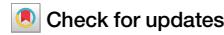


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# Public discourses and personal narratives of learning from disaster

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Super Typhoon Haiyan, also known as Yolanda, made world history as one of the strongest storms to ever make landfall when it struck the central Philippines in November 2013. In the decade since this focusing event, there has been extensive media coverage and scholarly study of the multiple facets of the disaster and the physical reconstruction of the most devastated regions. Whether and how these public discourses percolate to everyday, on-the-ground learning processes and approaches to future typhoons has been much less studied. We address this gap by leveraging a computational approach to analyze the thematic content in >15,000 newspaper articles and 300 academic abstracts along with conducting field interviews and producing a public-facing podcast series to assess lessons learned from Haiyan by institutions and individuals. The project examines mass media and academic framings and personal narratives to shed light on the prolonged recovery and learning processes. Integrating the expertise of researchers, practitioners, and policymakers with the lived experiences of Haiyan survivors and responders, the original audio series elucidates diverse understandings of disasters and climate resilience with important implications for science-based risk communication and everyday decision-making.

Super Typhoon Haiyan, known in the Philippines as Yolanda, remains one of the most destructive disasters in contemporary times. Haiyan made landfall near Guiuan, Eastern Samar on 8 November 2013, at 04:40 a.m. local time, as a Category 5 typhoon and one of the strongest storms to ever strike land (Fig. 1)<sup>1</sup>. Official government statistics estimate some 6300 casualties, sixteen million people affected, and over four million displaced<sup>1</sup>. Estimated economic damages range from 2 to over 12 billion USD<sup>2</sup>. Tacloban, a coastal city on the island of Leyte in central Philippines, is regarded as ground zero of the disaster as the city was devastated by 4- to 6-m high storm surges and suffered over 2200 casualties<sup>3</sup>.

The devastation of Super Typhoon Haiyan overwhelmed local and even national capacities to respond, making it a large-scale catastrophe that required considerable international assistance<sup>4,5</sup>. As coverage of the storm's impact flooded traditional news outlets and social media, a multitude of international humanitarian aid organizations made their way to the affected regions for relief operations. Researchers also arrived to study the disaster from multiple vantage points. In this sense, Haiyan was a focusing event that brought increased attention to a myriad of issues associated with disaster risks in the Philippines<sup>6</sup>. Focusing events shed light on systemic failures and open "windows of opportunity" for societal change, serving as enablers of

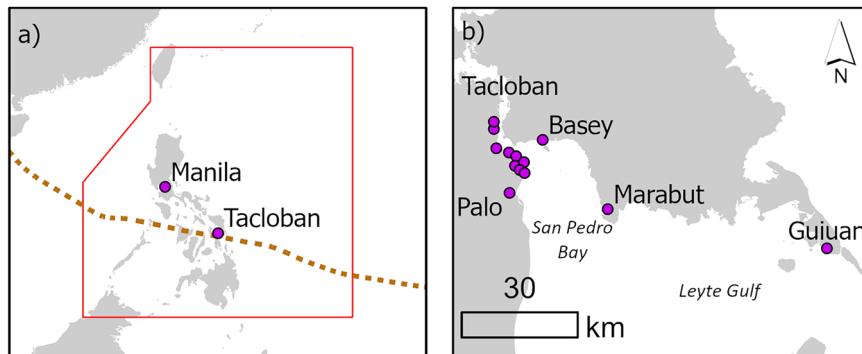
adaptation<sup>7,8</sup>. The increased attention and mobilization of ideas in the public sphere means that focusing on events offers substantial avenues for learning.

Birkland proposed that learning from focusing events is best evidenced by policy change in the form of legislation<sup>9</sup>. His event-focused policy learning framework traces the migration of legislative policies and agendas from public discourses following disasters. In the domain of natural hazards such as earthquakes and hurricanes, the framework shows that policy change arises not from any single event's learnings but from the accumulation of knowledge and experience over multiple events. Policy change thus involves long-term learning processes. Disasters as focusing events can function as necessary, but not sufficient, conditions for policy change, as lessons may decay over time or be superseded by more salient agendas.

Tracking the temporal evolution of public discourses can shed light on this long-term learning process, while analyzing the geographic distribution of such discourses may offer insights into the spatial scales of various responses. Mainstream news media is a significant space of influence for such discourses, and analyzing the content of news can thus uncover the types of framing that shape a national or subnational policy agenda in the wake of a disaster. Academic research is another major arena where competing ideas about a disaster—its nature, causes, implications, and potential solutions—are mobilized and where fundamental learning for broader

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**Fig. 1 | Study region.** **a** Typhoon Haiyan entered the Philippine Area of Responsibility (red polygon) on 8 November 2013 and exited on November 13, tracing a path of devastation along the central portion of the country, particularly in Tacloban and surrounding areas. **b** Locations of interviews in the Leyte and Samar region. Typhoon Haiyan track (a) is from NOAA's International Best Track Archive for Climate Stewardship (IBTrACS).



change can thus be fostered. Novel approaches that leverage natural language processing (NLP) are a promising avenue to distill key insights from the large amounts of news coverage and scholarly research that characterize such focusing events<sup>10,11</sup>.

Personal learning can also emerge from disasters, and the aggregation of such experiences contributes to social learning. Narrative-based approaches provide the foundation for a rich understanding of this type of experience and learning<sup>12</sup>. Pfister, employing the methods of environmental history, used several case studies to illustrate learning across different phases of the disaster cycle, namely, emergency, recovery (which he termed damage compensation), and reconstruction<sup>13</sup>. In line with Birkland, Pfister emphasized that the learning process from disasters often occurs in the *longue-durée*, sometimes spanning decades or even centuries, as shown in his case studies.

The importance of lessons accumulated over such long periods may ultimately manifest in “the everyday”, a locus of analysis advanced by cultural scholars of climate change loss<sup>14,15</sup>. Personal learning for everyday decision-making is particularly relevant in societies such as the Philippines, where hazards are a “frequent life experience” due to the country’s geography as an archipelago within the western Pacific typhoon belt and the Pacific Ring of Fire<sup>16</sup>. The role of everyday decisions to mitigate the potential consequences of disasters has long been discussed within the disaster research community, yet gaps remain in our understanding of links between experience, learning, memory, and knowledge mobilization across time<sup>17–20</sup>.

Geographically specific and community-engaged field interviews for the purposes of localized storytelling about disasters offer a promising approach for connecting technical lessons with the experiences and values of nonexpert audiences, suggesting that narrative is crucial to learning in local communities<sup>21–24</sup>. Narrative-driven approaches enable co-production with such communities as active co-constructors of knowledge, thereby building trust and enhancing retention, as evident in local knowledge systems<sup>25,26</sup>. Oral stories and the embedded local and indigenous expertise they transmit and archive have proven to be lifesaving in multiple disasters<sup>27–29</sup>. Storytelling has also been demonstrated as a means for collective sensemaking, processing trauma, and building empathy with disaster survivors<sup>30–32</sup>.

