Climate Extremes and the COVID-19 Pandemic:
Advancing the Resilience of Michigan Communities to Compound Hazards

Michigan Applied Public Policy Research Brief

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EXECUTIVE SUMMARY

In May 2020, unexpected dam failures and associated flooding caused the displacement of over 11,000 people to public and private shelters in Midland County, Michigan. The flooding coincided with the COVID-19 pandemic, introducing a novel form of conflicting stressors that prevented the traditional logistics for single-hazard emergencies from functioning. The competing goals of preventing virus transmission and expediting the flood response and recovery processes posed unique challenges for state and local government agencies conducting evacuation and sheltering operations. For example, practicing social distancing and enforcing mask wearing were demanding in crowded shelters. The interaction of climate extremes with the pandemic also brought about overlapping issues such as supply chain disruption and market inflation, amplifying the community's anxiety and slowing their social and economic recovery. As current state emergency management plans presume independent hazards and barely address the potential issue of concurrent threats, revised guidance is needed to properly prepare for future dangers. To the best of our knowledge, the overlapping and conflicting planning priorities of compound emergencies have yet to be thoroughly explored. This project provides timely answers to important questions regarding how Michigan hazard management policies should be advanced to balance the need to protect communities with preparing for the next cycle of uncertain and likely compounded hazards. The goals of this project were to: 1) identify the overlapping and conflicting priorities of emergency actions necessary during compound disaster response and recovery; 2) examine what specific compound risks affected the community's decision to evacuate and return home during and after the 2020 Midland flooding event; and 3) suggest adjusted policy orientation to manage competing objectives that emerge during compound hazards.

Funded by the Institute for Public Policy and Social Research at Michigan State University (MSU), this report highlights the major activities and achievements of the project. First, the research team comprehensively reviewed federal, state, and local emergency management plans developed to address climate extremes and pandemics. Through a content analysis, potential conflicting and overlapping planning priorities were extracted and summarized. Second, based on the review findings, we developed an internet-based survey to assess the community's perception of the common and competing risks that emerged from COVID-19 and flooding during the 2020 Midland flooding event. The perceived concerns and risks affecting residents' decision to evacuate and return home were estimated using binary logistic regression and partial proportional odds models. Finally, in-depth interviews were conducted with government agencies and one non-profit organization committed to operating evacuation and shelter programs in Midland County or managing and overseeing emergency-related actions at the state or county level. Their administrative perception of compound hazards, lessons learned from the 2020 Midland flooding, and suggestions on possible interventions were explored.

The results revealed that Midland residents' concern about COVID served as a determinant of their decision to evacuate during the 2020 event. Fear of exposure was found to be greater among non-evacuees than evacuees. When controlling for covariates, the binary logistic regression model

demonstrated a significant interaction effect from COVID-related concerns and the number of seniors on the likelihood of evacuation. In other words, households with aged family members were less likely to evacuate with the greater concern about COVID at sheltering locations, and this relationship was stronger as the number of seniors in the household increased. Similarly, the partial proportional odds model revealed a tendency to stay for shorter periods at shelters as respondents' concern about the lack of mask enforcement increased.

At the administrative level, COVID-19 brought additional burdens to state and local agencies in terms of operating and managing evacuation and shelter programs. Travel restrictions and amplified health risks for the aged population curtailed the normal operation of volunteer programs during the 2020 emergency. The remote work environment triggered by stay-at-home orders prevented the immediate gathering of administrative bodies once the flooding occurred. The greatest concern was related to congregate sheltering. After implementing the standard congregate sheltering plan, the county decided to transfer people to non-congregate shelters to prevent the transmission of COVID. However, the lack of interorganizational communication delayed the process, resulting in some residents leaving shelters.

Based on these findings, we recommend that policymakers in Michigan develop a plan for non-congregate sheltering, enhance COVID protocols at shelter locations, ensure workers' safety, prepare for a shift to virtual and hybrid environments when operating recovery programs, diversify funding sources to stabilize the post-disaster economy, foster inter-organizational coordination, and employ training and drills that use real-time scenarios. These recommendations are replicable to other states and scalable to the national level. The refined state and local emergency plans will contribute to enhancing the capacity of people living in Michigan to adapt to future compound hazards in a more systematic manner.

CURRENT STATE EMERGENCY MANAGEMENT POLICY

Since enactment of the federal Disaster Mitigation Act of 2000, the Michigan State Police Emergency Management and Homeland Security Division has been developing hazard mitigation and emergency operation plans describing who will do what, when, and how, and with which resources before, during, and after multiple types of natural and human-caused hazards (MSP/EMHSD, 2019; MSP/EMHSD & MCCERCC, 2019). By 2019, 78 counties out of the 83 in Michigan had developed hazard mitigation plans approved by the Federal Emergency Management Agency (FEMA), thus allowing the county to remain eligible to request federal disaster funds when needed.

However, the underlying assumption of current state emergency management plans is an independence of hazards, a notion proved fallacious by the outbreak of the COVID-19 pandemic. In 2020, many US states, including Michigan, experienced multiple climate disruptions during the pandemic, such as floods, wildfires, tornadoes, and earthquakes (NCEI, 2021). After the first COVID case was confirmed in Michigan in March of 2020, the massive flooding in Midland illustrated the unexpected, amplified risk of concurrent hazards, also known as *compound hazards*.

CONCURRENT FLOODING AND THE PANDEMIC IN MICHIGAN

The most recent striking case of compound hazards observed in Michigan is the co-occurrence of flooding and the COVID-19 pandemic in May 2020 in Midland County. Flooding has long been the most devastating climate hazard in Michigan. From 1996 to 2017, an average of $102M in annual property damage was caused by flooding in the state (MSP/EMHSD, 2019; MSP/EMHSD & MCCERCC, 2019). As a result, the current state and local emergency-related action plans focus heavily on flood events and assert that public health emergencies have decreased in risk in Michigan. Local plans barely address pandemics as high-priority hazards.

