts in terms of both direct and indirect losses. This is due to the localized and immovable production assets and the high dependence on supply chains. A focus on Ho Chi Minh City further allows us to zoom into one of the most hazard-prone regions of the world. According to the World Economic Forum's (WEF) *Report on Regional Risks for Doing Business* (2019), natural disasters are seen as the single most important business risk in East Asia and the Pacific region. This is in line with other studies which highlight the region's high disaster risk (e.g., World Risk Report, INFORM, ND-Gain). Learning from empirical lessons in Ho Chi Minh City offers important insights for firms in other cities of the region and eventually globally.

Specifically, we aim to explore to what extent manufacturing firms prepare themselves against flood impacts. We are particularly interested in understanding if adaptive action occurs more intensively amongst firms with high direct impacts and which other

internal firm characteristics or even external conditions such as the institutional support determine the decision of firms to take flood adaptation measures.

The paper is structured in six parts. In Section 5.2, we develop a conceptual framework for our analysis based on the slowly emerging literature on firm adaptation. Section 5.3 and 5.4 introduce our study area and methodology. Section 5.5 presents and discusses our empirical findings on adaptation strategies of manufacturing firms in HCMC. In Section 5.6, we discuss the implications of our findings for future research needs.

5.2 Conceptual considerations: firms' flood response between action and inaction

Over the last two decades, adaptation research has contributed significantly to improving the perception and understanding of natural hazards such as flooding. However, existing research tends to exclude business perceptions and responses, particularly in developing countries and transition economies (Halkos & Skouloudis, 2019). Although the private sector has always suffered greatly from climate disasters (UNISDR, 2013), their responses were often not followed up or featured in global reports on climate change assessments (e.g., IPCC Assessment Reports before 2014). Research on firms' adaptation to natural hazards and climate change is still at the beginning. The slowly emerging body of literature focuses on current on-ground adaptation practices in social-ecological systems (Wise et al., 2014). In human systems, adaptation refers to *"the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities"* (IPCC, 2019, p. 678). Regarding the empirical work on adaptation strategies of firms, Linnenluecke et al. (2013) constitute that most of the associated studies indeed focus on changing business conditions, but exclude how firms adapt to changing dynamics of the natural environment and what efforts they put into adaptation measures towards expected future hazards which are mostly driven by climate change. Daddi et al. (2018) come to the same conclusions and argue in particular that a theoretical framework on firms' adaptation strategies is lacking, even though management studies have already put research with regard to environmental changes on their scientific agenda years ago.

Recently, Neise and Revilla Diez (2019) derived a typology of how manufacturing firms strategically adapt to changes in their natural environment and to hazard exposure,

focusing on Jakarta, hence a similar setting to Ho Chi Minh City which will be the focus of this paper. They distinguished between proactive, relocation, reactive, surrendering, depending, and collaborative strategies, which can be followed dynamically and overlapping. Proactive strategies are defined as continuously and intended long-term shifts in behavior; a *"process of mediating between sustaining and re-organising"* (Garschagen, 2013, p. 29). If firms realize that in situ adaptation is not sufficient, the most drastically adaptation measure would be to relocate the production site for future production lines. Short-term, reactive strategies in turn are understood as *coping* or *resistance* (Garschagen, 2013) in response to a specific flooding event. Firms focus on avoiding direct impacts and securing resources and products (Fischer, 2018). Collaborative strategies rely on cooperation with other companies, the community, or the state, whereas depending and surrendering strategies are characterized by firms' inactivity. In the first, firms count on large-scale adaptation measures (e.g., dyke-systems) initiated by state authorities, industrial parks (e.g., local drainage systems), business networks, or NGOs (Neise & Revilla Diez, 2019). In the latter firms follow a *wait-and-see* strategy (Berkhout et al., 2006) or even surrender.

Based on this conceptualization, we argue that firms' adaptive behavior moves between action and inaction and often, no clear delimitation between the strategies exists. It remains unclear what efforts firms put into adaptation measures and why firms are engaging in proactive strategies, reactive coping mechanisms, or even stay inactive. In particular, adaptation research does not yet clearly understand why some firms implement proactive adaptation strategies to expected future hazards or why others rely on rather reactive coping mechanisms in response to particular hazard events. We assume that various factors on different scales influence the individual flood adaptation and lead to different forms of adaptation action by manufacturing firms or even to inaction towards flood risks. In the following, these influencing factors are derived from the burgeoning conceptual work and the available empirical evidence.

First, we expect that the adaptive behavior of firms in flood-exposed areas highly depends on their previous flood experience and the degree of flood impacts (Agrawala et al., 2011; Weinhofer & Busch, 2013). Recently, research to assess the impact of floods on manufacturing firms has been emerging. Some empirical research has investigated short- and long-term impacts and targeted specifically the assessment of loss and damages due to natural hazards (Bahinipati et al., 2017; Wedawatta et al.,

2014). Firms in the manufacturing sector are at the frontline in terms of loss and damage caused by flooding as they are characterized by hard-to-change infrastructure and a strong dependence on upstream supplier systems. They suffer from property damage, spoilt stocks, electricity shortages, and additionally on indirect damages which are usually not covered by insurance and therefore urge action (Wedawatta et al., 2014). Particularly for SMEs, flooded production sites pose a serious threat to their viability as flooding critically affects the ability to continue business operations in time (Wedawatta & Ingirige, 2012). Agrawala et al. (2011), Kato and Charoenrat (2018), and Linnenluecke et al. (2011) emphasize that flood-experience is a key driver for firms' adaptive behavior and their investment decisions. However, even if they have to adapt adequately to floods in order to remain successful, it is not clear to what extent high flood exposure leads to the implementation of proactive adaptation (Inan & Bititci, 2015).

Second, in line with Averchenkova et al. (2016), Gasbarro and Pinkse (2016), Halkos et al. (2018), and Howe (2011) we assume that the adaptive behavior of firms in flood-exposed areas is additionally influenced by internal firm characteristics and external conditions in the business environment. Empirical research focusing on the role of firms' internal resources and dynamic capabilities regarding their flood adaptation in the East- and Southeast Asian context is arising (Asgary et al., 2012; Halkos et al., 2018; Kato & Charoenrat, 2018; Neise & Revilla Diez, 2019; Neise et al., 2018; Pathak & Ahmad, 2016). Trinh and Thanh (2017) emphasize that insufficient technological capabilities and insufficient access to credits prevent firms from implementing effective adaptation and rather tend to push them to catch temporary opportunities or surrender. The implementation of intended long-term planned adaptation measures such as business continuity management, property-level flood protection or relocation plans thus strongly relies on financial liquidity (McKnight & Linnenluecke, 2016; Wedawatta et al., 2014). The organizational learning approach (Berkhout et al., 2006) assumes that firms rely on their dynamic capabilities, including higher level competencies such as skills and knowledge, in order to adapt autonomously to changing business situations (Neise et al., 2018; Teece et al., 1997). In this line, proactive adaptation is an anticipatory manner which is realized based on managerial risk perceptions and preparations in order to reduce impacts of future flood events (Howe, 2011; Meinel & Schüle, 2018; Ung et al., 2016). Moreover, the managerial

perception of responsibility influences whether a firm takes adaptive action by itself or transfers the whole responsibility to the next available level of authority.

However, Tompkins et al. (2010), Meinel and Schüle (2018), and Wachinger et al. (2013) argue that even if firms are highly impacted by flooding and firm managers have the knowledge, capacity, and resources to undertake measures (i.e., the internal factors), this does not automatically lead to strategic adaptive action. The questions of how external factors and processes influence firms' adaptive decision-making to recurring flood events and shape future climate change adaptation arises und still remains poorly understood (Fischer, 2018; Mansur et al., 2018; Wise et al., 2014). First insights suggest that the role of the state in flood risk management and regulatory drivers appear to be crucial for individual flood adaptation (Agrawala et al., 2011; Averchenkova et al., 2016; Neise et al., 2018). Halkos et al. (2018), for instance, show that institutional conditions and governmental support and guidance have a direct positive impact on the measures against the negative consequences of extreme weather events that SMEs take. Left alone to adapt to floods, SMEs in particular are struggling to survive as they are exposed to many other risks (e.g., economic crises, skills shortages, competition). Other studies indicate that the climate risk requirements of lead companies in value chains put pressure on supplier firms to implement adaptation measures. Thus, foreign ownership and export orientation are seen as organizational drivers of business adaptation (Averchenkova et al., 2016; Pulver & Benney, 2013).

Against this backdrop, this paper contributes to an emerging field of business adaptation research. We empirically investigate firms' responses to recurrent flood events and expected future impacts of climate change, applying an actor-centered perspective. We hope to provide decision makers and administrative bodies with currently lacking insights from the firm level of decision-making.

5.3 Study area: flood exposure in HCMC

HCMC is an illustrative example from which many other expanding flood-prone areas in Southeast Asia and beyond can hopefully learn. Due to the topographical conditions, HCMC is already affected by regular flood events, which will be exacerbated by climate change hazards in the future.

The city is located in South Vietnam on the north-eastern edge of the Mekong Delta and downstream of the Saigon-Dong Nai River. Many districts of the city are part of a complex river delta and built on low-lying marshlands. As about 60 % of the city has a maximum elevation of 1.5 m above the mean sea level, urban flooding has become one of the most pressing issues (ADB, 2010; Storch & Downes, 2011). Also from a business perspective, flooding could have a severe impact, threatening especially the viability of SMEs which represent the backbone of the Vietnamese economy (see below). The manufacturing firms located in the urban area are sensitive to different flooding sources.

During the French colonial time, the urban core of HCMC was built on higher areas (4–6 meter above mean sea level), presently located in the urban center of District 1 (Duy et al., 2018; Nguyen et al., 2016). Since the liberalization policies (Doi Moi) in 1986, HCMC has been expanding rapidly. The population increased from 3.5 million in 1976 to almost 8.3 million people in 2016 (GSO, 2018). Urban development pressure and a strong economic development led to a shortage of space and pushed newly developed manufacturing firms to lower elevation areas outside the city center. As a result, today's typical industrial areas face a high flood exposure (Leitold & Revilla Diez, 2019).

Currently, greater HCMC generates about 40 % of the country's GDP and accounts for 70 % of its export revenue growing rate (Duy et al., 2018). The constant economic growth is borne by an emergence of the private sector. About 350,000 private firms are operating in a range of sectors like food processing and light manufacturing (Leitold & Revilla Diez, 2019; Mishra, 2011). SMEs account for almost 96 % of all manufacturing firms in HCMC (GSO, 2016). Many manufacturing firms located within the newer development areas close to the Saigon river are exposed to regularly tidal and fluvial flooding which is aggravated through an increased riverine level and water reservoir releases (Duy et al., 2018). Firms in western parts of the city are mainly exposed to pluvial flooding (surface inundation) which happens frequently and particularly during the rainy season (April to November) due to clogged waterways and insufficient drainage systems. Constant land subsidence exacerbates the flooding situation (Minh et al., 2015). Moreover, HCMC faces severe flooding events about once a year. Duy et al. (2018) depict that the economic planning in HCMC does not sufficiently consider these topographic and environmental conditions. As stated by the World Bank (2019),

Vietnam has lost 1–1.5 % of GDP annually over the last two decades due to water-related natural disasters, and this number is predicted to rise sharply due to the effects of climate change, hitting the economic powerhouse of the country. Some efforts have been made recently to implement flood control strategies, i.e., the currently performed *Flood Prevention Planning 1547*, approved 2015 by the Ministry of Agriculture which convenes disaster risk reduction within its mandate. This project aims to build an integrated flood risk management, tidal sluice gates, and embankments east of the Saigon River. However, there is still a discrepancy between the current flood risk planning, the implementation of measures, and their effectiveness for different social and economic realities. For instance, the planning on improvements of canal bank revetments or storm water sewage systems are mainly addressing FDI and private firms in industrial zones (VCAPS-consortium, 2013). Thus, particularly firms outside of industrial parks suffer from their location as well as insufficient institutional support.

5.4 Method and data

This paper applies an exploratory case study approach (Yin, 2014). To grasp our empirical questions, we divided our empirical work into two steps: (1) Definition of flood-exposed areas and (2) semi-structured interviews and stakeholder discussions.

In order to understand the role of flood exposure for firm-level adaptation decisions, it was necessary to define urban areas with different levels of flood exposures. In a first step, we used information on the severe flooding in November 2018 at street level. Among the impacted districts, we have opted for multiple case study areas consisting of six administrative districts (Fig. 5-1) to elaborate the impact of different flooding sources and depict the implementation of adaptation strategies more holistically. Binh Chanh and Binh Tan provide examples for a peri-urban and Tan Binh for an urban district mainly exposed to pluvial flooding. The eastern districts Nha Be (as a rural district in transition) and District 7 represent areas highly impacted by tidal and fluvial flooding and thus integrated in urban flood prevention planning. District 2, east of the Saigon River, is likewise impacted, but not covered by recent flood prevention planning.

Information on flood depth and the location of the November flooding from the Steering Center of the Urban Flood Control Program in Ho Chi Minh City were combined with the location of manufacturing firms in ESRI ArcGIS. On the basis of

the Vietnam Enterprise Census (VEC) 2016 by the General Statistics Office of Vietnam (GSO, 2016), any manufacturing firm that has its production site within a commune, i.e., the sub-district administrative entity, and that was flooded in November 2018 is considered as potentially exposed (Fig. 5-1). In total, 5,371 manufacturing firms are located within our case study districts. Almost one third (1,432) of them is located in flooded communes and thus considered as potentially flood-exposed. 81,0 % of exposed firms are small- (less than 50 employees), 11,4 % medium- (50-200 employees), 7,6 % large-sized firms (more than 200 employees).

Fig. 5-1: Case study areas in Ho Chi Minh City

In a second step, we conducted in-depth discussions with selected representatives of manufacturing firms, different stakeholder groups (government bodies, NGOs, consulting sector) and two business associations in HCMC in 2018. The aim of this inductive preliminary phase was to gain basic local knowledge about the exposure and adaptation strategies of firms and to identify underlying rationales of external systems of flood risk management in HCMC. Based on this knowledge, together with our Vietnamese colleagues we developed a semi-structured questionnaire on the economic situation of firms, investment decisions, flood impacts, adaptation procedures and perceptions of future risk und local risk management systems. The sample of the firms for interviews was randomly selected and included all types of micro, small-, medium-sized and large manufacturing firms. As we were interested in different perceptions and adaptation strategies, the number of medium- and large-sized firms interviewed corresponds more than their actual occurrence.

We contacted manufacturing firms along lists of the Vietnam Chamber of Commerce and Industry (VCCI) and asked whether suitable respondents experienced a flood in the last five years. Our respondents were firm leaders as strategic decisions, particularly in SMEs, are usually organized top-down and the hierarchical *"command-and-control"* (Halkos & Skouloudis, 2019: 2) way of thinking is still prominent in Vietnam. The interviews, mainly conducted together with co-researchers in Vietnamese, were translated on the spot and paraphrased transcribed afterwards. The final results draw on 30 semi-structured interviews (10 micro/small, 11 medium-sized, 9 large, see Tab. 5-1) with manufacturing firms conducted in 2018 and 2019.

With regard to our specific content interests, the qualitative material was analyzed as follows: First, to investigate the adaptive responses of firms, we collected the implemented adaptation measures and those planned for the future. Based on our theoretically derived conceptualization (see Section 5.2), we categorized them into action (proactive vs. reactive strategies) and inaction against flood exposure. Second, we also grouped the reported flood impacts in direct, indirect, and wider effects (UNISDR, 2013) and qualitatively correlated them with the type and intensity of response action. Third, we then tested criteria of internal and external influencing factors for different manifestations of adaptive behavior (see Fig. 5-2). This criterion was inductively supplemented by additional emerging factors for decision-making.

Here, we specifically paid attention to action barriers and factors which could lead to adaptive inaction.

Tab. 5-1: List and coding of interviewed firms in Ho Chi Minh City

Code	Business Size	Staff	Industrial Park	Origin	Main Product	Market
MI-1	Micro	6	no	Private	Printing	Domestic
MI-2	Micro	6	no	Private	Construction	Domestic
SM-1	Small	10	no	Private	Construction	Domestic
SM-2	Small	10	no	Private	Construction	Domestic
SM-3	Small	15	no	Mix	Transport equipment	Domestic
SM-4	Small	16	no	Private	Plastic products	Domestic
SM-5	Small	25	no	Private	Textiles	Domestic
SM-6	Small	27	no	Mix	Mechanical products	Domestic
SM-7	Small	30	no	FDI	Mechanical products	Export
SM-8	Small	40	no	Private	Steel products	Domestic
ME-1	Medium	63	no	Private	Plastic products	Domestic
ME-2	Medium	90	no	Private	Light bulbs	Domestic
ME-3	Medium	100	yes	Private	Painting products	Domestic
ME-4	Medium	100	no	Private	Beverages	Domestic
ME-5	Medium	100	no	Private	Refrigeration products	Domestic
ME-6	Medium	100	no	Private	Flowers	Domestic, Export
ME-7	Medium	115	no	Private	Beverages	Domestic
ME-8	Medium	130	yes	FDI	Food Processing	Export
ME-9	Medium	130	yes	Private	Paper products	Domestic
ME-10	Medium	200	yes	FDI	Fertilizer	Domestic, Export
ME-11	Medium	200	no	Private	Textile products	Domestic
LA-1	Large	260	yes	FDI	Electronic spare parts	Export
LA-2	Large	300	no	Private	Plastic products	Domestic, Export
LA-3	Large	300	no	Private	Precision molding	Domestic, Export
LA-4	Large	680	yes	FDI	Electronic spare parts	Export
LA-5	Large	800	no	Private	Pharma products	Domestic
LA-6	Large	920	yes	FDI	Hydraulic valves	Export
LA-7	Large	1000	no	Private	Textile products	Domestic, Export
LA-8	Large	1000	no	Private	Textile products	Domestic, Export
LA-9	Large	1000	no	Mix	Electronics	Domestic, Export

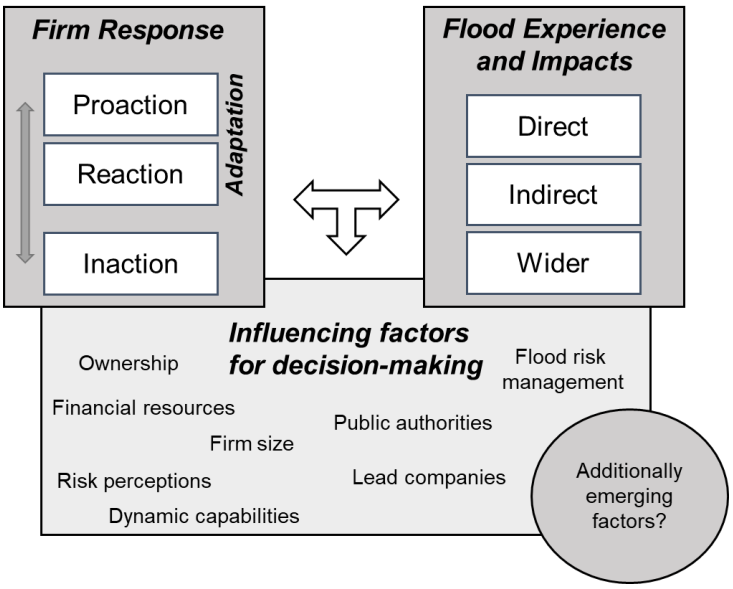

Fig. 5-2: Qualitative data analysis

5.5 Results and discussion: adaptation strategies between action and inaction

More than half of the surveyed firms suffer from the damage of buildings, machineries, transport vehicles, or even finished products, and almost all firms report on indirect and wider impacts (see Tab. 5-2). The greatest risks reported are damaged buildings, machineries and materials, and the prolonged suspension of production, which takes up to 30 days (SM-4) per year due to regular flooding caused by storms and heavy rainfall.