Over the past decade, the popular form of audio storytelling—known as podcasting—has gained attention as an effective medium of science communication as well as participatory knowledge co-production, fostering partnerships between academia and diverse public audiences<sup>33–35</sup>. Podcasts are on-demand audio media streamed over the internet, although they vary widely in their formats, genres, and subject matters<sup>36</sup>. There is a growing body of podcasts about science, climate change, and environmental issues<sup>37</sup>. Kinkaid et al.<sup>38</sup> outlined three distinctive strengths of podcasts for learning: they can convey knowledge that engages the emotions of listeners, incorporate the perspectives of diverse voices, and reach broad audiences. Polyvocality, the coexistence of multiple voices and viewpoints, invites listeners to participate in a dialogic mode of thinking and to consider diverse perspectives on contested or otherwise complex topics. Finally, podcasts offer researchers an opportunity to reach non-traditional audiences through

streaming services as well as RSS feeds that can be posted on publicly available and freely accessed websites. On balance, narrative podcasting is a promising medium for science communication writ large and for communicating lessons learned from disasters in particular.

In this research, we employ NLP-aided content analysis and audio podcasting to explore three questions: i.) What themes constitute how Typhoon Haiyan was communicated and framed during and after the storm event within the news media and academic research? ii.) How have these public discourses evolved over time? and iii.) How do public discourses compare to personal narratives of lessons learned from the disaster? We do not directly assess learning in terms of policy change or personal outcomes, but rather in terms of ideas generated and knowledge mobilized. We leverage NLP-aided content analysis of global newspaper coverage and academic research about Haiyan over the span of 2013–2023 to inductively identify themes in the public arenas of newspaper coverage and academic research about the storm. We pair this analysis with the production of a seven-part podcast featuring personal narratives from interviews with researchers, government officials, NGO representatives, and survivors in affected communities in the Philippines. Through an inductive-deductive, mixed-methods approach, our work traces trends in public framings and personal stories of lessons from Haiyan.

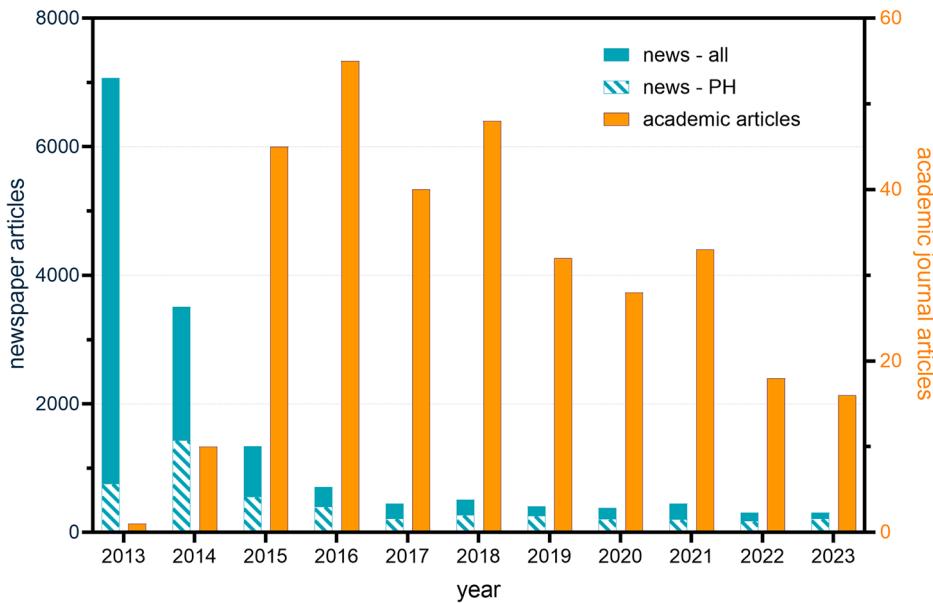
## Results

### Survey of newspaper coverage and academic research on Haiyan

Our search yielded  $n = 15,428$  English-language newspaper articles published between November 2013 and December 2023 that mention “Typhoon Haiyan” or “Typhoon Yolanda” in the Lexis Nexis Web Services API (Supplementary Fig. 1). Newspapers in the Philippines accounted for  $n = 4663$  articles (30% of global corpus). The Philippine newspapers most represented in the dataset were *BusinessWorld* (33% of Philippine corpus), a business-focused broadsheet, *Philippine Daily Inquirer* (30%), widely regarded as the national newspaper of record, and *Philippine Star* (17%), another prominent national paper. Global newspaper coverage peaked during the year of the disaster and exponentially declined afterwards, with the number of 2023 articles being only 4% of 2013 articles (Fig. 2). Philippine newspaper coverage peaked in 2014 and declined afterwards, although the number of articles published between 2020 and 2023 remained at 20–30% of the number in 2013, suggesting sustained coverage. Articles from the Philippines accounted for 11% of global newspaper coverage in 2013 and remained at levels above 40% from 2014 onwards, accounting for 69% of total coverage by 2023. For both the global dataset and the Philippines-only data, coverage peaked in Q4 (October–November–December), suggesting a potential annual increase in attention around the anniversary of the storm, although there is notable year-to-year variability (Supplementary Fig. 2).

For comparison, we conducted a similar search for newspaper articles on Hurricane Katrina (2005–2015) and Hurricane Sandy (2012–2022), two storms that are also widely regarded as focusing events. Without filtering out possible duplicates, Katrina was covered in  $n = 102,133$  articles, and Sandy

**Fig. 2** | Temporal distribution of newspaper and academic journal articles on Super Typhoon Haiyan.



had  $n = 29,633$  articles in the 10-year period following their occurrence (Supplementary Fig. 3). The numbers indicate lower media attention on Haiyan. The annual temporal distribution followed the same pattern of Haiyan newspaper coverage, exhibiting a sharp decline following the year of occurrence.

Our search for academic articles on Web of Science (WoS) that mention “Typhoon Haiyan” or “Typhoon Yolanda” in the title or abstract and were published from 2013–2023 yielded  $n = 326$  papers (Fig. 2, Supplementary Fig. 4). The first WoS research article was published in December 2013 in *Science Diliman*, a journal of the University of the Philippines<sup>39</sup>. The journal constituting the largest share of the corpus was the *International Journal of Disaster Risk Reduction*, which published 31 Haiyan-related articles. The temporal trend of WoS articles differs from that of newspapers, as academic publications exhibited a steady increase until a peak in 2016. Peer-reviewed research on the storm continued to be published regularly until 2023, exhibiting secondary peaks in 2018 and 2021.