Dam failure caused massive flooding in Midland County immediately after the first wave of coronavirus deaths was recorded in April. Between May 17 and 19, 2020, a 500-year storm event brought 7 to 8 inches of rainwater to the Tittabawassee River watershed in Midland County. The record-breaking high-water level overwhelmed the aging Edenville and Sanford Dams, inundating downriver areas and destroying over 2,500 homes, businesses, and bridges (EGLE, 2020; Hayes, 2020; NWS, 2020). As protocoled by the county's hazard mitigation plan, the Emergency Alert System was immediately activated via mobile text messages, alerting people of imminent threats to safety in the area. This disastrous event occurred in the middle of the COVID-19 pandemic, with no vaccinations being available at that time. The stay-at-home order was issued on March 23, 2020 and remained active when the flooding struck communities. Nevertheless, the disaster eventually caused over 11,000 people to evacuate to multiple private and public shelter locations. Those staying in public, congregate shelters were required to maintain social distancing to avoid the spread of the coronavirus (see Figure 1) (Borowski et al., 2021; Wong et al., 2021).

Figure 1. Evacuated people congregating in shelters on May 20, 2020, in Midland. Credit: Kimberly P. Mitchell, Detroit Free Press.

CONFLICTING AND OVERLAPPING PRIORITIES IN COMPOUND HAZARD MANAGEMENT

As seen with the pandemic being coupled with flooding in Midland County, conflicts among multiple stressors can pose additional challenges to emergency response and recovery processes (Quigley et al., 2020; Tripathy et al., 2021). The objectives of reducing transmission of a virus and expediting the response and recovery processes during and after a climate event present conflicting planning priorities to policymakers at all administrative levels. These conflicting matters can adversely affect a community's decision to meet demands for evacuation, shelter, and recovery, and ultimately their capacity to adapt to multiple hazards (Hill et al., 2021). The interaction of climate extremes with a pandemic also introduces more common risk factors that can amplify the magnitude and intensity of potential damage. The physical, social, and economic stresses heightened by the pandemic can be intensified with consequent climate hazards.

Yet, policies coordinating COVID and climate-related disaster responses are currently not documented, and no clear guidance is provided regarding how to enhance the resilience capacity of local municipalities and communities in the wake of compound hazards. The amplified risks, particularly those coinciding with a pandemic, have been substantially under-studied in related disciplines. A better

understanding of the overlapping and conflicting priorities inherent in compound hazard management will enhance the adaptive capacity of the state to accommodate future uncertain, unexpected, and unprecedented hazards. The following chapters outline the potential conflicting and overlapping planning priorities emerging from coinciding pandemics and climate extremes. Two reviewers conducted a content analysis and extracted data from 12 federal, state, and local plans. These included pandemic influenza plans, hazard mitigation plans, emergency operation plans, recovery plans, and associated guidebooks issued by the US Homeland Security Council, US Department of Homeland Security, US Department of Health and Human Services, Michigan State Police ─ Emergency Management and Homeland Security Division, Michigan Department of Health and Human Services, and Midland County Office of Emergency Management.

Conflicting Priorities

1. Movement Restriction vs. Evacuation and Sheltering

An appropriate response to pandemic events involves restricting movement and enforcing quarantine and isolation rules. Restricting movement can involve closing borders, enforcing lockdowns and social distancing, canceling mass gatherings, and implementing teleworking for businesses (MDHHS, 2020; USDHHS, 2017). When a disaster caused by a climate extreme occurs, coordination of evacuation efforts comprises one of the most important steps in minimizing injuries and casualties (MSP/EMHSD, 2013, 2019; MSP/EMHSD & MCCERCC, 2019). As evacuation inherently involves population displacement, major conflicts can occur. Search, rescue, and evacuation efforts can be delayed with enforced movement restrictions. Crowded mass shelters can also face issues when trying to mandate quarantine and social distancing rules. Additionally, volunteers are often utilized to staff evacuation efforts at shelters, providing food and care to those affected. As travel is restricted during a pandemic, deploying and managing volunteers can be challenging.

2. Personal Protective Equipment Enforcement vs. Evacuation and Sheltering

One of the most integral parts of managing a pandemic response is enforcement of the use of personal protective equipment (PPE). PPE can greatly reduce the spread and transmission of the viruses and bacteria being involved with a pandemic event (USHSC, 2005). Climate-related disasters often force people to evacuate to mass shelter facilities (MSP/EMHSD, 2014, 2019). Given the large size and makeshift nature of such facilities, enforcing the use of PPE may be difficult. An earlier study found that lack of a mask could even curb people' willingness to share rides with strangers during evacuation (Borowski et al., 2021).

3. Supply Chain Recovery vs. Shelter Supply Collection

A major part of the response to climate extremes is providing proper emergency shelter to evacuees. Creating and maintaining mass shelters require that supplies such as water and food be collected to support the sheltered population (MSP/EMHSD, 2013, 2019). During a pandemic, however,

various manufacturing industries and supply chains are disrupted by sudden demands for basic goods, resulting in a supply shortage and inflation. The prompt recovery of supply chains to the pre-pandemic state is crucial (USDHHS, 2017), but the rising demand for food, water, and other supplies by mass shelters for prolonged periods can further strain the system.

4. Shutdown of Non-essential Medical Services vs. Medical Assistance Supply

Pandemic events can place severe stress on medical and healthcare systems, especially during peaks and waves. Excess strain on such systems can cause supplies and personnel to be unable to meet demand, limiting the effectiveness of medical care. Therefore, one important emergency strategy is to limit or eliminate non-essential medical activities and direct additional supplies and human resources to the pandemic response (MDHHS, 2020). This may conflict with a response priority favoring climate extremes; evacuees housed in mass shelters could be injured during evacuation or the disaster event and require medical assistance (MSP/EMHSD, 2013). Local assessments of mental health needs and crisis counseling services are also needed to moderate survivors' mental stress and anxiety (MSP/EMHSD, 2019). However, limited medical and human resources directed toward pandemic response can limit or delay the timely support of the medical needs of a sheltered population.

