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Skouloudis, Antonis, Tsalis, Thomas, Nikolaou, Ioannis, Evangelinos, Konstantinos and Leal Filho, Walter D (2020) Small and Medium-Sized Enterprises, Organizational Resilience Capacity and Flash Floods: Insights from a Literature Review. Sustainability, 12 (18). 7437

DOI: https://doi.org/10.3390/su12187437

Publisher: MDPI AG

Version: Published Version

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Small & medium-sized enterprises, organizational resilience capacity and flash floods: Insights from a literature review

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- 5 Sustainability 12(18):7437-7437 08 Sep 2020 DOI
- 6 https://www.mdpi.com/2071-1050/12/18/7437

7 Abstract: From a managerial standpoint, sustainability poses numerous challenges for the business 8 community. One of the prominent concerns in the context of organizational sustainability is the 9 impact of climate change and extreme weather events (EWEs) which create discontinuity and 10 damages to business operations. In this respect, small and medium-sized enterprises (SMEs) are 11 particularly vulnerable to EWEs, such as flash floods, having disastrous consequences to SMEs 12 which tend to be ill-prepared. Taking into consideration that these negatives effects are also 13 transferred into the local communities in which SMEs are located, it is crucial to create appropriate 14 mechanisms that will enable these enterprises to build relevant capacities and acquire necessary 15 resources in order to deal with relevant disruptive events. With this in mind, this paper attempts to 16 delineate the emerging literature in relation to strategic approaches in dealing with high 17 impact/low probability EWEs. With this analysis, we aim to provide insights for enhancing the 18 robustness of SMEs against such natural hazards through effective resilience and adaptation 19 strategies. The paper reveals that resilience to EWEs is indeed a multifaceted issue posing 20 numerous challenges to SMEs. Taking into account their intrinsic characteristics, there is a need for 21 a holistic management approach which will assist SMEs to safeguard their assets against extreme 22 weather.

Keywords: climate change, resilience, extreme weather events (EWEs), small and medium
 enterprises (SMEs), floods

25 1. Introduction

26 In the new era of sustainability transitions defined by the launch of United Nations' 2030 27 Agenda for Sustainable Development, climate change adaptation sets key directions for formulating 28 policies at global and national levels (UN, 2015). Particularly, sustainable development goal (SDG) 29 13, stipulates an array of targets that focus on improvements in climate-related resilience and 30 adaptive capacity. In this context, scientific evidence supports that climate change impacts are 31 pivotal challenges for sustainable development, threatening the balance of both natural and human 32 systems (Williams and Schaefer, 2013; IPCC, 2014a,b). Climate change is defined as the "change in 33 climate over time, whether due to natural variability or as a result of human activity" (IPCC, 2007 p.6) with 34 the anthropogenic activities (causing excessive levels of greenhouse gas emissions) to be recognized 35 as having dramatic effects on the global climate system. Due to climate change, ecosystems and 36 societies, all over the world, will be exposed to increasing risks and impacts (IPCC, 2014a; Winn et 37 al., 2011; Linnenuecke and Griffiths, 2010; Hoffmann et al., 2009).

38 Climate change is considered accountable for atmosphere and oceans warming, ice loss mass 39 and sea-level rise (IPCC, 2014a; Linnenuecke et al., 2015). It is also linked with EWEs such as, 40 flooding events, droughts, heat waves and storm surges, while it is anticipated to be a change in 41 their frequency of occurrence, the duration and the magnitude of such events (Winn et al., 2011; 42 Linnenluecke and Griffiths 2010; Linnenluecke et al., 2011; Linnenluecke et al., 2012; IPCC, 2012; 43 Wedawatta and Ingirige, 2012). Current experience reveals that EWEs have increasing catastrophic 44 consequences for local communities and society-at-large, creating discontinuities and adverse 45 conditions due to asset and infrastructure damages (Gough et al., 2019; Ingirige and Wedawatta, 46 2011; Suarez et al., 2005).

47 Apart from the impacts on societies, EWEs pose a major risk to industries, threatening for-profit 48 activities and may eventually force businesses to cease operations. From an organizational 49 management standpoint, EWEs can be regarded as external shocks with high uncertainty 50 (Linnenluecke and Griffiths, 2010; Barnett, 2001; Berkes, 2007; Wyss et al., 2015). For-profit entities 51 are under continuous pressure to devise and maintain proper strategies and mechanisms which will 52 allow them to effectively address EWEs impacts and, thus, reduce their relative vulnerability (IPCC, 53 2014b; Marshall et al. 2013), i.e. the level of susceptibility to destructive impacts of climate variability 54 and extreme weather (IPCC, 2007 p.6; IPCC, 2014b). Vulnerability levels differ across business 55 sectors and it is strongly associated with the relative exposure to EWEs of the area in which a 56 business operates as well as with the characteristics of each sector (IPCC, 2007). Agriculture, forestry, 57 energy, oil and gas, insurance, tourism and construction industries are examples of business 58 activities being particularly susceptible to EWE effects (IPCC, 2007; Craig and Feng, 2018; Ingirige 59 and Wedawatta, 2011; Linnenluecke et al., 2011; Hoffmann et al., 2009; Cruz and Krausmann, 2013).

60 One of the most critical EWEs is flash flooding which encapsulates abrupt and severe effects on 61 businesses. As a result of heavy downpours and thunderstorms, such flooding events are expected 62 to increase in absolute numbers placing greater stress on organizations (Coates *et al.*, 2020; EA, 2007; 63 Wedawatta and Ingirige, 2012), which have to face a wide range of effects such as damage to assets 64 and infrastructure, difficulties in daily operations, increased insurance premiums as well as impacts 65 related to human capital (Wedawatta and Ingirige, 2012; Wedawatta *et al.*, 2012; Linnenluecke *et al.*, 66 2011).