For comparison, we also searched WoS for articles on Hurricane Katrina (2005–2015) and Hurricane Sandy (2012–2022). The temporal trends for research on the storms were similar, with peak article publication four to five years after the event followed by a gradual decline (Supplementary Fig. 3). As with newspaper coverage, Haiyan was notably under-researched compared to Katrina ( $n = 1878$ ) and Sandy ( $n = 734$ ).

### Topic modeling of Haiyan-related newspaper coverage and academic research

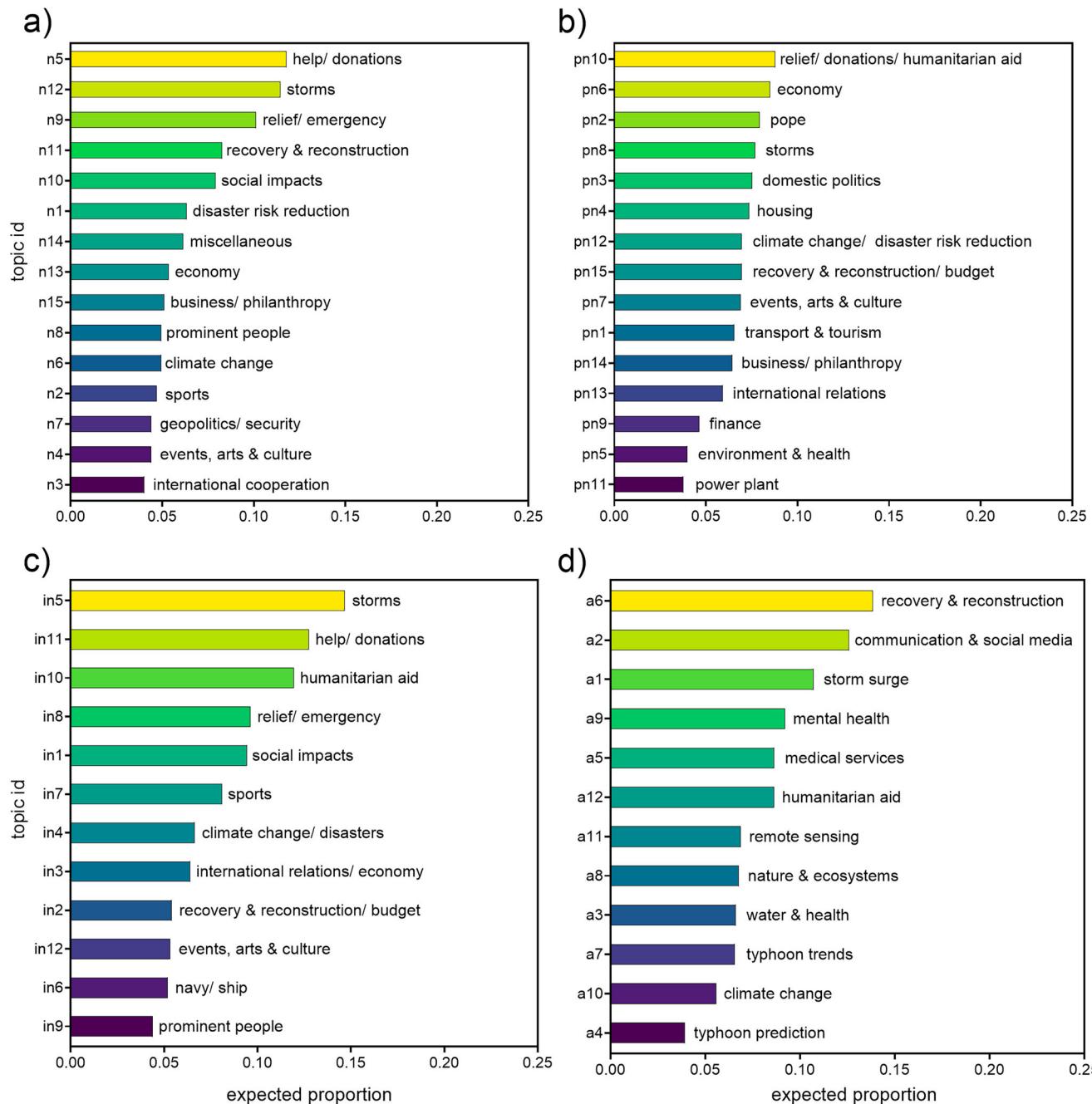
We identified key topics in the text corpora with the aid of NLP. Specifically, we employed structural topic modeling (STM) to determine dominant themes (Methods). Topics are groups of words that frequently co-occur and coherently describe a particular theme. STM assigns each word in the corpus to one topic, and each document (i.e., newspaper article or academic abstract) is characterized by a probabilistic distribution of topics. Separate analyses were conducted for all newspaper articles (shorthand: *n*), Philippine newspapers only (*pn*), international newspapers only (*in*), and academic abstracts (*a*). We evaluated models with three different values for *K*, the number of topics, along with an optimal tradeoff between average exclusivity and semantic coherence. Here, we present the results for selected models with the highest exclusivity. Results for models with alternative values of *K* are presented in the Supplementary Information.

Fifteen topics described the corpus of global newspaper articles mentioning Typhoon Haiyan (Fig. 3a and Supplementary Table 1). Three of the top five topics (n5, n9, n11) were related to the immediate aftermath of the

storm, including coverage of the destruction and casualties, as well as calls for donations from ordinary citizens. The second most prevalent topic (n12) was on storms, including Haiyan itself as well as later storms being compared to Haiyan. Completing the top five was Topic n11, which was related to long-term recovery and reconstruction, including discussions of governmental budget allocations and progress in housing for displaced residents. Two topics of particular interest for disaster learning, Topic n1 and n6, on disaster risk reduction and climate change, respectively, constituted a considerable portion of the corpus when taken together. Newspapers have discussed Haiyan in relation to these two topics to bring attention to the impacts of climate change and the need for action to mitigate such impacts and reduce disaster risks. Other topics include the economic impacts of the storm (n13), the response from the business and philanthropic communities (n15), coverage of prominent people, including government officials and the pope (n8), news about sports (n6), and other events (n4), as well as geopolitics and security affairs (n7) and international cooperation (n3). Topic n14 was labeled as miscellaneous, as no discernible unifying theme appeared within the words constituting the topic and the representative documents.

