

Extreme Weather Preparedness for Institutions of Higher Education: Impacts and Lessons Learned to Inform Campus Health

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BACKGROUND: On September 1, 2021, a tornado touched down at Temple University's Ambler, PA campus. The tornado, a byproduct of Hurricane Ida, damaged most of the buildings on the campus, destroyed thousands of academic resources, and killed hundreds of irreplaceable trees, plants, and natural resources. The purpose of this study was to identify needs among the Ambler campus community, document the impact of the tornado, and capture student, faculty, and staff perceptions toward disaster preparedness, climate change, and lessons learned for future disaster preparedness. **METHODS:** Data were collected in partnership with the Ambler campus community. A Rapid Needs Assessment, influenced by the Centers for Disease Control (CDC) Community Assessment for Public Health Emergency Response (CASPER) was utilized. The needs assessment was comprised of a mixed method approach via a site visit, an online survey, and in-depth interviews. **RESULTS:** A total of 74 survey responses and 20 interviews were collected. Survey and interview respondents included students, faculty, and staff. Findings indicated that participants: felt unprepared for the tornado; experienced a variety of social, professional, mental, and physical impacts; and require additional training, education, and communication for future emergencies and natural disasters. **CONCLUSION:** As climate change continues to impact weather patterns, institutions of higher education must prepare for more frequent, more severe, and unprecedented natural disasters. It is time to ensure that (1) campuses have transparent protocols in place for the full spectrum of possible weather events, and (2) that students, faculty, and staff receive comprehensive education, training, and communication about such weather-related events and potential negative outcomes.

Keywords: Needs assessment, disaster response, campus health.

Introduction

Campus preparedness for natural disasters is crucial as it can save lives and keep institutions running. Institutions of higher education must establish readiness and

preparedness plans across natural disaster scenarios as they are responsible for the safety of students, faculty, and staff on campus.

Additionally, campus administrators must consider the secondary impacts natural disasters can have on campus finances as well as campus operations. Colleges and universities often experience substantial financial loss in the wake of a natural disaster. Reasons for this include increased student dropout rates and substantial cost of repairs (recent storms have yielded costs ranging from 6 million to 132 million dollars)¹. Furthermore, campus closures and the discontinuation of campus services can impact the campus community as many students rely on campus resources for housing, food

The Setting

Temple University is a large institution of higher education with a student body of over 40,000 students. It consists of six campuses across Pennsylvania, with its main campus located in North Philadelphia. The university also has two international sites in Rome, Italy and Tokyo, Japan.

Temple University's Ambler campus is a 187-acre campus located in Montgomery County, Pennsylvania. The campus houses approximately 40 undergraduate programs, numerous minors and certifications, continuing education credits, and graduate programs such as the Master of Landscape Architecture. Ambler additionally hosts a Law Enforcement Training Center, as well as a Science and Mathematics Scholars Program for high school students.⁴ Community members frequently use the campus space for physical activity, event space, as well as mental health and wellness. Unique features of the campus include the arboretum, the field station, numerous gardens, and a greenhouse which houses over 1,600 species of rare and tropical plants. Ambler Field Station's Temple Forest Observatory, which was established in collaboration with the Smithsonian Institution's Forest Global Earth Observatory (ForestGEO), is an active platform for research and training at the forefront of environmental, ecosystem, and climate sciences⁵. The Ambler campus is a major asset to

security, physical health and mental health services, internet access, and safe spaces.^{1,2} Those institutions that can show that they are able to handle these challenges will be in a better place to vie for future student applicants as colleges and universities are becoming more scrutinized based on their 'disaster management plan' rankings.² We call upon decisionmakers across institutions of higher education to take steps in preparedness and readiness for climate change's increasingly common and severe weather events.³

Temple University as evidenced by its high level of community engagement, unique learning opportunities, and membership in several national and an international science networks.⁶

The Ambler campus was struck by a tornado, triggered by Hurricane Ida, on September 1, 2021.⁷ The tornado measured at an EF-2, touching down at about 5:30pm with up to 135mph winds. While no lives were lost or injured on campus, the damage to the campus infrastructure was significant. 16 out of 18 buildings were impacted and over 17,000 items within the library were lost. In addition, there was irreversible damage to their arboretum that included the loss of over 175 historic trees and hundreds of plants. The Temple Forest Observatory site was heavily impacted, with most large trees either blown down or heavily damaged. Students, faculty, and staff (many of whom sheltered-in-place overnight during the storm) lost entire departments. Surrounding roads were washed out, local areas were flooded, cars were destroyed, neighboring homes were damaged, and there were numerous downed power lines, falling trees, and broken glass scattered throughout the area. Campus recovery began early on September 2nd, 2021. Faculty and staff returned to campus over the next two weeks, and in-person learning was reinstated on September 15th, 2021.