67 Regardless the vulnerability level of firms and the severity of the direct (e.g. property damage) 68 and indirect (e.g. insurance costs) impacts of flash floods in particular and EWEs in general, 69 businesses have to be well-prepared to deal with such 'acute business interruptions' which lead to 70 excessive discontinuities and increased repair costs (Herbane, 2015, p 583). While it is difficult to 71 predict the occurrence and the intensity of such events (Linnenluecke and Griffiths, 2010), 72 businesses need to develop and implement agendas for action which will enable them to gain 73 necessary resources and competencies in order to deal with flood risks. One critical notion in the 74 context of business preparedness to cope with and overcome such events is the organizational 75 resilience capacity (Linnenluecke and Griffiths, 2010; Clément and Rivera, 2017; de Bruijn et al., 76 2017). Many definitions of organizational resilience have been set forth in an attempt to emphasize 77 on diverse perspectives describing the ability of organizations to resist and recover, to adapt and 78 anticipate low probability situations and high impact events (Duchek, 2019; Ortiz-de-Mandojana 79 and Bansal, 2016). With respect to EWEs, resilience capacity can be defined as "the organizational 80 capacity to absorb the impact and recover from the actual occurrence of an extreme weather event" 81 (Linnenluecke et al., 2012, p.2). It is a multidimensional construct reflecting the ability of an 82 organization to experience a disruption without drastically affecting its normal operation or the 83 capacity to bounce back from the negative impacts of an EWE and quickly recover (at least) to its 84 original state (Coates et al., 2020; Linnenluecke and Griffiths, 2010; Tish and Galbreath, 2017; 85 Clément and Rivera, 2017; Linnenluecke et al., 2011; Linnenluecke, 2017). Linnenluecke and Griffiths 86 (2012) present two fundamental dimensions of organizational resilience, namely "rapidity" and 87 "impact of resistance" while the understanding of the vulnerability is a crucial factor that shapes the 88 directions for improving organizational resilience (Marshall et al. 2013). By assessing their relative 89 vulnerability, organizations are able to engage in capacity-building which equips them to address 90 the unpredictability and severity of EWE impacts Winn et al., 2011; Ortiz-de-Mandojana and Bansal, 91 2016; Marshall et al., 2013). The development of resilience capacity is a dynamic and continuous 92 process through which organizations shape new capabilities and establish new routines as well as 93 procedures that contribute to accomplish various aspects of organizational resilience, such as the 94 anticipation, extended coping and recovering range, along with increased adaptation potential over 95 EWEs (Linnenluecke and Griffiths, 2010; Duchek, 2019; Linnenluecke *et al.*, 2012; 96 Ortiz-de-Mandojana and Bansal, 2016).

With projections of EWEs occurrence indicating that such unexpected natural hazards will bemore frequent and severe, organizational resilience capacity should be regarded as an invaluable

99 ability towards business continuity in order to reduce detrimental impacts of environmental 100 perturbations on their daily operations and production processes. Apart from direct benefits related 101 to the ability to withstand external weather-related shocks, organizational resilience capacity is also 102 an important business attribute in developing sustainable competitive advantages that endorse 103 long-range planning and growth (Clément and Rivera, 2017; Ortiz-de-Mandojana and Bansal, 2016; 104 Duchek, 2019). Hence, such essential advantages derived from building resilience could act as strong 105 and meaningful incentives to motivate businesses to nurture and promote essential 106 resilience-specific as well as sustainability-oriented capabilities and resources.

107 Additionally, conceptual underpinnings of organizational resilience to weather extremes set 108 forth a new prospect for corporate environmental management and strategic planning, under the 109 scope of the inadequacy of existing environmental management systems to address challenges and 110 impacts linked with EWEs (Winn et al., 2011). This is because environmental management 111 approaches mainly focus on assisting business to understand how their various operations and 112 products/services affect environmental quality and how to implement effective policies, plans and 113 programs to minimize negative environmental externalities. While this approach and point-of-view 114 of environmental management frameworks is vital for organizational sustainability and businesses' 115 contribution to sustainable development, it is insufficient in terms of elements and features that 116 business encounter from an outside-in perspective when they face climate or weather-related threats 117 (Winn et al., 2011).

118 As adverse and intense impacts of EWEs, including flash flooding, are nowadays far from 119 negligible, affecting societies and business systems worldwide, scholars started placing specific 120 attention on how small and medium-sized enterprises (SMEs) can be better prepared to deal with 121 such environmental perturbations and, ultimately, what drives their ability to configure appropriate 122 responses and build resilience (Skouloudis et al., 2016; Halkos et al., 2018; Halkos and Skouloudis, 123 2020; Williams and Schaefer, 2013; Blundel et al., 2014; Coates et al., 2020; Li et al., 2015; Ingirige et al., 124 2008; Wedawatta and Ingirige, 2012; Asgary et al., 2012; Pathak and Ahmad, 2016; Marks and 125 Thomalla 2017). Crucially, the impacts of flash floods (among other natural hazards) on SMEs can be 126 greater and more severe compared to their larger business entities (Ingirige and Wedawatta, 2011; 127 Wedawatta and Ingirige, 2012; Asgary et al., 2012). SMEs are extremely vulnerable to flooding 128 (Wedawatta et al., 2014) and have been characterized by low level of resilience and insufficient 129 preparedness to confront such events (Coates et al., 2020; Asgary et al., 2012). Various factors have 130 been identified as explanatory parameters (Ingirige et al., 2008) with limitations in financial, 131 managerial and human resources to be primary ones (Coates et al., 2020; Williams and Schaefer, 132 2013; Ingirige and Wedawatta, 2011; Blundel et al., 2014. Li et al., 2015).

133 In this respect, it is of critical importance to examine the wide spectrum of factors which 134 facilitate or discourage SMEs to develop their resilience capacity due to the fact that the impacts of 135 EWEs on SMEs could also bring significant problems at local, regional and/or national levels (for 136 instance, supply chains experiencing long-term interruptions or ceasing to function). This is owing 137 to the crucial role of the SMEs in the local societies as job providers and another explanation is that 138 SMEs consist the vast majority of businesses operate both in developed and developing countries 139 (Wedawatta et al., 2014; Ingirige and Wedawatta, 2011; Coates et al., 2020; Pathak and Ahmad, 2016; 140 Marks and Thomolla, 2017; Samantha, 2018). Therefore, the great impacts of SMEs on the economic 141 development, at all levels, clearly shows the necessity for effective tools for protecting them for 142 EWES.