Two thirds of the firms interviewed are already implementing some sort of adaptation, while one third stays inactive. For those firms being active, responses range from proactive and long-term ideas to many pure coping actions that allow firms to become active only temporary and reactively and are often used in parallel.

Tab. 5-2: Direct, indirect, and wider business impacts of flooding (percentage of firms in the sample)

Impacts	Micro & Small (%)	Medium (%)	Large (%)
Direct impacts of flooding by flooded production sites & surroundings			
Damage of buildings, machineries, transportation vehicles, raw materials, components, and products	13.3	23.3	16.7
Lower or suspending production	10.0	20.0	23.3
Absence of staff	13.3	13.3	6.7
Paying salaries due to work overtime	3.3	3.3	3.3
Repairing costs of infrastructure	3.3	3.3	0
Subsidence of production area	0	3.3	0
Indirect impacts of flooding by supply chain disruption			
Postponed distribution	13.3	26.7	20.0
Logistical problems	10.0	10.0	13.3
Wider impacts			
Loss of customer trust	3.3	6.7	6.7
Non-compliance with contracts	6.7	0	6.7
Disrupted supply (of, e.g., raw material)	6.7	6.7	0

Contrary to our expectations, future-oriented and strategic adaptation measures are not intensively implemented or planned by flood-experienced firms that suffer from high exposure and impacts. Most of the severely affected firms more likely cope in the event of flooding (SM-4, ME-1, ME-3, LA-2, LA-3) or invest into less capital-intensive strategies such as time-adjustments for employees or rearrangements within product delivery schedules (LA-7, LA-8, ME-6, ME-11). Particularly private SMEs in the western districts Binh Chanh and Binh Tan producing light manufacturing products from paper (e.g., food packaging), food (processing), or textiles for the domestic market suffer from business disruptions, damages, and losses, but fail to introduce proactive measures. One domestic firm producing plastic bags (SM-4), for instance, once lifted up the production site, but still suffers from a destruction of assets and stocks, threatening the economic viability. However, further strategic plans are lacking, particularly with regard to future flood impacts. Another firm reported that their food packaging products are regularly damaged, and in November 2018 they needed to stop the production for a week, leading to total damages of about 500–600 million VND

(LA-2). However, in the event of flooding, they only block all doors and windows, remove wet products, and install small temporary pumping systems. SMEs facing indirect losses regarding supply chain interruptions and postponed distributions of their products also tend to react at short notice (SM-1, SM-2, ME-4, ME-7). During the rainy season and high tide, it is difficult to preserve the products just in time for processing and exporting (ME-5). This situation could lead to at first sight invisible, but wider impacts such as the risk of non-compliance with contracts, the loss of trust, and as a next step loss of customers (UNISDR, 2013; Wedawatta et al., 2014). On the contrary, we clearly see that export-oriented, foreign firms, often located in industrial parks in District 7 and Nha Be, are already much more protected from direct impacts of flooding, but still implement long-term flood protection measures like the installation of well-developed drainage systems to prevent the factories from future flooding (LA-6, LA-4). Regarding indirect impacts on the delivery process, they respond by time-adjustments and for example provide suppliers with water resistant plastic boxes to support the logistical process of agricultural products during heavy rain (ME-8).

In general, firms that are best prepared are currently the least directly affected, while firms with high direct impact usually tend to cope in the event of flooding, but lack long-term adaptation. This result can be explained through specific internal firm characteristics and external conditions in the business environment, influencing the decision and opportunity of firms to take adaptation measures.

First, as assumed by McKnight and Linnenluecke (2016), Neise et al. (2018), and Wedawatta et al. (2014), the size and financial liquidity of firms play a predominant role. It is striking that firms have difficulties in providing financial resources for an effective response. In addition to floods, firms are often exposed to other risks (i.e., economic crises, lack of skilled workers, competition) that overstretch financial budgets and lead to postponed or unimplemented proactive adaptation (Trinh & Thanh, 2017). We find that the majority of SMEs with limited capital and limited access to credits for long-term investments usually cope directly after a flood event and hardly ever implement property-level flood protection. Once the flood occurs, firms continue their established business routines, put products and other relevant material in higher places to proof them dry, elevate machines and built barriers with, e.g., sandbags in order to protect their production sites from the water. They only react partially with intended business plan adjustments (SM-8), private hedging, and small insurances

(SM-2, SM-6). Although those organizational measures are seen as the basis for flood adaptation efforts (Herbane et al., 2010), they do not prevent production sites from direct impacts of flooding. Factory premises in Binh Chanh, Binh Tan and District 7 are often based in lower locations than the adjoined streets, thus in the event of flooding the water runs from the street into the production facilities. As a result, particularly firms with exposed products such as flowers, paper products, or textiles plan to raise their production sites, but they lack sufficient financial resources, which in the long run could lead to surrender (SM-4, ME-1, LA-2). In this case, Neise and Revilla Diez (2019) argue on the basis of their empirical research in Jakarta that missing proactive strategies bear the risk of insufficiently addressing the impacts of flooding by shifting them recurrently to the future.

Second, the proactive behavior of micro- and small-sized firms strongly relies on the risk perception of decision-makers. Contrary to what Neise and Revilla Diez (2019) have shown for Indonesian firms, the future economic impact of flooding in HCMC is commonly present on the firm management side, but this does not automatically lead to proactive measures (MI-2, SM-7). Hence, we find that some firm managers assess other business risks such as shortage of workers, financial crises and the emergence of competitors as more relevant for their viability and improvement of competitiveness than flooding issues: *"[…] we have more than 20 years of experience with floods and we have learned how to adapt. For us it is a kind of regular business, but we recognize that the magnitude of rain and tidal flooding is increasing"* (ME-8). Whether there will be a rethink with regard to future risks and the necessity of flood protection therefore depends strongly on the individual risk perception and the personality of the decision-makers.

Third, we find that external risk management systems strongly influence the extent of firms' individual flood adaptation. Our analysis shows that close contact with headquarters and subsidiaries overseas or strong relationships along the value chains drive the adaptive behavior of firms. Their engagement is not primary relying on the actual flood impact or local managers' decisions, but much more forced by guidelines and instructions. Firms enjoy advantages of an international exchange, knowledge spill-over regarding flood impacts, and flood-related adaptation like the implementation of evacuation plans (LA-6). Moreover, they have well-trained staff that is capable to adopt, develop, and implement new techniques and strategies by

participating in training courses and workshops. Firms with linkages to international value chains often possess sufficient financial resources to introduce proactive measures. A Japanese firm in the Tan Thuan industrial park reported for example that they lifted up their whole production site by 70 cm to prevent flooding inside the company. Additionally, they installed an internal drainage system which was presented by their mother company and joined a regional business association where adaptation possibilities are discussed with other firm managers (LA-4). In principle, locating in an industrial park with an internal flood risk management is regarded as a panacea, since capital-strong companies in industrial parks tend to contribute more often to the resources of industrial park administrations for protection against natural hazards and support the expansion of local measures such as drainage systems. Firms that are not in a position to prepare efficiently for future flood risks are often located outside industrial parks, but want to move and take advantage of the infrastructural benefits in parks (LA-8). Often managers mention that they already planned to relocate the production site, but hardly no interviewed firm ever moved in less exposed areas: *"I am not satisfied in the long term, because of not being in the industrial park and the flooding problems outside. This makes the company less appreciated by partners and ineligible for receiving foreign investments. For the future, we are trying to move to another area and upgrade the land"* (LA-2).

Fourth, it becomes clear that the risk management and public responsibility to reduce flood risks on the part of local governments play a central role for firms' adaptive action. So far, firms usually see the responsibility for action by the park administrations and public authorities, which already seem overburdened to ensure flood protection and to manage integrated flood adaptation strategies (Hall & Solomatine, 2008; Neise et al., 2019). If firms are not implementing adaptation practices even if they are highly exposed to flooding, they often depend on public solutions and mechanisms of support which might be a risky strategy (Nalau et al., 2015). Although the local government organizes some small conferences to raise public awareness of flood issues, information on major adaptation measures and practices does not seep into the business environment of micro- and small-sized enterprises. Most of the firms interviewed stress that the state does not take sufficient care of the flood problem: *"We think the government should be responsible, but they are just lifting up some streets in the city center or in other districts. They use our taxes for this kind of infrastructure"* (ME-8).

Some urban development efforts of the public authorities even lead to firms no longer considering the risk of flooding and its reduction. Recently, there has been a trend of pushing the relocation of labor-intensive production towards areas outside the city center, which are often already highly flood-exposed (Katzschner et al., 2016). Thus, being located in an official resettlement area leads to inaction due to any upgrades of firm infrastructure and premises and, as a result, to a *wait-and-see* strategy (SM-4, ME-1, LA-1). Moreover, some firms are aware of the risk of flooding and willing to adapt, but have to wait for permission to physically upgrade their production facilities (LA-2, ME-10). As Meinel and Schüle (2018) already stated, this procedure poses a barrier for the implementation of sufficient flood protection. A precision-molding firm for instance reported that they registered for an upgrading certificate, but have not received the permission in three years. Therefore, all flood adaptation efforts are just temporary solutions (LA-3). These firms even experience a double impact as they receive a penalty from the local authorities if oil or other hazardous substances leak out of the machines as a consequence of flooded production sites. These uncertainties of support and permission lead to, if at all, coping in severe flooding situations rather than the implementation of proactive strategies related to future risks. Beyond that, counterproductive and competing adaptation plans of neighbors and local governments could lead to individual surrender. The most widespread challenge is the elevation of roads by the government. Firms in District 7 and also Binh Chanh report that the effects of flooding have increased since the government lifted up some main roads in the city center (SM-3, SM-4, ME-1, LA-2). Afterwards, the production sites of firms are sometimes lower than the road surface which leads to major flooding, presents firms with challenges, and cannot be solved by individual measures: *"The problem of the floods is not solved by our own measures because the government is also lifting up the streets outside. Sometimes the flooding is so severe that our raised production facility is still flooded"* (SM-4).

To meet the challenges of insufficient individual financial resources, capabilities, and support by public authorities, the approach of collaborative adaptation is gaining ground (Abe et al., 2019; Neise et al., 2019). In our case study areas, the implementation of collective measures on a neighborly level, but also with different other stakeholders such as NGOs or local authorities has so far been rather an exception. One of the collective coping examples is the joint installation of sandbags and

floodwalls. Personal relationships and trust within local communities were identified to be a decisive factor for the commitment of collective action. One proactive initiative exemplifies collaborative ideas, responding to lacking local infrastructure: *"Previously there was an investor in our district who assured to invest in infrastructure, but this investment never happened. As a consequence, we decided to do it on our own. We lifted up parts of the street in front of our business together with our neighbors. Everyone who is located in this road payed for it. Some neighbors do not agree and refused to pay, so you see some parts of the street have not been improved"* (MI-2).

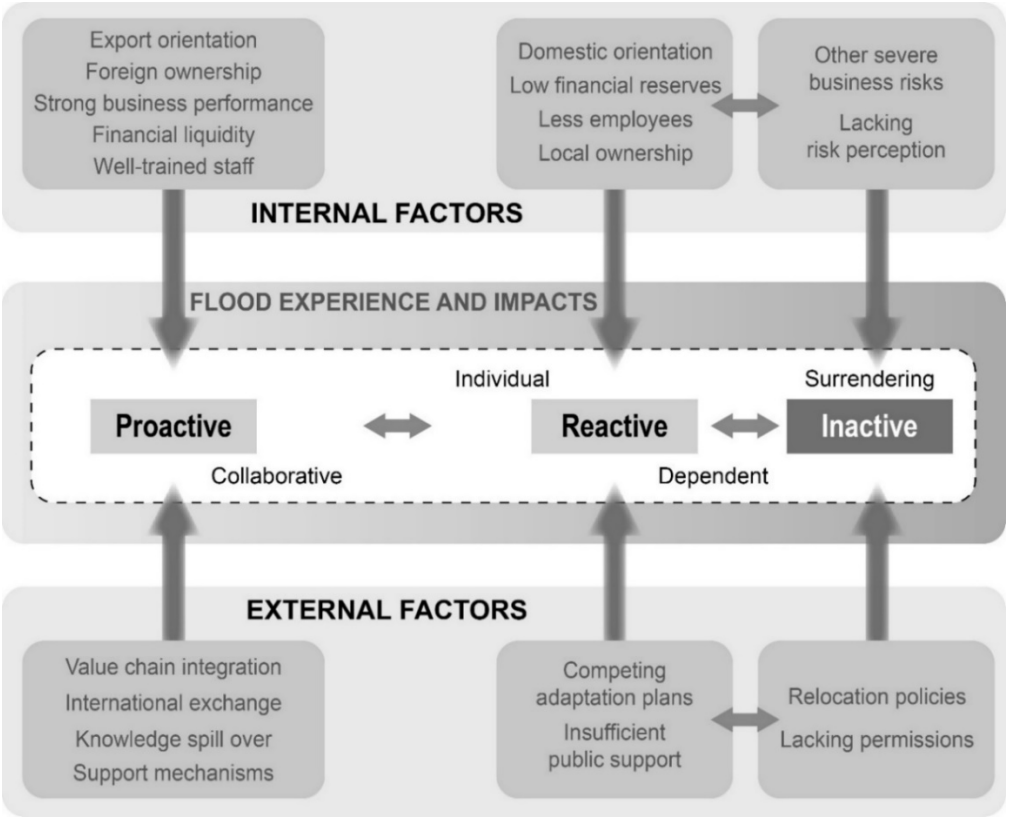

Fig. 5-3: Firm adaptation framework: determining factors of adaptive responses

5.6 Conclusion and outlook

Despite the increasing interest on climate change, its economic impacts and potential adaptation solutions, the scientific understanding on whether and how firms take adaptation action is surprisingly thin. This paper has reviewed relevant literature, developed a first conceptual framework for sorting the factors that might explain action and inaction, and provided empirical heuristics from firm-level adaptation decisions in one of the hotspots of climate change adaptation, Ho Chi Minh City in Vietnam (see

Fig. 5-3). In particular, we were interested to understand if adaptive action occurs more intensively amongst firms with high direct impacts and which other internal firm characteristics and external conditions influence the decision of firms to take flood adaptation measures. Our framework therefore differentiated into proactive, reactive, and inactive adaptation behavior. In order to explain these different behaviors, we looked into previous flood exposure and impacts of firms as well as into other influencing factors, spanning internal dimensions such as the firm size and performance as well as external ones, including for instance the support by public authorities.

The analysis yields four main results: First, two thirds of the firms interviewed introduce proactive or reactive adaptation strategies while one third stays inactive. Most of the manufacturing firms cope only temporarily and reactively to prevent severe impacts from flooding, but do not pursue long-term strategies. Often the existing plans focus on keeping people, products, material, and machines safe in a flood event rather than addressing systemic issues to avoid flooding damage holistically. Second, experience with past events and a high impact of floods do not automatically lead to strategic adaptation. The firms that are best prepared are currently the least directly affected, while directly impacted firms are more likely to introduce pure coping strategies. Third, a high exposure to floods and specific internal business characteristics are intertwined. Large firms with a stronger business performance and financial liquidity are generally more structured in their environmental responses as they tend to act proactively even without severe flooding experience. Whereas small firms with low financial reserves are often located in highly exposed locations, but lacking to adapt to flood risk in the long term. This in turn increases their exposure and leads to a self-reinforcing effect which quickly endangers their future business viability. Moreover, the perception of managers plays a key role in adaptive decision-making as they have to assess the urgency of flood impacts compared to other business risks. Fourth, external risk management and support systems strongly influence the extent of firms' flood adaptation. The proactive engagement of well-prepared firms is mostly forced by external requirements and along the value chain and facilitated by support and incentives from headquarters and industrial park managements. Whereas highly impacted micro and small firms are left behind, usually receive no institutional support and are even exposed to competing adaptation plans of different actors. As a result,

they cope with severe flooding situations only reactively or even surrender instead of implementing proactive strategies, although they are aware of future risks.

Regarding our methodology, findings show potentials, but also analytical difficulties. The depicted adaptation strategies present local examples only for discussion of adaptation trends within the business environment in the case study areas. To get a more detailed analysis on the business landscape, one would have to derive further business characteristics to assess differentiations with regard to their adaptation strategies. While our study presents a first exploratory step in firm adaptation analysis to floods, more in-depth research is needed to understand the dynamics of both internal and external barriers and facilitating conditions which may present oneself system-inherent and shape decision-making under uncertainty.

Looking into the future, our analysis shows that there is an urgent need to pay increased attention to firms within larger adaptation considerations and a better understanding of their adaptive capacities as well as their considerations for or against taking action. As the example of HCMC has underscored, SMEs are a particularly vital part of the economy. Their long-term success is therefore of great relevance for societies. Future risk governance thus needs to be steered to facilitate the effective adaptation of firms to climate change threats. Science needs to increase its efforts to support the relevant knowledge, e.g., with regards to providing typologies of adapting firms in different context, examining the effectiveness of supporting tools and analyzing the specific needs of SMEs which typically do not receive the same attention as large international corporations. A particular focus should be with the question how firms act – or ought to act – as agents within larger adaptation partnerships across state agencies, civil society, and private sector peers. With poor public adaptation capacities in many parts of the world, SMEs will need to bear a major part of their adaptation costs. But they will increasingly make their voice heard, pushing for integrated adaptation solutions and cost sharing with other parts of the society.

Data availability

Datasets for this research are available from GADM (2018), Natural Earth (2018), Open Street Map (2018), and World Bank Group (2013). Due to confidential

agreements, the Vietnam Enterprise Census (GSO, 2016) and qualitative research data are not publicly accessible, but can be requested from the GSO and the first author.