The Study

The purpose of this study was to inform decision makers of the impacts and continued needs resulting from the September 1st, 2021 tornado at the Temple University's Ambler Campus. Results are aimed toward raising awareness of the possible risk and impacts other campuses may face in this unpredictable age of unabated climate change. This study utilized an Emergency or Rapid Needs Assessment predicated on the US Centers for Disease Control and Prevention (CDC)'s Community Assessment for Public

Health Emergency Response (CASPER) model, which we modified for this campus-specific mixed-method study.⁹ A CASPER assessment traditionally uses an epidemiologic technique to provide quick, post-disaster data about community's needs for decision makers. The overall aims of this study were to (1) Determine and document any critical health needs; (2) Provide insights into how students, faculty and staff perceived the impacts of the tornado; and (3) Evaluate aspects of Temple University's response to the tornado.

Methods

Qualitative and quantitative data collection took place from October – December, 2021 and included: (1) a site visit to Ambler campus, (2) an online survey, and (3) a series of qualitative interviews. The site visit took place on October 22nd, 2021 to inform the study design, gather observational data, connect with partners, and collect informational interviews. Results from the site visit led to the development of the survey questions and interview guide format. The survey and interview instruments were reviewed by campus partners prior to data collection.

Once data collection instruments were approved by the campus partners, an anonymous online survey was sent to students, faculty, and staff to collect perceptions toward, experiences of, and needs produced by the

tornado. Students, faculty, and staff each had a unique version of the survey to best capture the impact of the tornado on their unique roles at Ambler campus. Survey data were analyzed for basic descriptive statistics. The last survey question asked respondents to provide an email address if they were interested in participating in a follow-up interview to share their experiences with the tornado and recovery efforts. Those who listed contact information were contacted via email to schedule a Zoom interview. Zoom automatically recorded the interviews and produced transcripts. Transcripts were reviewed for accuracy, line-by-line coded, sorted into categories, then thematically analyzed via Grounded Theory. Exemplar quotes were selected to demonstrate key themes.¹⁰

Results

In total, 74 survey responses and 20 interviews were collected. The characteristics of survey respondents are presented in Table 1. Interview representation spanned across students, faculty, and staff (some of which were Temple University administration members). Overall, the results indicate that

participants felt unprepared for the tornado, were largely negatively impacted by the tornado, require more resources during this recovery period, require additional training and education for future natural disasters, and request an increase in transparent communication. All participants will remain anonymous.

Table 1.

Participant Characteristics

	Number of Respondents	Number of Years at Ambler Campus			On Ambler Campus During the Tornado	
		< 2 years	2 - 5 years	5+ years	Yes	No
Students	38	45%	50%	5%	29%	71%
Faculty	6	17%	33%	50%	0%	100%
Staff	30	6%	27%	67%	20%	80%

Preparedness

The tornado that hit Temple University’s campus was highly uncharacteristic and unexpected. Hence, results are unsurprising as almost all respondents (89% of students, 100% of faculty, and 73% of staff) did not feel at all prepared for such an event. Post-tornado, a large proportion of respondents felt at least somewhat prepared for a future tornado (57% of students, 33% of faculty, and 83% of staff). Although numbers suggest survey respondents feel more prepared for a future tornado, interview insights demonstrated that there is still a substantial way to go for the people to feel confident or very prepared for

such a future disaster. This notion is illustrated in the following quote:

“Of course, I wasn’t prepared for a tornado! I live in Pennsylvania and have never thought about tornadoes a day in my life. Why would I believe a tornado threat? That sounds ridiculous. Now I feel somewhat more prepared because I can believe it could happen to me. Do I know what to do if a tornado touched down again? Absolutely not.” (Interviewee 2, Student)

Communication

Communication before, during, and after natural disasters is essential to ensure students, faculty, and staff are best prepared, protected, and able to recover as quickly as possible. On September 1st, 2021, Temple University Alerts (TUALerts), the campus’s emergency communication system, sent information pertaining to the tornado watch and warning to cell phone numbers and email addresses registered for this service.¹¹ However, this communication was widely reported by participants as nonexistent or insufficient. Conversely, participants reported that communication during the recovery period has been sufficient in making them feel safe and informed. As was stated,

“I had no idea what was going on after the tornado, there was seriously no communication, none at all, from anyone. I was panicking

not knowing how my staff, students, peers, whoever were doing...but now I feel like they’re trying to communicate more frequently at least”. (Interviewee 11, Staff)

Survey respondent perceptions toward the communication provided by TUALerts on the day of the tornado, during the tornado, and after the tornado can be found below in Table 2.