143

144 **2.** Theoretical Background

The occurrence of EWEs can result in extremely negative environmental, social and economic impacts. Bergmann *et al.* (2016) explore the effects of the different types of EWEs (e.g. cold waves, severe thunderstorms and flash floods) on various organizational operations and aspects, e.g. procurement operations, marketing and services, logistics and human resources. In this context, Linnenluecke *et al.*, (2012) suggest a critical and instructive classification for EWEs in three groups: simple extremes (local phenomena based on clear variables), complex extremes (local phenomena relied on a variety of variables) and unique extremes (global phenomena). The negative impacts of EWEs differ among various economic and social actors such as public authorities and local communities (Nikolaou *et al.*, 2015). Particularly, previous studies reveal that EWEs can bring adverse effects on construction industries (Hopkins, 2014; Alshebani and Wedawatta, 2014) and the tourism sector with shorter seasons, transport disturbance, less security, loss of revenue (Craig and Feng, 2018) to be some of the critical impacts.

157 Previous studies also indicate that the level of influence of EWEs varies across firms 158 (Skouloudis et al., 2016; Halkos et al., 2018). As mentioned above, firm size has been identified as key 159 factor explaining the variation in vulnerability to EWEs. The impacts of EWEs are more disastrous 160 on SMEs than on larger firms (Linnenluecke and Griffiths, 2012; Crichton et al., 2009) and SMEs 161 encounter many obstacles in their efforts to face extreme weather. Such barriers are mainly 162 associated with the lack of financial capital, inadequate know-how as well as limitations in 163 technological competencies and skilled human resources (Sullivan-Taylor and Branicki, 2011). 164 Runyan (2006) points out that due to the limited resources SMEs are ill-prepared to achieve a quick 165 recovery from EWEs. However, a contrary view holds that some of the SMEs' features may offer 166 them an advantage in order to cope with EWE impacts (Pal et al., 2014): low level of bureaucratic 167 processes, quick decision-making or effective internal communication and routines for an immediate 168 implementation of strategies (Sullivan-Taylor and Branicki, 2011).

169 In the field of SMEs vis-à-vis EWEs, there is an urgent need to devise and disseminate effective 170 and efficient ways to assist SMEs to deal with the underlying negative impacts of EWEs and ensure 171 business continuity. Against this background, numerous concepts (i.e. business resilience, business 172 vulnerability, business adaptation, business continuity, organizational coping strategies, risk 173 management and natural hazards crisis management) have been coined to outline management 174 practices necessary for firms to confront EWEs as well as management tools developed to assist 175 SMEs to withstand and overcome these types of environmental change. For instance, Wedawatta 176 and Ingirige (2016) propose a management system approach in order for SMEs pertaining to the 177 construction industry to effectively cope with EWE damages through a triangulation of 178 vulnerabilities (e.g. size of SMEs, location of projects, firm specialization), coping strategies (general 179 risk management, coping strategy at business level) and coping adaptation (e.g. previous experience 180 with EWEs, financial resources). In a similar vein, Bostick et al. (2017) suggest a stakeholder-based 181 multicriteria model to assist firms in decision-making concerning their resilience status, which 182 consists of five stages: moderated discussion (e.g. resilience, system domain), stakeholder input, 183 decision-maker input, model, output, and reassessment. Likewise, Centobelli et al. (2019) propose a 184 conceptual model to classify the current literature in organizational resilience regarding supply 185 chain management. Specifically, their contribution examines the business resilience strategy in the 186 context of the supply chain which can be divided into three overarching domains: anticipation (e.g. 187 capability, distribution management and strategy formation, planning and design, and properties), 188 resistance (e.g. supply chain reengineering, collaboration, agility, and supply chain risk 189 management culture) and recovery-response actions (e.g. recovery preparation, long-term impacts). 190 Haraguchi et al. (2016) set forth a business continuity management model based on public-private 191 partnerships to face EWEs. According to this model, business resilience is classified into four levels: 192 firm level resilience, supply chain resilience, public-private level resilience, and societal resilience. 193 Linnenluecke et al. (2012) point out a framework to strengthen business resilience which comprises 194 of three parts. The first one includes the anticipatory adaptation strategy, examining the previous 195 experience of business regarding EWEs, the second pertains to organizational capabilities 196 developing a management algorithm to examine sense-making of disaster, sensitivity, disaster 197 response and reconstruction, while the third part refers to procedures for future adaptation 198 strategies adressing future organizational capabilities in confronting EWEs. In a similar vein, 199 Linnenluecke, et al. (2011) propose a relocation model for firms to deal with EWEs relying on 200 environmental sensitivity factors, feasibility of strategy implementation along with the relocation 201 costs.

202 SMEs need to develop and deploy strategies in order to successfully recover and maintain their 203 organizational viability after an abrupt, unexpected and disastrous flooding event. From a 204 theoretical standpoint, such business resilience strategies can be explained through various 205 conceptual frameworks and analytical lenses (Table 1). All these theoretical frameworks have been 206 utilized to disaggregate the different approaches and explain firms' responses to the challenges 207 arising from sustainable development under the scope of climate and weather-related hazards. A 208 common ground for the development of these theories is that they recognize that the mere focus on 209 financial goals is inadequate to guide firms to success. Environmental and social parameters should 210 be integrated into corporate strategy in order for firms to thrive in a complex and turbulent 211 environment.

212 A well-established theory to explain the reaction of firms to flash floods and other EWEs is the 213 organizational theory and behaviour. Under this theoretical lens, there are two fundamental 214 approaches, namely reactive and proactive responses to external stimuli. While the former focuses 215 on the ability of a firm (organization) to overcome unexpected events, the latter examines not only 216 the organizational capabilities to deal with extreme events but also how these capabilities can allow 217 firms to identify or create new opportunities in a timely manner (Lengnick-Hall et al., 2011). An 218 indicative example of the proactive approach can be found in the work of Linnenluecke and Griffiths 219 (2012) who suggest the need for making better links between organizational resilience and adaptive 220 response strategies in order for organizations to successfully withstand, absorb and eventually 221 recover from the occurrence of unexpected weather extremes such as flash flooding.