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6 Are we expecting too much from the private sector in flood adaptation? Scenario-based field experiments with small- and medium-sized firms in Ho Chi Minh City, Vietnam

Leitold R, Revilla Diez J, Tran V (2020) Are we expecting too much from the private sector in flood adaptation? Scenario-based field experiments with small- and medium-sized firms in Ho Chi Minh City, Vietnam. Climatic Change 163:359–378. https://doi.org/10.1007/s10584-020-02888-y

Abstract:

Adaptive governance approaches emphasize the crucial role of the private sector in enabling climate change adaptation. Yet, the participation of local firms is still lacking, and little is known about the conditions potentially influencing firms' adaptation decisions and mechanisms that might encourage private sector engagement. We address this gap with an empirical analysis of the willingness of manufacturing small- and medium-sized enterprises (SMEs) to participate financially in collective flood adaptation in Ho Chi Minh City (HCMC), a hotspot of future climate change risk. Using scenario-based field experiments, we shed light on internal and external conditions that influence potential investments in collective initiatives and explain what role SMEs can play in flood adaptation. We find that direct impacts of floods, perceived self-responsibility, and strong local ties motivate firms to participate in collective adaptation, whereas government support, sufficient financial resources, and previously implemented flood protection strategies reduce the necessity to act collectively. Here, opportunity costs and the handling of other business risks play a decisive role in investment decisions. This study shows that although private sector engagement appears to be a promising approach, it is not a panacea. Collective initiatives on flood adaptation need formal guidance and should involve local business networks and partnerships to give voice to the needs and capacities of SMEs, but such initiatives should not overstretch firms' responsibilities.

Keywords:
Private sector adaptation, Climate change, Flood response, Small- and medium-sized firms, Field experiments, Vietnam

6.1 Introduction

Floods are a growing economic concern, particularly for small- and medium-sized enterprises (SMEs), which are a driving force for economic development, employment, and value creation (Halkos et al. 2018). Although the private sector has always suffered from climate disasters (UNISDR 2013), its responses have often been disregarded in global reports on climate change assessments (e.g., IPCC Assessment Reports before 2014). Just recently, the interplay between climate disasters and economic impacts, such as those caused by flooding, has triggered recent debates. Following the Fifth IPCC Assessment Report of Working Group II, the critical role that the private sector can play in risk reduction has gained fresh momentum (Abe et al. 2019). Policy frameworks (e.g., Sendai Framework for Disaster Risk Reduction 2015–2030) and future-oriented scientific research on climate change adaptation (hereafter *adaptation*) call for more integrated and collaborative adaptive strategies that include the private sector (Challies et al. 2016; OECD 2015; The World Bank 2019). Considering projections that climate change will significantly increase future flood risks and that governmental authorities will likely be overburdened with providing integrated flood-protection, these new frameworks emphasize the role of private sector knowledge and financial resources in facilitating adequate adaptation measures, including collective flood-protection initiatives.

Although recent literature highlights co-responsibility with the private sector, participation of smaller and locally based firms in collective adaptation is still very limited. Unlike large, often multinational firms, most adaptation initiatives do not involve SMEs in formal agreements or even consider their needs and interests (Pauw and Chan 2018). Moreover, the extent to which SMEs are willing to participate in collective action and contribute their capacities toward adaptation measures both remains unclear. Initial findings on their flood responses show that they often only engage in individual coping measures to the neglect of any integrative measures that involve cooperation with other private actors or local governments (Neise and Revilla Diez 2019).

While the relevance of internal firm characteristics for adaptive behavior has already been a subject of analysis on collective adaptation (Neise et al. 2019), little is known about the influence and attitudes of individual decision-makers, the external firm environment, and local complexities (Verrest et al. 2020). Agrawala et al. (2011), Halkos et al. (2018), and Marks and Thomalla (2017) assume that external conditions, such as local partnerships or institutions, play crucial roles that are in need of more detailed investigation. With respect to this lacuna, adaptation research calls for further analytical work to determine what conditions are required for collaborative approaches to work and how private sector engagement could be encouraged and facilitated, with the aim of developing clear guidance for governments and decision-makers (Averchenkova et al. 2016; Challies et al. 2016; Chen et al. 2013).

Against this backdrop, we see two major challenges: first, the need to better understand what determines firms' decisions regarding active participation in collective flood adaptation, and second the urgent identification of mechanisms and conditions that can be put in place to enhance the role of the private sector (Averchenkova et al. 2016; Clark-Ginsberg 2020). This study aims to address these challenges by providing an empirical analysis of the willingness of SMEs to participate financially in collective flood adaptation measures. We focus on internal and external considerations and identify those conditions that either facilitate or hamper firms' potential investment. The findings help to clarify what role SMEs can play in adaptation and what kind of incentives should be developed to increase private sector contributions.

Methodologically, our approach of *scenario-based field experiments* contributes experimental, ex-ante designs that have hardly been used in epistemological analyses of the private sector (Delmas and Aragon-Correa 2016; Linnenluecke and Griffiths 2013). Evidence is sought from experiments with manufacturing SMEs in Ho Chi Minh City (HCMC), which face high flooding risk but have limited financial reserves to invest in improving performance and competitiveness (Trinh and Thanh 2017). The focus on HCMC as one of the most flood-prone urban areas in the future serves as a perfect case from which to obtain insights that will be transferrable to other increasingly flood-prone cities, such as Hanoi, Bangkok, Jakarta, and Manila.

We begin by elaborating the conceptual background, indicating the limits of current research, and by developing four hypotheses concerning SMEs' financial contribution toward collective flood adaptation. We continue by detailing our methodological

approach and empirical framework. We then proceed to describe and interpret key results from our analysis, before making a few concluding remarks that also point toward future research.

6.2 Conceptual background and research framework

6.2.1 The private sector and its potential role in collective flood adaptation: determinants of SME participation

Flood risk adaptation was long seen as a task exclusively for state and local authorities. However, particularly in developing countries and transition economies, public authorities are increasingly overburdened with tasks of implementing integrated flood protection and financing large-scale measures (Averchenkova et al. 2016; Bisaro et al. 2020). Developing local adaptation is complex and time consuming, as it involves negotiations between state and non-state actors, including local and regional governments, households, and private sector firms, each of which has their own particular needs and interests (Clark-Ginsberg 2020). In Thailand, for example, a high-tech industrial area was flooded in 2011. As a response, the industrial estate planned to build a dike around the area, which led to protests as the project would alter water flows and affect nearby local villages (Druce et al. 2016). For this reason, recent policy trends, as well as an emerging body of literature on adaptive governance, highlight the importance of shifting away from hierarchical and top-down initiatives and toward collaborative, multi-stakeholder, and participatory flood adaptation efforts in order to address the lack of public resources and capacities (Challies et al. 2016; Chen et al. 2013; Clark-Ginsberg 2020; Djalante et al. 2011).

Despite the public nature of measures for flood adaptation, Tompkins and Eakin (2012: 10) point toward *"the potential growing need for private provisioning of a public adaptation good"*, but emphasize that private adaptation for public benefits requires the development of specific institutional mechanisms and collaborations. Collective action among local stakeholders, such as households, firms, social associations, and NGOs, should lead to more effective initiative and flood risk reduction outcomes, based on the pooling of knowledge, the exchange of information, and the sharing of costs and responsibilities (Pahl-Wostl 2009; Pauw and Chan 2018; Verrest et al. 2020). As the private sector is generally equipped with financial resources, unique technological

expertise, and organizational flexibility (Halkos and Skouloudis 2019; Linnenluecke et al. 2013; Lo et al. 2019), the issue of what role private firms could play in the future provisioning of public adaptation goods and collective risk governance is gaining attention.

To date, SMEs' flood adaptations do not typically pursue long-term, cost-intensive strategies, but rather rely on individual, short-term, reactive coping mechanisms – or even inaction. Instead, firms count on large-scale adaptation measures, like dike or sluice systems initiated by public authorities (Neise and Revilla Diez 2019). To understand their decision for or against collective adaptation and to strengthen the potential role of SMEs in collaborative approaches, we must better understand the factors influencing their adaptation strategies (Linnenluecke and Smith 2018). Initial findings in risk reduction and adaptation literature suggest that firms' adaptive behaviors are determined by a variety of factors (Fig. 6-1). We consider the scope of different adaptation measures, as well as individual and firm-internal factors, institutional conditions, and the external firm environment. We place particular emphasis on relationships with other stakeholders, such as public authorities, civil society, the business community, and NGOs in shaping the adaptive behaviors of SMEs.

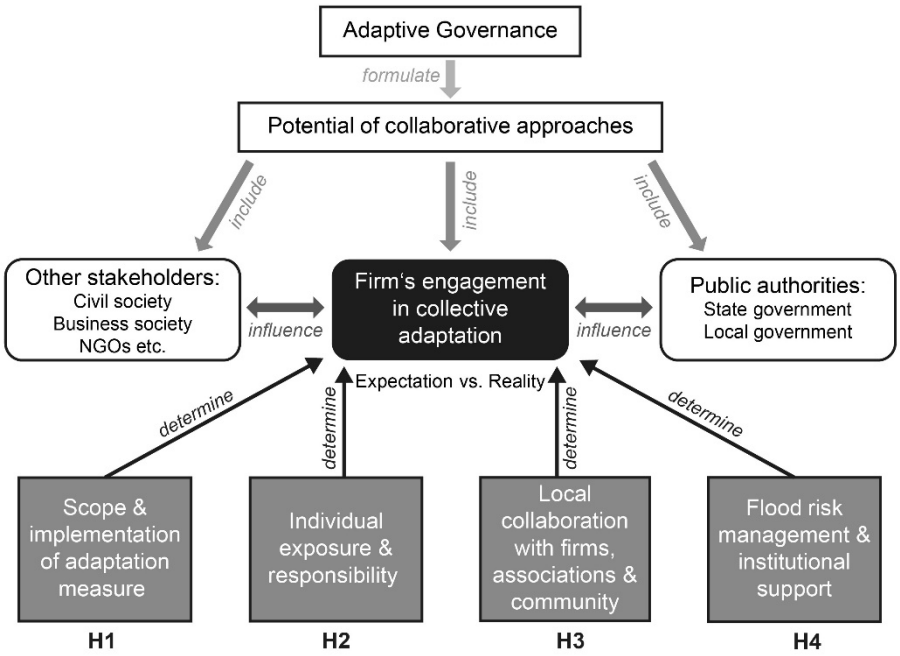


Fig. 6-1: Research framework and hypotheses

Source: Authors

First, we emphasize that the costs and the constellation of the actors involved in an adaptation measure jointly determine firms' commitments. With respect to future sea-level rises in low-lying areas, such as HCMC, Tol et al. (2006) argue that individual in situ responses may be insufficient and too costly in the long run. Linnenluecke et al. (2011) thus suggest that more drastic adaptation measures, such as firm relocations, might constitute better alternatives. By contrast, a survey by Geaves and Penning-Rowsell (2016) shows that large-scale protection measures, like dike systems, do not attract long-term participation due to a lack of local bonding. Locally funded small-scale flood adaptation schemes, on the other hand, could raise awareness and often encourage the participation of those who benefit from the provision of relevant local infrastructure.

Second, firm-level characteristics such as firm size, business performance, and financial resources have been proven to be critical factors shaping adaptive action (Agrawala et al. 2011; Halkos et al. 2018; Pulver and Benney 2013). Marks and Thomalla (2017) show, for instance, that the recovery of SMEs following a severe flood in Thailand in 2011 was exacerbated by financial constraints including a lack of flood insurance coverage. Trinh and Thanh (2017) further argue that SMEs in Vietnam face numerous risks and uncertainties in their daily business life. When assessing flood risks, firms have to weigh these risks against other business risks as well as their limited financial resources. Limited access to such resources, capacity bottlenecks (e.g., in terms of skilled labor), knowledge and technological innovation, as well as increased competition are viewed as primary obstacles to growth and thus as factors shaping vulnerability to crises (Yoshino and Taghizadeh-Hesary 2016).

Even if firms have sufficient internal capacities and resources, they often fail to invest in flood-reduction measures (Meinel and Schüle 2018). Hence, the influence of managerial risk perceptions (Linnenluecke et al. 2013) and the division and understanding of responsibilities (Mees 2017) are issues that have come to the fore. Nalau et al. (2015) indicate that an unclear division of adaptation responsibilities could hamper the effective implementation of adaptation measures and management. Along similar lines, Neise et al. (2019) show that the adaptive behavior of manufacturing SMEs in Indonesia is positively related to managers' risk-preparedness.

Moreover, empirical studies reveal that prior flood experiences including the degree of impacts are key determinants for whether or not firms will consider flood adaptation in

their investment decisions (Agrawala et al. 2011; Kato and Charoenrat 2018; Weinhofer and Busch 2013). In the present context, on the one hand, direct impacts (i.e., the destruction of assets and stocks, suspending production) are based on firms' local exposure through flooded production sites (Pauw 2015). Indirect impacts, on the other hand, are more difficult to capture and refer to supply chain disruptions, logistical problems, and wider effects such as the non-fulfillment of contracts and loss of customer trust (Wedawatta et al. 2014).

Third, the extent of which firms' adaptations are shaped by their local embeddedness, flood risk management, and institutional conditions has been neither extensively explored nor systematized, although these multidimensional factors seem to be strongly interwoven. Lo et al. (2019) emphasize that adaptive action is more likely to be taken when firm owners perceive strong expectations from the community and when social capital is strong. Manufacturing SMEs account for the highest share of locally-based businesses, are generally operated by a few individuals, and interact with a wide range of customers, business partners, employees, and local community members (Halkos and Skouloudis 2019; Kato and Charoenrat 2018). Building upon such observations, Pauw and Chan (2018) argue that SMEs could take active responsibilities in localized partnerships that link different actors at the local level and beyond. On this point, state authorities may play significant roles in supporting, guiding, and formulating laws and regulations that could foster collective initiatives and public-private partnerships (Agrawala et al. 2011; Neise et al. 2018). Halkos et al. (2018), for example, found that institutional conditions, support, and guidance all have direct impacts on SMEs' levels of commitment in undertaking measures against extreme weather events. For instance, insufficient promotion activities by the authorities, or insufficient information on the design and implementation of adaptation measures, hinder SMEs' adaptation activities. Moreover, a lack of SME-specific knowledge in external support mechanisms and insufficient guidance by trade associations and business chambers are considered critical obstacles to adaptation.

Institutional frameworks also determine possibilities and costs of participation in investments beyond direct business activities by specifying the approval costs and time frames involved in reconstructing or expanding production facilities to reduce impacts of flooding. In addition, the provision of incentives, such as tax breaks, is considered essential for the development opportunities of SMEs (Wang 2016; Yoshino and

Taghizadeh-Hesary 2016). In Vietnam, for example, private firms often develop in the shadow of state-owned enterprises and are underserved with respect to institutional support and distributions of resources (Nguyen et al. 2013; Revilla Diez 2016). Thus, it is not only a general question of how the state could support the private sector in flood adaptation, but above all a question of accessibility. In this regard, Marks and Thomalla (2017) and Pathak and Ahmad (2018) analyze the role of the Thai government in supporting SMEs during past flood events, focusing in particular on efforts made by the government to reduce flood risks. They show that the government made little effort to reduce risks at the local level, leaving the primary vulnerabilities of SMEs unaddressed.

6.2.2 Hypothesized relationships

Building on existing empirical evidence, our research framework assumes that the willingness of manufacturing SMEs to participate in collective flood adaptation is determined at different levels (Fig. 6-1). In order to test the validity of the framework, we hypothesize four positively impacting relationships in which SMEs are more likely to contribute to collective flood adaptation:

Hypothesis 1 (H1): SMEs are more likely to contribute to no- and low-regret measures, rather than to hard, capital-intensive measures.

Hypothesis 2 (H2): SMEs that are directly impacted by floods and consider themselves responsible for reducing flood risks are more likely to contribute.

Hypothesis 3 (H3): SMEs are more likely to contribute when local ties with firms in the neighborhood, business networks, or the community are stronger.

Hypothesis 4 (H4): SMEs are more likely to contribute when they are formally integrated in flood-risk management and receive institutional support.

Explanations for the use of specific variables and parameters to test the hypotheses presented are provided in Section 6.3.2.

6.3 Methods and research design

Our approach is based on the methodology known as scenario-based field experiments (Neise et al. 2019). This approach combines (1) *public-good games in a field-experiment environment* by using (2) *vignette studies*.

First, we chose a public-good game design to test the willingness of SMEs to financially participate in flood adaptation measures under different stakeholder constellations based on the hypothesized relationships (Section 6.2.2). Public-good games are usually applied in behavioral economics and aim to decipher why collective actions variously succeed or fail. They explore the participant's individual contribution to a public good and examine whether the participant is willing to contribute to the public good or prefers to free-ride on the others' contributions (Ones and Putterman 2007). The rationale behind such contributions is called the voluntary contribution mechanism. In our case, flood adaptation is defined as a so-called discrete public good, whose provision is only guaranteed if several actors cooperate and individually provide certain financial contributions (i.e., threshold value). Hence, the public-good game implies that if the provision point of the adaptation measure is not reached, then a money-back guarantee is applied. In this case, the individual contribution of each actor in the experiment is refunded (Groothuis and Whitehead 2009).

In scenario-based field experiments, the public-good game is conducted in a real-world environment. The advantage of this approach is that field experiments can make causal inferences by testing options and strategies in real situations (Delmas and Aragon-Correa 2016). For our study, field experiments with firm owners allow for a better understanding of the factors influencing decisions concerning (non-)engagement in collective adaptation than would be the case with laboratory experiments.

Second, we applied vignette designs in order to examine how different adaptation schemes are assessed. Vignette studies are commonly used in social and political sciences and contain two major components: a vignette experiment as a core element and a small follow-up survey (Atzmüller and Steiner 2010; Rooks et al. 2000). The vignette experiment presents a set of carefully constructed and realistic, but still hypothetical, descriptions of a situation or scenario, which is shown to participants so that they can make their own judgments. The follow-up survey allows researchers to collect additional, respondent-specific characteristics and to control for independent variables in the analysis (Aguinis and Bradley 2014; Atzmüller and Steiner 2010; Oll

et al. 2018; Rooks et al. 2000). Vignette scenarios are well-suited to capturing the complex interplay between internal and external factors and for studying the underlying rationales behind (anticipated) decision-making (Oll et al. 2018).

6.3.1 Data collection: design and implementation of scenario-based field experiments

To test the preference for adaptation measures regarding scope (H1), we contextualized four realistic adaptation schemes and developed respective vignettes in an extensive preparatory phase. We also took into account findings from semi-structured interviews with 30 flood-prone manufacturing firms and 9 discussions with local authorities, as well as stakeholder groups, such as NGOs, consulting agencies, research institutions, and business associations, all of which occurred between October 2018 and April 2019. For each of the adaptation schemes, we used the same locational setting, representative of typical flood-prone neighborhoods in HCMC, which were identified during several prior visits of industrial sites in HCMC (for example, see Fig. 6-2; for the overall experiment setting, see Online Resource 1).