Articles from Philippine newspapers exhibited a more uniform distribution across fifteen topics compared to the global corpus (Fig. 3b and Supplementary Table 2). The most prevalent topic, pn10, was related to the immediate needs in the aftermath of the disaster. Economy, Topic pn6, occupied second place, followed by Topic pn2 on Pope Francis, which was primarily about his 2015 visit to Yolanda survivors. Topic pn8 involved coverage of storms, while Topic pn12 combined articles on climate change and disaster risk reduction. Topics pn3, pn4, and pn15 were related to various aspects of governance and recovery from the disaster, including news about political blame for the inadequate response. Other topics identified were events, arts & culture (pn7), transport & tourism (pn1), corporate philanthropy (pn14), international relations ranging from cooperation to military affairs (pn13), finance, related to debt relief and tax matters for affected communities (pn9), miscellaneous news about environment and health, including mental health (pn5), and coverage about business negotiations for a power plant (pn11).

Topics identified from international newspaper articles largely mirrored the topics identified in the global corpus (Fig. 3c and Supplementary Table 3). The most prevalent topic, Topic in5, was about storms. Within this corpus, the model was able to differentiate between donations from regular citizens (in11) and aid from governments and humanitarian organizations (in10). Topic in6 was also unique to this corpus, and it consisted of articles on the HMS *Illustrious*, an aircraft carrier mobilized in the Haiyan response.

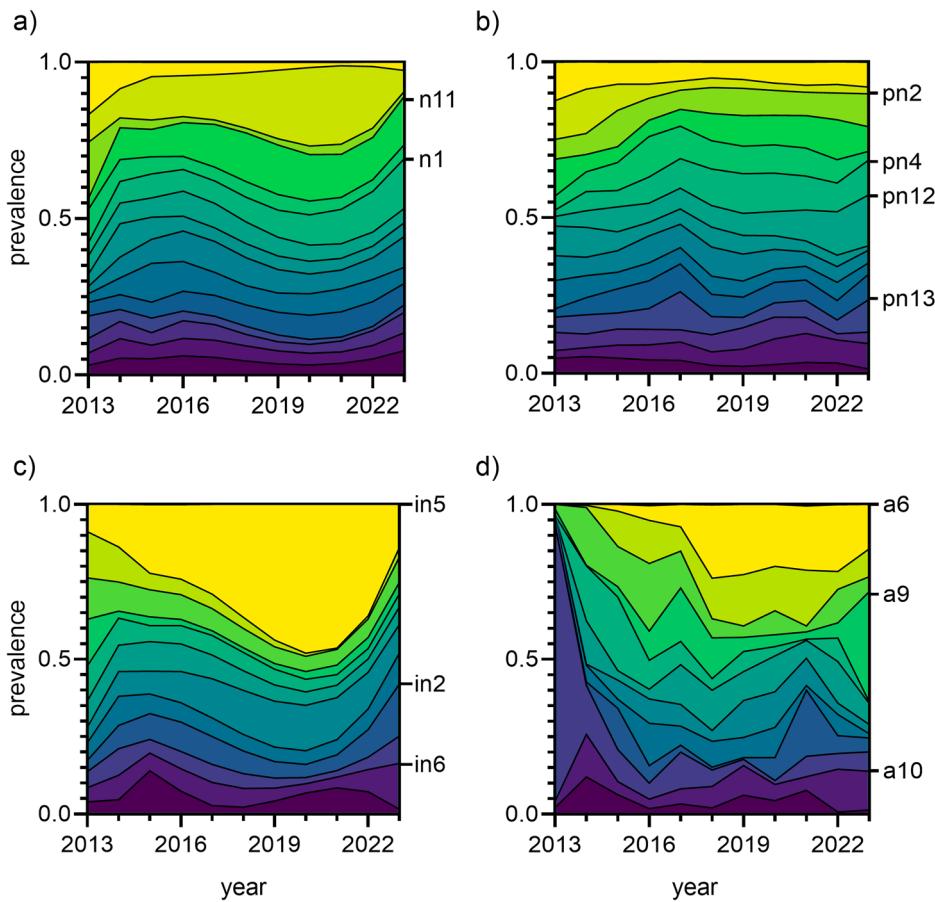


**Fig. 3 | Expected proportion of topics.** Individual panels show results for **a** 15-topic model for all newspaper articles (model *n*), **b** 15-topic model for Philippine newspaper articles (model *pn*), **c** 12-topic model for international newspaper articles (model *in*), and **d** 12-topic model for academic journal abstracts (model *a*).

Prevalent topics in the academic abstracts were notably different from those in newspaper articles (Fig. 3d and Supplementary Table 4). The research represented a wide array of disciplines across physical sciences and engineering, health sciences, social sciences, communication, and media studies. The most prevalent topic, Topic a6, encompassed research on post-disaster recovery, reconstruction, and relocation. Multiple dimensions of recovery were included in this topic, including physical infrastructure, socioeconomic vulnerability, and community empowerment. Topic a2 involved research on the use of social media for communication during the storm and coordination of response operations. Next, Topic a1 represented research on the storm surge, including work on prediction, post-disaster field surveys, damage assessment, and surge-associated debris mobilization and sediment deposition. A related topic was Topic a8, which revolved around the interaction of the surge with coastal ecosystems, primarily mangroves and coral reefs. Topics a9,

a5, and a3 were all related to health. Topic a5 covered the impact of Haiyan on medical conditions, hospital admissions, and mortality. Topic a9 was related to mental health issues among survivors, particularly posttraumatic stress and coping mechanisms. Topic a3 was identified as a water, sanitation, and hygiene cluster, relating to work on drinking water and water-borne diseases. Humanitarianism was covered in Topic a12, which included case studies elucidating the role of states as well as international and local non-government organizations in relief efforts. Topic a11 described data and models used to assess damage and recovery, particularly involving remote sensing approaches. The last three topics, a4, a7, and a10 were related to research on weather and climate. Taken together, they constituted 16% of the corpus, which would make this group the most prevalent theme. Research within this theme included methods for improving typhoon forecasting and monitoring, analysis of typhoon trends, and climate change attribution and projections.

**Fig. 4 | Topic prevalence over time.** Individual panels show results for model **a** *n*, **b** *pn*, **c** *in*, and **d** *a*. Topics are shown in an identical order and color scheme as in Fig. 3. Topics with individual prevalence  $>0.1$  in 2023 are labeled.



Aside from overall prevalence, we also assessed temporal trends in the topics for the different corpora (Fig. 4). The vertical axis in these plots represents the relative prevalence of topics in any given year. For illustration, there was only one academic article published in 2013 (Fig. 4d). This document was primarily associated with Topic *a7*, accounting for the high relative popularity of *a7* for 2013. The same document was also partly associated with Topic *a4* and *a10*.