222

Table 1. Theoretical background of organizational resilience to extreme weather.

Theoretical lens	Key points	Authors			
Organizational theory	Organizations ability to respond to	Linnenluecke and Griffiths, 2012;			
	EWEs as well as to adapt their	Linnenluecke and Griffiths, 2010;			
	processes in order to make new	Tisch and Galbreath, 2018;			
	responses.	Halkos et al., 2018.			
Institutional theory	An organizational adaptive	Winn et al., 2011; Berkhout, 2012; Wejs			
	capability is associated not only	et al., 2014.			
	with their internal capabilities, but				
	also with the external environment				
	(e.g. social, political, and economic				
	environment).				
Systems theory	Business and external environment	Dalziell and McManus, 2004; Nikolaou			
	are interrelated variables.	et al., 2015; Tsalis and Nikolaou, 2017.			
Resource dependence	Business operation dependence on	Chand and Loosemore, 2015, Bergmann			
theory	natural and ecological resources.	et al., 2016; Tashman and Rivera, 2016.			

223 224

225

Institutional theory has also been employed to explain business resilience strategies and the level of resilience capacity demonstrated. According to this perspective, for-profit activities and the

226 adaptive strategies for coping with EWEs (as abrupt and unexpected changes) should not only be 227 associated with the internal organizational capabilities but with the enabling conditions provided by 228 the institutional environment as well (Berkhout, 2012). Winn et al., (2011) suggest that institutional 229 theory offers an extremely valuable and fruitful context to analyze how organizational adaptation 230 processes are adopted, shaped and endorsed within the enterprise. In a similar vein, focusing on 231 Scandinavian business systems, Wejs et al. (2014) identify an array of institutional factors affecting 232 companies through both anticipatory and mandatory actions in order to implement climate change 233 adaptation strategies.

234 Systems theory has also been proposed as a theoretical lens to shed light on business 235 vulnerability, adaptive capacity and resilience potential (Dalziell and McManus, 2004). In line with 236 systems thinking, organizations and their external environment consist of a complex and dynamic 237 system where there are strong interrelationships between its components. Through systems theory 238 and system dynamics (SD) modelling tools, Nikolaou et al. (2015) analyze potential impacts from 239 physical risks such as droughts and floods, on business operations. The core findings of this model 240 indicate the strong relationship between physical risks and financial performance of business 241 entities. It is also suggested that floods (amplified by long-term global climate change) threat 242 business continuity through discontinuities in the supply chain and daily operations. Managers 243 need to overcome such problems through new investments in equipment and recovery measures. 244 Similarly, Tsalis and Nikolaou (2017) propose a system dynamic model in order to manage risks 245 faced by firm due to climate change. Their model identifies a significant influence of climate change 246 risks on business economic performance. Conceptual models such as the above attempt to shed light 247 on the key relationships of flash flooding effects on business performance through a systems theory 248 lens.

249 Organizational responses to EWEs have also been studied through a natural resource 250 dependence theoretical perspective where the ecological resilience paradigm is introduced into 251 organizations' strategic management. The underpinnings of this theory in relation to business 252 planning posit that every entity (human or business) depends on the ecosystem (and its biophysical 253 processes) as it needs an array of natural resources to survive and (eventually) thrive. In this context, 254 Bergmann et al. (2016) employ resource dependence theory to explain how EWEs affect the financial 255 performance of businesses. Similarly, based on resource dependence and institutional theories, 256 Tashman and Rivera (2016) point out a critical relationship between the status of the US ski resort 257 industry and climate change implications and point out the notion of ecological uncertainty as a 258 supporting argument of the difficulty of businesses to gain access to vital natural resources. In this 259 respect, in order to overcome ecological uncertainty, it is suggested that businesses should adopt 260 "natural-resource-intensive practices" in order to moderate and overcome its negative impacts 261 (Tashman and Rivera, 2016).

262 Nevertheless, fundamental questions still remain on how businesses can overcome the effects of 263 EWEs such as flash floods as well as whether the organizational capabilities are sufficient to 264 overcome the negative impacts of such environmental perturbations or why firms should cooperate 265 with key social constituents/stakeholders to increase their preparedness against natural hazards. The 266 emerging literature on the specific 'business and the environment' domain does offer insightful 267 theoretical explanations on why businesses engage in (proactive or reactive) efforts in confronting 268 EWEs and also places emphasis on how SMEs can sufficiently adapt to extreme weather, minimize 269 the impacts of such disturbances and boost their performance in an uncertain environment.

270 In this respect, in order to provide a general outline of such practices, a novel (rudimentary) 271 framework is suggested, classifying them into three strategic layers denoted as micro-, meso- and 272 macro-level (Figure 1). The micro-level refers to capabilities of SMEs which are critical for the 273 effective planning, mitigation, adaption and recovering processes in relation to EWEs and their 274 consequent impacts (Wedawatta and Ingirige, 2012; Ingirige and Wedawatta, 2018). It can be based 275 on organizational, resource- and knowledge-based theories where businesses face the negative 276 impacts of a highly unpredictable environment through their capabilities and resources and manage 277 to return in the initial state by creating new opportunities for sustainable competitive advantage (organizational-based theory). Such theoretical lens can be helpful to businesses which have
sufficient resources (e.g. financial capital and skilled human resources), previous experience with
EWEs (e.g. existing capabilities, knowledge-creating routines, and adaptive procedures), and/or
demonstrate a low level of vulnerability with negligible impacts of EWEs on their operations.