The following adaptation schemes have been jointly developed with our local project partners:

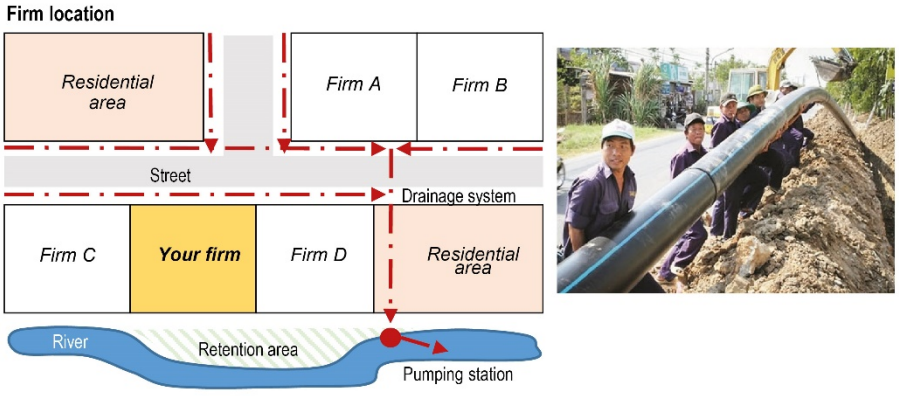
(1) Firm relocation entails large investments and long-term planning. The aim of this collective, proactive strategy is to avoid flood exposure by jointly relocating neighboring firms into small industrial areas within a protected environment. Firms with labor-intensive production in HCMC are already relocating due to the government's relocation policies in urban areas (Katzschner et al. 2016).

(2) The construction of a dike system is a hard adaptation measure[12], requiring specific technologies and actions, and generally aims at a gradual but long-term protection of riparian zones. This adaptation scheme is based on current flood-control strategies, such as the *Flood Prevention Planning 1547* that aims to build tidal sluice gates and a dike system east of the Saigon River.

[12] See OECD 2015 for a definition and conceptual overview of the different types of adaptation measures ranging from soft to hard.

(3) Cleaning and upgrading local drainage systems represents a medium-term, but no-regret measure aimed at increasing drainage capacity in industrial neighborhoods. The interviewed firms cited cleaning and upgrading drainage systems as the most urgently needed improvements, as the systems are often clogged. Upgrading and regular maintenance combines a hard measure (upgrading drainage canals) with soft elements (cleaning canals and accesses) and brings benefits even in the absence of climate change.

(4) Implementing and funding a joint awareness program for the local community are an example of a soft, no-regret approach that is already enforced by climate-adaptation strategies for HCMC. In the short term, such programs aim to strengthen local flood-risk management capacity and sensitize community members, for example, by explaining the consequences of discharging waste into river and drainage systems.



Business losses & investment options

	without measure*	with measure*
Annual loss of revenue	20%	15%
Total costs (for neighborhood)	0	20 Bn VND
Your (fixed) budget	0	0-6,5 Bn VND
The part of your budget that you do not invest is automatically saved for other investments.		

*** Adaptation measure:**
Clean and upgrade drainage system within the community
Strategy:
- Increase drainage capacity
- Reduce inundation level

Fig. 6-2: Vignette example: cleaning and upgrading the drainage system (inspired by Neise et al. 2019; photo credit: Vietnamnet Bridge 2016)

To complete the adaptation scenarios, we used five different constellations of actors to finance the adaptation measures (see Tab. 6-1). To test the impact of a joint contribution of the participant with local firms or the local community (H3) on the participant's willingness to participate financially in collective adaptation, we develop two scenarios

in which either the residents or other firms in the neighborhood make sufficient contributions to support the adaptation measure. To test the impact of how political guidance influences the participant's willingness to participate financially in collective adaptation (H4), we further test a joint contribution of the participant with local authorities versus a demanded contribution that is punished with a fine for non-compliance.

Tab. 6-1: Overview of scenarios

	Firm relocation	Dike system	Drainage system	Awareness program
Community contribution (residents make a contribution)	A1	B1	C1	D1
Balanced contribution by firms (other firms contribute the same amount)	A2	B2	C2	D2
Unbalanced contribution by firms (other firms contribute less than the necessary amount)	A3	B3	C3	D3
Political support (local authorities provide financial incentives)	A4	B4	C4	D4
Political pressure (local authorities demand implementation or impose fines for non-compliance)	A5	B5	C5	D5

The contents of the adaptation schemes and proposed actor constellations were discussed and reviewed by local experts on flood adaptation in HCMC before the survey period. Overall, we conducted scenario-based experiments (20 scenarios per firm) with 63 manufacturing firm owners located in different flood-prone areas in HCMC (e.g., garment and textile manufacturing, metal, iron, and steel production) in the period from September 2019 to March 2020. All firms had fewer than 250 employees. The participants were firm leaders responsible for strategic decisions in manufacturing SMEs. The sample was stratified by firm size, but SMEs were randomly selected within its stratification. For each experiment, we organized appointments in advance by telephone, e-mail, or letter. Since some firm leaders were quite reluctant to participate in the experiments due to confidential concerns and lack of time of availability, local district officers and the Vietnam Chamber of Commerce and Industry (VCCI) supported us with additional firm lists and contact details. Five Vietnamese co-

researchers were trained in two extensive work sessions. The standardized scenarios were tested in a week-long trial run that was conducted jointly by Vietnamese and German researchers.

The experiment was divided into two parts. First, we played the 20 scenarios with each participant (one-shot, public-good game) to determine the general preference for adaptation measures and to identify the scenario conditions under which firms are willing to invest part of their budget in collective adaptation. Illustrations of the scenario scheme (scenario cards, see Online Resource 1) were shown to participants to ensure that they fully understood the scenario situation. Second, we conducted a follow-up survey with each participant to collect additional independent variables on firm characteristics related to out hypotheses, including individual flood exposure and perceived responsibility (H2), neighborhood relations (H3), and the institutional environment (H4).

6.3.2 Data analysis: multilevel regression analysis

The scenario-based field experiments generated 1,020 observations. Missing values reduced the number of experiments to 51, which is slightly lower compared with other field experiments with SMEs or farmers (e.g., Alpizar et al. 2011; Neise et al. 2019; Saenger et al. 2013). However, the total number of observations is comparable due to a higher number of scenario options, and thus provides a valid basis for obtaining meaningful results at each level of analysis (i.e., scenario characteristics, firm characteristics, commune characteristics). Only the cross-causality relationship of factors between different levels influencing participants' decision-making was not statistically reliable due to the limited number of experiments and would lead to weak interpretations.

As each participant answered 20 scenarios, the scenario data are nested within the firm and commune characteristics. Thus, we worked with hierarchically structured data, applying a logit-multilevel regression analysis. Running a standard ordinary least squares regression would lead to spatial autocorrelation and violation of the assumption of independence for scenario observations that are clustered in the same higher levels (Hox et al. 2017; Sohns and Revilla Diez 2018). Applying a multilevel analysis allowed us to consider the interdependencies and differences between the scenario

characteristics, the firms, and the level of the commune where the firms are located (Neise et al. 2019; Park et al. 2012).

For the analysis, "willingness to participate in collective flood adaptation" was used as a dichotomous-dependent variable, where 1 indicates that the threshold of the required contribution for each scenario had been reached and 0 means that firms were unwilling to contribute sufficiently.

In order to gain an impression of the preference for adaptation schemes (H1), we designed two variables, "relocation option" and "soft measure". The latter includes the option of developing a joint awareness program in the firm's neighborhood.

To test H2, first the dummy variable "high flood exposure" was used to indicate that the firm had been impacted by flooding at least once a year in the previous 5 years. Second, we generated the dummy variable "firm responsibility", which serves as an indicator of the firm's high perceived responsibility to undertake flood-protection and risk-reduction measures. We controlled for revenue development ("expected growth"), "firm size" by number of employees, and "good financial resources" for individual measures to combat flooding, as Marfai et al. (2015) found the type of adaptation measures implemented to be strongly determined by economic considerations.

We tested the influence of local ties (H3) using different explanatory variables. Following Neise et al. (2019), we used "balanced contribution by firms", which demonstrates that the private sector contribution needed was distributed fairly among all firms, and "community contribution", indicating whether the residents contributed financially to the adaptation scheme at the scenario level. "Unbalanced contribution" served as a control variable.

At firm level, we used "collaboration with local firms" and "collaboration with business associations" to test whether different business-related collaborations and structures in the neighborhood influenced firms' willingness to contribute. We controlled for "collaboration with district firms" and "collaboration with suppliers". Additionally, the variable "stakeholder collaboration" shows whether firms were already collaborating with local community groups, NGOs, or consultancies in order to enhance their competitiveness, thereby testing the influence of local ties with civil society.

With regard to H4, we designed six variables. First, we tested for "political support" at the scenario level, which means that the government provided financial support for the

implementation of flood protection. Second, we used “support during flood events” at the firm level, which indicates whether firms had already received government support due to flooding. “Access to capital” shows whether firms had access to external sources such as loans from banks or microcredit institutions (see Trinh and Thanh 2017). In addition, we used “collaboration with People’s Committee” as a proxy for cooperation with the city council. All four variables serve as indicators for flood-risk management and institutional support. Third, based on the assumption, that private firms remain underserved compared with both state-owned (SOE) and foreign firms (FDI) with respect to access to institutional support and resources (Nguyen et al. 2013), we used the variables “SOEs” and “FDIs” to test the effect of the existence of state-affiliated and foreign-related firms at the commune level. The general control variable “individual flood adaptation” was intended to indicate that firms were unwilling to participate in collective initiatives because they had already invested in individual adaptation measures to reduce flood impacts (Neise et al. 2019). To test for multicollinearity, we calculated the variance inflation factors (VIFs) for the independent variables. Since the test resulted in an average VIF of 2.15, multicollinearity can be rejected.

6.4 Findings and discussion

6.4.1 Firms’ contribution and preferences for adaptation scenarios

The descriptive data analysis shows that in 48.6 % of all scenarios conducted, SMEs were willing to contribute to flood-adaptation measures. This first insight coincides with average results obtained in one-shot public-good games, which amounts to 40–60 % of personal endowment (Chaudhuri 2011). However, the results show slight differences between adaptation schemes and substantial differences regarding financial participation by the community, other firms, and the state (see Tab. 6-2). The willingness to contribute to joint firm relocation and the dike system was below average, whereas the drainage system and particularly the awareness program were favored. Regarding the actor constellations, the study shows that a balanced contribution of all firms was preferred (A2, B2, C2, D2). By contrast, an unbalanced contribution by the other firms leads to a well below average willingness to contribute (A3, B3, C3, D3). In the scenarios where either the community (A1, B1, C1, D1) or the government (A4, B4, C4, D4) supports flood protection financially, the contribution share was below the

overall average. Scenarios in which firms have to pay an annual fine if they do not invest in adaptation measures led to a below-average contribution (A5, B5, C5, D5).

Tab. 6-2: Contribution to different adaptation schemes and actor constellations (share as % per scenario)

	Contribution	No contribution
Adaptation schemes		
Firm relocation	40.8	59.2
Dike system	48.2	51.8
Drainage system	50.2	49.8
Awareness program	55.3	44.7
Actor constellation		
Community contribution	56.9	43.1
Balanced contribution by firms	72.1	27.9
Unbalanced contribution by firms	5.4	94.6
Political support	61.8	38.2
Political pressure	47.1	52.9

We substantiate the descriptive impressions with the analytical results of the three-level logistic regression. A closer look at the fixed effects of the scenario level allows us to interpret the direction of the influence of estimated scenario characteristics on investment decisions by calculating the odds ratios (see m3 in Tab. 6-3).

Generally, SMEs prefer low-cost, soft measures to cost-intensive and hard measures, which supports H1. They are significantly less likely to participate in the relocation scenario, while they tend to be more willing to invest into scenarios with soft measures. These initial findings align with the analysis conducted by Agrawala et al. (2011), which stresses that soft adaptation and low/no regret measures are the most common climate adaptation actions implemented by the private sector. These measures are not exclusive and usually do not require high financial investment. Hard measures, on the other hand, are usually implemented by large corporations that own long-term assets and thus urgently need to consider future climate impacts.

It is unsurprising that, in almost 60 % of the scenarios, the participants are unwilling to participate in a joint relocation and tend to react rather cautiously to flood-induced relocation. This can be explained by the costly, long-term orientation of a relocation process, especially as SMEs operate according to short-term financial reward cycles

and often cannot afford to relocate (Neise and Revilla Diez 2019). Relocation as an in situ and short-term adaptation measure is not feasible, but is rather a response to a general economic business orientation or is induced by a range of external stressors, incentives, or political conditions (Linnenluecke et al. 2011).

Tab. 6-3: Multilevel regression results for willingness to participate in collective flood adaptation

Fixed effects	Odds ratio (std. error) m0	Odds ratio (std. error) m1	Odds ratio (std. error) m2	Odds ratio (std. error) m3
Scenario characteristics				
Relocation option		0.551**	0.552**	0.552**
		(0.139)	(0.139)	(0.139)
Soft measure		1.443*	1.446*	1.445*
		(0.316)	(0.317)	(0.317)
Community contribution		1.900**	1.882**	1.883**
		(0.486)	(0.477)	(0.478)
Balanced contribution by firms		5.505***	5.412***	5.401***
		(1.511)	(1.478)	(1.474)
Unbalanced contribution by firms		0.011***	0.009***	0.008***
		(0.006)	(0.005)	(0.005)
Political support		2.633***	2.600***	2.600***
		(0.682)	(0.670)	(0.669)
Firm characteristics				
Firm size			1.026***	1.030***
			(0.006)	(0.006)
Expected growth			2.816**	2.327**
			(1.205)	(0.997)
Good financial resources			0.410**	0.417**
			(0.175)	(0.176)
High flood exposure			17.146***	16.810***
			(9.600)	(9.252)
Individual flood adaptation			0.034***	0.039***
			(0.020)	(0.019)
Firm responsibility			2.033	2.220*
			(0.928)	(1.008)
Support during flood events			0.074***	0.089***
			(0.045)	(0.053)
Access to credits			0.331***	0.367**
			(0.136)	(0.153)
Collaboration local firms			2.117*	2.108*
			(0.926)	(0.908)
Collaboration district firms			0.797	0.728
			(0.396)	(0.356)
Collaboration suppliers			0.513	0.486
			(0.302)	(0.280)
Collaboration BA			4.783***	3.997**
			(2.586)	(2.187)
Collaboration PC			3.562**	3.232**
			(1.798)	(1.656)
Stakeholder collaboration			0.956	1.145
			(0.710)	(0.880)

Commune characteristics				
Number of state-owned enterprises				0.890
				(0.236)
Number of foreign firms (FDIs)				0.963
				(0.024)
Constant	-0.795	0.857	0.155**	0.311
	(0.212)	(0.344)	(0.143)	(0.304)
Random effects				
Commune var.(_cons)	0.138	0.154	6.974	6.072
	(0.339)	(0.974)	(2.794)	(2.433)
Commune > firms var.(_cons)	1.366	4.380	0.111	0.098
	(0.445)	(1.459)	(0.172)	(0.167)
Model fit statistics				
Observations	1,020	1,020	1,020	1,020
ICC commune	0.029	0.020	0.672	0.642
ICC firm	0.285	0.560	0.011	0.010
Prob > chi2	0.000	0.000	0.000	0.0000
Deviance	1262.457	893.670	852.364	848.599

***Significant at 1% level (p < 0.01); **significant at 5% level (p < 0.05); *significant at 10% level (p < 0.1).

Source: Own calculation based on survey conducted and Vietnam Enterprise Survey Data 2017

6.4.2 Firms' flood exposure and responsibility to take action

The multilevel analysis shows that the variables "high flood exposure" and "firm responsibility" achieved positive statistical significance (see m3 in Tab. 6-3). The participation in collective flood adaptation increases when the firm has already experienced direct flood impacts within the last 5 years. SMEs that consider themselves responsible for flood protection alongside state authorities are also more willing to participate in collective initiatives. These analytical results support H2, as decision-makers in SMEs focus on their individual vulnerability and their past flood experience (Kato and Charoenrat 2018; Pinkse and Gasbarro 2016).

Moreover, as Halkos et al. (2018) stress concerning adaptation at the individual level, managerial perceptions seem to be key parameters for collective engagement. In this study, only 31 % of firms rate themselves as highly responsible for flood adaptation and protection. Even if firms suffer from indirect flood impacts, such as flooded streets and disrupted supply chains, they usually see the authorities or the management of industrial parks as being responsible for infrastructure and flood-protection measures outside the company premises. Thus, the active role assigned to the private sector for more collaborative and integrated flood risk reduction management (Averchenkova et

al. 2016; McKnight and Linnenluecke 2016; Pauw 2015) crucially depends on strengthened role awareness.

Though not the main focus of our analysis, some of the firm-performance characteristics that we controlled for yielded interesting results. As anticipated, expected revenue growth and firm size were found to have a significantly positive effect. This implies that the larger and more competitive a firm is, the more willing it is to participate financially. Interestingly, however, good financial resources for adaptation measures and the implementation of individual adaptation significantly reduce the probability of participating in collective initiatives. Collective adaptation is thus the preferred response when firms are directly impacted by flooding and have insufficient financial resources to invest in individual measures.

6.4.3 Firms' embeddedness in local collaborations and structures

The results of the multilevel analysis show that local ties play an important role for the engagement of SMEs in collective adaptation and support H3. The involvement in local business networks yield positive, strongly significant results, while collaboration with neighboring firms yields positive, but only slightly significant results (see m3 in Tab 6-3). The latter result should therefore be interpreted with caution. In addition, SMEs prefer to participate in scenarios in which all firms in the neighborhood share investment costs fairly.

Neise et al. (2019), however, find that pure business cooperation with other companies does not yield significant results for investment in collective measures in Jakarta, Indonesia. A closer look at the various local relationships in the firm's immediate environment is therefore necessary. Our survey reveals that SMEs have strong links to their neighborhoods. On average, about 65 % of their employees live in close proximity to the firm, and local relations often go beyond business contacts. What can be further argued is that floods are generally perceived as a local challenge. With regard to discussing and solving common local challenges (e.g., environmental and infrastructural issues), local business associations are assigned a particularly important role. Above all, they strengthen local knowledge through regular exchanges of information, which leads to growing flood risk awareness. Supporting arguments for this claim are also highlighted by Pahl-Wostl (2009), who suggests that non-state actor

groups and informal networks in governance systems support social learning and strengthen information exchange. In a similar vein, Marfai et al. (2015) reveal that the lack of coordination between stakeholders is a key factor that increases flood vulnerability. In this regard, business associations consolidate firms' concerns and act as a mouthpiece when dealing with local authorities.

