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Intersections of small business mobility, adaptive capacity, and resilience during crises

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Abstract

Over 5 years, multiple hurricanes and a pandemic impacted small businesses in Charleston, South Carolina. In order to better understand the impacts of disasters on public-facing small businesses, we conducted a case study of customer, labor, location, and supply chain mobility. Although the disaster contexts of multiple hurricanes and the 2019 novel coronavirus (COVID-19) pandemic vary considerably, comparing the experiences of small business operators furthers our understanding of local disruptions and the potential for adaptive capacity. Drawing on 2 years of survey data, we focus on the importance of mobility to public-facing (e.g. service and recreation) small business recovery and adaptation. We then consider the relationship between multiple forms of mobility and resilience to two different disaster types. We conclude by identifying additional areas of small business adaptation and resilience inquiry informed by both hurricane and pandemic experiences. In contrast to previous global or regional mobility studies, this case study explores hyper-local small business mobility disruptions.

Keywords

Small business, resilience, 2019 novel coronavirus, hurricanes, mobility

Introduction

The mobility of people, goods, and services is central to small business disaster response and resilience. Disasters have highlighted the vulnerability of globalized transportation systems such as the Eyjafjallajokull volcanic explosion that brought air traffic to a standstill (Adey and Anderson 2011). Beyond natural hazards, human-caused hazards impact mobility like the Colonial Pipeline ransomware attack that resulted in state emergency declarations and gas shortages throughout the southeastern United States (WBTV Web Staff 2021). As seen with both the H1N1 and COVID-19 pandemics, public health crises also change mobility patterns of goods and labor (Kim and Kwan 2021; Zhong and Bian 2016).

As global and local systems are increasingly dependent on physical and social mobility, the vulnerability and adaptive capacity of the enabling systems (e.g. supply chains) are at the forefront of thought and decision making (Hannam, Sheller, and Urry 2006). Natural hazards impact mobility and these impacts are likely to increase with climate change (Banholzer, Kossin, and Donner 2014; IPCC 2021). When disasters occur, there are observed tradeoffs between people (i.e. labor and social mobility of those impacted) and the movement of supplies and support (Cowen 2014). The experiences of small business operators shed light on these intersections between disasters, mobility, and local resilience.

Small, local businesses can provide insight into how changes to mobility affect communities during disasters. The survival of small businesses during disasters is critical to community recovery and resilience (Adekola and Clelland 2020). Small businesses and their operators provide employment, community disaster support, advocacy and leadership, and other economic and social local benefits to their communities (Cutter 2016; Pierel, Helgeson, and Dow 2021a; Rose 2007). Yet, small businesses tend to be more vulnerable than larger firms due to their smaller size and lower access to financial capital (Basker and Miranda 2018; Corey and Deitch 2011; Sydnor et al. 2017).

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We investigate small business resilience through two related lenses: small business mobility, as the adaptation of physical and social movement practices, and motility, the potential for mobility, as a source of flexibility that leads to resilience. The intertwined physical and social mobility has the potential to increase small business resilience through adaptation (Kreutzmann 2012; Williamson, Hesseln, and Johnston 2012). Disruption of certain mobilities may result in immobility which does not necessarily decrease resilience but also does not improve motility or adaptive capacity. For example, lack of mobility (rigidity and stasis) can lead to maladaptive coping strategies that facilitate a rapid return to normal without adding resilience for future events (Duchek 2020; Limnios et al. 2014). Disruptions to supply chain, employee, and customer mobility impact small businesses, although ties to the local community may support survival and improve adaptive capacity (Blondin 2020).

We argue that this tension between stasis and movement in the geographic discourse on mobility and motility is also present in the organizational resilience discourse on adaptation. In this conceptualization, motility is the business' pre-event adaptive capacity while immotility is the potential to not move or adapt (Blondin 2020; Ferreira, Bertolini, and Næss 2017). During disasters, through an assemblage of enabling systems and operator decision making, the business either embraces mobility or stasis. Studying these moments of local disruption is valuable for furthering our understanding of the traits comprising small business resilience. We illustrate these intersections between mobility and adaptation through a view of five systems related to small businesses: external decision making, customers and sales, labor, location, and supply chains.

Methodology

Between 2019 and 2020, we studied the experiences of small businesses in Charleston, South Carolina as they experienced hurricanes, the COVID-19 pandemic, and the confluence of these two event types. Through engagement with public-facing businesses (e.g. service and recreation), we explore the mobility of goods, labor, and perspectives that contribute to or detract from a firm's multi-hazard resilience.

Research questions

To build upon existing literature through this case study, we organize this paper around the following research question:

1. How do local components of mobility (i.e. supply chain, labor, customers, and government) influence business' resilience during disasters?
2. How do these local components inform our understanding of the relationship between mobility and adaptation?

We follow 15 businesses between 2019 and 2020 as they navigate two different types of disasters and the related disruptions to their mobility. Our research is limited by the number of businesses studied in a single location. Because of these limitations, we consider only the mobility of these specific businesses within the local disaster context and the lessons learned from their experiences.

Data collection

Marshall and Schrank (2014) identified the need for comprehensive research on business recovery and developed the Small Business Disaster Recovery Framework to guide studies (Marshall and Schrank 2014). Guided by their comprehensive framework, we returned to a select group of small business owners in the Charleston, South Carolina metro area (Figure 1). Their names were initially drawn from the Reference USA business dataset curated by InfoGroup (ESRI 2019). Schools, medical institutions, and other sensitive organizations were excluded from the sample in addition to nonprofits and government agencies. Due to Charleston's tourism-focused economy, we contacted public-facing businesses with storefronts going in person during the first wave and virtually during the second wave of the study (NAICS 44, 45, 71, and 72) (U.S. Census Bureau 2017). Spatially, the study area was restricted to the City of Charleston and the adjoining suburbs of North Charleston and Mount Pleasant. The study defined small businesses with fewer than 200 employees at a single location; ultimately, no respondents exceeded 100 employees.

In 2019, the businesses answered a semi-structured 60-question interview (Helgeson, Pierel, and Dow 2020). The survey focused primarily on hurricane recovery status and response actions. Qualitative and quantitative information and answers were recorded by the interviewers. During the summer of 2020, the same businesses that responded to the 2019 survey were contacted again for an in-depth online survey (Pierel, Helgeson, and Dow 2021c). This survey built upon the recovery status and response actions questions from 2019 while adding additional questions on COVID-19 response and community support. Both surveys included questions relevant to business mobility and adaptive capacity.

In 2020, the COVID-19 cases had peaked in July and were in a moderate decline before increasing again in the winter of 2020 (Johns Hopkins University and Medicine 2021). The business operators were emailed and then received a follow-up reminder call. They also received a $5 gift card as appreciation for their time. Of the 15 businesses, one identified as minority-owned and three as women-owned. A total of 11 businesses rented their business location and seven were single owners, four were family-owned, and four were corporations or franchises. All businesses were over 2 years old