282 Natural resource-based theory, knowledge-based theory and intellectual-based theory offer a 283 concrete context to explain how organizational responsibility and environmental management 284 practices provide incentives and motivate enterprises towards better performance and promoting 285 long-term businesses growth (Hart, 1995; Nikolaou, 2019). The basic principles of such theories rely 286 on capabilities, skills, resources and competencies of businesses to face modern challenges. 287 Crucially, these business attributes (e.g. technological competency, design procedures, procurement 288 strategies, production processes, distribution channels and service capabilities) can 'shield' the 289 organization from external risks. In this logic, businesses with specific capabilities and resources as 290 well as intellectual capital creating knowledge (tacit, social complex and rare) can successfully 291 confront environmental perturbations and change such as flash floods and other EWEs (Backman et 292 al., 2017).





Figure 1. Organizational resilience to EWEs – a general framework of theoretical perspectives.

295 The meso-level implies that merely relying on business capabilities is not enough to 296 successfully bounce back from EWEs. Some disturbance in business operations may arise from 297 problems caused in the supply chain and in other business partners or regions. Actually, EWEs may 298 have significant impacts on the supply chain which can indirectly affect business operations. 299 Wedawatta et al. (2010) identify that over 50% of the problems stemming from EWEs in the UK SME 300 construction industry are associated with supply chain issues (e.g. suppliers' disruptions, loss of 301 energy and water supply). Some significant problems in the supply chain derived from EWEs 302 affecting business operations can also be delays on scheduled procurements and logistics 303 disruptions (Wedawatta et al., 2011). Businesses can overcome such issues through participatory 304 activities with governmental bodies, business chambers/associations and supply chain managers in 305 order to promote knowledge sharing among key actors (Wedawatta et al., 2011).

306 It is significant to point out that many reactions of businesses on climate change problems are 307 strongly associated with institutional pressures and could be explained through the institutional 308 theory lens. Institutional theory posits the many types of external pressures which stimulate 309 enterprises to adopt strategies to address environmental and climate change problems. For instance, 310 Escobar and Vredenburg (2011) point out the three forms of isomorphism described by 311 neo-institutional theory (coercive isomorphism, normative isomorphism and mimetic isomorphism) 312 in explaining sustainability transitions in firms. The first two types reflecting aspects of the 313 regulatory regime can affect decisions of businesses regarding climate change and weather extremes 314 impacts. The third form explains business climate change adaptation and resilience building 315 behaviour as a mimetic process driven by peer firms. This (mimetic) effect can be placed in the 316 second (meso-) level while the first two forms of isomorphism in the third (macro-) level (indicated 317 by the dashed green line in the figure). It is worth noting that cooperation of businesses at the 318 meso-level could be so explained from a systems theory perspective. Several scholars suggest that 319 cooperation of businesses in an industrial ecology context plays a critical role in resilience capacity 320 building against environmental change (Korhonen et al., 2004; Kendall and Spang, 2020). This 321 viewpoint also lends support to the theoretical connection between institutional theory and systems 322 theory to further clarify how business participatory and multi-stakeholder actions can be a 323 meaningful planning endeavour to address EWEs.

324 The macro-level encapsulates collaborative activities of businesses not only with governmental 325 bodies and other businesses but also with local communities and third sector organizations (NGOs) 326 in order to overcome problems linked with the occurrence of EWEs. Systems theory explains the 327 necessity of business cooperation with various social constituents and economic actors in order to 328 promote resilience and ensure continuity. To build a robust level of resilience capacity against flash 329 flooding and other EWEs, enterprises should engage and cooperate with other societal agents and 330 local community members. In this respect, Wyss et al. (2015) suggest that the cooperation of such 331 various individual agents, due to relative independencies and mutual interests, is a necessary 332 condition for resilience and adaptation processes in the tourism and hospitality sector as the support 333 of governmental authorities as well as media, NGOs and local community is deemed to be vital. This 334 approach can be explained through the systems theory and the natural resource dependency 335 theoretical perspectives.

336

337 3. An overview of empirical studies on SMEs resilience to weather extremes

Over the past decade an emerging wave of empirical studies around the world have sought to explore how SMEs are affected by EWEs and flooding specifically, their coping range of strategies as well as inhibitory factors to adaptation and organizational resilience (see Table 2). Such research endeavors attempt to interpret the underlying threats and opportunities stemming from resilience capacity (or the lack of) SMEs demonstrate.

Hermann and Guenther (2017) assess SMEs barriers to adopting climate change adaptation strategies in a large city in Germany. Following a questionnaire survey method, a barrier scale was developed allowing causal explanations for the occurrence of barriers and how they can be managed and addressed. Likewise, Halkos et al. (2018) and Halkos and Skouloudis (2019) investigate resilience barriers to EWEs and flooding among Greek SMEs through structural equation modelling and quantile regression analysis allowing for fruitful insights and essential, context-specific, evidence for practitioners and policy-makers respectively.

350 Karman (2020)investigates individual, organizational, community-specific, and 351 extreme-related factors affecting the resilience mechanisms applied by business entities from 20 352 European countries. Aiming to provide a better understanding of business resilience to weather 353 extremes, the study sheds light on the relative frequency particular mechanisms (including 354 disposition and administration of resources, self-organization, intra-organizational communication, 355 damage assessment, review of previous events, and the acquisition of external information) are 356 applied in and verifies determinants of their employment.

Mullins and Soetanto (2013) focus on the relative importance ethnic differences and demographic factors have in the disaster management field linked to flooding in Birmingham (UK) communities. By employing a quantitative approach in data collection, they find three levels of resilience and an association of those with different ethnic groups as well as that ethnic differences consistently exist within the perceptions of business groups within the study's communities which have recent experience of flooding, but not in a community without recent flood experience.

363 Wedawatta et al. (2011) employ a mixed methods research design to elicit data on how 364 construction SMEs located in the Greater London area respond to EWE risks and stress that coping 365 strategies implemented leave much to be desired. In this respect, the authors stress the need for 366 better integration of EWE occurrence into initial project planning stages through better risk 367 assessment models as well as more accurate EWE prediction data. Similarly, Ingirige et al. (2012) 368 examine impacts of flooding on SMEs in Cockermouth (Cumbria, UK) using a mixed method of 369 interviews with experts having long-standing experience in advising SMEs on post-flood 370 reinstatement along with a questionnaire survey to 48 SME owners/managers. The findings of the 371 study provide fruitful and actionable insights on chartered surveyors' capacity-building in the field 372 of SME adaptation to flood risk under the scope of reliable and valid advice on property-level flood 373 protection measures.