However, the willingness of SMEs to participate in adaptation is not influenced by collaborations with other non-state stakeholders (e.g., civil society organizations); yet, they significantly prefer scenarios with a joint investment among neighborhood residents. This result can be explained by the fact that efforts made by civil society organizations, environmental consultancies, or NGOs to reduce the risk of flooding focus more on households or urban development challenges than on business concerns. A perspective that considers firms as vulnerable to flooding is still fairly novel (Pinkse and Gasbarro 2016). The descriptive results of our study support these claims, as we find little cooperation between companies and other stakeholders. Only 18 % of the sampled SMEs report that they exchange information, for example, with civil society organizations or NGOs. Manufacturing companies, in particular, have so far been seen as greater sources of environmental and climate risks, rather than potential sources of local risk reduction.

6.4.4 The role of risk management systems and institutional support

We hypothesized that the roles of risk management and institutional support are highly important for fostering local collective action. But with respect to H4, our analysis reveals differentiated results (see m3 in Tab. 6-3).

First, SMEs significantly prefer scenarios in which local authorities make financial contributions to adaptation measures. In addition, existing collaborations with the city council lead to a higher probability of participation in collective adaptation measures. Due to its political legitimacy (i.e., formulation of rules and laws, consideration of public preferences), the role of the state in supporting adaptation measures still seems decisive. In this vein, Djalante et al. (2011) and Neise et al. (2018) emphasize the ongoing need for strong governmental action and institutional impulses. In the follow-up survey, firms rated local authorities (42 %) and state authorities (28 %) as the most important actor for flood risk reduction. This supports the findings of Geaves and

Penning-Rowsell (2016), who suggest that society still sees flood management as public priority goods to be provided by the state.

Second, this study shows that institutional support in the event of floods and access to external credit significantly reduce the likelihood of firms contributing to collective action. In other words, firms that already receive financial support for flood protection are less willing to participate collectively. This could be explained in two ways. On the one hand, although access to external financial resources for private sector action on climate change is highlighted (Pulver and Benney 2013; Trinh and Thanh 2017), firms use their internal resources for other aspects of business development if they already receive support from the local authorities. In our follow-up survey, the risk of natural hazards ranks only fifth behind general economic crisis, competition, lack of skilled workers, and regulatory framework in terms of relevance. In the follow-up survey, the firms also reported on plans to invest in new machinery (67 %), staff training (53 %), technological innovations (47 %), expansion (49 %), and relocation (31 %) of production sites in addition to other measures to combat natural hazards (55 %).

On the other hand, public authorities do not yet see SMEs as a priority for private sector involvement and do not focus on creating incentives to encourage SME involvement in disaster-risk management. Pathak and Ahmad (2018) reach the same conclusion that there was a serious lack of communication between the local government and impacted local SMEs following a flood disaster in Thailand. In the same vein, Christoplos et al. (2017) argue that recent decentralization policy is redefining disaster-risk governance in Vietnam. Local authorities have discretionary powers in implementing national policy, leading to the privatization of former government functions and new relationships with the private sector. However, the overall objective of strengthening public-private partnerships is primarily aimed at large flagship manufacturing and insurance companies.

Third, contrary to expectations it can be noted that the number of SOEs and foreign firms in the commune does not yield significant results and therefore appears to be irrelevant for the willingness of SMEs to participate. Possible explanations for this result are, first, that the majority of SOEs and foreign firms are not located in flood exposed areas, but rather in protected industrial parks, and therefore have no direct influence on the adaptation behaviors of local SMEs. Second, the units where the data were collected may have been too small to investigate local or even regional factors

influencing firms' collective adaptation decisions. On a larger scale, however, a bias in favor of multinational and state-owned firms can still be observed (Leitold and Revilla Diez 2019; Nguyen et al. 2013; Revilla Diez 2016). SOEs are still seen as lead players in the economy and should therefore also play a lead role in managing and implementing flood adaptation. But it is not possible to conclusively state whether the presence of SOEs or foreign firms create incentives or stakeholder pressure for SMEs to engage in collective action.

6.5 Concluding remarks

This study provides an empirical, scenario-based analysis of the willingness of manufacturing SMEs to invest in collective flood adaptation measures in HCMC. The results show that SMEs generally prefer to invest in low-cost, soft measures. SMEs that are already directly impacted by flooding and perceive themselves responsible for flood adaptation are more willing to participate in collective adaptation. Further, interaction with neighboring firms, local business networks, or the city council is a driving factor for participation. In contrast, existing support mechanisms tend to inhibit collective action. If SMEs have sufficient capital or already receive support from the authorities, they still prefer to act individually. Opportunity costs and the handling of other business risks therefore seem to play a critical role in investment decisions. Our case study shows that SMEs have not yet exhausted their potential for reducing future flood risk. Collective adaptation is largely only a response when firms are directly impacted by regular floods and have insufficient resources to deal with the effects individually. However, due to climate change, flood risks are becoming increasingly pressing and SMEs themselves are called upon to take action. We therefore give three policy-related recommendations for the engagement of SMEs in flood adaptation in Ho Chi Minh City and other flood-prone urban areas such as Jakarta, Bangkok or Manila.

First, encouraging SMEs to prioritize flood risk and its management is crucial for collective adaptation. Nevertheless, the responsibilities of SMEs in collective adaptation should not be overstretched, as they must continue to invest in business-related capacities in order to contribute to sustainable regional development through job creation and tax payments. Most SMEs have little financial leeway, and investment in adaptation measures would simultaneously mean less investment in new machinery

and technological innovation. The participation of SMEs is therefore no panacea and can only be successful as supplementary to and embedded within public efforts.

Second, SMEs need formal support and effective guidance to improve adaptation, even if public authorities are not directly involved in implementation. Although decentralization tendencies in transition economies such as Vietnam evolve toward greater openness of collaborative risk-reduction responsibilities, the state is still seen as a major actor in initiating flood risk reduction. Creating conducive conditions (e.g., political programs, tax incentives, and legislative mandates for public-private partnerships) that facilitate SME participation might not be a new challenge, but it requires genuine action and a clear allocation of responsibilities.

Third, we underline that private sector engagement should not only focus on the co-financing of large adaptation measures, but on introducing small-scale measures that meet local needs. Here, the creation of strong networks and partnerships between local SMEs, multiplier organizations, and state actors can play a crucial role. For instance, business associations should act as a voice for SMEs, promote their concerns, and trigger the transfer of information and support from higher political levels.

In terms of methodology, our analysis is based on a hypothetical, simplified design of adaptation scenarios, which are strongly adapted to the local context. Thus, we recommend that similar experiments be conducted in different field contexts to improve external validity. As firm characteristics and the impact of the institutional setting are based on the participants' personal assessments, the results should be interpreted accordingly. Unfortunately, we are unable to examine the depth of local cooperation and its influence on collective adaptation, which opens up a relevant avenue for further research.

Data availability

Due to confidentiality agreements, the survey data are not publicly accessible, but can be requested from the first author.

We used Stata 15 for the multilevel regression analysis. The application code can be requested from the first author.

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Supplementary Material - Online Resource 1:

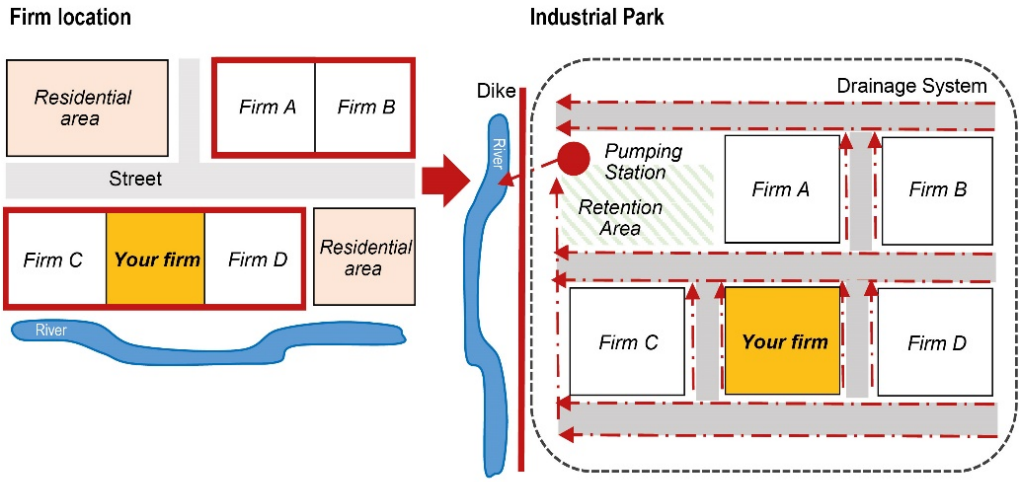
Overall experimental setting

Your firm is located in a small neighborhood with a total of five manufacturing firms and two small residential areas close to a river (see picture on scenario card), all of which face severe economic losses (20 % of annual revenue) due to flood events. There are collective flood adaptation options that can be implemented as effective risk reduction strategies. But funding for these measures requires joint collaboration by your firm and various other actors. In other words, the adaptation measures can only be implemented if specific financial contributions are secured by all stakeholders. In our case, it is assumed that all firms face the same economic losses by floods and also control the same budgets, although you do not know the exact amount of money that other actors are willing to contribute. The part of your budget that you do not invest is automatically saved for other investments.

In what follows, you will be presented with four different options. Each adaptation scheme will consist of five different actor constellations involved in funding the adaptation measure. In total, you will be presented with 20 different scenarios. You will be asked to decide how much of your fictitious budget (which is fixed for each adaptation scheme) you are willing to invest as your contribution to the adaptation scheme.

At the beginning of each option, we will present the situation and different measures in detail by using small setting-cards and pictures as well as answer your questions. Please decide according to your personal experience as a decision maker.

Scenario card: Relocation (A)



Business losses & investment options

	without relocation*	with relocation*
Annual loss of revenue	20%	0%
Total costs (for neighborhood)	0	100 Bn VND
Your (fixed) budget	0	0-33 Bn VND
The part of your budget that you do not invest is automatically saved for other investments.		

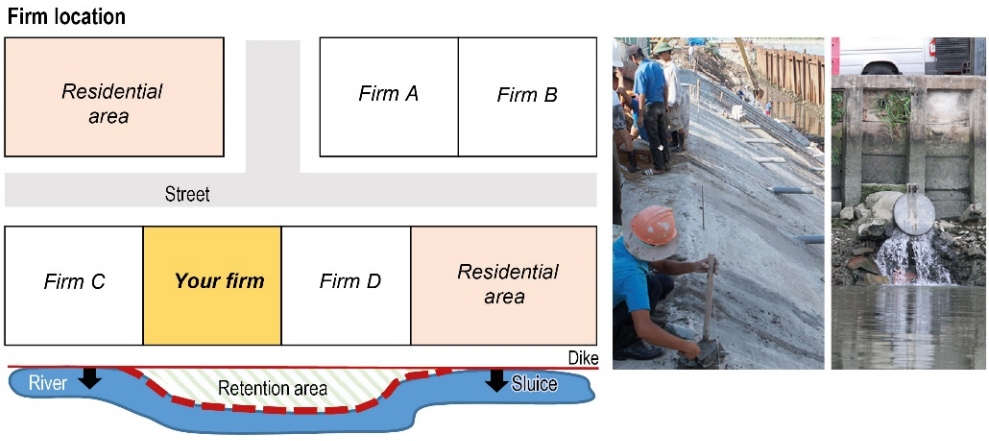
* **Adaptation measure:**
Relocation of firm into small industrial park outside of your neighbourhood (>5km distance)
Strategy:
- Construction of smaller, secured industrial parks
- Joint relocation of firms

Fig. 6-3: Scenario card relocation

Description of the setting:

- Aim of the measure: Relocate your firm to a small industrial park outside of your neighborhood (> 5 km distance).
- This will be a joint relocation of all firms in your direct neighborhood.
- The industrial park system is secured from flooding and will reduce your annual economic losses by 100 %.
- Total cost to relocate all firms: 100 Bn VND
- Your budget: 0–33 Bn VND

Scenario card: Dike system (B)



Business losses & investment options

	without measure*	with measure*
Annual loss of revenue	20%	10%
Total costs (for neighborhood)	0	50 Bn VND
Your (fixed) budget	0	0-16,5 Bn VND
The part of your budget that you do not invest is automatically saved for other investments.		

*** Adaptation measure:**
- Sophisticated dike system with two sluices in front of the river
- Retention area in front of the riverside

Strategy:
- Safeguard riparian zones
- Reduce inundation level

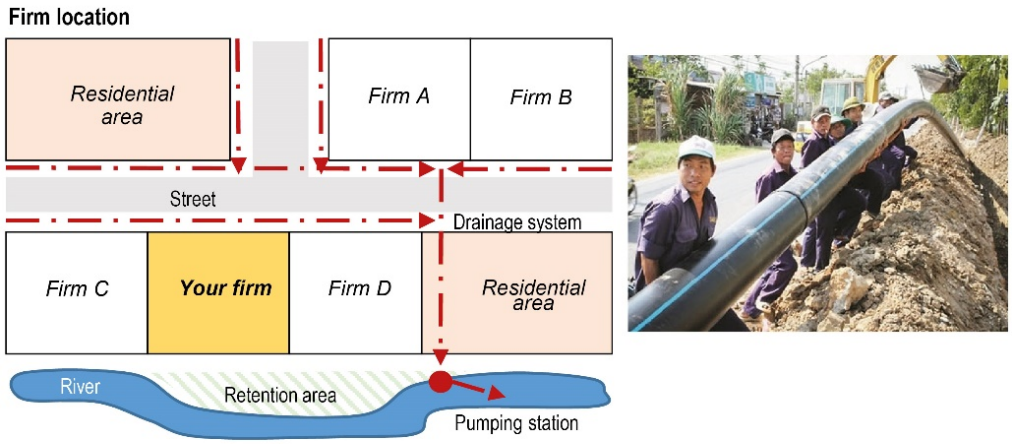
Fig. 6-4: Scenario card dike system

Description of the setting:

- Aim of the measure: Build a sophisticated dike system with two sluices in front of the river and a retention area along the riverside.
- The dike system will reduce your annual economic losses by 50 %.
- Total cost for the dike system: 50 Bn VND
- Your budget: 0–16,5 Bn VND

Photo credit: VCAPS-consortium (2013) Climate Adaptation Strategy Ho Chi Minh City. Moving toward the sea with climate change adaptation, Ho Chi Minh City, Vietnam, p 62, p 87. http://www.vcaps.org/assets/uploads/files/HCMC_ClimateAdaptationStrategy_webversie.pdf

Scenario card: Drainage system (C)



Business losses & investment options

	without measure*	with measure*
Annual loss of revenue	20%	15%
Total costs (for neighborhood)	0	20 Bn VND
Your (fixed) budget	0	0-6,5 Bn VND
The part of your budget that you do not invest is automatically saved for other investments.		

* **Adaptation measure:**
Clean and upgrade drainage system within the community
Strategy:
- Increase drainage capacity
- Reduce inundation level

Fig. 6-5: Scenario card drainage system

Description of the setting:

- Aim of the measure: Clean and upgrade the drainage system within your neighborhood.
- The upgrade and cleaning will reduce your annual economic losses by 25 %.
- Total cost to clean/upgrade drainage system: 20 Bn VND
- Your budget: 0–6,5 Bn VND

Photo credit: VIETNAMNET Bridge (2016) Vietnam seeks capital for water supply and drainage systems. https://english.vietnamnet.vn/fms/environment/164115/vietnam-seeks-capital-for-water-supply-and-drainage-systems.html

Scenario card: Awareness program (D)

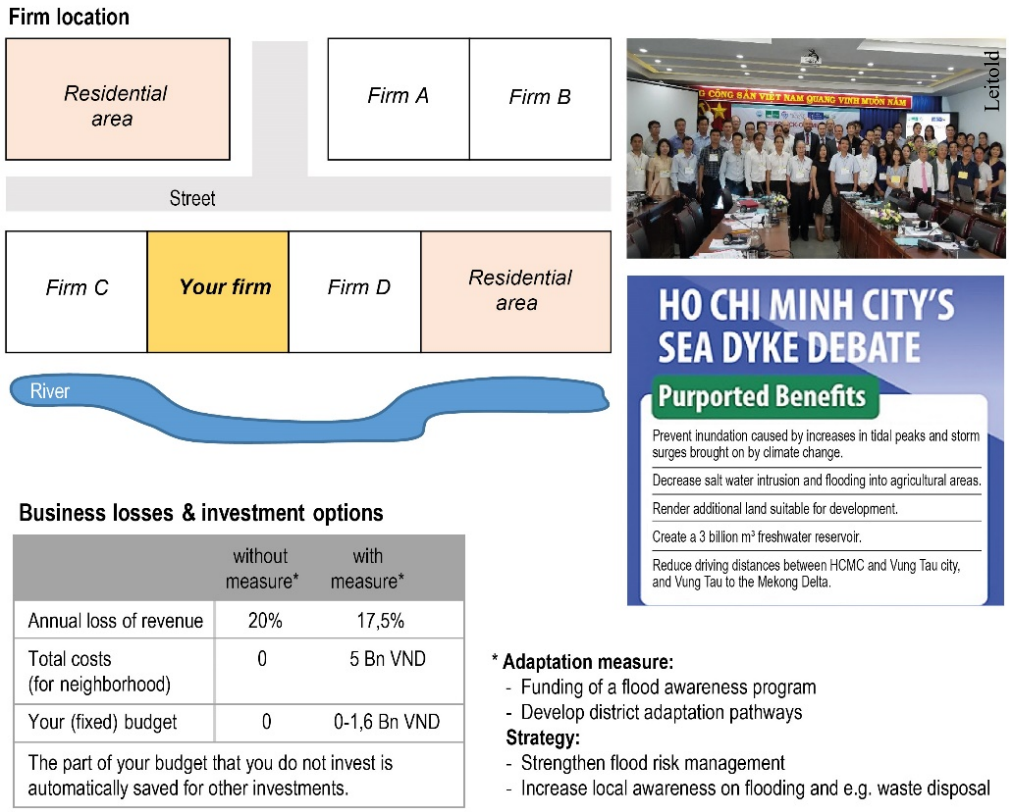


Fig. 6-6: Scenario card awareness program

Description of the setting:

- Aim of the measure: Fund a flood awareness program that will inform neighborhood firms and residents on waste disposal, flood risks, and so forth, thereby raising local awareness about flooding issues and strengthening flood risk management.
- The awareness program will reduce your annual economic losses by 12.5 %.
- Total cost of the flooding awareness program: 5 Bn VND
- Your budget: 0–1,6 Bn VND

Photo credit: Mekong Eye (2018) Noose or life ring: Ho Chi Minh City's proposed super dyke. https://www.mekongeye.com/2018/11/27/noose-or-life-ring-ho-chi-minh-citys-proposed-super-dyke/

Supplementary Material - Online Resource 2

Tab. 6-4: Independent variables: scenario, firm and commune-level characteristics