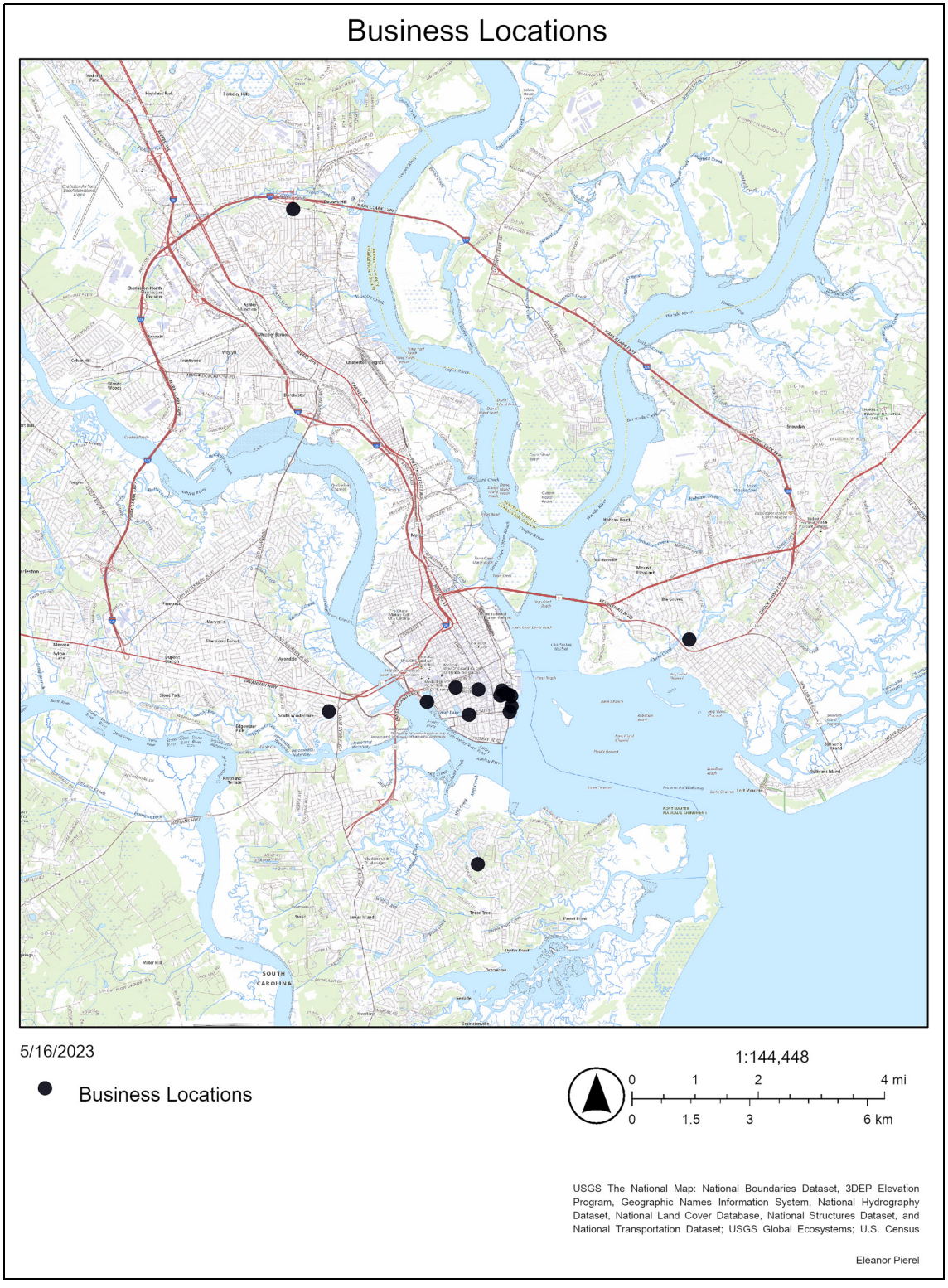

Figure 1. Locations of the 15 small businesses included in this 2-year case study.

(Figure 2). The U.S. Bureau of Labor Statistics consistently finds that 20% of new businesses fail within 2 years, 45% within 5 years, and 65% within 10 years with only approximately 25% making it more than 15 years in business (U.S. Bureau of Labor Statistics 2022). More than half of the businesses, in this case, study are in that top quarter in terms of longevity. This suggests they may be particularly adept at business resilience which is relevant to this study due to their extensive experiences with local disasters. Employment size at the businesses changed substantially between 2019 and 2020 and will be discussed later in the article; however, no business had more than 70 employees in 2019 and seven were microbusinesses (less than 10 employees) as defined by the U.S. Small Business Administration (SBA) (Headd 2017) (Figure 3).

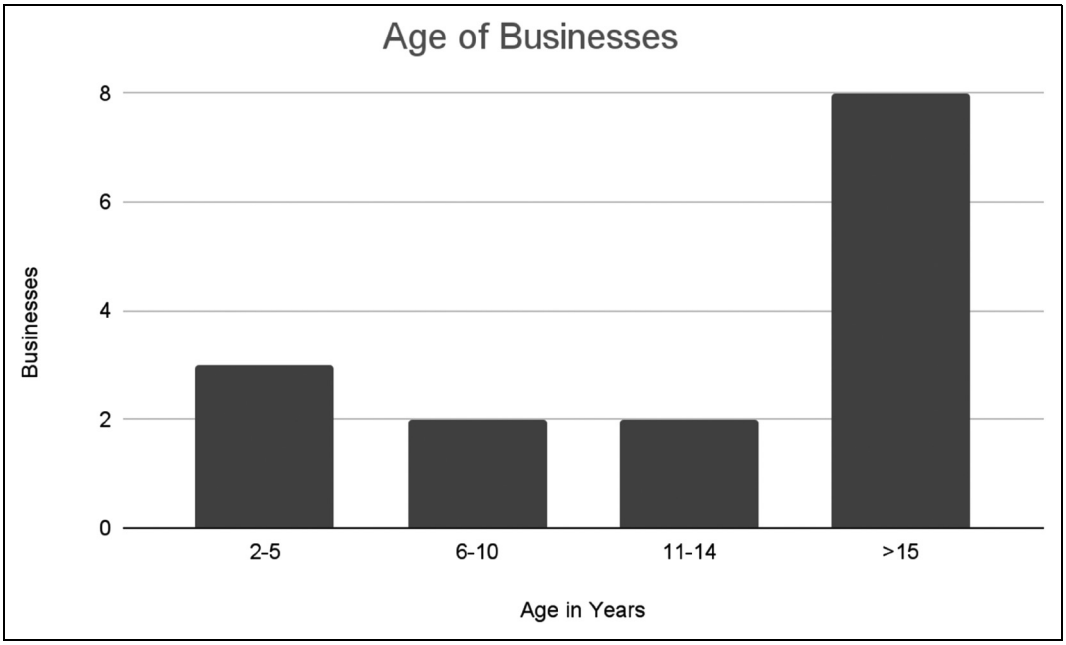

Figure 2. Age of surveyed small businesses in years as of 2019. All businesses were still open in 2020.

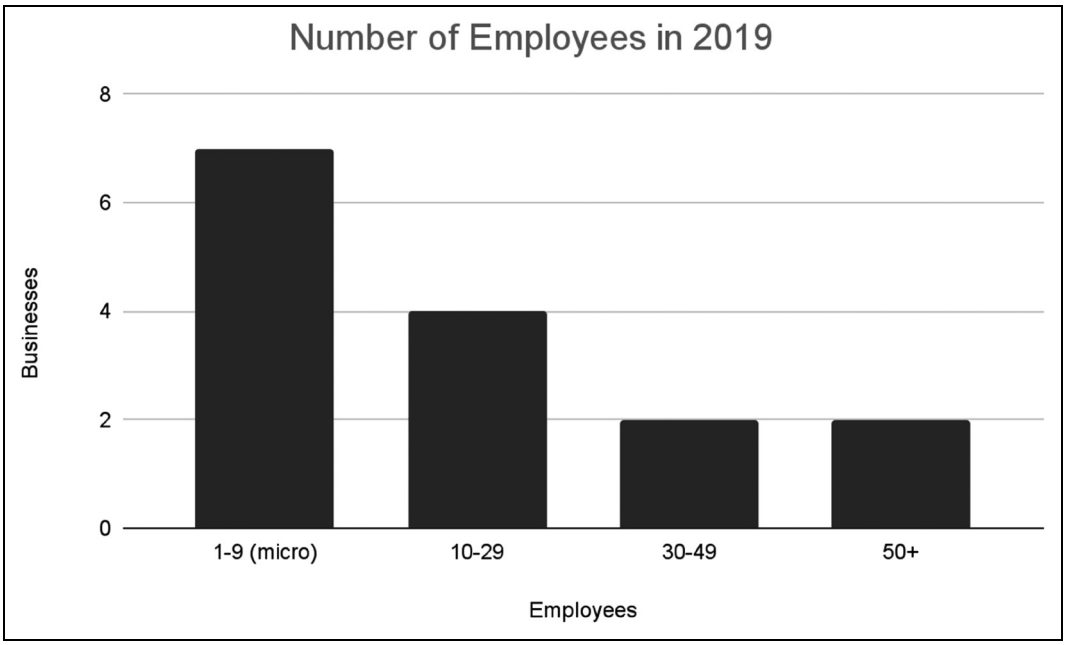

Figure 3. Employment numbers by small businesses in 2019. Seven out of the 15 businesses are defined as microbusinesses, or those with fewer than 10 employees, by the U.S. Small Business Administration (SBA).