374 Kuruppu et al. (2013) conducted a mixed method approach involving a set of semi structured 375 interviews, case studies and a workshop to examine underlying factors and processes shaping the 376 adaptive capacity and resilience potential of Australian SMEs to climate change and weather 377 extremes. The study highlights the critical importance that contextual processes encapsulate in 378 enhancing the adaptive capacity of SMEs and Kuruppu et al. point out that contextual processes had 379 been largely overlooked in formal programmes aiming to build business resilience, being primarily 380 reactive and focusing on recovery during and after disasters rather than on anticipatory prevention 381 and preparedness.

382 Wedawatta and Ingirige (2012) conduct a number of short case studies among UK SMEs to 383 identify responses to flood risk as well as measures undertaken to address impacts. The authors 384 observe that, following a post-flood situation, SMEs tend to implement diverse property-level 385 protection measures and generic business continuity/risk management practices, according to 386 individual requirements, with the overarching aim of achieving a desired status of flood protection. 387 Ingirige and Russell (2015) also employ a case study analysis in seven SMEs in Braunton (North 388 Devon, UK) offering valuable evidence across a range of enterprises and highlighting innovative 389 approaches to flood impact mitigation. Aiming to contribute to behavioural changes, the report finds 390 that interviewed SMEs became 'experts by experience' on those resilience measures they 391 implemented and highlights the enthusiasm among the SME community for sharing and enhancing 392 their capacities further.

393 Utilizing an agent-based simulation model to assist UK SMEs facing flood disruptions Li et al. 394 (2015) and Li and Coates (2016) offer evidence towards the development of effective response 395 strategies which SMEs can employ to reduce the flood impacts, better assess the level of continuity 396 of operations and, ultimately, increase their resilience. In a similar vein, Alharbi and Coates (2018) 397 focus on UK manufacturing SMEs in Sheffield (UK) and model SMEs' behaviours that can be 398 enacted pre- and post-flood and shed light on the influence of different types of insurance coverage 399 and financial status on the response and recovery from different levels of flooding, in attempt to 400 indicate the influence of combinations of these attributes on SME recovery. More recently, Coates et 401 al. (2020) provide findings of an application of a similar computational modelling and simulation 402 approach to evaluate SMEs' operational resilience to extreme floods based on combinations of 403 structural and procedural mitigation measures that may be implemented to improve SMEs 404 resistance to flooding and ensure business continuity. Using the major flood event of 2007 in 405 Tewkesbury (UK) as case study, the assessment enables an evaluation of operational resilience of 406 manufacturing SMEs in terms of the relative effectiveness of flood mitigation measures and stresses 407 that structural mitigation measures are more effective compared to procedural ones.

408 Kato and Charoenrat (2018) investigate business continuity management practices employed by 409 Thai SMEs in order to highlight underlying assistance needs. Analysing questionnaire-based data 410 gathered from SME managers the study confirms the increased disaster experience of Thai SME and 411 points out inadequate levels of preparedness towards business continuity planning allowing to 412 suggest the critical importance of extending support to SMEs in disaster-prone areas. Pathak and 413 Ahmad (2016) employ a mixed methods approach in order to examine flood recovery capacities 414 adopted by SMEs affected by flooding in the Pathumthani province (Thailand). Focusing on 415 manufacturing SMEs the study provides fruitful evidence of coping strategies and in ascertaining 416 the impacts of flood disasters in the area. In a similar vein, focusing in a flood-prone area of the 417 Bangkok Metropolitan Region, Mark and Thomalla (2017) examine SME responses and recovery 418 from the 2011 Bangkok floods and measures taken to reduce the vulnerability to future floods. By 419 conducting in-depth key informant interviews and a questionnaire survey with SME owners, the 420 authors shed light on how (and the extent to which) SMEs were affected by the 2011 Bangkok floods 421 and actions by SMEs and governmental bodies respectively in order to reduce vulnerability to future 422 flooding. The study concludes that socioeconomic factors interacted with the 2011 flood to 423 negatively affect SMEs as well as key political economy drivers of vulnerability of SMEs are far from 424 addressed.

425 Crick et al. (2018) report on the extent to which micro enterprises and SMEs in Senegal and 426 Kenya are adapting to climate risks. Drawing from findings derived from a questionnaire survey on 427 SMEs in semi-arid regions in these countries the assessment estimates the maturity of adaptation 428 measures in place and attempts to distinguish between sustainable and unsustainable adaptation. 429 The study encapsulates meaningful implications for policy interventions in building resilience to 430 future climate risks by indicating a number of factors affecting the level of organizational adaptation 431 to current climate variability: availability of financial resources, general business support, access to 432 information technology and adaptation assistance.

433 Focusing on SME sector in Philippines Ballesteros and Domingo (2015) set forth strategic 434 recommendations for local and national policy design in order to embed disaster risk reduction and 435 management into the SME planning and stress the key role of the regional economic forum of 436 Asia-Pacific Economic Cooperation (APEC) for endorsing the resilience of member-countries' SMEs 437 towards natural hazards. Similarly, Samantha (2018) conducted semi-structured interviews with 438 micro and SME owners regarding the adverse impacts of flooding in Sri Lanka and provides 439 recommendations on strategic multi-stakeholder policies to disaster risk reduction and disaster 440 coping mechanisms into the respective business sectors. The qualitative data allowed to outline 441 organizational experiences on various aspects of damage, rehabilitation and re-establishment and 442 indicated specific vulnerability points within the enterprise in terms of capital, labour, logistic and 443 market impacts.