Table 2.
 Temple University Communication Before, During and After the Tornado (%)

	Information Provided by TU Before the Tornado			Information Provided by TU During the Tornado			Information Provided by TU After the Tornado		
	I did not receive information from TU before the tornado	I did receive information, but not enough	Yes, the information provided made me feel safe and prepared	I did not receive information from TU during the tornado	I did receive information, but not enough	Yes, the information provided made me feel safe and prepared	I did not receive information from TU after the tornado	I did receive information, but not enough	Yes, the information provided made me feel safe and prepared
Students	74	24	3	37	47	16	4	41	56
Faculty	100	0	0	33	33	33	33	33	33
Staff	87	10	3	70	20	10	43	43	13

Deeper conversations via interviews found that the TUAAlerts lacked specificity, which made it difficult for individuals to know what to do or how to prepare. For example, there was no explanation of the difference between a “tornado watch” versus a “tornado warning”. Furthermore, many interviewees noted that due to the high influx of TUAAlerts, they rarely pay attention to these text messages or emails. It’s also important to note that the related TUAAlert messaging came after 5:00pm when most people had already left campus or were preparing to do so.

A common misconception was that Temple University decision makers put little thought into the tornado watch and tornado

warning decisions. Several interviews with campus administration explained that such a decision-making process is quite extensive as it entails the university-wide emergency team to connect with one another across campuses to process information they’ve received from SEPTA transit operations, local organizations, and Temple University’s AccuWeather partners. In this case, as a tornado was unprecedented, and severe rainstorms common, the emergency team proceeded as a typical weather event dictates. This decision-making process is fastmoving and dependent upon numerous variables to which most students, faculty, and staff are not made privy to.

Impact Assessment

This study demonstrated that the tornado impacted participants’ sense of security, work, schoolwork, finances, housing, physical health, and mental health. Results show that 66% of students, 100% of faculty, and 60% of staff felt their sense of security was at least somewhat negatively impacted by the tornado. Similarly, 97% of students, 100% of faculty, and 100% of staff felt their work or schoolwork was at least somewhat negatively impacted by the tornado. Only 31% of students, 34% of faculty, and 43% of staff felt their physical health had been at least somewhat impacted. However, 95% of students, 83% of faculty, and 93% of staff believed their mental health had been at least somewhat negatively impacted by the

tornado. Table 3 depicts a more nuanced view of how students, faculty, and staff felt their physical and mental health , as well as their fall semester , were impacted by the tornado.

The tornado impacted most students’ sense of security on campus, work or schoolwork, and mental health. The most common outcome of the tornado amongst students (34%) and staff (43%) was that the tornado caused or triggered anxiety or stress. Most faculty and staff felt the tornado impacted their sense of security on campus, work, and mental health. Almost all faculty (83%) and staff (60%) had their research and/or administrative work negatively impacted by the tornado. Data from interviews further detailed how substantial

the destruction was to Ambler campus' arboretum, field station, greenhouse, gardens, and green spaces. These issues were not only physically harmful, but also greatly disrupted the campus community's mental health. As one interviewee stated:

“The worst part of the storm is that now we have to just like exist in the wreckage. I mean what was damaged was our classrooms, our research, or

peace and quiet. It's hard to feel better or whatever when you're constantly reminded of what happened every time you walk around campus.” (Interviewee 5, Faculty)

These campus spaces brought not only joy, tranquility, and collective pride to the Ambler campus, but they also served as research sites, workstations, classrooms, community learning areas, and safe spaces.

Table 3.
How the Tornado Impacted Participants (%)

	Physical Health			Mental Health			Fall Semester				
	Access to food	Lack of areas to walk or exercise	Not feeling safe on campus	Anxiety	Stress	Depression	Route to campus	Quality of work	Ability to focus	Teaching/learning	Research/staff work
Students	5	13	11	34	32	26	18	21	26	26	—
Faculty	0	33	33	1	33	33	17	50	33	83	83
Staff	10	40	17	43	37	37	10	27	30	7	60

Resources Provided and Needed

At each institution, resources necessary to help minimize damages and recover from environmental events should be determined for all possible events. Plans should be made to determine how gaps in resources can be filled, either through institutions obtaining resources, or methods for sharing resources promptly within regions, and if necessary, at the national level should be developed.