There was initially a larger group of respondents; however, there was significant attrition between 2019 and 2020 which can partially be attributed to closures or business changes (Table 1). Of the 50, 2019 businesses initially surveyed, four had permanently closed, two were sold, and two were unavailable due potentially to retirement or closure. This attrition is unsurprising because, although other businesses did not permanently close, businesses were temporarily closed or were functioning at a lower capacity (e.g. remote work, curbside or delivery only, restricted capacity, etc.). The additional stress on these businesses may have reduced their willingness to respond to the survey as only five businesses functioning at lower capacity responded and four of the temporarily closed businesses responded. To determine the loss of businesses due to sale or closure, we conducted a content analysis of the businesses' websites and social media pages between 2019 and 2020 to determine any changes to their status. Content analysis of social media posts started in the summer of 2019 and ended when we closed the 2020 survey. We searched each business' website for press releases, notices, and announcements during the same period. The businesses we determined to have closed or changed ownership had posted on their website or

Table 1. Response rate changes and business attrition over the three survey waves.

Survey wave	*N*	Percent of businesses lost due to sale/closure from Wave 1	Response rate from the original sample	Response rate from the previous wave (not including *N* lost)
Wave 1: 2019	50	N/A	49%	N/A
Wave 2: 2020	15	16%	15%	36%

social media relating to this change. Due to this attrition, this case study focuses on the 15 businesses and their experiences with hurricanes and the COVID-19 pandemic and aims to compare and contrast two types of crises.

Although longer studies may result in smaller samples, the experiences of small businesses over time provide valuable insights into multi-hazard experience and resilience. In mobility research, there are opportunities for qualitative studies of mobility to be linked with big data to overcome the limitations, though sample attrition must be addressed (Kwan and Schwanen 2016). This documented sample attrition demonstrates the importance of capturing ephemeral data such as small business owner disaster experiences. This is especially true for minority-owned businesses, none of whom responded after the first year of data collection. Maintaining relationships with owners without creating a burden can also be complex. This may mean tailoring contact methods for different businesses or sending updates on research progress. These changes should be further considered for future studies in addition to the collection of opinions on contact methods from a diverse sample of business owners and operators.

Local and small business context

Small businesses are more vulnerable to disasters than larger enterprises (Alesch et al. 2001; Basker and Miranda 2018; Dahlhamer and Tierney 1998; Sydnor et al. 2017; Tierney 1997). This is generally due to fewer cash reserves, geographic limitations for customers and revenue, and lower financial access to disaster-related insurance (Alesch et al. 2001; Kroll, Landis, and Shen 1990; Zhang, Lindell, and Prater 2009). Other factors such as industry, age of business, and ownership characteristics can influence vulnerability (Corey and Deitch 2011; Danes et al. 2009; Marshall et al. 2015; Wasileski, Rodríguez, and Diaz 2011). Access to loans or disaster aid can also impact their ability to recover from disasters (Watson et al. 2020). In the case of these 15 businesses, preparation for disasters may also be limited by the number of staff available to implement existing plans (Tierney 1997).

The definition and study of small businesses is extremely broad which may obscure the nuances of operator and owner experiences in varying locations and sectors (OECD 2005; Schindehutte and Morris 2001; U.S. Small Business Administration 2019). This varying definition within the literature may impact studies' results (OECD 2005; Schindehutte and Morris 2001; U.S. Small Business Administration 2019). The size that qualifies as small also varies by sector and annual revenue (U.S. Small Business Administration 2019). These broad definitions may lead to research also treating small businesses within the same sector or in the same location similarly even though size has been found to impact disaster planning and vulnerability (Perry and Lindell 2006; Runyan 2006). There are multiple definitions of SMEs from the United States and international governments and organizations. These range from under 200 to under 500 employees (OECD 2005; Schindehutte and Morris 2001; U.S. Small Business Administration 2019). This study uses 200 employees as the maximum size and focused on businesses in public-focused sectors, specifically retail trade (NAICS 44-45), Arts, Entertainment, and Recreation (NAICS 71), and Accommodation and Food Services (72) (U.S. Census Bureau 2017).

Due in part to the closure of the Naval Complex closure in 1993, Charleston county's government and business sectors focused on building tourism and other economic avenues (Charleston County Economic Development 2022). The non-profit, Charleston Area Convention & Visitors Bureau, is credited with over $10 billion a year in tourism-based economic impact in Charleston (Lumpkins and Pardue 2022). Charleston sees approximately seven million tourists a year and two of its top employment sectors are trade and accommodation and food services with arts, entertainment, and recreation in the top six by growth (Charleston County Economic Development 2022). The result is that the City of Charleston relies heavily on tourism and these sectors are highly relevant for understanding small business impacts, response, and recovery in the area as well as broader local economic impacts.

Situating this study in both a specific time and place is critical for understanding the experiences and perceptions of small business owners and operators. The initial survey examined small business hurricane adaptation and resilience. The location for the study was chosen based on the long history of hurricane impacts in South Carolina as well as the more recent experiences of small business with four disaster declarations during the previous five hurricane seasons.

This case study in Charleston represents the experiences of a small number of local businesses in a specific place. Due to the place-based nature of disaster experience and mobility, the operator experiences are not necessarily representative of small business operator experiences in other places. However, this case study raises questions and identifies the value of considering mobility in future studies. These operators are unique in their experience with prior hurricanes as well as

the state government decisions that differed significantly from other regions. Small businesses in locations such as New York or California who have experience with hurricanes or wildfires may find the study's findings relatable while other findings may be less relevant based on their pre-disaster preparation, relationship with the state government, and overall COVID-19 social norms and precautions. This research adds to the broader conversation on small business and community resilience through the experiences of small business operators during anticipated and unanticipated disasters.

Disaster context

Each disaster occurs within its own context which results in varying magnitudes of disruption and related mobility impacts. Identification of these differences is essential to better understand how a firm's mobility and adaptive capacity may manifest within each event. Certain types of mobility, such as financial or location mobility, are not necessarily engaged during a low-severity or short-term event. We draw upon McKnight and Linnenluecke's (2019) three dimensions to analyze the disaster context of the two disasters that were included in the study. "Impact dispersion" refers to the spatial extent of the disaster impact. "Expected recurrence" is the average occurrence of a type of hazard at a specific location. Their last dimension is "warning," the amount of advanced notice for an event (McKnight and Linnenluecke 2019). In addition to these three dimensions, we add a fourth dimension, "impact duration," which highlights issues of mobility and the temporal differences caused by disasters.

Previous literature has explored disrupted mobilities and differing event contexts. Raleigh and Jordan (2009) compared chronic (e.g. drought, desertification, etc.), sudden-onset disasters (e.g. floods, hurricanes, wildfires, etc.), climate extremes (e.g. sea level rise, increased temperatures), and their relationship with human mobility. They concluded that these disasters would not likely result in large-scale relocations in the short-term though government decisions and social changes could still result in migration (Raleigh and Jordan 2009). Over time, large-scale mobility changes will likely become more common due to complex disasters where multiple crises interact such as public health epidemics, climate change, and sudden-onset events (Cutter 2018; IPCC 2021; Simonovic, Kundzewicz, and Wright 2021). Short-term mobility changes already occur during disasters such as during the Icelandic volcanic eruption and Hurricane Katrina (Clayton and Spletzer 2006; Woolley-Meza et al. 2013). The complex disaster created by the COVID-19 pandemic interacting with natural disasters such as hurricanes and floods provided insight into small business future mobility changes due to climate change. We compare a sudden-onset event (hurricane) with a complex disaster (COVID-19 and sudden-onset events) to better understand local small business mobility changes.