444 Wilk et al. (2013) conduct interviews with commercial and small-scale farmers in South Africa 445 in an attempt to frame challenges and adaptive strategies to address climate-related stressors and 446 EWEs. The analysis suggests that small-scale farmers tend to be more vulnerable due to factors such 447 as the limited access to finance as well as to agricultural techniques for water and soil conservation 448 along with the high input costs of improved seed varieties. In contrast, commercial adaptation 449 strategies were primarily hindered by the vague governmental directives towards sustainable 450 agriculture and the climate-proofing of the agricultural production. Being part of a larger 451 participatory (climate) adaptation planning project with local stakeholder groups, the study 452 concludes knowledge transfer within and across farming communities, clearer governmental 453 directives and targeted locally-adapted finance programmes should be the best way forward.

454 Studies such as the above offer multiple actionable insights and provide implications to SME 455 management and policy-design in achieving a climate-proof and EWE-resilient SMEs sector. 456 Nevertheless, reflecting on the available literature, much work needs to be done to provide the 457 enabling conditions for SMEs to successfully to better prepare and successfully overcome such 458 environmental perturbations.

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Table 2. Empirical studies	assessing SMEs responses to	b EWEs/flooding stimuli.
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Year	Author(s)	Journal/Outlet	Country(-ies)	Method(s)	Analytical lens
2011	Wedawatta, Ingirige, Jones and Proverbs	Structural Survey	United Kingdom	Mixed methods	Micro-level coping strategies
2012	Wedawatta and Ingirige	Disaster Prevention &	United Kingdom	Semi-structured	Micro-level coping strategies
		Management		interviews	
2012	Ingirige, Proverbs and Wedawatta	RICS Education Trust	United Kingdom	Mixed methods	Organizational/micro-level;
					resource dependency; institutional
					capacities
2013	Wilk, Andersson and Warburton	Regional Environmental Change	South Africa	Interviews	Organizational/micro-level;
					institutional capacities
2013	Mullins and Soetanto	Disaster Prevention &	United Kingdom	Questionnaire	Informal institutions (cultural
		Management			norms)
2013	Kuruppu, Murta, Mukheibir, Chong and	National Climate Change	Australia	Mixed methods	Organizational and meso- level;
	Brennan	Adaptation Research Facility			institutional capacities
2015	Ingirige and Russell	UK Climate	United Kingdom	Interviews	Micro-level coping strategies;
		Impacts Programme,			resource dependency and
		University of Oxford,			institutional capacities
2015	Li, Coates, McGuinness and Johnson	International Conference on	United Kingdom	Semi-structured	System dynamics; micro- and
		Flood resilience Zurich,		interviews &	macro-level interactions
		Switzerland, 13-14 January		agent-based modelling	
2015	Ballesteros and Domingo	Philippine Institute for	Philippines	Secondary data	Organizational responses and
		Development Studies		analysis	macro-level/institutional support
2016	Li and Coates	International Journal Of Design	United Kingdom	Semi-structured	System dynamics; micro- and
		Nature & Ecodynamics		interviews &	macro-level interactions
				agent-based modelling	
2016	Pathak and Ahmad	International Journal of Disaster	Thailand	Mixed methods	Micro-level responses and

Risk Reduction

					supporting mechanisms
2017	Hermann and Guenther	Journal of Cleaner Production	Germany	Questionnaire	Organizational capacities &
					resource dependence
2017	Mark and Thomalla	Natural Hazards	Thailand	Mixed methods	Micro-level responses and system
					dynamics/macro-level support
2017	Kato and Charoenrat	International Journal of Disaster	Thailand	Questionnaire	Organizational/micro-level;
		Risk Reduction			institutional capacities
2018	Samantha	Procedia Engineering	Sri Lanka	Semi-structured	Organizational/micro level
				interviews	
2018	Alharbi and Coates	WIT Transactions on The Built	United Kingdom	Semi-structured	System dynamics; micro-level
		Environment		interviews &	responses & institutional capacities
				agent-based modelling	
2018	Halkos, Skouloudis, Malesios and Evangelinos	Business Strategy & the	Greece	Questionnaire	Organizational/micro-level
		Environment			
2018	Crick, Eskander, Fankhauser and Diop	World Development	Kenya, Senegal	Questionnaire	Organizational/micro-level
2020	Halkos and Skouloudis	Climate and Development	Greece	Questionnaire	Organizational/micro-level
2020	Karman	Business Strategy & the	20 European countries	Questionnaire	Micro- & meso-level intreactions;
		Environment			system dymanics
2020	Coates, Alharbi, Li, Ahilan and Wright	Philosophical Transactions of	United Kingdom	Semi-structured	System dynamics; micro- and
		the Royal Society A		interviews &	macro-level interactions
				agent-based modelling	

institutional capacities; macro-level

475 4. Conclusion and implications for future research

476 Undoubtedly, changes in weather patterns due to climate change and the increase of EWEs in 477 absolute numbers create a new reality for the business community. Special attention should be 478 devoted to flash flooding which emerges as one of the most critical EWEs with abrupt and disastrous 479 consequences for business and society (Coates et al., 2013; Pathak and Ahmad, 2016; Kreibich et al., 480 2017; Li et al., 2015). Given that SMEs are particularly vulnerable to EWEs, lacking adequate 481 resources and managerial skills to minimize the negative impacts and successfully recover from 482 such disruptions (Samantha, 2018; Ingirige and Wedawatta, 2011; Coates et al., 2020; Crick et al 2018; 483 Lo et al., 2019), it is crucial to assess the wide range of factors associated with the internal and 484 external business environment in order for SMEs to become better-prepared against flooding and its 485 damaging effects. Supporting arguments for this claim can also be found in previous studies on 486 flood impacts which indicate that such events can be a defining moment in SME operation causing 487 numerous severe damages and, in a worst-case scenario, forcing them to cease operations (Pathak 488 and Ahmad, 2016, Marks and Thomalla, 2017; Wedawatta et al., 2014; Craig et al., 2019).