Level	Variable	Description	Obs.	Mean	Std. Dev.	Min	Max
Scenario level*	Relocation option	Scenarios with relocation option (A)	1,020	0.25	0.43	0	1
	Soft measure	Scenario awareness program (D)	1,020	0.5	0.50	0	1
	Community contribution	Residents contribute financially (A1, B1, C1, D1)	1,020	0.2	0.40	0	1
	Balanced contribution by firms	Required amount of contribution is equally distributed by all firms (A2, B2, C2, D2)	1,020	0.2	0.40	0	1
	Unbalanced contribution by firms	Firms need to invest more than the other firms (A3, B3, C3, D3)	1,020	0.2	0.40	0	1
	Political support	Authorities contribute financially (A4, B4, C4, D4)	1,020	0.2	0.40	0	1
	Political pressure	Authorities demand financial contribution of firms (A5, B5, C5, D5)	1,020	0.2	0.40	0	1
Firm level**	Firm size	Number of employees	1,020	66	82.96	3	250
	Expected growth	Expected revenue growth in the next five years	1,020	0.63	0.48	0	1
	Good financial resources	Rating of financial resources for flood adaptation (rating from 1-5, good equals 4 and 5)	1,020	0.35	0.48	0	1
	High flood exposure	Firm was affected by floods more than once a year for the last five years	1,020	0.31	0.46	0	1
	Individual flood adaptation	Firms are implementing flood adaptation measures individually	1,020	0.63	0.48	0	1
	Firm responsibility	Highly rated firm responsibility to undertake flood-protection measures (rating from 1-5, high equals 4 and 5)	1,020	0.31	0.46	0	1
	Support during flood events	Firms have already received flood support from the government	1,020	0.08	0.29	0	1
	Access to credit	Firms have access to external sources such as loans and credit	1,020	0.49	0.50	0	1
	Collaboration local firms	Firms already collaborate with firms in the neighborhood to enhance competitiveness	1,020	0.49	0.50	0	1
	Collaboration district firms	Firms collaborate with firms in the same district to enhance competitiveness	1,020	0.43	0.50	0	1
	Collaboration suppliers	Firms collaborate with firms in the value chain to enhance competitiveness	1,020	0.92	0.27	0	1

	Collaboration BA	Firms collaborate with business associations to enhance competitiveness	1,020	0.31	0.46	0	1
	Collaboration PC	Firms collaborate with the People's Committee to enhance competitiveness	1,020	0.57	0.50	0	1
	Stakeholder collaboration	Firms collaborate with NGOs, consultancies, or the civil society to enhance competitiveness	1,020	0.18	0.38	0	1
Com-mune level***	Number of SOEs	Number of SOEs (more than 50 % state shares)	1,020	3	2.51	0	11
	Number of FDIs	Number of foreign manufacturing firms (100 % FDI, FDI + joint ventures, FDI + private shares)	1,020	12	29.58	0	129

7 Synthesis and concluding discussion

This dissertation starts by characterizing the research gap on firm responses to natural hazards, their adaptation efforts, and the factors influencing firms' decision-making. Therefore, the aim of this dissertation is to enrich adaptation literature by integrating firms' perspective and reflecting on the role of firms in collective adaptation by answering the respective research questions (see Section 2.4). In what follows, the empirical results, the conceptual added value, and methodological lessons learned are presented. Derived from these results, policy makers are offered advice on how to encourage adaptation action from (manufacturing) SMEs against future risks and to realize their potential for collaborative initiatives.

7.1 Empirical results

The empirical results of this dissertation add important insights from the particular case of HCMC toward the broader understanding of flood impacts on firms as well as their individual and collective adaptation measures. The results are summarized according to the guiding research questions:

The newly developed methodology for linking firms' locations to future SLR projections shows that the predicted SLR is likely to affect manufacturing activity in HCMC **(RQ1)**. The map presented in Chapter 4 demonstrates that more than half of the geocoded firms are located in two hot spot areas of future exposure. Particularly important manufacturing areas in the eastern districts close to the Saigon River, as well as some western areas of lower elevation outside of the city center are highly exposed to future flooding. Although I have used a simplified elevation model for the analysis, recent studies on future SLR in HCMC (e.g., Scussolini et al., 2017) support these results at the macro-spatial level. While private SMEs operating in labor-intensive industries are of great economic and social importance, they represent the largest share of firms in the identified areas.

In addition to the overall exposure to future floods, as once explicitly stated for the selected case study of HCMC, it is necessary to take into account the flood impacts already experienced by firms in order to understand the extent to which they are responding to current and future risks. Results of the semi-structured interviews in flood-prone areas of HCMC reveal that manufacturing firms are sensitive to different

sources of flooding (Chapter 5). Almost all of the firms reported indirect and wider effects, while more than half have already experienced direct impacts due to small-scale flood events (see Section 5.5). River flooding due to the recurring rise of the tides has become an accepted element of everyday life, while unpredictable storms and heavy rainfall lead to pluvial flooding, often with consequences such as damage to buildings, machinery, and even manufactured goods. This distinction is also reflected in a recent study on SMEs and urban floods in Asian megacities, which concludes that SMEs have normalized everyday floods and consider business disruption caused by major flood events as the most severe effect of flooding (Verrest et al., 2020).

Most of the firms interviewed already implement measures against regular floods, ranging from a few proactive and long-term ideas to many purely coping activities that are only active temporarily and are often used in parallel **(RQ2)**. The results demonstrate that the individual response of firms does not depend solely on flood impacts and experience, and indicate that the adaptive capacities of smaller, domestic firms and their larger counterparts differ significantly. The main firm-internal determinants that contribute to increasing adaptive capacity are financial liquidity, technical know-how and well-trained staff. Further, social capital has proven to be highly relevant in connection with the embedding of firms in international value chains and their location in export-oriented industrial parks. Foreign and export-oriented firms with high financial capital tend to be more structured in their strategies, even if they have not yet experienced the destruction of assets and stocks by floods. In some cases, they have already implemented proactive adaptation measures, taking into account future flood risks, such as raising the production sides, installing flood gates and pumping systems, and changing product delivery systems for their suppliers. These actions are forced and supported by guidelines and instructions from lead firms or customers. With regard to domestic SMEs, the results show that many of them are already suffering from business interruptions and damages, but lack the financial resources, technical know-how, and support to take effective adaptation measures. Existing coping measures rather focus on the safety of workers, materials, and products instead of implementing long-term strategies (e.g., by using sandbags, blocking doors and windows, moving materials and products to higher ground). This in turn leads to a self-reinforcing effect, increases their flood risk and jeopardizes their future economic viability. Insights from another regional context in Indonesia imply similar results

(Neise and Revilla Diez, 2019). In summary, firms that already suffer damage and losses from floods tend to act on short notice in the event of flooding, but lack long-term adaptation strategies. In contrast, and against the general assumptions (e.g., Agrawala et al., 2011), firms that are currently the least directly affected are already best prepared for future impacts.

The qualitative interviews also reveal that some firms remain inactive and do not apply systematic adaptation to prevent flood impacts, even if they have sufficient financial resources and know-how. For this reason, the empirical analysis in Chapter 5 goes beyond these first insights and in a second step explains why the adaptive capacity of firms is not more often turned into effective adaptation measures and why various barriers to adaptation persist **(RQ3)**. First, there is an inherent mismatch between the manager's awareness of future climate risks and the perceived potential level of flood risk to their own business. Although they have basic knowledge on the effects of future climate change in HCMC, firm leaders of SMEs often do not transfer and apply that knowledge to their own situation. Small and recurrent floods are not considered a major business risk. Thus, SMEs give priority to other urgent risks (e.g., emergence of competitors, labor shortages, economic crises) and short-term profit maximization goals (Linnenluecke et al., 2013). Second, the results emphasize the importance of structural factors, such as the dynamic effects of external (supply chain) management and state intervention on adaptation action. Lack of managerial awareness and uncertainties in who shoulders the responsibility for flood protection are intertwined with and reinforced by political transformation and economic liberalization processes. In the Vietnamese case, the transformation in the political system partly shifts responsibilities from a former socialist risk management to a more neo-liberal risk management strategy at the individual level (see Section 3.1.1). Still, it remains unclear exactly which tasks are assigned to the private sector within the new state risk reduction policy. The information does not seep into the business environment of small firms, and they do not receive support and guidance on individual adaptation practices. So far, SME decision-makers have tended to rely on large-scale public solutions, as they generally see the responsibility for action as lying with local authorities or industrial park administration. Further, some institutional constraints have proven to be highly relevant structural barriers to adaptation. Due to pressing urban development, manufacturing firms are confronted with relocation policies and uncertainties about

future production locations. In addition, they often lack permits to implement small-scale structural adaptation measures (i.e., the physical modernization of their production facilities), which leads to *wait-and-see* strategies and adaptive inaction, at least to some degree. Insights from regional contexts elsewhere, such as Thailand (Marks and Thomalla, 2017; Pathak and Ahmad, 2018) and Greece (Halkos et al., 2018), imply similar findings concerning institutional barriers and insufficient guidance and support mechanisms.

Only a few bottom-up collective initiatives by firms for flood protection can be identified. Chapter 6 provides empirical evidence on the willingness of SMEs to invest in collective flood adaptation measures using future-oriented scenario-based field experiments. A key finding is that participation in collective adaptation requires different enabling factors for SMEs compared to individual adaptation, especially in the external firm environment. Strong local ties, such as interaction with neighboring firms in local business networks or the district councils, increase the probability of participation. In contrast, sufficient financial resources, the receipt of government support, and already implemented flood protection measures reduce the need to participate in collective action. Thus, although generic adaptive capacity is present, it is often not activated. This argument is also reflected in the analysis by Neise et al. (2019) on firms' investment in collective adaptation measures in Indonesia. Moreover, and compared to the results at individual level, the probability of participating in collective flood adaptation increases when firms are already directly impacted by floods. On a more general note, the findings indicate that collective adaptation is considered to be a response when firms do not have sufficient financial resources to deal with the experienced flood impacts on their own.

This case study leads to the assumption that SMEs have not yet exhausted their adaptation potential, but provides some first indications about the role that SMEs can play in adapting to future flood risks **(RQ4)**. The decision for or against adaptation measures by SMEs is influenced by complex individual and place-based interrelations. Local authorities do not yet see SMEs as a priority for flood adaptation in particular and private sector involvement in general. As SMEs thus fall by the wayside, the perception of them as decision-makers regarding future climate change impacts, as well as their own responsibilities within respective adaptation pathways, has not changed.

However, flood risks are an increasingly pressing issue and SMEs will be called upon to take action in the future and bear a major part of their adaptation costs.

With regard to their possible role in collective initiatives, the experiments in Chapter 6 provide new results that show that SMEs are generally willing to invest in local adaptation measures under certain circumstances. They have clear preferences for the design of the respective measures and generally refuse and poorly understand the relocation of business sites as an anticipatory mechanism (Linnenluecke et al., 2011). Although public risk reduction focuses on large physical infrastructure measures (see Section 3.1.1 and 3.1.2), the decision-makers of SMEs prefer to invest in less capital-intensive soft measures that meet local needs, such as promoting awareness programs and modernizing the drainage system. This is an encouraging result, as it strengthens local know-how and capacity building. In terms of stakeholder involvement, SMEs prefer to invest in measures that are developed and financed jointly with the community, other firms in the neighborhood, and, above all, with the local government. In the same vein, business networks and both formal and informal relationships with local district representatives are potential ways of giving SMEs a voice in integrated solutions and articulating their needs and capacities. Compulsory levies for physical measures, on the other hand, oblige firms to make a short-term financial contribution, but do not lead to increased adaptive mindsets in the long run. In summary, the empirical results show that greater involvement of SMEs seems a promising and optimistic approach, but is not a panacea to compensate for poor public adaptive capacities. Rather, they reveal a mismatch between the responsibilities transferred to private firms and the actual measures taken on the ground.

7.2 Conceptual contributions

What lessons can be drawn from this dissertation for research on the responses of firms to floods? In addition to the empirical findings, integrating the perspective of firms in research on climate change adaptation brings about important conceptual advancements in the following ways.

The role of firm-specific adaptive capacities has been elaborated in order to open the black box of firms' responses to natural hazards (Daddi et al., 2018; Linnenluecke et al., 2011). In this respect, the present study has taken a closer look at the differences in

adaptive capacities that lead to a number of measures ranging from proactive adaptation to reactive coping mechanisms (Chapter 5). Focusing on firms' adaptive capacities is particularly important when seeking explanations for following action or inaction strategies at the level of firm characteristics. Financial resources, specific technological know-how, dynamic capabilities, and the social integration of firms in their sectoral and local business environment have all proven to be relevant when it comes to the implementation of long-term adaptation strategies. This finding demonstrates that firm-specific adaptive capacities are closely linked to generic factors that have been identified in debates on economic development, and increasing competitiveness of SMEs in developing countries and emerging economies (Neise et al., 2018; Trinh and Thanh, 2017).

Closely related to these findings, this study highlights that the conceptual distinction between adaptive capacities and the actual implementation of adaptation measures proved necessary to understand the decision-making of firms. The empirical results clearly show that adaptive capacity is often potentially available, but not always turned into future-oriented adaptation measures. The focus on more specific determinants of decision-making at various levels of influence (see Section 2.4) thus fills a critical but previously marginal analytic space (Pelling et al., 2015). The determining factors for activating the adaptive capacity of firms at the individual, and external level were elaborated both theoretically from action-based, institutional and governance perspectives, and inductively from the empirical results. Factors at the managerial level, such as perceived responsibility, risk perception, trade-offs with other risks, and opportunity costs are often reinforced and influenced by a number of external structural factors. The empirical results show, for example, that, especially in transition countries such as Vietnam, the changing formal regulations in DRM lead to external uncertainties and unclear responsibilities that are reflected in individual decision-making.

In the same line, the research framework reconsiders the role of future flood exposure and previous flood impacts and experiences for adaptation action. The results reveal that future flood exposure often leads to a general, normative understanding of *what should be done to reduce flood risks* rather than actually initiating long-term adaptation measures on the ground. Specific risk perception is more likely to be derived from impacts and losses already experienced, regardless of future exposure and conditions, which are considered uncertain and may change. What has been clearly demonstrated,

however, is that both flood impacts and risk perception do not automatically lead to adaptation action. In fact, their role differs for the implementation of individual and collective measures.

Further**,** this study contributes to extending the individual adaptation perspective by assessing factors that might influence participation in collective initiatives using a scenario-based, future-oriented methodology (Section 6.2.2). The methodology developed here allows for a critical assessment of the general willingness of SMEs to participate financially in adaptation measures, and provides new insights into preferences on the design of collective initiatives as well as the actors involved for the further development of integrated adaptive governance approaches (Chapter 6). In this way, bridging between impact horizons, adaptation scales, and the actors involved has provided a useful overview of future adaptation possibilities. The derived results contribute to a better understanding of why collective adaptation has been sparse so far. It shows that the local implementation of collective flood adaptation is not only determined by the adaptive capacity of firms, but rather by an interwoven network of aspirations, considerations, preferences and opportunities for firms and their local environment.

More generally, this study meets the recent critique of leaving SMEs outside the observation horizon (Averchenkova et al., 2016). It generates new insights on how to integrate private sector perspectives into broader risk reduction and climate change adaptation by discussing both adaptation potentials and barriers. Knowledge about adaptation financing and efforts of large and often multinational companies is not transferable to SMEs. On the contrary, it becomes clear that SMEs have a dual role to play. First, they bear a large part of the impacts and costs that threaten their viability and, second, they hold relevant capacities and knowledge for integrated adaptation efforts. In this sense, these conceptual contributions point to the need to link adaptation agendas with the debate on regional economic development in general, and on improving the competitiveness and business performance of SMEs in particular, always taking into account local, place-based specificities.

In summary, this study underlines the added value of integrating the perspective of firms, and especially SMEs, into research on adaptation and adaptive governance. It has highlighted the great importance of opening the so-called black boxes on the

capacities, needs, and guiding principles of SMEs in order to improve and rescale their assigned role for risk reduction and adaptation to climate change in the future.

7.3 Policy implications

Based on the above insights, this section derives implications and recommendations for Vietnamese policy-makers, international organizations, and other actors in the fields of risk reduction, climate change adaptation, and regional development.

(1) The findings call for a more specific understanding of the private sector's engagement in future adaptation approaches. Due to the hybrid character and the different adaptive capacities and needs of the business landscape, it is necessary to define specific roles and responsibilities in relation to different economic sectors and firm types. The adaptation possibilities of local SMEs in the manufacturing sector must be understood differently from the financial investment of large multinational and state-owned firms in risk-reducing hard and grey infrastructure in Vietnam. The integration of and cooperation with the majority of the business landscape – smaller local firms – goes beyond a question of financing adaptation infrastructure, to becomes question of capacity building, the use of place-based embedding, and close neighborhood relations. Accordingly, there is an urgent need to pay increased attention to the twofold adaptation perspective of SMEs *(protection vs. potential)*. On the one hand, national and local policies should protect SMEs from hazard impacts by including them in the overall adaptation horizon and developing sector- and company-specific support mechanisms. On the other hand, SMEs should be integrated into larger public adaptation efforts and local risk management systems to benefit from their adaptive capacities and local knowledge, as recognized by the Sendai Framework for Disaster Risk Reduction 2015–2030. In this sense, bottom-up and soft adaptation at the local level must also be promoted and used.

(2) Encouraging SMEs to prioritize flood risk and its management should be a key priority, as changing perceptions of risk and responsibility have been found to be critical components of adaptation action. Yet, the direct link between the need to adapt to future climate change and sustainable business growth is not sufficient (Frei-Oldenburg et al., 2018). Raising awareness of and explaining personal ownership of climate change adaptation are therefore concrete starting points for

stimulating proactive adaptation behavior. Furthermore, the business and competitive advantages of a long-term adaptation strategy should be outlined for SMEs. This requires forward-looking knowledge and its public dissemination about the location, timing, and extent of flood risks, which should be a much more important agenda item for the risk management of public authorities.

(3) Building on the above, SMEs need effective guidance, incentives, and support mechanisms to improve proactive adaptation. A step forward in Vietnam is the recent introduction of the *Small and Medium Enterprise Development Fund* (SMEDF) by the Ministry of Planning and Investment. This fund defines a list of priority sectors for SME support, including support programs with loans and consultancies for SMEs to prepare for and recover from disasters (ADPC, 2017). A major challenge will be to transfer this fund and the advisory services from the national to the local level, build capacity for implementation and distribution, and make it equally accessible. Nevertheless, further mobilization of earmarked financial flows and the simultaneous dovetailing of governmental and non-governmental incentives is necessary to promote adaptation action of SMEs. To preserve some of the existing financial leeway for other business investment and technological innovations, a robust system of different insurance schemes for adaptation and social protection could be a parallel approach. As there is so far little indication about the introduction of disaster risk insurance in Vietnam, creating the political conditions for the establishment of an insurance system (e.g., access to market data) as in other ASEAN countries (e.g., Thailand and Malaysia) is a top priority (UNDP, 2019).