The first disaster experienced by the small businesses during this study was Hurricane Irma. Hurricane Irma made landfall in the Florida Keys as a Category 4 Hurricane on the Saffir-Simpson scale (National Weather Service 2017). Between 9th September and 12th September, Charleston experienced tropical storm conditions and severe flooding, and storm surge. Hurricane Irma caused gusts up to 65 mi/h, between six to eight inches of rain, and between three and six feet of storm surge. Flooding continued and the Charleston Harbor tidal gauge reached almost ten feet, the third highest level on record (National Weather Service 2017). Businesses and roads were shut down as a result though employee, customer, and supply chain mobility quickly resumed after the storm passed. Many businesses closed for Hurricane Irma though there was not a mandatory evacuation declaration for Charleston. Over 11,000 people in the area lost power and 111 roads closed (Charleston Regional Business Journal 2017). At the time it was the fifth costliest tropical cyclone to hit the United States with approximately 50 billion dollars in damage (NOAA NHC 2018). In the sample, all but two businesses closed during the impact of the storm and all reopened within three days. The women and minority-owned businesses followed the same trend two out of three closed for the storm and one women-owned business stayed open by working from home. In general, businesses experience no or minor damage. One business experienced moderate damage due to flooding.

In 2020, the small businesses experienced the impacts of the COVID-19 pandemic. At the time of the survey in 2020, reported cases in South Carolina had decreased to < 1000 a day from a peak of over 2000 a day in July 2020 (Johns Hopkins University and Medicine 2021). The non-essential business closures had been lifted by the state government (McMaster 2020). The vaccine was not announced until many months later in December 2020 and it became available to the general public in March 2020 (CDC 2020; McMaster 2021). The federal State of Emergency was in place until 7 June 2021 (Schechter and Koeske 2021).

Small businesses are often vulnerable due to their lack of access to financial capital and lower profit margins (Zhang, Lindell, and Prater 2009). They may rely on the SBA Disaster Loan Program, the largest provider of individual assistance to businesses (Watson 2021). Applying for these loans often comes with significant paperwork burdens such as financial statements and tax returns over a period of 5 years and these documents can be lost due to flooding or other disaster impacts (Runyan 2006). Watson (2021) found that businesses that received disaster loans were significantly more likely to survive. They also found that businesses that moved were also more likely to survive, further demonstrating the importance of mobility in the face of some disasters. COVID-19 presented a significantly different type of disaster. It was unanticipated by the businesses in this study and had a longer, unpredictable financial impact. Evidence is still accumulating from the impact of COVID-19 on small business survival; however, the Coronavirus Aid, Relief,

and Economic Security (CARES) Act and Paycheck Protection Program (PPP) clearly featured prominently in small business experiences. Bartik et al. found small businesses anticipated bureaucratic difficulties with accessing funds, similar to previously established difficulties with SBA disaster loans (Bartik et al. 2020a; Watson 2021). Once disbursed, PPP loans were found to increase business's expected survival rates and boost employment though perhaps not perfectly and equitably distributed due to a focus on speed (Bartik et al. 2020b). Additionally, there are potential indications that the PPP stimulated conventional small business lending from banks (Karakaplan 2021). There are likely many lessons to be learned from the rapid role out of the CARES Act and PPP for future disaster response and unanticipated events. Out of the businesses in the study, none applied for federal aid for Hurricane Irma compared to 12 that applied for financial assistance during COVID-19. Prior experience with hurricane disaster support had dissuaded business operators from applying even with moderate damage. Future work on the perception of disaster support types and the timing could provide a better understanding of the significant differences in uptake between the two disasters.

Hurricane Irma and the COVID-19 pandemic have significantly different disaster contexts. Although infrastructure was damaged by Hurricane Irma, the damage was concentrated in the southeastern United States, whereas the COVID-19 impacts, such as sick employees and financial losses, were dispersed globally. The expected recurrence is also different as a 2019 respondent commented, "We experience [hurricanes] annually and are prepared for future events." In contrast, businesses are unprepared for pandemics and believe that natural hazards are more likely (Rebmann et al. 2013). Business operators expressed their uncertainty about the pandemic's impact and length.

Technically, both types of disasters had long warning periods. However, businesses anticipated a hurricane impact whereas COVID-19 was not anticipated, impacting their perceptions and response (Pierel, Helgeson, and Dow 2022). Communities are aware of a hurricane threat days before impact (Elsner 2003). In the United States, the first COVID-19 case was reported in January 2020 and the National Emergency and subsequent state-level emergencies that closed or reduced businesses' capacity did not occur until March 2020 (Kim and Kwan 2021; McMaster 2020). However, the advanced warning did not offset the impacts due, at least in part, to the difference in duration from a few days for hurricanes to a few months or longer for COVID-19. Businesses with perishables and staff explained they prepare for hurricanes by hiring refrigerated trucks or moving staff to other locations, even going so far as to anticipate an annual hurricane in their planning. They did not have those plans for a pandemic with an undefined end point and unprecedented global impacts.

Mobility

Over the last two decades, geographers and social scientists have increasingly focused on the mobility of humans and their relationship with society and space (Kwan and Schwanen 2016). Cresswell (2006) defines mobility as the entanglement of physical geographic movement, the experienced practice of movement, and the social constructs related to movement or the "dynamic equivalent of place" (Cresswell 2006: 3). Other scholars employ a definition that gives more attention to the contrasting dimensions of mobility (rest, stasis, etc.) (Enders, Manderscheid, and Mincke 2016; Frello 2008). While much has been written about mobility, the decision to not be or the inability to be mobile can be just as significant for understanding populations, economies, or businesses. Additionally, it is critical to note that mobility is not necessarily equally distributed and that this forced stasis or immobility is also important to consider when studying mobility.

The word "mobility" is used in multiple contexts and definitions in geography research. Mobility can refer to the movement of individuals during travel and commuting (Bissell 2016; Spinney 2016), technological or commodity movement (Adger, Safra de Campos, and Mortreux 2018; Zander, Wilson, and Garnett 2020), and economic shifts and locations (Eidse, Turner, and Oswin 2016; Gorman-Murray and Bissell 2018). These diverse uses center around movement or lack thereof to inform conversations on the flow of goods, services, and people.

In the business literature, mobility is both movement and flexibility, particularly around the movement of the supply chain and employees (Bissell 2016; Long and Reuschke 2021; Pin et al. 2008; Williamson, Hesseln, and Johnston 2012). Cowen (2010), for example, highlights the power that governments have when setting borders and reducing the mobility of supply chains. When a disaster such as the COVID-19 pandemic disrupts supply chains, businesses, and consumers can be impacted by this reduction in mobility (Cowen 2010; Garnett, Doherty, and Heron 2020).

In contrast to movement as mobility, other literature focuses on mobility as synonymous with flexibility (Pin et al. 2008). Flexibility is a consistent theme in both geography and business mobility literature and highlights the relationship between mobility and adaptation. This linkage is not particularly new. For example, in 1941, geographer Carl Sauer studied mobility as a measurement of dynamism or flexibility (Sauer 1941). Later, business researchers adopted dynamism as a version of mobility to improve a firm's adaptive capacity (Pin et al. 2008; Williamson, Hesseln, and Johnston 2012). Drawing upon this context, mobility in a supply chain can help to mitigate disruptions and reduce risk (Kleindorfer and Saad 2005). If we adopt this flexibility definition of mobility, demonstrating the ability to adapt to changing circumstances falls within mobility research.

Resilience and mobility

The concepts of adaptation and resilience lend themselves to an understanding of a business' mobility or immobility. Adaptation has many definitions centered around an adjustment of practices in the context of disasters and climate change while adaptive capacity is the potential for this adjustment (Bierbaum et al. 2014). The National Academy of Sciences defines resilience as, "the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events'' (National Research Council 2012: 18). We study resilience through repeated recovery and adaptation of small businesses in Charleston to multiple disruptions. It is also important to note that a business may demonstrate resilience to one type of disaster that does not extend to other, unanticipated events.

Small businesses create an opportunity to study local adaptation and mobility. Previous studies focused on larger-scale human migration (Adey and Anderson 2011; Koyama 2013). During migration, mobility and adaptation to new political, economic, and physical environments are intertwined (Adger, Safra de Campos, and Mortreux 2018; Koyama 2013). Climate change and complex disasters are expected to create more circumstances with mobility impacts (Adger, Safra de Campos, and Mortreux 2018; Zander, Wilson, and Garnett 2020).