Results from Table 4 indicate that only a small portion of students, faculty, and staff received some form of post-tornado academic support, mental health services, food, financial support, social support, or training for future natural disasters. Most students (37%), faculty (33%), and staff (43%) reported receiving no additional

resources during the tornado recovery stage. All aforementioned resources were widely requested across students, faculty, and staff.

A key finding of this study is that the Ambler community requires more opportunities to voice concerns, needs, and opportunities for response improvement. Anonymous, frequent, feedback mechanisms are highly encouraged. Needs will change throughout this period of recovery and administrative support must be agile to meet those needs. While many needs are still apparent, there also exists a duality of optimism, as many interviewees see this tragedy as an opportunity to rebuild stronger, smarter, and ready for Ambler's future as a Temple University asset.

Table 4.
Resources Provided and Resources Needed (%)

	Resources Reported as Provided						Resources Reported as Needed				
	Academic support	Mental health services	Food/financial support	Social support	Training for future natural disasters	None of these	Academic support	Mental health services	Food/financial support	Social support	Training for future natural disasters
Students	11	18	3	29	24	37	16	16	13	13	58
Faculty	17	33	0	33	0	33	67	67	0	33	67
Staff	3	17	0	10	17	43	17	30	3	23	87

Barriers to Recovery

This study found three major barriers to Ambler campus’ recovery: (1) an unknown chain of command, (2) unclear communication, and (3) hesitancy to request assistance. Interviewees characterized the first few weeks after the tornado as being filled with confusion about the amount and severity of campus damage; who was allowed to be on campus; who was in command of which task; and who to contact for assistance in recovery efforts. For example, immediately after the tornado many faculty and staff were unsure if they should be reaching out to students and staff teams to check on their health, wellness, and safety, or if Temple University would be systematically checking that all Ambler campus members were safe and accounted. Interviews and survey responses show that this task fell on Ambler faculty and staff, yet they felt unprepared and underqualified to be working with students in such ways.

Interviewees explained that students, faculty, and staff were unaware of what communication to expect; from where communication would come from; a timeline of what to expect moving forward; and what was happening on campus. As access to the campus was limited in the first few weeks after the tornado, issues with unclear communication and unknown chain of command led to tension, rumors, and confusion throughout campus as people were unaware of what decisions were being made, by whom, and what decision-making processes were taking place. Examples

of such issues frequently related to the how the clearing of storm debris occurred. Reports of contracted workers sexually harassing students, leaving biohazard waste in faculty offices, and destroying research areas were common examples throughout interviews. One interviewee stated:

“...seriously, the contracted people hired to clear the debris were haphazardly discarding rare, endangered, and valuable materials; harming healthy plants; leaving trash around campus; and treating the campus community like an afterthought. It was rude, disrespectful, and was like salt in the wound. We were all mad, stressed, and just trying to get back to normal...and you had these guys just making things worse by disrespecting the healing process we all needed.”
(Interviewee 19, Staff)

Interviewees expressed concern as to if, and how, to ask for help after the storm. This is not uncommon in disaster scenarios. Oftentimes there is pressure for communities to appear resilient so that they be rebuilt, as opposed to being discarded as a “lost cause”. This notion was found throughout interviews as participants explained that the Ambler’s “Ready to Rebuild” post-tornado campaign felt insincere or neglectfully and condescendingly optimistic in contrast to the many negative physical, mental, and academic impacts of the tornado. While several barriers to recovery are present, the biggest facilitator to recovery is

community. We must note that we observed a great attachment to the Ambler campus from the students, faculty, and staff. This appreciation and great desire to rally behind the recovery efforts will move this campus past “normal” and

to a place of “even better.” Ambler Campus is a beloved Temple University asset, frequently viewed as a place for education, inspiration, and recreation.

Discussion

This case study aims to demonstrate the impact that an unprecedented weather event could have on a university campus. This report serves as a national call to action for institutions of higher education to ensure that they are best preparing their campuses for any form of natural disaster. All campuses should have specialty taskforces assembled to ensure their campus, students, faculty, staff, and administration are prepared for any number of natural disasters, no matter how unprecedented it may seem. Table 5, highlights key considerations campuses should prioritize to ensure their campus and personnel are thoroughly prepared before, during, and after an emergency event.