Overlapping Priorities

1. Damage Assessment

During the post-disaster recovery phase, assessment of damage is vital to informing further recovery activities. Several action strategies have been designed to assess damage after climate-related disasters. The most impacted areas and sources of cascading damage must be monitored, documented, and reported to the appropriate government entities (MCOEM, 2017a, 2017b; MSP/EMHSD, 2019; MSP/EMHSD & MCCERCC, 2019). In particular, critical infrastructure should be carefully monitored and impacts swiftly reported. Similarly, during pandemic events, contact tracing must be implemented in order to continually monitor and assess damage (MDHHS, 2020; USHSC, 2005, 2006).

2. Monitoring of Price Gouging and Inflation

During disaster events pertaining to both climate extremes and pandemics, essential supplies are often scarce, due to disruption of the supply chain and increased demand. In such situations, the government must monitor and inspect essential commodities such as water, food, toilet paper, and gasoline, and ensure that retailers do not partake in price gouging (MSP/EMHSD, 2013). Extensive governmental relief and assistance can also trigger market inflation, and thus the effect on the economy should be continuously monitored.

3. Ensuring Worker Safety

Pandemics and climate-related disasters require the use of many public and private workers, as well as federally recognized or self-deployed volunteer personnel (e.g., national disaster medical

assistance teams, urban search and rescue teams, citizen corps, community emergency response teams, medical reserve corps, fire corps, national volunteer organizations active during disasters, etc.). Ensuring the safety of these workers and volunteers should be of high priority during any type of disaster. For climate events, debris clearance and removal are essential parts of the recovery process. Debris can often be contaminated and dangerous to those who come into contact with it. Safety information should be carefully disseminated to all personnel who encounter debris (MSP/EMHSD, 2008). Similarly, medical workers can be in danger during pandemic events. Safety protocols such as the proper use of PPE should be enforced at all medical facilities (USDHHS, 2017).

4. Economic Assistance

Recovering from both pandemics and climate-related disasters requires monetary assistance to those affected. When the President declares a major disaster under the federal Stafford Act, individuals severely affected by the disaster become eligible to receive Individual Assistance (IA), while any repair and reconstruction of public infrastructure can be funded by the Public Assistance (PA) program (MSP/EMHSD, 2008, 2019). As both pandemics and disasters related to climate extremes can severely disrupt people's livelihoods and local economies, financial assistance programs offering emergency payments and distributing food stamps (as part of the IA program) can greatly improve households and individuals' likelihood of recovery. PA grants can also be used for items such as repairing damaged supply chains. Both programs can help reduce the economic hardship endured at such times.

METHODS

This study employed both quantitative and qualitative methods. Based on the overlapping and conflicting planning priorities identified through a review of existing federal, state, and local emergency-related plans, we collected local input regarding the community perception of overlapping and competing risks during the COVID-19 pandemic and 2020 flooding event in Midland County, Michigan. In collaboration with the Office for Survey Research at MSU, a survey was administered online from April 5 through 12, 2022. Using an address-based sampling method, the survey was randomly distributed to 5,000 households in the flood-prone area along the Tittabawassee River and branching tributaries, where properties were predicted by the County of Midland to be inundated during the 2020 flooding event. After excluding incomplete, unreliable, or missing responses, 556 responses (11.1%) from adults aged 18 years or older were sampled, providing a 4% margin of error at the 95% confidence interval.

The questions were developed in a variety of formats (e.g., Likert scale, binary, open-ended, etc.) to evaluate: 1) the impact of the pandemic on communities' decision-making regarding evacuation, sheltering, and recovery during and after the 2020 flooding event; 2) COVID-related barriers to emergency assistance; and 3) future directions for advancing compound hazard management. Socio-demographics and damage data were also collected to control for covariates in subsequent statistical analyses.

In parallel with the survey, in-depth interviews were conducted with state and local government agencies and a non-profit organization, using structured questions regarding: 1) administrative personnel's perceptions of compound risk management; 2) major issues with applying current emergency plans to compound hazard conditions; and 3) potential policy interventions that might minimize overlapping or conflicting risks. Five participants at various administrative levels were identified from the Michigan State Police's Emergency Management and Homeland Security Division, County of Midland's Office of Emergency Management, and United Way of Midland County, the latter being the local organization responsible for operating and managing the sheltering efforts. The interviews were conducted from April 21 through June 24.

Finally, the policymaker and community opinions solicited through the interviews and surveys were used to derive policy recommendations for future compound hazard management. Additionally, with the results of the survey, a series of Mann-Whitney U, Kruskal-Wallis, and Spearman's correlation tests were performed to assess if socio-demographic characteristics were determinant of COVID-related concerns during the 2020 flooding event, and if those concerns were significantly different for evacuees and non-evacuees. Furthermore, binary logistic regression and partial proportional odds models were developed to predict how people's perceived risk of COVID affected their decision to evacuate and return home in response to the compound hazard. For both models, socio-demographic, damage, and situational factors, such as activation of evacuation warnings, sheltering conditions, etc., were controlled as covariates.

RESULTS

How Did COVID-Related Risks Affect People's Decision to Evacuate During the 2020 Flooding Event?

The survey responses revealed that 60% of sampled households evacuated to either congregate or non-congregate shelters during the 2020 flooding event, while 40% remained at home. In addition, 32% of evacuees responded that the threat of COVID-19 influenced their decision regarding to where they would evacuate. Based on the fact that only 3% of responding evacuees stayed at congregate shelters such as high schools, churches, family centers, and township halls, peoples' concerns about human contact in crowded shelters were likely to have influenced their evacuation choices. Despite this, 10% of evacuees responded that they felt under-protected from COVID-19 when staying at their evacuation location.