There are many capacities that enable adaptation and increased resilience. Economic resources, social networks, governance style, and access to labor are additional examples (Smit and Wandel 2006). Overall, however, adaptive capacity can be difficult to measure due to the interconnectedness of these capacities as well as latent capacities that manifest under duress. Studying businesses during multiple crises and an unprecedented complex disaster created an opportunity to study local adaptive capacity and its relationship with mobility and resilience.

Small business research often includes adaptation and resilience which can be augmented by applying a mobility lens (Long and Reuschke 2021). For example, when a small business operator changes practices to respond to an event or to prepare for a future event, they may draw upon their business' mobility. Their ability to move location, shift sales platforms, or adjust employee schedules or working environments are all intersections with mobility and adaptation. These latent abilities are further examples of social, technological, and geographical motilities that allow for adaptive capacities.

Before an event, all firms have a potential for mobility or "motility" (Kaufmann 2002). We draw upon Kaufmann's definition of motility to demonstrate its relationship with adaptive capacity and business practices. After an event, businesses may pursue one of two pathways to adapt (mobility) or not adapt (stasis). If they choose to not adapt, they rely on pre-event existing resilience whereas adapting their movement and practices potentially enhances their resilience for the next event. Conceptualizing mobility as both the practice of movement and stasis allows for parallels between mobility and adaptation in comparison to stasis and not adapting (Adger, Safra de Campos, and Mortreux 2018; Williamson, Hesseln, and Johnston 2012). The businesses then return to a state of motility between events (Figure 4).

An example of this cycle is the process of decision making around firm assets. A firm may have certain assets as static inventory pre-event. They then experience the event and decide to adapt their practices and shift business assets from static inventory into liquid capital (mobility). This in turn enhances their resilience and potential for mobility (motility, a form of adaptive capacity) for the next event (Williamson, Hesseln, and Johnston 2012). Studying small businesses over a series of disasters allows for observation and analysis of adaptive capacity during periods of immobility and mobility.

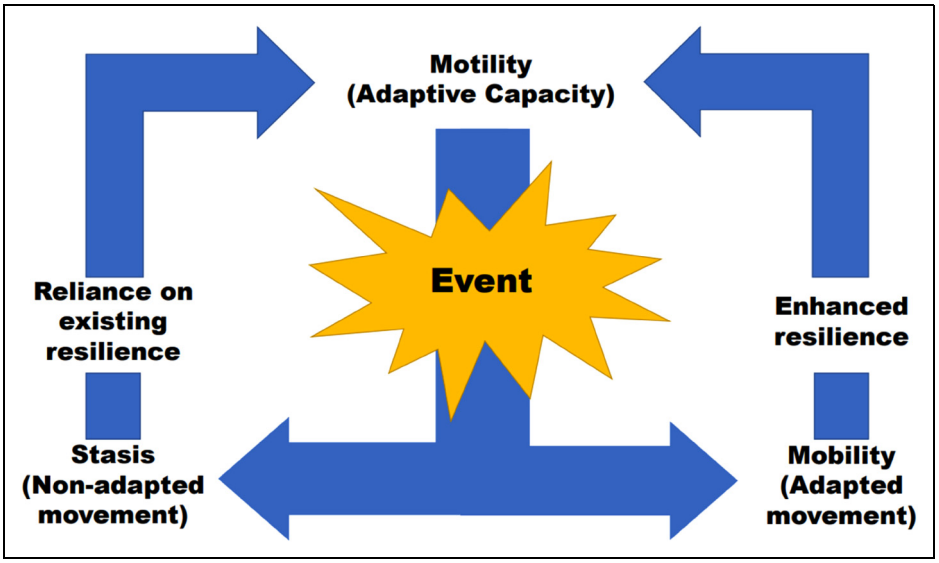

Figure 4. Conceptual model of the relationship between adaptation, resilience, mobility, and motility.

Planning for resilience

Researchers and practitioners have long advocated for multi-hazard planning solutions and the value of anticipatory adaptation (Grimm 2013; Linnenluecke, Griffiths, and Winn 2012; Sahebjamnia, Torabi, and Mansouri 2015; Spillan and Hough 2003). Despite the significance of small businesses, there is little information on how they plan for or respond to pandemics (Burton et al. 2011; Watkins, Barnett, and Links 2008a; Watkins et al. 2008b). Previous research documents extremely low rates of preparation and response for previous pandemics (Rebmann et al. 2013; Terry 2020; Watkins et al. 2008b). This is despite the clear importance of disaster and continuity of operations planning (COOP) and the existing resources available for businesses from the Federal Emergency Management Agency (FEMA) and non-governmental organizations (e.g. FEMA 2022; U.S. Chamber of Commerce Foundation 2017).

In the event of an unexpected disaster, there may be significant uncertainty in decision making. Existing pandemic recommendations for small businesses may not have been enough to prepare for the COVID-19 pandemic (Agility Recovery 2019; CDC 2017). In previous studies, very few businesses had prepared for a pandemic. Among health care agencies that experienced the H1N1 pandemic, 78% agreed that they should have pandemic preparations, however, during the pandemic these agencies relied primarily on employee training rather than more disruptive measures like social distancing (Rebmann et al. 2013).

In line with previous research, there were relatively low levels of general disaster planning, such as COOP, in this study's sample. None of the businesses had developed a pandemic plan and only two had a COOP prior to the pandemic. However, eight businesses had a hurricane plan of some form and most felt their plan helped with hurricane recovery. The businesses with COOP's found their hurricane preparation helped their businesses cope with COVID-19 while the businesses with hurricane plans found their experiences only slightly helpful or not helpful at all. While there are low rates of planning for more general disasters, this may indicate the importance of COOP and a need for further resources or communication on the value it provides.

Mobility components of disasters

During disasters, businesses emerge as focal points of mobility due to customer, goods, and employee movement (Williamson, Hesseln, and Johnston 2012). When a disaster occurs, these movements are disrupted. A firm's capacity to adapt their movements may determine the firm's survival and resilience to disruption (Pforr et al. 2014; Pin et al. 2008; Wedawatta and Ingirige 2012). Both Hurricane Irma and the COVID-19 pandemic highlighted the proposed relationship between mobility, motility, adaptation, and resilience.

The COVID-19 pandemic highlighted the multidimensional mobility impacts possible during a global disaster (Garnett, Doherty, and Heron 2020; Gössling, Scott, and Hall 2021; Park and Kim 2021; Ratten 2020). During the pandemic, populations and labor markets experienced significant changes in mobility both mirroring and exceeding expectations from previous studies on disaster mobility (Park and Kim 2021). Before the pandemic, within business mobility research, the tourism sector was most impacted by mobility-disrupting disasters such as the September 11th attacks (Hopkins 2020; Larsen, Urry, and Axhausen 2007; Pforr et al. 2014; Rowen 2016). During the pandemic, observed disruptions were more distributed across sectors (Dua et al. 2020). The pandemic disrupted both upstream and downstream supply chains (Das et al. 2021).

Supply chain mobility measurement is particularly difficult as disruptions occur at varying spatial scales leading to complex interactions. Disasters and their interactions with supply chains are generally studied as spatially discrete events with short time scales (Thomas and Helgeson 2021). In this context, disasters do not result in national-level impacts (Mileti 1999). However, the COVID-19 pandemic exposed vulnerabilities in the social and physical systems that led to global and long-term supply chain mobility decreases. The global supply chain, which is both valuable and fragile, could not adapt quickly enough to meet changes in labor and demand (Boyd 2020; Donnan et al. 2020; Garnett, Doherty, and Heron 2020).