489 Outlining the relevant literature, a key finding is that there is not a widely-applicable 490 management approach for addressing challenges accruing from flash flooding events. Although 491 there is a growing body of research on this field, the majority of previous studies have employed 492 questionnaire-based surveys or semi-structured interviews in order to elicit various factors and 493 approaches adopted by firms and associated with their resilience capacity, vulnerability to weather 494 extremes and their preparation level for future flooding extremes. These studies mainly document 495 previous experience or analyze the mechanisms and response (ex-post) strategies developed by 496 firms in order to increase their resilience capacity. Undoubtedly, such information is necessary for 497 understanding the context in which enterprises operate in relation to EWEs but it is insufficient in 498 guiding them to opt for the appropriate measures which will reduce their vulnerability to future 499 flooding events. This is because most of such studies fall short in proposing scalable tools and 500 s.m.a.r.t. targets (specific, measurable, achievable, realistic, and timely) which will definitely help 501 SMEs to assess the effectiveness of various flood protection measures taking to consideration their 502 their intrinsic characteristics.

503 Research on SMEs resilience capacity to EWEs, and flash floods in particular, leaves much to be 504 desired and should be advanced on its own merits beyond mere rhetoric and anecdotal evidence or 505 particularly fragmented data. With this in mind, there are some fruitful directions for future research 506 concerning the preparedness of SMEs to EWE threats in order take advantage of essential benefits 507 accruing from bouncing back and eventually thriving after such events. Flash flooding events 508 encapsulate multiple and diverse impacts on business, which can be closely interrelated, 509 complicating organizational efforts to build efficient mechanisms to deal with such natural hazards. 510 This is evident from the various approaches and criteria proposed to categorize floods impacts on 511 firms. Apart from direct impacts (such as damages to business premises and equipment, injuries as 512 well as losses of raw materials and stock), there are indirect impacts which can create serious 513 obstacles to business continuity, i.e. problems associated with the supply chain, human resources 514 and logistics (Syndnor et al., 2017; Samantha, 2018; Wedawatta et al., 2014; Wedawatta and Ingirige, 515 2012; Woodman, 2008). It is also worth mentioning that firms which have not been physically 516 affected by floods can also experience indirect impacts from these environmental perturbations 517 (Wedawatta et al., 2014). The temporal dimension is another aspect employed to classify impacts of 518 floods on firms into long- and short-term impacts (Wedawatta et al., 2014; Samantha, 2018). 519 According to Wedawatta and Ingirige (2012), damages to capital assets are indicative examples of 520 short-term impacts, while low income and high insurance premiums pertain to long-term impacts 521 among others. Additionally, flash flood impacts can be examined in relation to aspects of business 522 operation affected. In this respect, Metcalf et al. (2010) propose a list of climate change impacts 523 namely, markets, logistics, premises, people, procedure and finance while Ballesteros and Domingo 524 (2015) define four aspects of business operation affected by natural disasters: capital, logistics, labor 525 and market/buyers (see also Samantha, 2018). In light of the above, flash floods contribute to a 526 dynamic and complex environment in which firms have to develop increased resilience and 527 adaptation capacities. It is essential for SMEs to gain a full understanding and appraisal of all the 528 dynamic multidirectional interactions between flooding impacts and business operation, time lags 529 which exist in these interactions and their effects on organizational performance over time. 530 Considering the limited resources of SMEs, SD can be a promising approach in facilitating SMEs to 531 respond to management challenges arising from floods. Both qualitative and quantitative tools of SD 532 may give room to SMEs to assess how a flash flood can affect various business aspects and to 533 evaluate the outcomes of alternative strategic scenarios (e.g. through quantitative simulation 534 models) or perform a what-if analysis testing of short- and long-term implications from flooding 535 (Sterman, 2000; Tsalis et al., 2015; Tsalis and Nikolaou., 2017). Such feedback can be a valuable input 536 for shaping strategies and developing mechanisms for adequate protection from floods. Thus, future 537 empirical studies could emphasize on the SD approach and its application in facilitating SMEs to 538 enhance their resilience capacity to flash floods and other EWEs.

539 Furthermore, a comprehensive analysis of past flooding events and the assessment of their 540 impacts on SMEs can be a meaningful approach in advancing our understanding of how various 541 internal and external measures affect SMEs' level of resilience capacity (Samantha, 2018; Asgary et 542 al., 2012). By examining SMEs which have previous experience with flash floods, in-depth 543 knowledge can be obtained on the effectiveness of strategies and measures employed in order to 544 reduce impacts of and contribute to the recovery process. While several recent studies have sought 545 to analyze impacts and factors associated with the recovery from floods and other EWEs (Asgary et 546 al., 2012; Pathak and Ahmad, 2016, 2018; Samantha, 2018; Davlasheridze and Geylani, 2017; 547 Bahinipati et al., 2017), more empirical research is required in order to gain a better understanding of 548 particular measures and actions that facilitate SMEs to robustly address short- and long-term flood 549 impacts. Such knowledge, which can also be gained through the application of composite firm-level 550 indicators assessing organizational, behavioral and contextual factors of the resilience capacity level, 551 can serve as a basis for developing sets of actionable guidelines of good practices which may be 552 adjusted to individual needs and adopted by SMEs in order to strengthen their resilience capacity. 553 This can be achieved in collaboration with critical stakeholders in order to plan and implement 554 agendas for action which will enhance the resilience at a community or regional level (Metcalf et al., 555 2010; Neise et al., 2019).

556 Lastly, in line with the above research recommendations, it is essential to consider and examine 557 in detail the role of the particular internal characteristics that distinguish SMEs from other firms and 558 pose barriers in their efforts to manage challenges and tensions linked to (previously unforeseen) 559 disruptive events such as flash floods (Coates et al., 2020;. Sullivan-Taylor and Branicki, 2011; Ates et 560 al., 2013). For a SME-specific flash flood management system to be robust and effective, additional 561 research shedding light on and allowing to overcome these barriers is essential. Research endeavors 562 focusing on these barriers can contribute in transforming such obstacles into new opportunities for 563 securing performance and continuity while minimizing negative impacts and bottlenecks associated 564 with flash floods among other natural hazards.

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Funding: The research work was supported by the Hellenic Foundation for Research and Innovation
(H.F.R.I.) under the "First Call for H.F.R.I. Research Projects to support Faculty members and
Researchers and the procurement of high-cost research equipment grant" (Project Number:
HFRI-FM17-1844).

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