Specifically, when people were asked how concerned they were or would be about COVID-19 risk at sheltering locations (including a lack of mask enforcement or PPE, shortage of basic supplies, closely spaced sleeping arrangements, poor ventilation, and access to health systems), non-evacuees' concerns were significantly greater than those of evacuees for all options ($p < 0.001$, see Figure 2). This implies that concerns about COVID served as a decisive factor in non-evacuees' decision not to evacuate. In contrast, a limited number of evacuees, less than 20% overall, were concerned about

COVID-related risks while sheltering. It is likely that their personal safety from the destructive flooding generally outweighed their fear of COVID.
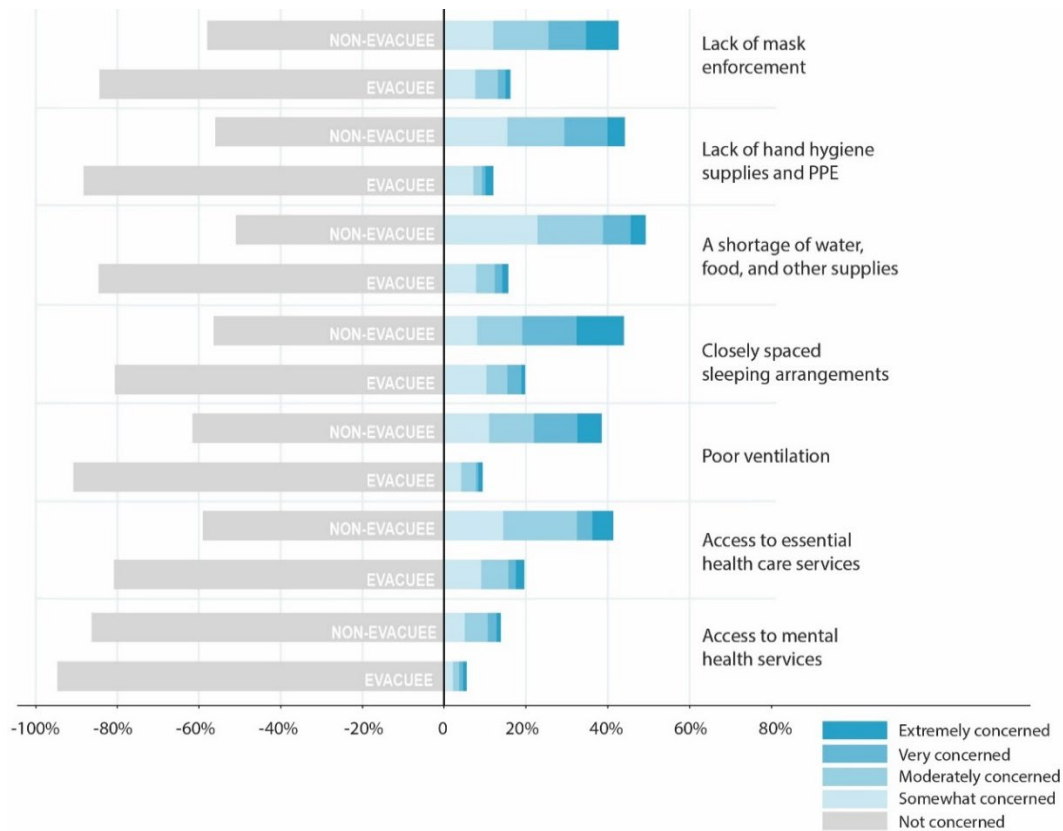

Figure 2. Peoples' concerns about COVID-related risks at sheltering locations.