In contrast to supply chain research, the level of analysis for human-focused mobility studies has occurred at broader spatial scales and longer temporal scales. Zander, Wilson, and Garnett (2020) studied the impact of natural hazards on labor mobility across Australia with a sample of over 1000 participants. They found that although hazard risk did not necessarily dissuade participants from migration if wages were high, devastating experienced hazards (i.e. wildfire risk in Australia) were the most important environmental factor when choosing a new employment location (Zander, Wilson, and Garnett 2020). There are fewer studies on the experience of those impacted by local shifts in mobility or over different time scales. Adger, Safra de Campos, and Mortreux (2018) highlighted this crucial temporal difference in adaptation and policy responses for short-term versus permanent mobility changes.

By integrating these conceptualizations of mobility from both the geography and business literature, we can further understand small business operators' experiences during disasters. In this article, we demonstrate that the potential for and then actualization of mobility by operators can influence the business' resilience during multiple disasters as a component of adaptive capacity and adaptation. Beyond the individual business, external mobility changes such as supply chain disruptions influence a business' resilience.

Discussion

Due to the small sample size of this dataset, our analysis of mobility is limited to the local perspective identified by Adger, Safra de Campos, and Mortreux (2018). Although there is a geographic limitation, the collection of data across 2 years and two disasters allows for a unique examination of similarities and differences in disaster mobilities over time. We focus this study on several moments that highlight the value of understanding both the movement and flexibility dimensions of mobility and motility for small business resilience (Cresswell 2006; Pin et al. 2008).

External decision making

Government decision making related to disaster mobility can both create and reinforce unequal power dynamics and adaptive capacities (Sheller and Urry 2006). Evacuations represent a mandated change of mobility. In South Carolina, evacuation orders are always mandatory though people choose to evacuate sometimes without an order or a "shadow evacuation" (Dow and Cutter 2002). During Hurricane Irma, there was no mandatory evacuation, though many of the business operators remembered it as an evacuation. As one operator commented in 2019, "The premature evacuation cost [the business]. If there is no evacuation order, then [the business] is unlikely to close."

Even when there is no evacuation, government decisions can reduce mobility though not always in time. One business operator explained that he puts signs out to warn oncoming traffic of the flooding on the road though the staff still needed to push flooded cars out of the road. A business operator stated that "The city doesn't barricade the road in time when there's flooding." For some businesses, local road closures mean they must also close because customers and employees cannot get to the business. The risk of flooding in combination with government closures limit businesses' agency to adapt during a hurricane.

Support for small businesses from the government or other external entities can also support resilience during disaster-related mobility disruptions. The loans and grants provided during COVID-19 allowed small businesses to continue employment and support employee mobility. Previous studies have found disaster loans to be beneficial to small business resilience (Watson 2021). In another weighing of safety and economy, the government's decision to designate "essential" businesses during the COVID-19 pandemic caused significant economic impacts. Knowledge of essential goods and services has been previously found to be uncertain in government decision making (Boettke 2002). The creation by government entities of an essential economy comes with many difficulties and consequences (Boettke and Powell 2021). The assumptions made by decision makers about essentialness during the COVID-19 pandemic varied substantially between states, highlighting the subjectivity of the designation (Storr et al. 2021). These decisions had significant implications for mobility for business operators, customers, and employees. In a study of shutdown policies and unemployment, Kong and Prinz (2020) found that non-essential business closures accounted for 6.4% of unemployment insurance claims. Even if a business did not close, capacity limitations accounted for another 6% of claims (Kong and Prinz 2020).

In this case, study of businesses, size, sector, and essential designation may play a larger role than access to funds for revenue, reopening, and employment. Of the businesses who received the Paycheck Protection Program funds, they lost between 0% and 83% of their employees with three losing no employees. The five who did not receive the PPP lost between 0% and 100% of their employees. The impact of PPP is clearly illustrated in other studies and yet it is not as clear for those in this study. We explore additional factors that may contribute to these businesses' mobility and resilience.

Customers and sales

Beyond the essential designation, travel restrictions and stay at home orders resulted in reduced mobility and highlighted a lack of adaptive capacity for tourism-reliant businesses. The diminished mobility of customers can reduce the resilience of businesses. Charleston, South Carolina is a tourist destination and receives an estimated 7.37 billion dollars in economic impact from tourism annually (Palkowski 2018). The tourism sector suffered during the COVID-19 pandemic as it has during previous disasters (Williams 2021). As one 2019 respondent explained about their business, "It's a tourism-based business so when there is a decline in tourism then there is a decline in business." In this study, eight businesses relied on customers from outside of the city of Charleston. Of those businesses, six were < 50% recovered with three not recovered at all. This is in contrast to the businesses with customers from the same neighborhood that were all 50% or more recovered.

To illustrate the impact of reduced customer mobility, we contrast two small liquor store single-owner microbusinesses. Both of the businesses were deemed essential to stay open and both have similar space restrictions that do not allow for social distancing. However, one sells primarily to local customers while the other is reliant on out-of-state tourists visiting the area. In the 2020 survey, the business that relied only on local customer mobility was mostly recovered with zero loss in employees while the other business reported no recovery and experienced a 50% reduction in employees.

Differences in disaster context can have serious consequences on business adaptive capacity and observed resilience. The Icelandic volcano eruption and subsequent air transportation impacts foreshadowed the sweeping COVID-19 pandemic international travel restrictions. Globally, 189 countries closed their borders in an attempt to slow the spread of the virus (Shiraef 2021). One business in our study relied upon international customer travel for revenue. During

Hurricane Irma, they were one of the fastest to reopen and our 2019 estimates of adaptive capacity pointed to high resilience in the face of disasters. However, they had not reopened as of 2020 after 21 years in business because they were unable to serve their international clients. The impact length on mobility has highlighted critical vulnerabilities in certain sector's adaptive capacity.

Alternatively, the reduced mobility or immobility of customers may have increased other small businesses' future motility. During disasters, new technologies or new implementations of existing technologies redefine economic and social mobilities and reveal latent motility (Urry 2008). Online sales increased approximately 35% over pre-COVID-19 levels (Charm et al. 2021). In Charleston, multiple community initiatives appeared within 2 weeks of the shutdown to support local small businesses (Benson 2020; Rally for Restaurants 2020b). Businesses and their customers worked together on social media such as creating the Facebook group, Lowcountry Eat Out!, to advertise their take-out options (Lowcountry Eat Out 2020a). Online ordering and curbside pickup were supported by local government ordinances waiving parking restrictions (City of Charleston, SC 2020). Multiple experience-focused businesses in our sample like a gym and two tour companies took to social media to sell online classes, tours, and merchandise.

While all of these businesses that quickly adopted new virtual mobilities also returned to business-as-usual once restrictions were lifted, these decisions may impact business motility for future events. If certain businesses enhanced their resilience by improving flexibility and the potential for mobility, they may be more capable of responding to other types of disasters. Future work will be necessary to understand long-term learning and adaptations caused by the COVID-19 pandemic; however, multiple businesses in the study expressed optimism about their increased motility.

Labor

In 2019, businesses' employees had trouble returning to work after Hurricane Irma. A restaurant operator explained that "A lot of employees are students that had to evacuate," which disrupted their staffing capacity. Five reported that their employees could not work due to transportation delays. Three reported that their employees could not find childcare due to school closures. These experiences highlighted the motility of different labor groups where college student employees have high motility, they have the potential to evacuate and stay with family leaving their employment location, whereas employees with children may have lower motility due to childcare needs. Both motilities result in businesses having decreased employee capacity. These potentials are then tested when an event occurs and labor mobility (or immobility) is suddenly critical to small business functions. Experiences during hurricanes highlighted the differences in motility for different businesses and their employees and foreshadowed issues during the pandemic.

The demands made on labor during times of crisis may mobilize employees both geographically and socially. Natural hazards such as hurricanes and wildfires have resulted in the migration of labor to unimpacted or less vulnerable areas (Clayton and Spletzer 2006; Zander, Wilson, and Garnett 2020). The COVID-19 pandemic similarly resulted in the social mobility of labor away from the leisure and hospitality sectors (Klein and Smith 2021). This labor shift could decrease sectors' long-term resilience if small businesses are unable to hire employees to meet demand.