While a tornado may seem to be an unlikely and unprecedented event, campus administrators are urged to consider the inevitable influx and range of severe weather that is expected to become normalized as climate change continues. Tornadoes are no exception, as evident from the December 2021 tornado storms that crossed six states in one day, leaving thousands impacted.¹² More recently, a batch of tornadoes swept through Louisiana and Mississippi, damaging several campuses across states.¹³ It is highly recommended that other campuses take note as it is imperative to prepare for a wider variety of

natural disasters and crises that are highly likely to occur with unabated climate change.³

Beyond our recommendations for campus preparedness in Table 5, we call to the academic branches of higher education institutions to incorporate climate change readiness into the curriculum across disciplines as we recognize every member of our campus must be engaged in the collective effort to maximize solutions to these increasing events. Furthermore, we believe that all members of the campus community can contribute new insights for innovative approaches to climate change and preparedness.

It is critical to start developing university and campus-specific readiness and preparedness protocols and supportive mechanisms for a wide-range of natural disasters. It is time to think outside of our weather comfort zones and start making concrete plans for previously unlikely scenarios such as tornadoes, fires, and hurricanes. While this is a large undertaking, there are numerous resources available across institutions, organizations, and contexts.¹⁴⁻¹⁹ Now is the time to expect the unexpected. Campuses must start preparing for the unknown as weather gets more severe and widespread. We must start engaging with their campus communities to jointly create, strengthen, and support emergency preparedness.

Table 5.
Recommendations for Campus Preparedness

Recommendation	Operationalization
<p>PREPAREDNESS: Prepare early and thoroughly</p>	<ul style="list-style-type: none"> • Educate the campus community about how to prepare for all types of natural disasters • Train faculty and staff about how to support students in these conditions • Develop and require a standardized online training via Canvas • Start drills for events beyond a fire or active shooter event • Train campus police to be aware of how to help individuals within each campus setting • Frequently and widely distribute and restock safety boxes around campus that include first aid kits, phone chargers, flashlights, food, water, and other emergency materials.
<p>RESPONSE: Respond inclusively and with support in mind</p>	<ul style="list-style-type: none"> • Don't assume every person has equal ability to execute response measures • Don't assume every person has equal ability to understand the response communication • Create a crisis hierarchy to streamline future crisis response and recovery • Widely disseminate this crisis hierarchy via a document that explains who is considered essential, and how communication/delegation should flow during a crisis • Require debriefing of responders on: campus-specific information, expectations for how to treat the campus community, rules for interacting with the campus community, and best practices in disaster response and recovery
<p>COMMUNICATION: Communicate in a variety of ways with your audience in mind</p>	<ul style="list-style-type: none"> • Differentiate weather threat communications within campus alert systems • Clarify information between a weather warning vs. weather threat • Tailor messages for each campus and each campus population • Don't just rely on cellphones and internet for communication • Don't assume every student or faculty member registered for the TU Alert system. • Use an opt-out system to ensure at least campus email accounts are notified automatically • Install signs around campus that indicate where emergency resources are in each building • Put a hardcopy manual of information in each building on campus that includes information about the decision-making tree, list of key phone numbers, and basic information about what to do in each type of crisis or emergency • Communicate widely and repetitively when each of these initiatives are put into place so the campus community knows about the changes, improvements, and resources
<p>DECISION-MAKING: Decisions should be transparent with a two-way communication mechanisms established</p>	<ul style="list-style-type: none"> • Standardize a communication timeline so individuals know when to expect a decision • When disseminating a decision, deliver a rationale for that decision • Provide a contact person so individuals know who to contact for each possible need • Provide a separate contact person to address safety questions
<p>NEEDS ASSESSMENTS: Must be immediate and continuous throughout the recovery period</p>	<ul style="list-style-type: none"> • Use multiple forms of data collection methods (survey, interview, etc.) to immediately connect with the impacted community after a crisis • Continuously connect with the community for new or unresolved needs • Ensure all mechanisms for collecting information is neutral, anonymous, and multiple

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Conflicts of Interest

The authors have no conflicts to disclose

Statement of Contributions

Dr.'s Stolow and Cloutier designed the study, conducted data, analyzed results, and wrote the report. Dr. Freedman (Director, Temple Ambler Field Station) and Kathleen Salisbury (Director of the Temple Arboretum) were key informants, community partners, and helped write dissemination materials.

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