However, when controlling for covariates such as situational factors, flood risk, and socio-demographic attributes, the binary logistic regression revealed a significant association between COVID-related concerns and the logged odds of evacuation (see Figure 3). Concerns about violating the stay-at-home order and exposure to COVID while evacuating demonstrated insignificant relationships. Yet, a significant interaction effect was found between the number of seniors in households and concern about exposure to COVID while sheltering ($p < 0.05$). As seen in Figure 4, as the number of seniors in the household increased, the probability of evacuation decreased more dramatically with an increase in concern about exposure to COVID at sheltering locations. Considering that 37% of the sampled households had at least one family member over the age of 65 and six members at the most at the time of the 2020 flooding event, this result suggests that the competing risks of COVID and flooding reduced evacuation willingness in the aged population, the group most vulnerable to both types of disasters.
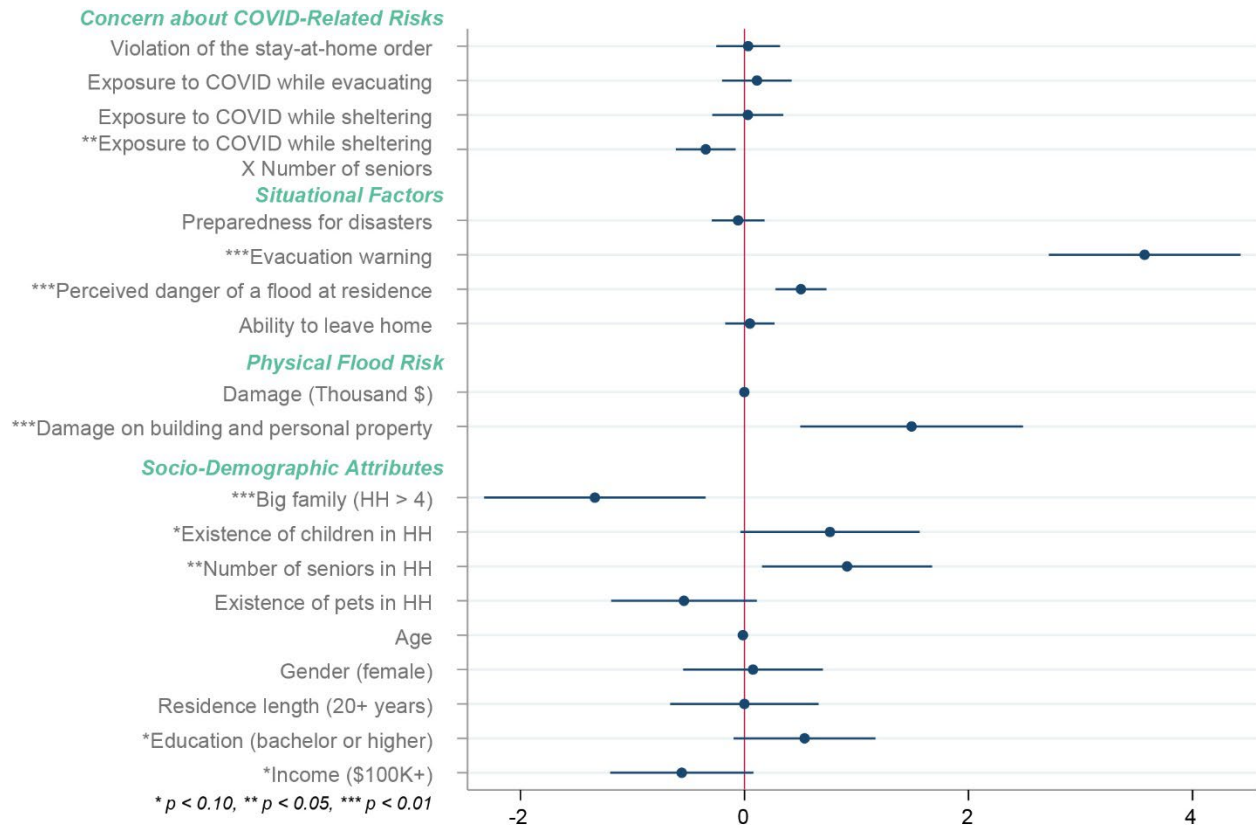
Figure 3. Non-standardized coefficients of binary logistic regression predicting the logged odds of evacuation.
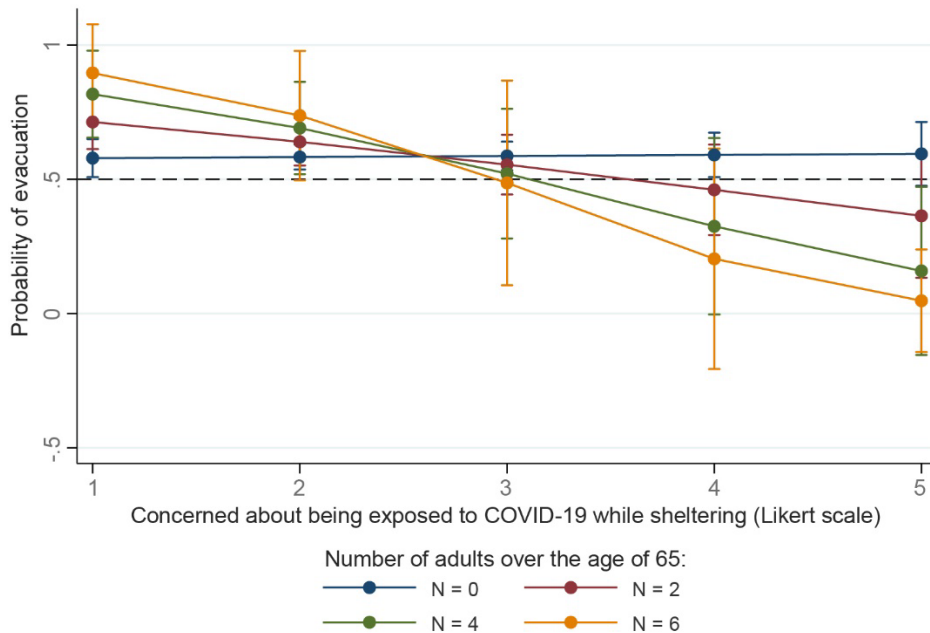(N = 391; Pseudo R^2 = 0.403, AIC = 355.9, and BIC = 435.3)

Figure 4. Probability of evacuation predicted by COVID-related concern and the number of seniors in a household, with 95% confidence intervals.

How Did COVID-Related Risks Affect People's Decision to Return Home after Evacuation During the 2020 Flooding Event?