Within the newspaper articles, topics related to the immediate storm impact and needs, including calls for donations, exhibited a rapid decline in relative prevalence, as the media moved on to other salient topics. However, these topics did not vanish entirely. Relief efforts for later disasters often mentioned previous experience with Haiyan to evoke a sense of organizational learning. Over time, topics related to recovery and reconstruction exhibited an increasing prevalence. The same trend was observed for topics related to climate change and disaster risks. The most pronounced increase in relative prevalence was associated with the topic of storms, especially within the global and international corpora (Fig. 4a, c). Newspapers outside the Philippines framed Haiyan as a benchmark for later storms. Examples from the representative documents include Hurricane Patricia (2015), Typhoon Haima (2016), Hurricane Irma (2017), Typhoon Mangkhut (2018), and Typhoon Goni (2020). This trend of benchmarking storms against Haiyan invokes social memory and a type of cognitive learning related to setting expectations and making sense of storm impacts. Trends were similar for Philippine newspaper articles, with events such as the 2015 papal visit, the 2016 national elections, and the 2017 ASEAN summit in Manila causing spikes in the corresponding topics on the pope, domestic politics, and international relations, respectively (Fig. 4b). On the topic of storms, Yolanda remained a salient benchmark even for typhoons forecast to strike outside the areas affected in 2013. The largest decline in relative prevalence was related to economic impacts, which peaked in 2014. The most notable increase in prevalence was observed for the topics of housing

and climate change/disaster risk reduction, suggesting that such discourses frame the perceived long-term lessons from Yolanda in Philippine newspapers.

Academic abstracts exhibited more temporal variability than newspaper articles (Fig. 4d). The topic of typhoon trends, most associated with the sole 2013 document, exhibited the sharpest decline in prevalence as more articles were published covering a diversity of topics. Studies on storm surges were most prevalent prior to 2017. Like newspapers, research articles on recovery and reconstruction exhibited an increasing prevalence over time and were most prevalent from 2018 to 2022. Research on emergency medicine peaked in 2015, water and health in 2021, and mental health in 2023, potentially indicating a shift in focus from medical emergencies to longer-term mental health outcomes. The topic of climate change exhibited similar peaks in 2014 and 2022, and it remained relatively popular in 2023.

Prevalent themes and temporal trends from alternative models were consistent with our main results, although differences in their relative distributions were observed as some topics combined under smaller  $K$  values (Supplementary Figs. 6–9, Supplementary Tables 5–12).

#### Podcast development and deployment

Informed by this analysis, we developed a seven-part podcast (*Carried by Water: Super Typhoon Haiyan, 10 years on*) that we produced as a multi-disciplinary environmental media and science communication group. The podcast interwoven the voices of academics, government representatives, non-government organizations (NGO's), and diverse Haiyan survivors, as well as contemporary soundscapes featuring human and non-human elements of the environment. A total of fifty-eight people were interviewed for the project. The podcast is organized into seven episodes, each of which provides narrative-driven explorations emphasizing various themes and examples of learning from both the disaster and the recovery process (Table 1). It is freely available on all major streaming platforms and on a

**Table 1 | Examples of learning featured in the podcast episodes**

Episode	Title	Themes	Examples of learning
1	A Cluster of Clouds Over the Pacific	weather forecasting	improvements in weather monitoring and forecasting capacity • "We increased the domain of the monitoring. Because, before, it's only within the Philippine Area of Responsibility (PAR). We made an imaginary domain, we call it the Tropical Cyclone Advisory Domain (TCAD), which is much bigger than the PAR. And aside from that, because the LGUs [local government units] are complaining about the lead time, so we increased again the domain, which is much bigger than the TCAD. And we call it the Tropical Cyclone Information Domain, which reaches farther than Hawaii." (M1)
		weather knowledge	possibility of rapid change in weather conditions • "What contributes to that assumption that they will not be affected by Yolanda is that [there was] no manifestation. No heavy rainfall, no strong winds. Whereas other cyclones, three days before it makes land, we already feel it. But during Yolanda, no precursory signs, as if it's just normal." (T1)
		risk communication	shift from numeric-focused (e.g., wind speeds) to impact-focused public weather bulletins • "Many of them wanted visual language. Now it's not so much visual, as in I wanna see a photograph of a truck flying to know that a truck is going to fly. It's more, when the warnings came in, they couldn't translate what 250 km/hr meant. That was not in their lexicon. They had to be told the wind will be strong enough to lift a truck." (M2)
		climate change	influence of climate change on typhoons "Even though the numbers [of typhoons] may be stable or not increasing into the future, the number of the most intense ones, for example, Haiyan-like category storms, will be increasing." (M3)
2	If We Called it a Tsunami	storm surge	awareness of storm surge • "We had had experiences of storm surges before, but we never recognized it as storm surges. We simply recognized it as a high tide together with the strong wind, although the waves would reach the city streets." (T2)
			designation of evacuation centers & protocols • "We lost many of our evacuation centers to Yolanda because many of our evacuation centers were buildings and school campuses along coastal areas." (T2)
			preparation of accurate hazard maps • "Maps could have told us that the inundation could be two to three kilometers inland, depending on the landscape. We did not have those maps." (M4)
			no-build / no-dwelling zone • "The blanket 40-meter no-build zone does not mean anything in terms of the Yolanda-type hazards. No-build zones must be based on hazard maps that are produced from the best available science." (M4) • "At least if no one lives there, maybe there will be less impact if there's another deluge like that." (T3)
3	They Said that Cancabato Bay is Already Dead	coastal infrastructure	infrastructure to protect the coast • "The tide embankment, we had proven it very effective. Why? Because it was constructed through the standard of build back better." (T2)
			nature & ecosystems ecosystems as nature-based solutions • "This mangrove helped our people during the super typhoon. If it weren't for this type of mangrove, a lot more people would have died. Because of this mangrove, there were only 23 casualties from our barangay." (T4)
			nature & well-being • "Sometimes, when we lounge around in the afternoon, we can spot several kinds of birds. Even with my sixty-six-year-old eyes, I can still see the abundance of colors of these birds. In the afternoon, the leaves even seem to fly. You see, those little things make us happy." (T5)
			human intervention to promote ecosystem recovery • "In this scenario where you have extensive damage from a super typhoon, allowing nature to recover and heal may not be effective, because the rubble just won't allow settlement of baby corals or reattachment of broken fragments. I think these are scenarios where humans need to assist a damaged ecosystem so that it can still support human lives." (M5)
4	Away from the Hazards	resettlement & recovery	groundwater vulnerability to saltwater contamination • "It became clear that the entire village was inundated, which means all their wells were underwater for an hour or so at the peak of the surge. Everybody told us, yeah, we could not use our well water because it got salty. They had nothing to drink, and they said boiling doesn't help. It makes it saltier." (R1)
			access to basic services • "If I'm going to turn back the time, I'd rather have my housing projects within the city. Not that far. Because if you're going to put it farther, let's say in the north, you have to spend a lot of money to provide the utilities. You have to open up roads. You have to have school buildings, health centers." (T6)
			access to livelihood • "Now, there are some who are returning to the coastal areas. Not that they live there. But they just go there to find livelihood." (T3)

