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

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

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

## 1. Introduction

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

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

97 With projections of EWEs occurrence indicating that such unexpected natural hazards will be  
98 more 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.

## 144 2. Theoretical Background

145 The occurrence of EWEs can result in extremely negative environmental, social and economic  
146 impacts. Bergmann *et al.* (2016) explore the effects of the different types of EWEs (e.g. cold waves,  
147 severe thunderstorms and flash floods) on various organizational operations and aspects, e.g.  
148 procurement operations, marketing and services, logistics and human resources. In this context,  
149 Linnenluecke *et al.*, (2012) suggest a critical and instructive classification for EWEs in three groups:

150 simple extremes (local phenomena based on clear variables), complex extremes (local phenomena  
151 relied on a variety of variables) and unique extremes (global phenomena). The negative impacts of  
152 EWEs differ among various economic and social actors such as public authorities and local  
153 communities (Nikolaou *et al.*, 2015). Particularly, previous studies reveal that EWEs can bring  
154 adverse effects on construction industries (Hopkins, 2014; Alshebani and Wedawatta, 2014) and the  
155 tourism sector with shorter seasons, transport disturbance, less security, loss of revenue (Craig and  
156 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 addressing 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
<b>Organizational theory</b>	Organizations ability to respond to EWEs as well as to adapt their processes in order to make new responses.	Linnenluecke and Griffiths, 2012; Linnenluecke and Griffiths, 2010; Tisch and Galbreath, 2018; Halkos <i>et al.</i> , 2018.
<b>Institutional theory</b>	An organizational adaptive capability is associated not only with their internal capabilities, but also with the external environment (e.g. social, political, and economic environment).	Winn <i>et al.</i> , 2011; Berkhout, 2012; Wejs <i>et al.</i> , 2014.
<b>Systems theory</b>	Business and external environment are interrelated variables.	Dalziell and McManus, 2004; Nikolaou <i>et al.</i> , 2015; Tsalis and Nikolaou, 2017.
<b>Resource dependence theory</b>	Business operation dependence on natural and ecological resources.	Chand and Loosemore, 2015, Bergmann <i>et al.</i> , 2016; Tashman and Rivera, 2016.

223 Institutional theory has also been employed to explain business resilience strategies and the  
 224 level of resilience capacity demonstrated. According to this perspective, for-profit activities and the  
 225

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.

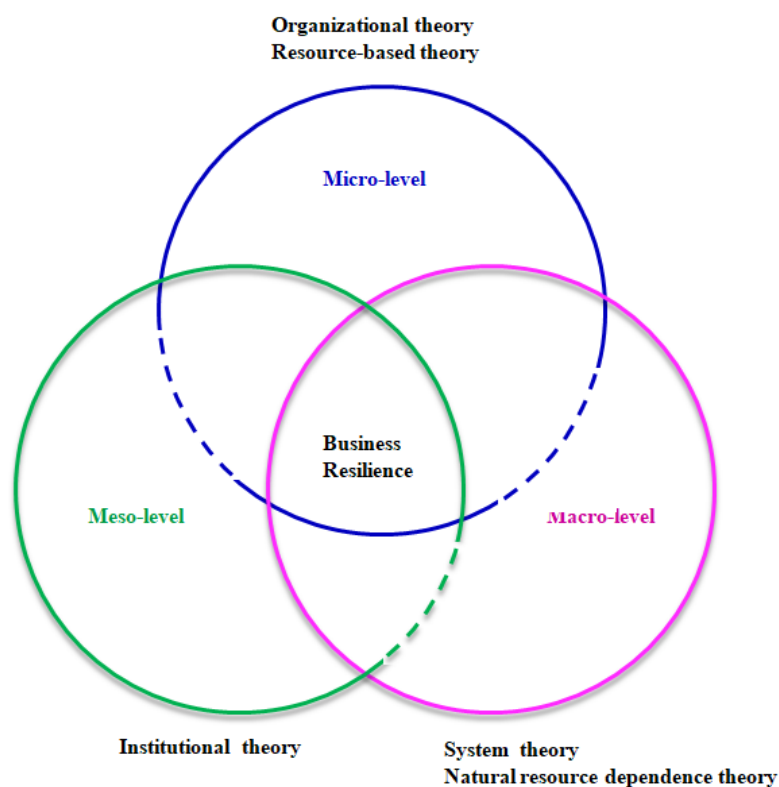
249 Organizational responses to EWEs have also been studied through a natural resource  
250 dependence theoretical perspective where the ecological resilience paradigm is introduced into  
251 organizations' strategic management. The underpinnings of this theory in relation to business  
252 planning 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

278 (organizational-based theory). Such theoretical lens can be helpful to businesses which have  
 279 sufficient resources (e.g. financial capital and skilled human resources), previous experience with  
 280 EWEs (e.g. existing capabilities, knowledge-creating routines, and adaptive procedures), and/or  
 281 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).



293

294

**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**

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

343 Hermann and Guenther (2017) assess SMEs barriers to adopting climate change adaptation  
344 strategies in a large city in Germany. Following a questionnaire survey method, a barrier scale was  
345 developed allowing causal explanations for the occurrence of barriers and how they can be managed  
346 and addressed. Likewise, Halkos *et al.* (2018) and Halkos and Skouloudis (2019) investigate  
347 resilience barriers to EWEs and flooding among Greek SMEs through structural equation modelling  
348 and quantile regression analysis allowing for fruitful insights and essential, context-specific,  
349 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.

357 Mullins and Soetanto (2013) focus on the relative importance ethnic differences and  
358 demographic factors have in the disaster management field linked to flooding in Birmingham (UK)  
359 communities. By employing a quantitative approach in data collection, they find three levels of  
360 resilience and an association of those with different ethnic groups as well as that ethnic differences  
361 consistently exist within the perceptions of business groups within the study's communities which  
362 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 EWEs/flooding stimuli.

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

		Risk Reduction			institutional capacities; macro-level 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 Risk Reduction	Thailand	Questionnaire	Organizational/micro-level; institutional capacities
2018	Samantha	Procedia Engineering	Sri Lanka	Semi-structured interviews	Organizational/micro level
2018	Alharbi and Coates	WIT Transactions on The Built Environment	United Kingdom	Semi-structured interviews & agent-based modelling	System dynamics; micro-level responses & institutional capacities
2018	Halkos, Skouloudis, Malesios and Evangelinos	Business Strategy & the Environment	Greece	Questionnaire	Organizational/micro-level
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 Environment	20 European countries	Questionnaire	Micro- & meso-level interactions; system dynamics
2020	Coates, Alharbi, Li, Ahilan and Wright	Philosophical Transactions of the Royal Society A	United Kingdom	Semi-structured interviews & agent-based modelling	System dynamics; micro- and macro-level interactions

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#### 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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