Once people feel safe from hazards, they return home and engage in recovery activities such as disposing of debris, reconstructing damaged structures, and reopening businesses, in the hopes of restoring pre-disaster conditions and livelihoods. However, how people's perceived risk of COVID affects their decision to return home remains unknown. After controlling for potential covariates, the results of the partial proportional odds model revealed that people's concern about the lack of mask enforcement at shelters tended to shorten their evacuation length ($p < 0.05$, see Figure 5). Securing private space also served as an important conditional factor; the lack of access to private space reduced the odds of long-term evacuation ($p < 0.05$). Conversely, the growing concern about closely spaced sleeping arrangements during compound emergencies was likely to prolong the evacuation period ($p < 0.01$). Considering that the majority of Midland evacuees (97%) stayed at non-congregate shelters during the 2020 flooding event, staying close to family members or acquaintances may have provided a sense of protection.
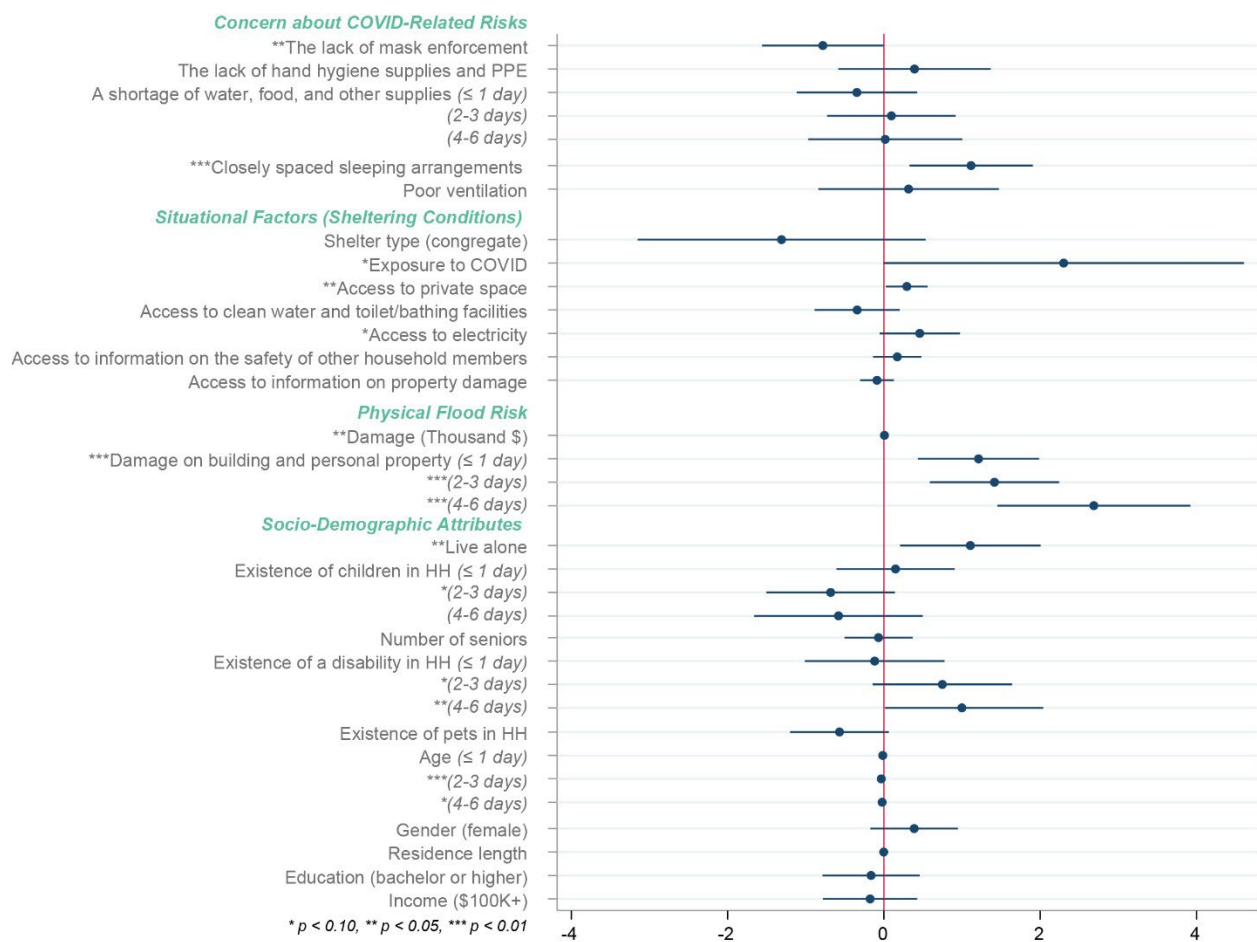

Figure 5. Non-standardized coefficients of the partial proportional odds model predicting the logged odds of evacuation length.
(N = 231; Pseudo R^2 = 0.194, AIC = 539.4, and BIC = 666.8)

Note. The dependent variable was measured on a four-part ordinal scale: 1) Less than or equal to 1 day; 2) 2-3 days; 3) 4-6 days; and 4) greater than or equal to 1 week.

The lack of hand hygiene supplies and PPE and poor ventilation at sheltering locations, conditions potentially amplifying the risk of virus transmission in a confined place, did not significantly affect evacuees' duration of stay. Similarly, shortages of food, water, and other supplies mainly caused by disrupted supply chains were not found to be significantly associated with evacuation length.

What Were Policymakers' Major Barriers to Responding to Compound Hazards During the 2020 Flooding Event?

For state policymakers, one of major challenges during this compound emergency was volunteer management. According to interviews with both state and local level interviewees, COVID substantially taxed volunteers during the 2020 flooding event. The increased concern about COVID and associated protocols such as travel restrictions reduced the number of volunteers and construction contractors that historically have organized to repair the city after a flood. As volunteer organizations are mainly staffed by the elderly, the threat of COVID increased their reluctance to travel and come in contact with the rest of the community. A shortage of PPE also inhibited a timely response to this compound hazard. When the State Emergency Operations Center (SEOC) was activated after the flooding in Midland County in May 2020, their initial response was to collect and send the resources needed by first responders and volunteers. Despite these efforts, critical disruptions in the PPE supply chain posed an initial challenge to ensuring workers' safety.

At the local level, another issue that arose during the 2020 flooding event was non-congregate sheltering. The traditional type of shelter operated by the American Red Cross is congregate, convening evacuees temporarily in a common, confined facility such as a local high school, church, family center, township hall, or gym. These offer tight quarters and require people to share basic facilities such as bathrooms, dining areas, and laundry. However, there was a call for change in normal shelter operations because of COVID. To lessen the chance of spreading the virus and enforce social distancing, non-congregate shelters such as hotels or motels, dormitories, and campgrounds were suggested as optimal options. State and local government agencies acknowledged the importance of non-congregate sheltering in the wake of the flooding. However, there was a lack of preparedness in securing non-congregate shelters for hundreds of people at the very initial stages of the flooding, so the impacted areas first adhered to the standard procedure and operated congregate shelters. According to an interview with the County of Midland and United Way personnel, the congregate sheltering program was instantly initiated with sufficient PPE, social distancing, and regular surface disinfection. Mask wearing was not enforced inside shelters, but people could access PPE at their discretion. However, several people remained in their cars in the parking lot and only used shelter bathrooms. People in congregate shelters were ultimately transferred to hotel rooms by the County of Midland, United Way of Midland County, and

American Red Cross, although this transition was disorganized and delayed. Communication and information sharing between the national and local organizations were not transparent.

Finally, ongoing stay-at-home orders and enforced movement restrictions inhibited prompt response to the hazard. When the dams failed, the County of Midland's Office of Emergency Management was working remotely, and thus local Emergency Operation Center (EOC) was significantly understaffed. With the full activation of the EOC, in-person gatherings were allowed and a prompter response to the urgency was the result. In addition, travel restrictions required FEMA to coordinate virtually with local governments and communities in Midland. However, using internet-based technology to connect with FEMA posed challenges for aged residents. With the absence of face-to-face interactions (which FEMA had previously engaged in for prior disasters), the lack of emotional intimacy could result in those who were injured or lost property receiving limited IA. The limited access to the internet caused by damage to telecommunications towers could also slow recovery from the flood.