The change in labor demand and increase in wages and benefits may impact employee resilience. This could occur through increasing employee hazard experience capacity if employees stayed during the pandemic, reducing capacity if employees left or the cost of labor increased, or potentially exacerbating labor inequalities which may decrease small business resilience if employees are now less resilient (Kochhar and Bennett 2021). The COVID-19 pandemic exacerbated the social vulnerabilities that exist within hierarchies of labor that had previously been observed (Cutter 2003; Jackson et al. 2021; Preston and McLafferty 2016). Additionally, the labor shift away from more vulnerable sectors is mediated by the unequal power of motility (Kaufmann 2002).

In contrast to previous studies where lack of motility was associated with vulnerability, the COVID-19 pandemic highlighted that the potential to remain immobile or allow employees to be immobile (i.e. working from home) can also be unequally distributed throughout sectors and classes. When lockdowns began in March 2020, there was a brief decline in mobility across labor classes. However, certain segments of the population quickly returned to normal levels of mobility mediated by poverty level and political affiliation (Kim and Kwan 2021). The study of movement often excludes those who do not have free geographic mobility and does not consider how that may impact their vulnerability (Hannam, Sheller, and Urry 2006). This is reflected in our study as well where we found managerial and senior management positions had more flexibility in their mobility. Business sectors also had varying levels of employee motility and immotility, such as restaurants that needed to make food in house, which may reduce their ability to recover.

Maintaining core employees was essential to the business' resilience and ultimately relied on adapting or supporting existing employee mobilities. The microbusinesses that stayed open or only closed for a few months had almost no employee loss. Only one microbusiness that reopened lost an employee; however, they reported most sales were due to tourism in 2019 which indicates a potential reason for downsizing. Only one microbusiness did not reopen in 2020 and had a full employment loss. The small businesses experienced larger losses with only one maintaining full employment and the other eight losing between 10% and 100% of employees. The business with full employment did not receive PPP though they are a seasonal business and may have more financial and physical mobility. During Hurricane Irma, they demonstrated adaptive capacity and mobility by moving employees to different locations. No essential businesses

lost all employees; however, the size and tourism-dependence of the business still appears to determine the magnitude of loss. Additionally, businesses who allowed employees to work from home saw almost no change in their employment levels. In contrast, businesses that relied on mobile labor such as college students or front-line labor saw a decrease in staffing of 10% to 100%. These findings suggest the complexity of external and internal circumstances on small business resilience.

Location

The location of a business may be considered a pattern of stasis in their physical mobility. These immobile material locations are connected to complex global and local systems until a disaster occurs (Hannam, Sheller, and Urry 2006). Location dependence is often essential and critical to a business' reputation and revenue though during a disaster, where mobility is necessary, it may also lead to reduced adaptive capacity (Cheung and Kwong 2017). This reliance on location can be another measure of small business pre-event motility and potential resilience.

Business location mobility can foster adaptive capacity. At a single location, business operators suggested options for continuing business even during floods. "The owner [of the gym] mentioned the parking lot could be used as an alternative location," Interviewer notes (2019). Although they did not make location changes for Hurricane Irma, their perceived location mobility may have helped this business adapt to working from home and then finding new solutions once they returned to work during the COVID-19 pandemic. One business had multiple locations around Charleston that helped them reopen quickly after Hurricane Irma.

Every business operator responded that their business was somewhat or extremely dependent on their location in 2019. Only one business operator estimated they could conduct business from home in 2019. By 2020, five businesses were able to pivot to working from home. The change in measured location dependence and location flexibility may be due to the fact that businesses defined their location dependence on the greater City of Charleston and not by the physical location of their store or office. Businesses in services such as wedding planning and athletics, established work from home options. However, businesses like city tours or restaurants did not offer this option to their employees. Although all of the small businesses were public-facing, they did not all have the same level of location mobility.

Businesses without the ability to change locations found this lack of location mobility led to reduced resilience and slower recovery. Out of the businesses with work from home options, three were at least mostly recovered in 2020 and none reported no recovery. Additionally, three of the businesses had not lost any employees. In comparison, out of the ten businesses with no work from home option, four were not recovered at all and only two were mostly recovered. None of the non-work from home businesses were completely recovered.

In certain sectors, the constraints on mobility were somewhat mitigated by the business' physical context. Outdoor tourism businesses reported more recovery in 2020 than indoor tourism businesses. A similar recovery experience existed for restaurants with the capacity to provide outdoor seating. One business with exclusively indoor space that could not accommodate social distancing closed for much longer than legally required due to the owner's interest in staff and customer safety. They stated, "We are closed since we are unable to operate safely." Exterior space and multiple locations increased the business' adaptive capacity when faced with the pandemic restrictions.

Supply chain

During both Hurricane Irma and the COVID-19 pandemic, small businesses in our study, experienced impacts to their supply chains. The retail and food service industries experienced the greatest disruptions. These supply chain impacts are interrelated with each of the previous intersections between mobility and decision making, customers, labor, and geographic location (Das et al. 2021). Research focused on the downstream effects is generally limited. Since supply chains involve activities and mobility surrounding raw material acquisition, material production, and transportation to the end consumer; tracing impacts on a micro-level is arduous since the causes of disruptions are nuanced and present risks to businesses. In their macroeconomic analysis employing input-output analysis, Thomas and Helgeson (2021) suggested that supply chain vulnerability can result in substantial and geographically distributed downstream impacts. Considering the difficulty of measuring supply chain pre-event motility and the local scale of this case study, we build upon their research by studying the downstream mobility impacts.

For example, previous hurricane experience and adaptation to address resource shortages aided a construction and landscaping business' resilience (Boyd 2020; Donnan et al. 2020). During Hurricane Irma, they purchased additional machinery in anticipation of increased demand. They were then prepared for the unanticipated demand coupled with supply shortages and price increases caused by the COVID-19 pandemic. Out of all of the businesses, they were the only business to have increased revenue from both the hurricane and pandemic. They also were the only business to hire additional employees during the pandemic.

Businesses who chose not to adapt their supply chains (e.g. redundancy) after issues during Hurricane Irma continued to experience disruptions that required adaptations during the COVID-19 pandemic. In the 2019 survey, a restaurant reported reduced mobility of supplies throughout their supply chain during the hurricane. They could not receive deliveries, but their

suppliers also could not receive supplies to deliver. They believed that this was due to the length of their supply chain (i.e. the number of other businesses required to transport their products to their physical sale location) (Brakman, Garretsen, and van Witteloostuijn 2020).

This compounded and widespread supply shortage that permeated the supply chain was further expanded and exacerbated during the COVID-19 pandemic. The impact of COVID-19 on global economics could potentially alter supply chain and business practices from the "just-in-time" delivery model to a more resilience focused "just-in-case" model (Brakman, Garretsen, and van Witteloostuijn 2020). In 2020, the same restaurant listed supply chain disruptions as a primary reason to change practices. They did not explain the exact changes during surveying though the restaurant offered special limited menus for curbside pickup through social media during the lockdown. This could potentially indicate shortages in the food supply chain as seen elsewhere during COVID-19 (Garnett, Doherty, and Heron 2020). A florist also listed disruptions as their primary reason to change business practices. They had previously experienced three days of flower and supply disruptions from Hurricane Irma.

Local supply chains may be more resilient to global mobility disruptions, but they are also vulnerable to infrastructure impacts associated with extreme weather event impacts. Seven businesses experienced longer delays during the hurricane; however, these were delays caused by local infrastructure impacts such as flooded roads or dangerous fishing waters instead of global supply chain disruptions. For example, another restaurant had local seafood delays for a week after the hurricane but that did not prevent them from reopening. These businesses with more local supply chains did not experience major supply disruptions during the COVID-19 pandemic. The differences between hurricane and pandemic impacts highlight the current tension and conversation around globalization versus local supply chains and whether adapting to favor one or the other may be practical or ultimately enhance resilience (Brakman, Garretsen, and van Witteloostuijn 2020).

Conclusion, opportunities, and challenges

Studying the intersection of small business and geographic mobility literature provides insights into local disaster adaptive capacity and resilience across interruption types. The businesses in this study were all hurricanes experienced and while some disaster response lessons were transferred, other vulnerabilities arose in the face of the unprecedented COVID-19 crisis. Based on this case study, we offer three sets of conclusions and recommendations on mobility and multi-year research studies.