**Table 1 (continued) | Examples of learning featured in the podcast episodes**

Episode	Title	Themes	Examples of learning
5	An Organized Chaos	humanitarian aid	<p>attachment to place</p> <ul style="list-style-type: none"> <li>“People there [in the resettlement areas], they become weak. Because there is no sea. The sea is far. It’s not good for the body. Here [in the coast], life is good, with the sea breeze blowing just like this. It’s nice.” (T7)</li> </ul> <p>attachment to people/ social capital</p> <ul style="list-style-type: none"> <li>“We were really lucky because those who were our neighbors before also became our neighbors here. There wasn’t too much adjustment because you already knew them. Other housing projects, people from different coastal barangays were mixed together.” (T3)</li> </ul> <p>participation and people-centered recovery</p> <ul style="list-style-type: none"> <li>“They [future resettlement residents] know where, they know when, they know the problems. They were involved, actually. People were informed.” (T8)</li> <li>“The people driven approach should be used appropriately and with refinements [of people’s involvement] along the way. It should not be a fixed formula. You should adapt to the changing environment.” (T9)</li> </ul> <p>land tenure</p> <ul style="list-style-type: none"> <li>“The land title is the concrete manifestation of ensuring land tenure security for them [resettled survivors].” (T9)</li> </ul> <p>potential replacement of hazards</p> <ul style="list-style-type: none"> <li>“If you go there, especially during rainy season, the streets in Tacloban North, they’re also flooded. Flooded streets, roads, when the wet season, sets in.” (T8)</li> </ul> <p>coordination, distribution &amp; duplication of aid</p> <ul style="list-style-type: none"> <li>“Some NGOs that we talked with said that, because there was no regional DRRM plan, it was difficult to prioritize. So, there was a tendency for some areas to receive more assistance, some areas received less, as some areas received none.” (M6)</li> </ul> <p>local empowerment as end goal of aid</p> <ul style="list-style-type: none"> <li>“Humanitarianism can also focus on localization and empowerment, instead of just providing material goods. The important thing is training and empowering and skills building or mentoring people. Because eventually they [aid organizations] will have to leave.” (M6)</li> </ul> <p>social impacts</p> <p>human connection between survivors and aid workers</p> <ul style="list-style-type: none"> <li>“There was such a divide in Tacloban in terms of, okay, I’m from the NGO world, I’m here to help. And then the other side would be like, okay, you help me. There was very little overlap, and I think these intersections [shared spaces] were important. Where they could just be themselves and not be like the helper and the ‘helpee.’” (T10)</li> </ul>
6	We Are Used to Storms	memory & risk perception	<p>historical awareness, intergenerational knowledge transmission</p> <ul style="list-style-type: none"> <li>“It was 1897, that Samar and Leyte account [of a nearly identical typhoon] and then Yolanda. So, you know that history will repeat itself.” (M7)</li> <li>“It happened a hundred years ago, but we didn’t know about it. Why didn’t our elders...why did that not become part of our oral stories?” (T11)</li> </ul> <p>traditional evacuation practices</p> <ul style="list-style-type: none"> <li>“There were probably about 30 families in that cave. There were many of us. If we had nowhere to hide, we would’ve all been wiped out.” (S1)</li> </ul> <p>social impacts, mental health</p> <p>role of culture in processing trauma</p> <ul style="list-style-type: none"> <li>“Death is very difficult to manage. Even if it is expected, so much so for death that is very shocking, like the death by way of natural cataclysm. We have a very elaborate culture that is filled with rituals in every stage of life. And if this is not factored in, it is very difficult to regain a sense of order again.” (T11)</li> </ul>
7	What Does Resilience Mean to You?	resilience	<p>multiple framings of resilience</p> <ul style="list-style-type: none"> <li>“Resilience for me is physical, economic, and also spiritual. When I say physical, I’m referring to the houses. Engineers should be constructing structures that can withstand at least the Haiyan strength so that there would be minimal damage. And then the kind of livelihood. What is a resilient livelihood? Third is the spiritual side. You need some faith, some spiritual anchor to withstand all these pressures.” (T8)</li> </ul> <p>personal resilience</p> <ul style="list-style-type: none"> <li>“Resilience means that if the same thing happens to you again, the effect shouldn’t be as big as the next time. You should empower and capacitate yourself. It shouldn’t just be that you survive and recover because someone else helps you. You should be able to do that on your own because you were prepared.” (S2)</li> </ul> <p>inequality of resilience</p> <ul style="list-style-type: none"> <li>“For me, there are only a select few that are resilient. Hopefully, everyone in Tacloban will be resilient.” (T4)</li> </ul>

Interviews are designated by location: *M* Manila, *T* Tacloban, *S* Samar (Marabut & Guiuan), *R* remote. Quotes have been edited for clarity and brevity.

companion website that includes, for each episode, a fully referenced transcript, relevant maps, and original photographs<sup>40</sup>. As shown in Table 1, interlocutors provided examples of learning at multiple levels, including institutional, social, and personal, across temporalities spanning everyday decision-making to long-term planning.

We now summarize key themes and examples of learning in each episode. Episode 1 features the voices of weather forecasters from the National Weather Bureau—the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA)—who share how Haiyan compelled them to break institutional protocols and issue public warnings even before the storm entered the Philippine Area of Responsibility (PAR, Fig. 1a). The episode elucidates gaps between technical and layperson understandings of typhoons (as compared to this unprecedented super typhoon) as well as the determinants of effective storm warnings to guide future communications: timeliness, accuracy, and salience. A critical lesson learned is that forecasts need to incorporate visual and everyday language that helps communities connect wind speeds and precipitation amounts to local knowledge of their environment. Throughout the episode, improvements in PAGASA's forecasting capabilities and communication protocols post-Haiyan are also discussed, as well as the potential implications of climate change for future tropical storms.

Expanding on the dynamics of expert communication and local knowledge, Episode 2 examines the failure of official warnings to prompt widespread evacuation as many people were unfamiliar with the term “storm surge” prior to the disaster. The episode juxtaposes the stories of two surge survivors, both of whom assumed that their locations would be safe from the hazard. Interviewees discuss the reasons these locations failed to provide effective storm refuges, including the lack of accurate hazard maps of storm surge inundation before the typhoon. The episode also discusses other reasons why people chose not to evacuate, including reasons rooted in land insecurity and poverty. It also demonstrates a need for more robust and sustained cultivation of intergenerational storm awareness in the region, as illustrated by Tacloban’s forgotten history of Haiyan-like storm surge disasters.