What Were the Major Changes Made to State Policies after the 2020 Midland Flooding Event?

While the shift to virtual administration for managing compound hazards has some drawbacks, it has also brought the opportunity for adaptive change. For example, virtual damage assessment allows for more efficient streamlining of federal grant programs. According to an interview with the Michigan State Police, traditionally, FEMA has traveled to the damage site accompanied by state and local government officials in order to measure the magnitude of loss and damage. The 2020 flooding event during the COVID-19 pandemic necessitated virtual assessment, leading to the creation of an online GIS platform, a central repository of data housing photos and maps of damaged areas that

> " *"COVID has really opened federal recovery programs to an extent that we have never seen in Michigan."*
>
> *- Michigan State Police* "

were collected by residents' self-reporting. This process not only shortened the time spent requesting a Presidential disaster declaration and assistance from federal assistance programs but also reduced FEMA's administrative costs. Similarly, FEMA's new drive-through recovery centers have replaced traditional in-person meetings, often held in a township hall or library in an impacted community. Since the 2020 flooding event, activation of the Michigan SEOC has been completely virtual, partially virtual, or completely in person. Having the option to use a virtual format makes responding to a disaster more streamlined and more efficient. One interviewee from the County of Midland stated that the county has adopted the similar model, activating the local EOC virtually and simultaneously briefing officials in diverse sectors and at various administrative levels on damage status, as well as making prompt decisions during the emergency.

Another major change is the PA program for non-congregate sheltering. Before the Midland flooding, except for in extraordinary circumstances, FEMA provided a PA program only for congregate

sheltering. As the need for non-congregate sheltering increased during the COVID-19 pandemic, FEMA changed their policy and have reimbursed the cost of non-congregate sheltering under the PA program.

POLICY RECOMMENDATIONS

Non-Congregate Sheltering and Enhancement of COVID Protocols

The statistical analysis conducted for this research demonstrated that people's evacuation choices were significantly affected by their concern about COVID. To lessen their stress and reduce the risk of infection, deconcentrated sheltering serves as a promising option, recently supported by new FEMA policy. For future compound hazard management, agreements between diverse types of non-congregate shelter businesses (e.g., hotels or motels, dormitories, campgrounds, etc.) and local governments will be needed to facilitate prompt evacuation. This will also make possible the isolation of COVID-positive or exposed individuals from others, focusing particular care on them. If the number of non-congregate shelters is limited in the area, the priority should be given to households with disabilities, those over 65 years of age, and children. In so doing, safe evacuations can be fostered during compound emergencies, preventatively moderating people's reluctance to evacuate and the risk of infection among the most vulnerable population.

The result of the partial proportional odds analysis in this study also suggests the importance of enforcing mask wearing while sheltering, regardless of the type of shelter. Enhancement of COVID protocols will afford evacuees mental relief from their fear of virus transmission and enjoy a safe environment until they return home. The survey results reflect this; of those queried, 43% answered that enhancing COVID protocols in shelters was very or extremely important. Another 42% felt that it was somewhat or moderately important.

Finally, along with non-congregate sheltering, implementing multiple distribution centers was found to be a successful response strategy in Midland County during the 2020 flooding event. The traditional response strategy supports installation of one central hub to collect local donations and distribute basic commodities to survivors. Conversely, dispersed outdoor distribution centers can meet people's needs while also complying with COVID protocols. A plan for setting up a central warehouse to store basic supplies and multiple distribution centers should be prepared for compound hazard response.

Safety Enhancements for Workers

Naturally, the risk of virus infection may hinder volunteers' willingness to travel and engage in the recovery process when a stay-at-home order is in place. For future compound hazards, not only should travel restrictions be lifted for volunteers, but also sufficient hand hygiene and PPE supplied to all volunteers and first responders. To avoid supply chain bottlenecks, establishing alternative sources and stockpiling the necessary supplies at the state level would help lessen local burdens. Additionally, recruiting younger generations of volunteers via social media and partnering with local youth groups, high

schools, and universities would compensate for the loss of traditional volunteer resources (i.e., the aged) during a pandemic.

Shift to a Hybrid/Virtual Environment

As mentioned in the Results section, the 2020 flooding event prompted a shift in major administrative processing to a virtual environment, partially or completely. While this change accelerated information sharing across diverse government levels and sectors during the emergency, the lack of in-person connection with the impacted community discouraged emotional recovery. Some residents' limited ability to access the internet or use technology posed additional challenges. From the local perspective, a sense of caring and face-to-face interactions can be invaluable to the severely impacted. In order to leverage trust-based communication with government personnel and share information on damage and available recovery resources, a local drive-through recovery center and public kiosk could serve as a promising option. Repairing damaged internet stations, sharing mobile hotspots, using web applications, setting up a bank of call centers, and arranging door-to-door visits by local officials were also found to be successful means of collecting damage data in Midland.

Economic Assistance

Grant and other monetary relief programs can become overburdened when climate-related disasters occur at the same time as a pandemic. Budget conflicts may delay the prompt recovery of destroyed infrastructure, homes, and businesses. Ongoing supply chain disruptions and market closures can substantially slow community recovery, much more than any single event. Price increases on goods and supplies add another financial burden to the community, requiring a long-term recovery plan. Based on a Likert scale analysis, survey respondents felt that on average, price increases were the most impactful factor hindering their ability to return to their pre-flood routine, followed by limited supplies for repairing damage to properties (e.g., construction materials, cleaning supplies, dehumidifiers, etc.).