First, we identified multiple intersections between small business mobility, motility, and resilience. We found that many businesses were more resilient than they anticipated to long-term revenue losses because they found opportunities to pivot practices (such as providing more takeout and delivery options) to remain open. Although the initial survey was focused on hurricane-related preparation and adaptation, COVID-19 highlighted the multidimensional and often local aspects of small business resilience that we may anticipate in future complex disasters. The heterogeneity of the sample also provides insight into multiple public-facing sectors and small business experiences. Even within sectors, there was significant variation due potentially to size and mobility indicating that future studies should consider the differences between and within small business sectors. By integrating the concept of motility into the discussion, we recognize that mobility and small business resilience are temporally as well as geographically dependent. The potential for mobility is a prerequisite for the ability to adapt when an event occurs. Studying motility as a form of adaptive capacity provides an avenue for analyzing small business resilience between crises. By following businesses from motility to mobility, this sometimes latent potential is then actualized and the resilience differences among sectors and hazard types may be further understood.

The second set of conclusions relates to the challenges of multi-year research. Over 2 years of study, we observed the business operators responding to complex disasters; however, sample attrition resulted in a diminishing basis for analysis. We may have seen attrition due to the COVID-19 required shift from in person to online surveying. Maintaining relationships with respondents became even more critical after this shift and knowing the owner or operator from the previous surveys helped to moderately improve initial response rates in the 2020 survey by calling and asking for previous participants by name. This lack of random data collection in the second year then disrupts the ability of surveyors to conduct statistical analysis; however, it still allows for insights into small business experiences across years. Future work should integrate and seek to advance best practices for maintaining research relationships with small businesses during multiple disasters and data collection to enable the study of resilience and recovery over the duration of these processes. This could involve both in person and virtual techniques including integrating emerging technologies such as video calling to simulate the face-to-face surveying experience. The increasing prevalence and normalization of virtual forms of interaction is a promising avenue to facilitate deeper understandings of resilience in the face of complex disasters.

We conclude by suggesting variables for inclusion in future studies to further the understanding of mobility as it relates to small business multi-hazard resilience. The development of future small business resilience surveys could consider the areas of local mobility impacts identified in this paper: external decision making, labor, customers, location, and supply chains. Although addressed in other sub-disciplines such as human migration or tourism, these business decisions and characteristics impacted the participants' adaptive capacity and multi-hazard resilience. As identified in previous mobility studies, there are significant mobility inequalities (Parks 2016; Sheller 2016). Considering the lengthy disaster experience of the minority-owned business in this study, addressing differences in mobility could provide further insight into small

business resilience. Technological competency and online work options were not a component of the original hurricane study, though they provided more flexibility and mobility for businesses and increased their resilience during the pandemic. This study enabled the identification of potential additional disaster resilience measurements by integrating previous understandings of geographic and business mobility with new small business disruption experiences.

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Author biographies

Eleanor Pierel, **PhD**, is the Climate Science Manager at Ocean Conservancy working to advance evidence-based climate solutions as part of OC's Science Team. She works across the organization and with external partners on climate-related topics, including blue carbon, adaptation, and community resilience. Prior to her position at Ocean Conservancy, Eleanor was a member of the 2022 John A. Knauss Marine Policy Fellowship serving as the Climate Policy Fellow to NOAA's first senior advisor for Climate and one of the first female vice chairs of the IPCC, Ko Barrett. In this role, Eleanor worked

across NOAA and other federal agencies to advance the administration's climate policy goals to build a Climate-Ready Nation. Eleanor also supported the IPCC's Gender Action Team and was a member of the US Delegation to the IPCC and NOAA Delegation to COP27, where she spoke about gender and climate change during one of the US Center's Climate Conversations. Eleanor has always had a passion for identifying community needs, conducting policy-relevant research, and communicating science. This led her to George Washington University where she discovered an interest in sustainability, private sector engagement, and international climate policy culminating in attending COP21 as a student representative. Recognizing the need for additional community-focused research, Eleanor accepted a graduate student position in the University of South Carolina's Department of Geography, where she worked with Dr. Kirstin Dow and the Carolinas Integrated Sciences and Assessments, an NOAA-funded lab, on co-produced community-focused research. Her master's degree focused on the impacts of sea level rise on coastal agriculture using a multidisciplinary approach blending social science and remote sensing. For her doctoral research, Eleanor continued to work with small business owners in multiple sectors because understanding small business decisions and challenges during disasters can support broader community resilience when confronted with the impacts of climate change.

Jennifer Helgeson, **PhD**, is a research economist in the Applied Economics Office of the Engineering Laboratory (EL) at the National Institute of Standards and Technology (NIST). She currently leads the office's work on the "Economics of Community Resilience Planning" and is Acting Program Manager for the Community Resilience Program at NIST. Her research interests focus on decision science, including survey assessments and economic analyses that consider behavioral aspects and approaches to dealing with environmental issues. Dr. Helgeson's research revolves around resilience to hazards (shocks and stressors) in the built environment, with consideration for the cost-effectiveness of community-scale climate mitigation and adaptation efforts. She is a chapter author for the Fifth National Climate Assessment and was recently a US delegate to the IPCC process. Dr. Helgeson has mentored over 20 high school and undergraduate students with an interest in environmental issues and behavioral economics. She continues to be a postdoctoral supervisor and enjoys working with students and early career researchers. At present, Dr. Helgeson is a member of the National Construction Safety Team (NCST) Technical Investigation of Hurricane Maria and its impacts on Puerto Rico. The NIST Hurricane Maria Program also includes NIST's National Windstorm Impact Reduction Program (NWIRP) Study to better understand recovery processes in Puerto Rico following Hurricane Maria. Under this NWIRP study, Dr. Helgeson leads a project to determine the impacts on and recovery of small and medium-sized manufacturers (SMMs), and retail and service industries. As part of her business resilience research, Dr. Helgeson led a primary data collection effort in partnership with NOAA focused on decision-making processes for small- and medium-sized businesses in response to complex events (e.g. weather/climate disasters during a pandemic). In the past, Dr. Helgeson was a researcher at the Centre for International Climate and Environmental Research, Norway, and the Organization for Economic Co-operation and Development, France. Following the completion of her BA degree in Economics at Brandeis University, she spent a year researching Environmental Economics issues on a Fulbright Grant to Norway. She earned her MS degree in Environmental Change and Management with a focus on Environmental Economics at the University of Oxford, UK. Dr. Helgeson holds a PhD in Environmental and Developmental Economics from the London School of Economics (LSE), where she was awarded a Grantham Institute for Climate Change Research Scholarship and was also supported by an NSF Graduate Research Fellowship.

Kirstin Dow, **PhD**, is a Carolina Trustees Professor in the Department of Geography, earning her PhD from Clark University and joining the South Carolina faculty in 1996. She is a social-environmental geographer focusing on understanding climate impacts, vulnerability, and adaptation. Dow served as principal investigator of the Carolinas Integrated Sciences and Assessments (CISA <https://cisa.sc.edu/>). The CISA team conducts research in North Carolina and South Carolina that integrates climate information into water, health, and coastal management and decision making. Currently, Kirstin is a member of NOAA's Science Advisory Board, and Climate Working Group and a lead author on the Southeast Chapter for the Fourth US National Climate Assessment. Kirstin was named as a fellow to the 2016 inaugural class of AAAS Leshner Leadership Institute Public Engagement with Science. She has also engaged public concerns as a lead author on the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment, Working Group 2 report, and author of the IPCC Summary for Policy Makers. Dow is co-author of *The Atlas of Climate Change,* a seminal work published in 10 languages. Kirstin is also a science advisor on climate change mitigation and adaptation for community and national efforts. She has also served as a lead author of a special report on recommendations for establishing a sustained US National Climate Assessment capability and a lead author on the Southeast chapter of the US National Climate Assessment 2018. Other publications on climate change, impacts, and adaptation have appeared in *Nature Climate Change, Sustainability, Journal of Environmental Assessment Policy and Management, Natural Hazards, Global Environmental Change, Journal of the American Water Resources,* and *Geography Compass.*