(4) In addition to creating strong sectoral partnerships between local producers, suppliers, and lead companies within the value chains of the manufacturing sector itself, the results emphasize the strengthening of the horizontal network idea at local level. This implies better use and selection of multiplier organizations and agents such as the VCCI and, at a smaller scale, local business associations, in order to network local communities, promote bottom-up actions, and to trigger the transfer of information, guidance, and support from higher political levels. To increase better communication between governmental agencies and local firms, and facilitate SME participation in local partnerships, other actors such as universities, NGOs, and international (donor) organizations should be further engaged. For instance, the GIZ program *Strengthening the Capacities of the*

Private Sector to Adapt to Climate Change (PSACC) has focused on supporting private sector multipliers like chambers of commerce, business associations, and industrial park management in different countries of the Global South to offer trainings and consulting services for SMEs on awareness raising, adaptation options, and financing possibilities.

(5) Results show that SMEs' decisions to engage in the local implementation of collective adaptation initiatives is strongly influenced by opportunity costs and cost-benefit calculations. SMEs that are interested in collective action are already directly impacted but have generally not yet invested in individual adaptation measures. The results also underline the need to reconsider dominant adaptation solutions in order to increase the involvement of the private sector. Collaborative adaptation approaches should not only be based on the co-financing of large infrastructure projects, but also on small-scale measures recognized by firms, which meet local needs and strengthen local ties. This could not only be an important step toward realizing the intermediary role of SMEs between the global level and local communities (Pauw and Chan, 2018), but also address for solid cooperation between different actors such as large companies, SMEs, public authorities, and local communities, based on knowledge sharing and capacity building.

Finally, while the participation of SMEs seems promising, it is not a panacea. It must be borne in mind that effectively integrating the perspective of SMEs into top-down risk reduction strategies, and strengthening their role in multi-stakeholder initiatives on climate change is a promising but also challenging task for national and sub-national government agencies. Since the political and economic transformation of Vietnam is ongoing, the country needs far-reaching legal and regulatory reforms to promote clear coordination between the central, provincial, and local levels of government and other stakeholders, such as the private sector and NGOs. In particular, the creation of conducive conditions that facilitate SME adaptation requires a clear allocation of responsibilities within flood risk reduction and adaptation approaches. Despite all these difficulties, a serious examination of the above-mentioned implications is valuable and relevant for initiating sustainable development pathways in the future.

7.4 Reflections and recommendations for future research

Given the relatively limited amount of published studies on flood impacts and adaptation of firms, particularly in Vietnam, this dissertation starts with an exploratory design. The combination of a large-scale exposure assessment (Chapter 4), exploratory semi-structured interviews (Chapter 5), and a quantitative scenario-based firm survey (Chapter 6) offers a far-reaching test of possible explanatory factors for firms' participation in individual and collective adaptation measures. Nevertheless, there are some limitations on methodology and resulting data that need to be mentioned. In addition, the results obtained open several scientifically and socially relevant avenues for future research.

First, the methodology presented in Chapter 4 provides a general overview of the exposure of manufacturing firms to future SLR in the urban area of HCMC. At the same time, the use of a basic elevation model leads to several uncertainties regarding the interpretation of the results at finer scales (see Section 4.3.3). Therefore, only cautious statements can be made on the basis of the data, which need to be further verified at various levels. Future research should combine the localized, spatial distribution of firms with a suitable, up-to-date hydrological model, which, in addition to SLR, implies various mutually reinforcing processes, such as subsidence, precipitation, upstream water releases, and land use changes. Predictions of future economic and social developments should be taken into account along with current patterns of firm location in order to make more detailed statements about future socio-economic risks. The *DECIDER* research project will further investigate these options in the coming years.

Second, the semi-structured interviews with firm leaders were essential in two respects. On the one hand, they offered insights about the range of current flood impacts, the adaptation measures that have been implemented so far, and the factors that influence decisions on adaptation actions. On the other hand, the interviews yielded important basic information for the conceptualization of the scenario-based field experiments. However, this method is not free of epistemological challenges and limitations. Due to the exploratory and time-consuming implementation, the number of interviews is limited and the results are therefore not representative. It is not a complete collection of information on the adaptation measures and strategies introduced, among others. I tried to address this problem by cross-triangulating the results, discussing them with

other scientific experts and comparing them with available reports, secondary data, and policy documents. The firm leaders considered some issues to be politically sensitive, and often refused to answer questions on the investment and business indicators or on the evaluation of government support measures. These knowledge gaps could only be partially filled through the expert discussions. It should be noted that insights on the political commitment to supporting the private sector in flood relief is still very limited. Further research should take this problematic issue into account and respond with an in-depth analysis of policy ambitions and realities, with particular attention on the impact on the private sector.

Third, the implementation of the scenario-based field experiments is subject to barriers and limits. Since the experiments are conducted by different individuals, the scenario situations are presented in slightly different ways, which can lead to differences in the subjects' understanding. The standardization of given background information and vignettes (Oll et al., 2018) was attempted, but was not always successful despite intensive training. In addition, despite the precise cleaning of the data, the transfer of paper-based survey documents to computer-based Excel spreadsheets leaves room for manual error, which has been reduced by several cross-checks. With regard to local collaborations of firms, most of the questions were answered with *yes* or *no* responses instead of a qualitative expression (e.g., days per month). This study therefore only shows that different local relationships and networks have an influence on the willingness to participate in collective initiatives, but cannot make any statements about the degree of intensity. Further research could continue along this path and attempt to add other methods, such as qualitative focus group discussions with various local actors, to go deeper into the field of local relations. Another relevant avenue of investigation is the quantitative investigation of cross-causality relationships of factors influencing SMEs' decision-making, which requires a higher number of scenario-based field experiments.

Fourth, in interpreting the results, issues of social expectation and language barriers could not be completely avoided. In order to minimize language barriers, the research assistants conducting the interviews in Vietnamese received intensive training about research intention, the project, and the overall objectives. In addition, I was present at all interviews and most of the experiments in order to immediately answer any questions and to experience as many interview situations as possible. After each

interview or experiment, I discussed the results with the assistants as early as possible in order to minimize translation issues and retain as much information as possible. In these discussions, the problem of social expectation was also considered. For example, some questions on relocation policies and the evaluation of institutional support might not have been answered honestly. As a result, they were removed from the questionnaire or reformulated in close consultation with local partners. Particularly problematic in this regard remains the supervision of local district officers in some appointments. The survey team attempted to address this problem by asking some introductory questions during the first five minutes until the local government representatives left the survey situation. Nevertheless, some firm owners seem to be intimidated by the initial presence of the officials, a factor which was taken into account when interpreting the results.

Fifth, the results cannot be automatically transferred to other firms and sectors in different field settings. Although this dissertation provides initial epistemological steps for understanding concrete firm decisions on future flood risks, further differentiated analyses will be necessary to better understand the potentials and barriers of private sector adaptation (Linnenluecke and Smith, 2018). Future studies should use scenario-based research in order to gain insights into possibilities of firm participation under different contextual environments. The focus, first, on value chain analyses to understand decision-making powers within further contextual circumstances and, second, the differences in adaptive capacities between formal and informal firms (e.g., household businesses) are only two exciting starting points to be mentioned here. Furthermore, findings on tipping points in adaptive capacity and adaptation processes (Garschagen and Solecki, 2017) against the consideration of other business risks are of great interest in order to understand the extent of commitment to future climate change adaptation.

Sixth, this dissertation offers an analysis of actor-centered decision-making processes. However, the methodology does not provide a sufficient overview of assessments at the regional level. Therefore, future research should broaden the view on the implications and actual outcomes of the respective adaptation measures at the regional level and over time. A very pressing question is the extent to which current private sector adaptation can influence future regional adaptation and, more generally, development pathways and economic growth.

8 References for Chapters 1, 2, 3, and 7

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Summary

Manufacturing firms in coastal areas of Southeast Asia are highly exposed to the risk of flooding, which will constantly increase by future climate and socio-economic changes. Although they play an important role in economic development in the form of job and value creation, small- and medium-sized enterprises (SMEs), in particular, are at the forefront of flood exposure and damages. However, detailed knowledge about experienced impacts and the ways in which firms adapt to these risks is surprisingly thin. To date, adaptation research has mainly focused on private households, small farmers, and state institutions.

This dissertation addresses this gap by exploring how firms respond to floods and by analyzing the role of their adaptive capacities in the decision for or against adaptation. Additionally, this dissertation offers an analytical framework on other determining factors, such as the individual attitudes of decision-makers, institutional conditions, and the local firm environment, which might influence firms' flood responses. Following a mixed-methods approach, primary empirical data was collected in Ho Chi Minh City in Vietnam, a hotspot of future climate risk. The study applies a three-step research design. In a first step, a spatial analysis of the exposure of manufacturing firms to future sea level rise is carried out. The findings reveal that the predicted sea level rise is probably likely to affect manufacturing activity in several areas of the city. In a second step, the flood impacts already experienced and adaptation measures implemented are analyzed based on semi-structured firm interviews. The results show that flood adaptation ranges from a few proactive steps and long-term ideas to many simple coping activities. A lack of business capabilities and financial capacity, combined with an insufficient support system, largely hampers proactive adaptation. Moreover, it is clear that the managers' risk awareness and perception is crucial for the implementation of adaptation measures. As participation in collective initiatives, especially among SMEs, remains low, scenario-based field experiments are applied in a third step to assess conditions that might determine cooperative behavior in flood adaptation. A key finding is that collective adaptation is a preferred response if SMEs are already severely impacted by floods, but have insufficient resources to deal with the effects individually. Further, strong local ties motivate SMEs to participate, while already receiving external support reduces the necessity to participate in collective initiatives. Thus, the handling of other business risks plays a crucial role in investment decisions.

With regard to the policy implications of this research, adaptation of the private economic sector appears to be a promising approach, but not a panacea. SMEs, in particular, should be encouraged to prioritize flood risk management, and above all they need effective guidance, incentives, and support mechanisms. On this point, the better use and selection of local multiplier agents and organizations is of key importance. Collaborative approaches targeting local SMEs should focus on small-scale actions that meet local needs and strengthen local ties, but not overstretch firm responsibilities. This dissertation thereby contributes to wider scientific and political debates about how to effectively integrate private sector perspectives into top-down risk reduction strategies, and strengthening their role in multi-stakeholder initiatives on climate change.

Zusammenfassung

Überschwemmungen sind eine Gefahr für das produzierende Gewerbe in den Küstengebieten Südostasiens, die durch künftige klimatische und sozioökonomische Veränderungen noch zunehmen wird. Kleine und mittlere Betriebe (KMU) sind durch die Schaffung von Arbeitsplätzen und die Einbindung in Wertschöpfungsketten für die wirtschaftliche Entwicklung Vietnams von zentraler Bedeutung; gleichzeitig stehen gerade KMU an vorderster Front der Hochwassergefährdung. Es gibt bislang jedoch überraschenderweise wenig Forschung über die bisherigen Auswirkungen der durch Überschwemmung entstandenen Schäden und die Art und Weise, wie sich Unternehmen an diese Risiken anpassen. Bisher hat sich die Anpassungsforschung hauptsächlich auf private Haushalte, Kleinbauern und staatliche Institutionen konzentriert.

Die vorliegende Dissertation befasst sich mit dieser Lücke, indem sie untersucht, wie produzierende Unternehmen auf Überschwemmungen reagieren und welche Rolle deren Anpassungskapazitäten bei der Entscheidung für oder gegen eine proaktive Anpassung spielen. Darüber hinaus bietet die Dissertation einen analytischen Rahmen, der weitere Faktoren wie die individuelle Einstellung von Entscheidungsträgern, institutionelle Bedingungen und das lokale Betriebsumfeld einbezieht. Die primären empirischen Daten wurden in Ho-Chi-Minh-Stadt in Vietnam, einem Zentrum des zukünftigen Klimarisikos, erhoben. Die empirische Analyse liegt einem Methodenmix zugrunde. In einem ersten Schritt wird eine räumliche Analyse der Exposition von Fertigungsbetrieben gegenüber dem zukünftigen zu erwartenden Meeresspiegelanstieg durchgeführt. Die Ergebnisse zeigen, dass davon auszugehen ist, dass der Anstieg des Meeresspiegels die Produktionstätigkeit in mehreren Gebieten der Stadt beeinträchtigen wird. In einem zweiten Schritt werden auf der Grundlage von Interviews mit Entscheidungsträgern von Fertigungsbetrieben die bereits erfahrenen Hochwasserauswirkungen und durchgeführten Anpassungsmaßnahmen analysiert. Es wird deutlich, dass die Hochwasseranpassung von einigen wenigen proaktiven und langfristigen Maßnahmen (proactive adaptation) bis hin zu vielen kurzfristig angelegten Bewältigungsaktivitäten (coping) reicht. Unzureichende finanzielle Kapazitäten und unzureichendes unternehmerisches Knowhow sowie ein mangelndes Unterstützungssystem behindern die proaktive Anpassung von produzierenden Unternehmen weitgehend und begrenzen so in vielen Fällen die unternehmerische

Handlungsfähigkeit. Zudem sind das Risikobewusstsein und die Risikowahrnehmung der unternehmerischen Entscheidungsträger für die Umsetzung von Anpassungsmaßnahmen entscheidend. Da die Beteiligung an kollektiven Initiativen insbesondere bei KMU nach wie vor gering ist, werden in einem dritten Schritt szenariobasierte Feldversuche durchgeführt, um die Faktoren zu bestimmen, die das kooperative Verhalten bei der Hochwasseranpassung beeinflussen. Eine wichtige Erkenntnis ist, dass die Investition in kollektive Anpassungsmaßnahmen dann bevorzugt wird, wenn KMU bereits stark von Überschwemmungen betroffen waren, aber nicht über ausreichende Ressourcen verfügen, um individuell auf diese Auswirkungen reagieren zu können. Während starke lokale Bindungen motivierend auf KMU wirken, verringert bereits erhaltene externe Unterstützung die Notwendigkeit zur Teilnahme an kollektiven Initiativen. Hierbei spielt der Umgang mit anderen Geschäftsrisiken eine entscheidende Rolle für die Investitionsentscheidungen.

Es lassen sich folgende politische Implikationen aus dieser Forschung ableiten: Anpassungsmaßnahmen des privaten Wirtschaftssektors sind ein vielversprechender Ansatz, aber kein Allheilmittel. Insbesondere KMU sollten ermutigt werden, dem Hochwasserrisikomanagement eine höhere Priorität einzuräumen. Hierfür sind wirksame Anleitungen, staatliche und nichtstaatliche Anreize und Unterstützungsmechanismen sowie die bessere Auswahl und Nutzung lokaler Multiplikatoren und Organisationen von zentraler Bedeutung. Kooperative Ansätze in Form von Multi-Stakeholder-Initiativen sollten sich auf kleinräumige Aktionen konzentrieren, die den lokalen Bedürfnissen gerecht werden und die bereits vorhandenen lokalen Bindungen stärken, die Verantwortlichkeiten von Unternehmen jedoch nicht überstrapazieren. Zusammenfassend leistet die vorliegende Dissertation einen wichtigen Beitrag zu einer wissenschaftlichen und politischen Debatte darüber, wie die Perspektiven des Privatsektors, und insbesondere der KMU, wirksam in top-down Strategien zur Risikominderung integriert und ihre Rolle in Multi-Stakeholder-Initiativen zum Klimawandel gestärkt werden können.

Appendix A: Supplementary material

List of interviews with manufacturing firms

Code	Size	Staff	Industrial Park	Origin	Main Product	Date
MI-1	Micro	6	no	Private	Printing	22/10/2018
MI-2	Micro	6	no	Private	Construction	28/10/2018
SM-1	Small	10	no	Private	Construction	14/11/2018
SM-2	Small	10	no	Private	Construction	14/11/2018
SM-3	Small	15	no	Mix	Transport equipment	22/03/2019
SM-4	Small	16	no	Private	Plastic products	31/10/2018
SM-5	Small	25	no	Private	Textiles	30/10/2018
SM-6	Small	27	no	Mix	Mechanical products	31/10/2018
SM-7	Small	30	no	FDI	Mechanical products	14/03/2019
SM-8	Small	40	no	Private	Steel products	29/10/2018
ME-1	Medium	63	no	Private	Plastic products	30/10/2018
ME-2	Medium	90	no	Private	Light bulbs	22/03/2019
ME-3	Medium	100	yes	Private	Painting products	26/02/2019
ME-4	Medium	100	no	Private	Beverages	12/03/2019
ME-5	Medium	100	no	Private	Refrigeration products	23/03/2019
ME-6	Medium	100	no	Private	Flowers	23/03/2019
ME-7	Medium	115	no	Private	Beverages	14/03/2019
ME-8	Medium	130	yes	FDI	Food Processing	25/10/2018
ME-9	Medium	130	yes	Private	Paper products	22/03/2019
ME-10	Medium	200	yes	FDI	Fertilizer	26/02/2019
ME-11	Medium	200	no	Private	Textile products	23/03/2019
LA-1	Large	260	yes	FDI	Electronic spare parts	20/02/2019
LA-2	Large	300	no	Private	Plastic products	12/03/2019
LA-3	Large	300	no	Private	Precision molding	22/03/2019
LA-4	Large	680	yes	FDI	Electronic spare parts	20/02/2019
LA-5	Large	800	no	Private	Pharma products	23/03/2019
LA-6	Large	920	yes	FDI	Hydraulic valves	20/02/2019
LA-7	Large	1000	no	Private	Textile products	23/03/2019
LA-8	Large	1000	no	Private	Textile products	23/03/2019
LA-9	Large	1000	no	Mix	Electronics	23/03/2019

List of expert discussions

Type of organization	Institution	Location	Date
Scientific institute	People's Committee's HCMC Institute for Development Studies (HIDS)	HCMC	06/10/2018 15/10/2018
Scientific institute	Centre for Economic and Financial Research, University of Economics and Law (UEL), Vietnam National University	HCMC	07/10/2018 several times
Scientific institute	Southern Institute of Water Resources Research (SIWRR)	HCMC	06/10/2018 several times
Scientific institute	Central Institute for Economic Management (CIEM)	Hanoi	13/10/2018 13/09/2019
Scientific institute	Center of Water Management and Climate Change (WACC), Institute for Environment and Resources (IER), Vietnam National University	HCMC	29/10/2018 22/10/2019
Scientific institute	Center for regional and urban studies (CRUS), Ho Chi Minh City Union of science and technology associations	HCMC	12/09/2019
Governmental authority	Steering Center of the Urban Flood Control Program, Ho Chi Minh City	HCMC	27/02/2019
Governmental authority	Tan Kien Commune People's Committee	HCMC	02/10/2019
Governmental authority	People's Committee of An Lac Ward	HCMC	11/10/2019
Governmental authority	Ba Diem Commune Committee	HCMC	25/10/2019
Business association	Delegation of German Industry and Commerce Vietnam (AHK)	HCMC	09/10(2018
Business association	Vietnam Chamber of Commerce and Industry (VCCI), HCMC Branch	HCMC	25/10/2018
Business association	Small and Medium-Sized Enterprises Promotion Center	HCMC	30/10/2018
Business association	Business Association of Tan Binh district	HCMC	23/03/2019
International Organization	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)	Hanoi	10/10/2018
International Organization	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)	HCMC	20/10/2018

Guideline for semi-structured firm interviews[13]

General information about the firm

- Could you please give us a short overview about your firm?
    - Amount of employees/factories/subsidiaries? (where)
    - Ownership (Household business, state enterprise, JV, collective/cooperative, foreign-owned, private domestic)
    - Products, market, supplier (how many, where? E.g., international, domestic market?)
    - Sales per year?
- When did you establish the firm? (firm owner, formal registration, when?) How long do have you been working for the firm (employee)?
- Where do your employees come from/live?
- What were the main factors for choosing this production site for your firm?
- Did this firm merge with (take over) another enterprise? If yes, when?