Financial support for vulnerable persons was regarded as the most important to recovering from future compound hazards (see Figure 6). Approximately 65% of respondents indicated its importance as very or extremely important. Financial support for basic needs such as food, clothing, and medicine was considered the second most important component. As FEMA expands grant opportunities during the pandemic, securing federal disaster relief will be of the utmost importance at the state level to stabilize the post-disaster economy. At the local level, fundraising campaigns can serve as another revenue stream, diversifying available resources.

Inter-organizational Coordination

When conflicting risks of compound hazards arise, coordination among federal, state, and local organizations is critical for executing interdependent response and recovery actions. The COVID-19 pandemic is unique in that for the first time, Health and Human Services is serving as the lead agency in

an emergency, supported by Emergency Management and Homeland Security. With this new hierarchical structure of planning, transparent communication contributes to the formalization of interorganizational relationships. During the 2020 Midland flooding, tension among organizations with regards to operating local non-congregate shelters threatened sustainable community governance. The lack of information sharing resulted in some residents leaving shelters with complaints. Federal organizations are often regionalized (e.g., one local office of the American Red Cross oversees more than 10 counties in Michigan), restraining their understanding of local resources. Developing a central platform for information sharing will be integral to removing communication barriers and regulating information exchange for future compound hazards.
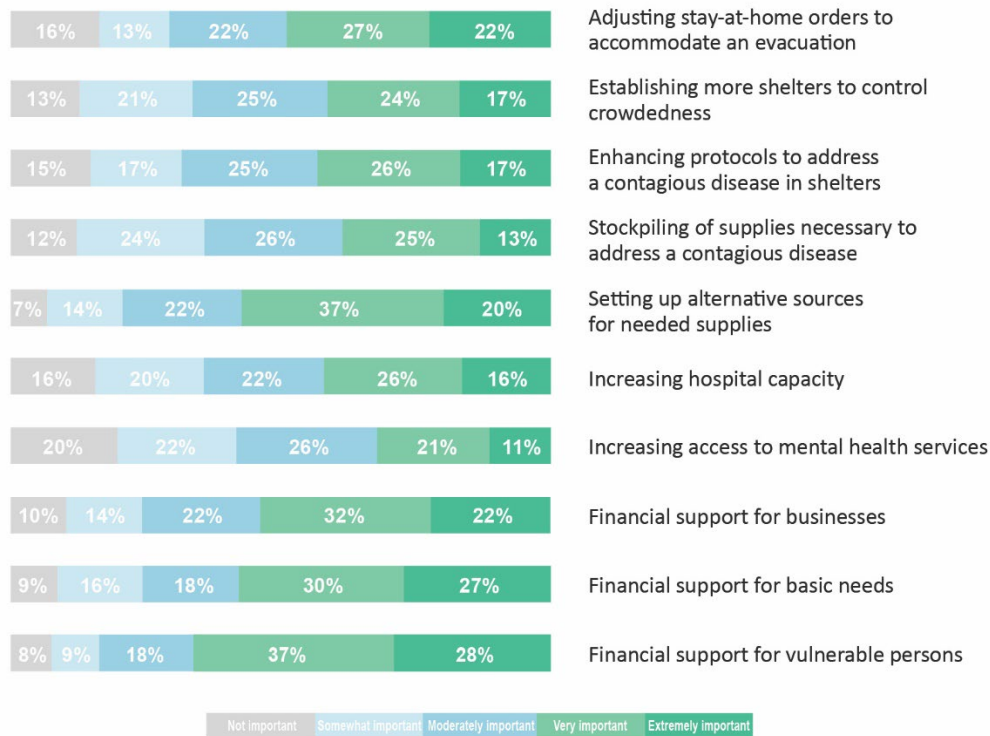

Figure 6. Importance of response and recovery strategies for future compound hazard management (N = 550).

Training, Exercises, and Drills

Simulation exercises and mock drills are effective ways in which the government, businesses, and other organizations can prepare for future high-risk low-probability compound hazards. Real-world simulations and management applications validate the efficiency of planned action strategies and protocols, given available resources. By assessing the current status of knowledge and skills, improvements and modifications can be applied. Online training in response and recovery actions can also serve as an effective education tool for workers and communities, enhancing existing safety protocols and instructing on new technology. Based on what was observed during the 2020 Midland

flooding, non-sheltering operations can be further revamped through collaborative drills and exercises with associated agencies and organizations.

Conclusion

The Michigan SEOC has been activated since the outbreak of COVID in 2020. This unexpected world-wide emergency has brought panic to the state, and compounding climate disasters have heightened residents' physical, social, and economic stress. Cascading disasters triggered by a single event (e.g., disruptions in the energy and transportation sectors, followed by flooding) have historically been well-managed in Michigan. However, the 2020 Midland flooding was different from previous emergencies in that two independent low-probability high-impact hazards simultaneously struck the community with little notice. This was the first time that a state in FEMA Region 5 received the Disaster Case Management Grant. The disaster opened a new horizon of federal recovery programs in Michigan, provoking another release of federal funding in 2021 for the massive flooding in Metro Detroit.

The pandemic is ongoing. What Michigan has experienced in the last few years offers insights into what should be replicated, adjusted, and improved in the future. The policy orientation recommended in this study focuses on handling the overlapping and conflicting risks a compound hazard presents, based on data collected throughout the 2020 Midland flooding event. The resulting knowledge acquisition and policy success are reflected in the recommendations herein, which are replicable across the country. Additionally, new avenues are suggested that will leverage the changes to the current response and recovery systems of Michigan. However, it is important to note that the findings of the present research are time dependent. As new technologies and policy interventions such as vaccination and real-time digital recording systems have been introduced worldwide after the 2020 flooding event, emergency responses must reflect those changes and continually evolve.

The state's most recent hazard mitigation and emergency operation plans were updated in 2019, at an early phase of the COVID-19 pandemic. As the next cycle of plan updates approaches, what we learned from the past will be documented, providing insightful information on how to handle future uncertainty of coinciding disasters. It is unquestionable that the capability of the state to adapt to compound hazards will advance as the plan progresses over time.

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