Episode 3 discusses two paradigms of coastal adaptation that emerged in Haiyan’s aftermath: (1) a push for coastal reclamation and the construction of concrete infrastructure, and (2) the emergence of nature-based approaches for hazard mitigation based on the ecology of mangroves and coral reefs. The episode also discusses the importance of coastal aquifers and presents a case study on saltwater intrusion from the Haiyan storm surge that demonstrates the vulnerability of communities solely dependent on coastal groundwater for household water supplies. Interviewees discuss how the politicization of infrastructure projects was met with grassroots resistance to top-down impositions of such projects. The episode also highlights the need for disaster response to pay attention to the recovery of critical ecosystems for human life and livelihoods.

Episode 4 examines approaches to and discourses about resettlement, focusing on Tacloban’s effort to relocate former coastal settlers to Tacloban North, an inland area far from the city center, as part of a strategy the government describes as a necessary retreat from hazards. Interviewees discuss the strategy’s tradeoffs and downstream effects, including disruptions of community members’ sense of place, social ties with neighbors, and access to livelihood and critical services. The episode presents multiple perspectives on the transparency and fairness of the resettlement process, the role of national and local politics in its implementation, and underlying sources of systemic risk such as poverty. The episode also highlights the relative successes of “people-centered” resettlement projects led by NGO’s while also documenting present-day challenges in these newly formed communities.

In Episode 5, listeners hear from Haiyan survivors who are preparing to move to concrete homes in an NGO-sponsored resettlement project after spending almost a decade in prefabricated transitional shelters. This episode centers on conversations about humanitarian aid and shows the need for more robust systems of disaster coordination and accountability to ensure the cultural and ecological appropriateness, equitable distribution, and

meaningful contribution of any one form of aid. Interviewees also emphasize the need for local training and empowerment to ensure the sustainability of humanitarian projects once implementing organizations leave a post-disaster area and turn their attention elsewhere.

Episode 6 widens the podcast’s narrative lens to foreground themes of memory, risk perception, collective trauma, and the role of local cultures in disaster recovery. It explores how stories and rituals function in processing and healing from trauma and in building community preparedness for future typhoons and other natural hazards. The episode also discusses the importance of documentation and archiving to preserve and strengthen the intergenerational transmission of technical and cultural knowledge. Interviewees articulate multiple visions of resilient shelter and share stories of local and indigenous evacuation strategies that saved lives during Haiyan.

Episode 7 concludes the podcast by presenting a montage of our interviewees’ perspectives on resilience. This juxtaposition of these voices highlights the contested framings of this increasingly prominent term in climate change adaptation and disaster planning, with responses varying from resilience as an aspirational quality to calls for abandoning the concept altogether.

At the time of revision, the podcast had over 1000 unique streaming sessions across all seven episodes (16% of which were from within the Philippines). We have also deployed it as a teaching tool in undergraduate classes, as well as in outreach activities with high school students and STEM teachers. Students connected their personal memories of storms to the podcast and shared feedback reflecting on the disaster’s implications for justice and equity (Supplementary Table 13). A comprehensive evaluation of the reach and impacts of the podcast is beyond the scope of this paper, but we recognize that such an assessment would yield valuable insights, particularly as the project is deployed in more settings in the future.

## Discussion

Our NLP-assisted content analysis of newspaper articles and academic publications on Typhoon Haiyan demonstrates the multiplicity of frames by which the disaster has been viewed in the ten years since its occurrence. As a focusing event, the storm brought attention to underlying issues that magnified the impacts and losses, mobilizing competing discourses and policy agendas on what should be learned to prevent similar disasters in the future.

Newspaper coverage declined rapidly and followed an issue attention cycle tracking the progression from the immediate emergency towards longer-term issues such as housing reconstruction<sup>41</sup>. Topics related to aid provision for survivors, while short-lived, were the most prevalent in overall newspaper coverage due to the disproportionately large number of 2013 articles. Still, the focus on relief echoes previous research that points to similar observations as evidence for the dominance of relief provision in setting disaster policy agenda<sup>9</sup>. In the Philippines, grassroots survivor groups protested the government’s “criminal negligence” for failing to provide relief months after Yolanda<sup>42</sup>. Coverage of the economic impacts of the storm was another topic that exhibited high initial prevalence followed by a sharp decline in domestic newspaper articles. Such prevalence may be driven by the large share of business-focused sources in our Philippine corpus, although we note that economic issues have similarly been observed to dominate media coverage following hurricanes in United States newspapers<sup>43</sup>. After the initial attention on emergency relief and immediate impacts, Haiyan/Yolanda appeared to be most salient as a benchmark for subsequent storms and disaster response, especially outside the Philippines. Over time, topics related to climate change and disaster risk reduction also gained an increasing prevalence. Previous research with four leading news outlets in the Philippines showed that Yolanda provided journalists an opportunity to elevate the issue of climate change to a “banner story”<sup>44</sup>. Internationally, Haiyan has served as a focusing event for the policy agenda of a climate change loss and damage fund since COP19 in Warsaw in November 2013<sup>45</sup>. A notable limitation to our analysis of newspaper articles is our consideration only of English-language sources that were available on the Lexis Nexis Web Services API. Regional newspapers, which may be

more representative of local discourses, were therefore not part of our content analysis. This limitation highlights the necessity for bottom-up approaches such as community-based storytelling.

Attention from the academic community has been more sustained, covering a multidisciplinary range of issues and methodologies across multiple spatial and temporal scales. Research appeared to exhibit a gradual shift from an initial focus on topics related to storm surge and emergency medicine to a later focus on topics related to recovery and mental health. Research related to climate change was prevalent in the immediate period after the storm, declined, and exhibited a resurgence more recently. The diversity of topics covered in the research suggests an active arena where new ideas continue to be generated. As with the newspaper sources, our analysis of academic articles is limited to only English-language publications indexed in the WoS database, thus potentially excluding a significant number of relevant research papers.

These public discourses only partly capture the diverse epistemologies and values that we assemble in our public-facing podcast. Time and resource constraints mean that the number of interviewees featured in the podcast is small relative to the vast populations affected by Haiyan, and important perspectives may not have been represented. We endeavored to feature interlocutors drawing on insights from years of experience conducting field interviews, administering surveys, analyzing policy documents, and listening to survivors over the decade since the storm. The podcast, through the relational medium of voice and the recognition-oriented practice of listening, serves as a bridge reconnecting public discourses published in global news and academic papers to the everyday narratives and experiences of local communities<sup>46,47</sup>. The stories featured demonstrate learning not only at institutional or organizational levels but also at individual and community levels<sup>7</sup>.