Risk perception/exposure/impacts of flooding

- What risks had your firm to deal with in the past?
- How did you handle these risks?
- Which persons are responsible for strategic and risk management in your firm?

Flooding November 2018 (If not spoken about flooding himself/herself)

- Have you been impacted by the storm and flooding at the end of November last year in HCMC?
    - How severe have you been impacted? Could you estimate the costs of this particularly flooding event?
    - How did you handle the situation? Which persons and institutions were involved?
    - Have you experienced flooding like this before?

Flooding in general

- Are regular flooding/extreme flooding events affecting your way of doing business?
- Is your firm directly exposed to flooding?
    - To what extent? How often is your firm affected by flooding per year and the last five years?
    - How much are the costs of damage (per year)? Which damages, losses and problems did you experience in the past?

[13]The interview guide is based on the methodology of Neise (2019), but was further developed and adapted to the Vietnamese context.

    - Which part(s) of your business is (are) particularly exposed?
    - Does your firm has ever been closed or stopped production due to regular flooding or extreme flooding events? How many days?
    - Have you ever lost customers due to the impacts of flooding?
- Is your firm indirectly exposed to flooding? (E.g., by infrastructure problems, suppliers or the changing demand?)
- What do you think, how probable is flooding in your neighborhood, in HCMC and Vietnam overall?
- In your opinion: Did the occurrence and/or magnitude of flooding increased or decreased in the past years? (regular flooding and extreme flooding?)
- How do you extend your knowledge about how to reduce the effects of natural hazards? What are your sources of information? Is this information sufficient for you?

Adaptation procedures

Adaptation is understood as a strategic decision such as protection measures (dikes, lifting up the street etc.) or change in business activity

- Did the impact of flooding changed your kind of doing business?
- What are you currently doing in order to reduce the impacts of flooding and to enhance your competitiveness?
    - What actions do you undertake to minimize the risk of flooding in advance?
    - How do you react immediately in case of an acute flooding event? (e.g., in November 2018, if not spoken about this)
    - Could you please give us an example how a typical process of adaptation proceeds? Which people and institutions are involved, who takes decision? How much time do you spend for the reaction?
    - Do you have sufficient resources to undertake 1. short-term and 2. long-term adaptation? Which resources are lacking?
    - Do you have any formal or informal (e.g., savings) flooding insurance?
    - How effective do you think are your actions? Are your adaptation initiatives sufficient? What was the reason of insufficiency?
- Do you have any strategic adaptation plans or ideas concerning flooding events for the future?

Relocation

- Have you changed the location of your firm in the last ten years?
    - What was the reason (e.g., expansion, exposure to floods, political willingness)?
    - Which factors were important for your choice of location?
    - Are you satisfied with the decision?
- Do you plan to relocate your firm?
    - What are the reasons (e.g., expansion, exposure to flooding, political willingness etc.)
    - Do you already know where to relocate?
    - Which factors are important for your choice?

Investment

- Do you have any medium or long term investment ideas? (human capital, technology, expansion etc.) If not: why?
- Does the uncertainty to flooding influence your investment decisions?

Collective initiatives

- Do you engage in any collective initiatives or cooperation (social, environmental, business cooperation)?
- Does your firm collaborate with other actors (jointly cooperation) to reduce the risk of flooding?
    - Type of cooperation?
    - Could you please explain the cooperation (intensity)?
    - What are the advantages/ disadvantages of the collaboration?
    - Local, regional or national?
- If you talk to other partners/managers, is flooding a topic of discussion?
- Do you know about initiatives/measures which aim to reduce the exposure in your neighborhood? Would it be interesting for you to take part in a social initiative (against flooding)?
- Which measures (e.g., for your neighborhood) should be undertaken in the future? How urgent are they and who should be responsible to cover the costs for protection measures?

Institutional setting

- Do other actors (other firms, political actors, NGOs) play a role in order to handle risks due to flooding?
    - Which actors? Please explain.
    - Have you learned from other actors to improve do deal with flooding? What did you learn to improve, e.g., your protection measures or daily business?
- Do you have the impression that the state authorities are taking care of your problems?
    - In which form and by whom do you receive support concerning flooding issues?
    - Do you have the impression that the state hampers the adaptation to flooding? How do you handle these disadvantages? Was there any change due to the support within the last years?
- Does political action influence your strategic decisions?
    - In terms of: Decision of firm location?
    - In terms of: Adaptation initiatives?

Final of discussion

- Is there anything you want to add to our discussion?

SME survey

We hope that you will spend about 40 minutes for discussion with us in order to have more input to build flood response scenarios. The information below will be kept anonymous and confidential for research purposes only.

A. Overall information (to be filled in by the interviewer)

1. Interview time: start at ___:___ on ___/___/2019 2. Finish interview at: ___:___

3. 1st enumerator name: 4. 2nd enumerator name:

5. Place of interview: address:

6. Name of firm:

7a. Address of firm:

7b. The firm locates in ☐ industrial park ☐ otherwise

B. Interviewee characteristics

8a. Name of respondent: 8b. Sex: ☐ male ☐ female ☐ divers

9a. Phone number: 9b. Email:

10. What is your position in the firm?: ☐ Owner ☐ Manager ☐ Other, specify: …..

11. How old are you? ..... years old

12. Where are you currently living?

☐ Same district as firm location ☐ Other province/city

☐ Other district in HCMC ☐ Other, specify: …..

13. How long have you the owned the firm (or worked for this firm)?..... years

14. Where did you work before?

☐ Same district as current firm location ☐ Other province/city

☐ Other district in HCMC ☐ Other, specify: ……

15. What is your position in previous work: ……..

16a. At your current position in the firm, how do you see yourself: Are you generally a person who is willing to take risks or do you try to avoid taking risks (1 - try to avoid taking risks, 5 - very much prepared to take risk)

(try to avoid taking risks) 1 2 3 4 5 (very much prepared to take risk)

C. Firm characteristics

16b. Industry sector:

17. Registered capital (or chartered capital)? ……. billion VND ☐ No answer

18. What are your firm's top-selling products

	Product	% of total revenue
1		
2		
3		
	Total	

19. What type of (the main) product do you produce

☐ Final product ☐ Input material for other firms

☐ Component of final product

20. What is your firm's legal form

☐ State-owned enterprise ☐ Joint-Venture ☐ Foreign-owned

☐ Private-domestic ☐ Cooperative

21. When was the firm established? ..... (year)

22. Is the current location the same as in the year of foundation?

☐ Yes, move to question 26 ☐ No

23. The previous location is

☐ Same district as current location ☐ Other province/city

☐ Other district in HCMC ☐ Other, specify: ……

24. When did your firm relocate: …….. (year)

25. What was the reason for relocation?

☐ Expansion ☐ Cheaper land/rent prices

☐ Flooding issues ☐ Other, specify: ……

☐ Induced by local authorities (relocate area)

26. How many employees work in your firm? ..... people

27. How many employees worked in your firm five years ago? ..... people

28. How many employees do you think will be working for your firm in five years? .....people

29. How many % of your employees are living close to your firm (2 km radius) .....%

30. Does your firm have more than one manufacturing location?

☐ No, move to question 32 ☐ Yes

31. Where is the other manufacturing location of your firm?

☐ Same district as firm location ☐ Other province/city

☐ Other district in HCMC ☐ Other, specify: ……

32. How did your firm revenue change in the last five years?

☐ Increase ☐ Stable ☐ Decline ☐ Fluctuate ☐ Don't know

33. What do you think: How will your firm's revenue change in the next five years?

☐ Increase ☐ Stable ☐ Decline ☐ Fluctuate ☐ Don't know

34. How do you finance your investments? *(multiple choices)*

☐ Personal funds, savings, etc. ☐ Loans from bank

☐ Loan from family members ☐ Loan from microcredit institutions

☐ Loan from relatives, friends ☐ Other, specify: ……

35. Where is your strongest sales market?

		% revenue
1	HCM city	%
2	Another province in the South	%
3	Another province in the North & Center	%
4	Another country in Southeast Asia	%
5	Another country in Asia except Southeast Asia	%
6	Another country except Asia	%
	Total	%

36. What inputs (e.g., raw material) do you need for your production? (pls. name the up to the three most important) and where do you buy? (pls. account by %)

	Main input →	1. ……	2. …..	3. ….
1	HCM city	%	%	%
2	Another province in the South	%	%	%
3	Another province in the North & Center	%	%	%
4	Another country in Southeast Asia	%	%	%
5	Another country in Asia except Southeast Asia	%	%	%
6	Another country except Asia	%	%	%
	Total	%	%	%

37. Do you have any investment plan in the next five years?

Training and improving capacity of employees; vocational training ☐ Yes ☐ No

New machineries ☐ Yes ☐ No

Research & develop new technologies ☐ Yes ☐ No

Expansion of production site ☐ Yes ☐ No

Preparations response natural hazards ☐ Yes ☐ No

Relocation of production site ☐ Yes ☐ No

38. Does the exposure to natural hazards have a direct influence on your investment decision-making?

☐ Yes ☐ No

D Flood exposure & adaptation

39. How often was your firm affected directly by flooding within the last five years? (direct inundation of plant with at least 10 cm)

☐ Never ☐ Once ☐ 2-5 times ☐ 6-10 times ☐ > 10 times

40. How often was your firm affected indirectly by flooding within the last five years? (Flooding access route, interrupted power distribution due to flooding, etc.)

☐ Never ☐ Once ☐ 2-5 times ☐ 6-10 times ☐ > 10 times

41. How much do you estimate the direct economic losses for your firm caused by flood damage in the last five years? …… million VND (*total five years*) ☐ Don't know

42. Has your firm undertaken preparations for floods within the last five years?

☐ Yes ☐ No, move to question 44

43. Did you already apply any of the following preparation against floods?

Sandbags	☐ Yes	☐ No
Pumps	☐ Yes	☐ No
Flood walls	☐ Yes	☐ No
Elevation of street or plant	☐ Yes	☐ No
Private hedging	☐ Yes	☐ No
Flood insurance	☐ Yes	☐ No
Data-backup system	☐ Yes	☐ No
Cleaning drainage system	☐ Yes	☐ No
Dry-proofing	☐ Yes	☐ No
Other, specify: …..	☐ Yes	☐ No

44. How would you rate your financial resources for the individual preparation against floods?

(1= very poor – 5= very good)

(very poor) 1 2 3 4 5 (very good)

45. Please weight the following business risks according to their relevance:

(1= least important – 5= most important)

General Economic crises	☐
Regulatory framework (e.g., fees, legal regulations)	☐
Competition	☐
Lack of workers	☐
Natural Hazards (e.g., floods, storms, heavy rain)	☐

E Cooperation

46. Does your firm collaborate with other actors in order to enhance your competitiveness (jointly cooperation)? If yes: How often to you meet/discuss per month?

		No (0)	Yes (1)	Times per month
1	Firms in neighborhood			
2	Firms in district			
3	Customers/suppliers			
4	Business associations, chamber of commerce			

5	Peoples Committee			
6	Other stakeholder (NGOs, consultants)			

47. If you talk to other partners/managers, is flooding a topic of discussion?

☐ Yes ☐ No

F Institutional setting

48. Did you receive any support concerning flooding events from the government?

☐ Financial support ☐ Non-financial support, move to question 50 ☐ Both ☐ No, move to question 50

49. Does this support cover your losses by about

☐ 100 % ☐ 75 % ☐ 50 % ☐ 25 % ☐ < 25 %

50. Who would you think is responsible to undertake measures to avoid flood damages? Please weight the following actors' responsibilities according to their relevance:

(1= less important – 5= most important)

Firms	☐
Business Association	☐
Community	☐
Local authorities	☐
State authorities	☐

51. How would you assess following support measures (1= very poor, 5= very good)

		1	2	3	4	5
1	Public flood management in your firm's location					
2	Support on obtaining permissions for constructions or export licenses					
3	Quality of infrastructure in your firm's location					
4	Access to loans and credits					

52. Has your firm faced problems due to flood damages?

		Yes = 1, No = 0	Value of damage (million VND)
1	Delay in Delivery		
2	Cancel contract		
3	Fines because waste/hazardous substances released into flood		
4	A temporary suspension of production		
5	Damage of products		
6	Damage of machines		
7	Other, specify: ….		

53. Have you ever been negatively affected by other flood adaptation measures (e.g., lifting up streets in the neighborhood)? ☐ Yes ☐ No

We pledge that all information of your firm will be kept anonymous and confidential.

54. Could you please tell us the total revenue of your firm per year?

☐ < 3 billion VND ☐ 3 - 20 billion VND ☐ 20-100 billion VND ☐ > 100 billion VND

55. Tax code: ……

G Experiments

Unit (billion VND)	1	2	3	4	5
A					
B					
C					
D					

H Notes on the interview

Appendix B: Own contribution

Article 1 (Chapter 4) was co-authored by Prof. Dr. Javier Revilla Diez (University of Cologne). Article 2 (Chapter 5) was co-authored by Prof. Dr. Matthias Garschagen (Ludwig-Maximilians-University Munich), Dr. Van Tran (University of Economics and Law, Vietnam National University, Ho Chi Minh City), and Prof. Dr. Javier Revilla Diez. Article 3 (Chapter 6) was co-authored by Prof. Dr. Javier Revilla Diez and Dr. Van Tran.

I have contributed to the three articles in the following ways:

- Review of relevant literature
- Development of the conceptual frameworks in all three manuscripts
- Development of research questions and hypotheses
- Selection of research methods
- Data analysis and processing of secondary data from GSO
- Selection and visiting of case study areas in collaboration with local research institutions and experts
- Conceptualization and modification of interview guidelines and the scenario-based field experiments (vignettes and firm survey)
- Organization of field research and coordination with local partner institutions in Vietnam
- Training and supervision of the co-researchers in HCMC during several training sessions and the survey conduction
- Conduction of the expert discussions, interviews and experiments in close collaboration with researchers from the UEL
- Cleaning and cross-checking of all transcripts, protocols, and survey data
- Independent analysis of qualitative results, using MAXQDA
- Independent multi-level binary-logistic regression, using STATA
- Independent writing of all manuscripts
- Revision of all manuscripts under the guidance of Javier Revilla Diez (all articles) and Matthias Garschagen (second article)

The second and third article are based on empirical data that has been collected during three research trips to Vietnam between October 2018 and December 2019. The trips have been funded by the German Research Foundation (Deutsche Forschungsgemeinschaft) and the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung).

The data used for this dissertation are stored on the servers of the Institute of Geography at the University of Cologne. For the research project *DECIDER*, the data will be used further and saved in superordinate project databases. Due to confidential agreements, the primary research data is not publicly accessible, but can be requested at any time. Individual information regarding the accessibility of the data is given in Chapter 5 and Chapter 6.

Appendix C: Eigenständigkeitserklärung

Hiermit versichere ich an Eides statt, dass ich die vorliegende Dissertation selbstständig und ohne die Benutzung anderer als der angegebenen Hilfsmittel und Literatur angefertigt habe. Alle Stellen, die wörtlich oder sinngemäß aus veröffentlichten und nicht veröffentlichten Werken dem Wortlaut oder dem Sinn nach entnommen wurden, sind als solche kenntlich gemacht. Ich versichere an Eides statt, dass diese Dissertation noch keiner anderen Fakultät oder Universität zur Prüfung vorgelegen hat; dass sie - abgesehen von unten angegebenen Teilpublikationen und eingebundenen Artikeln und Manuskripten - noch nicht veröffentlicht worden ist sowie, dass ich eine Veröffentlichung der Dissertation vor Abschluss der Promotion nicht ohne Genehmigung des Promotionsausschusses vornehmen werde. Die Bestimmungen dieser Ordnung sind mir bekannt. Darüber hinaus erkläre ich hiermit, dass ich die Ordnung zur Sicherung guter wissenschaftlicher Praxis und zum Umgang mit wissenschaftlichem Fehlverhalten der Universität zu Köln gelesen und sie bei der Durchführung der Dissertation zugrundeliegenden Arbeiten und der schriftlich verfassten Dissertation beachtet habe und verpflichte mich hiermit, die dort genannten Vorgaben bei allen wissenschaftlichen Tätigkeiten zu beachten und umzusetzen. Ich versichere, dass die eingereichte elektronische Fassung der eingereichten Druckfassung vollständig entspricht.

Teilpublikationen und Manuskripte:

- Leitold, R., Revilla Diez, J., 2019. Exposure of manufacturing firms to future sea level rise in Ho Chi Minh City, Vietnam. Journal of Maps 15 (1), 13–20. https://doi.org/10.1080/17445647.2018.1548385.
- Leitold, R., Garschagen, M., Tran, V., Revilla Diez, J. (under review), Flood risk reduction and climate change adaptation of manufacturing firms: global knowledge gaps and lessons from Ho Chi Minh City.
- Leitold, R., Revilla Diez, J., Tran, V., 2020. Are we expecting too much from the private sector in flood adaptation? Scenario-based field experiments with small- and medium-sized firms in Ho Chi Minh City, Vietnam. Climatic Change 163, 359–378. https://doi.org/10.1007/s10584-020-02888-y.

Datum, Ort Roxana Leitold

Manufacturing firms in coastal areas of Southeast Asia are increasingly exposed to flooding and threatened by the projected impacts of climate and socio-economic change. Although small and medium-sized enterprises (SMEs) are at the forefront of flood impacts, detailed knowledge about the ways in which SMEs adapt to flood risks is limited. This book addresses this gap by exploring how SMEs in the manufacturing sector respond to floods and which factors influence their decision to implement adaptation measures.

Based on innovative mixed-methods research collected in Ho Chi Minh City in Vietnam, the study adds the often neglected private sector perspective to adaptation research. It offers fresh empirical insights into flood impacts and the drivers and barriers of individual and collective adaptation. It concludes that private sector engagement in adaptation appears to be a promising approach, but it is not a panacea. SMEs should be encouraged to prioritize flood risk management in their business strategies, but they need effective guidance and support mechanisms by policy-makers.

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