The project also offers a model of expansively interdisciplinary disaster studies work built-in cultural specificity, the building of trust and open dialog with diverse communities, and thoughtful communication across epistemological differences<sup>48,49</sup>. Storytelling, and podcasting as a specific form of storytelling, is a vital communication tool for the important work of transmitting lessons from past disasters and improving disaster preparedness and response in the future. The narrative format of the podcast can be incorporated into traditional approaches such as classroom lesson plans to enhance learning and knowledge co-production<sup>25</sup>. Of course, learning does not automatically lead to such positive outcomes. The literature provides examples pointing to instances of negative learning, maladaptation, and learning as a “double-edged sword”, as well as examples that cast doubt on whether learning from disasters occurs at all<sup>50–54</sup>. In our work, we do not address the normative question of whether people are learning right or wrong lessons from Haiyan. Rather, by amplifying stories of survivors years after the mass media spotlight has faded and humanitarian agencies have issued their final reports and moved on to other large-scale disasters, our podcast frames learning from disaster as a continuous, *longue-durée* process that shapes experiences of the everyday. In Tacloban, this is evident in the enduring displacement of survivors, the still-ongoing process of reconstruction, and the city’s chronic exposure to typhoons. The city’s history of catastrophic storm surges brings forth questions about the policies and human decisions that dictated its sustained vulnerability to natural hazards in November 2013. In the storm’s aftermath, policies have centered discourses of resilience and “building back better”, with a portfolio of various measures including retreat, concrete coastal infrastructure, and reclamation. The actual implementation and lived experience of these policies must be carefully documented and examined, considering how contemporary decisions are reshaping and, in some cases, reinforcing vulnerability in the face of changing climatic and coastal hazards.

## Methods

### Document search and corpus preparation

We searched the LexisNexis Web Services API for English-language newspaper articles published between 2013 and 2023 that mention “Typhoon Haiyan” or “Typhoon Yolanda” in the document body

(Supplementary Fig. 1). Articles were downloaded from the API in json format using the requests and json libraries in Python-3.12.4. We imported this file into R-4.4.1 and prepared the corpus for further analysis, including removal of duplicate articles, using the following packages: jsonlite, lubridate, stringr, dplyr, and LexisNexisTools<sup>55–60</sup>. We searched the WoS database for English-language research articles that mention “Typhoon Haiyan” or “Typhoon Yolanda” in the title or abstract and that were published between 2013–2023. We excluded from further analysis results that were not directly about the disaster or its impacts in the Philippines and articles that could not be accessed (Supplementary Fig. 4). Full records from WoS were downloaded in .xls format and imported into R-4.4.1 using the readxl package for further analysis<sup>61</sup>. For comparison, we also performed similar searches for newspaper and academic articles on Hurricane Katrina that were published between 2005–2015 and Hurricane Sandy between 2012–2022.

### Structural topic modeling

We conducted STM to identify the dominant themes in the articles about Typhoon Haiyan. Separate STM analysis was conducted for the different corpora: all newspaper articles (shorthand: *n*), newspaper articles from Philippine sources only (*pn*), newspaper articles from international sources only (*in*), and academic articles (*a*).

Topic modeling is a form of unsupervised NLP that is used to identify latent topics based on word co-occurrence in a text corpus<sup>62</sup>. Various types of topic modeling have been used to examine trends in academic research, literature, and media discourse<sup>10,11,63,64</sup>. STM is a type of topic modeling that incorporates metadata information about each document to identify topics, in addition to word co-occurrence within the corpus itself<sup>65</sup>. A topic is characterized by a group of words, with each word having a probability of belonging to a given topic. Each document (i.e., newspaper article or abstract) is similarly defined by a probabilistic distribution of topics, such that for any given document, the sum of topic prevalence across all possible topics is 1. Incorporating document-level metadata may improve the quality of the topics identified by the model. In our application, we specified the following document-level metadata as covariates for the *n* models: year, source, and an indicator for local or international sources. In *pn* and *in* models, we used year and source as covariates. In *a* models, we specified year, WoS categories, and research areas as covariates.

The number of topics *K* is the most important specification in STM. There is no single approach to selecting the “correct” *K*. Following Roberts et al., we select *K* based on the average semantic coherence and exclusivity of topics<sup>66</sup>. Semantic coherence is a measure of how frequently the most probable words in each topic co-occur. This metric has been shown to be in good agreement with the human judgment of the logical consistency of topics<sup>67</sup>. Exclusivity is a measure of the degree to which words in a given topic occur in that topic alone compared to occurring in multiple topics. We evaluated models with *K* set to all individual values between 5 and 30, as well as multiples of 10 between 40 and 100. We selected three values of *K* based on a balance of the two metrics described, as well as qualitative intra- and inter-model evaluation of topics (Supplementary Fig. 5). Thus, out of an initial set of 132 models evaluated to find suitable values of *K*, we retained 12 models for further analysis. In the main text, we present results from the largest *K* we selected for each corpus, representing the models retained with the highest exclusivity. Results for smaller values of *K* are presented in the Supplementary Information. To differentiate from the main models, these alternative models are identified by the corpus abbreviation and the corresponding *K*, such that model *n*-13 refers to a model trained using all newspaper articles with thirteen topics specified. Labels for each topic, e.g., as shown in Fig. 3, were based on the most probable words and representative documents for each topic (Supplementary Tables 1–12). Following Weston et al., topic modeling was performed using the open-source R-4.4.1 platform with the stm and tidytext packages, as well as the tidyverse suite<sup>66,68–70</sup>.

### Podcast production

Informed by our survey of publications, we contacted researchers and key informants using purposive and snowball sampling, with initial contacts

focusing on interlocutors who could speak to the most prevalent themes we identified. We conducted ~30-minute remote pre-interviews where we explained the project goals and scheduled in-person interviews with interested participants. In-person interviews were conducted from July to August 2023 in Metro Manila, Tacloban and Palo (Leyte), Basey and Marabut (Samar), and Guiuan (Eastern Samar). Additional interviews were conducted remotely and in person at an academic conference. Each interview began by obtaining the participant's informed consent for recording, identification, and photographs, following a protocol approved by Princeton IRB No. 15579. Participation was voluntary. Interviews were semi-structured, conducted in English or Tagalog, and lasted between 30 min to two hours, depending on whether the interview was with an individual or a group. In one group interview, the participants gave their responses in Waray. The Tagalog and Waray responses were later translated into English by the first author and a professional translator. Translations aimed to preserve overall meaning and tone, but we acknowledge some degree of loss in linguistic nuance. Each in-person interview was recorded using a Zoom H6 portable recorder. Audio files were transcribed, edited, and assembled into podcast episodes using Descript and Adobe Audition. Episode storyboards were assembled using an inductive-deductive approach, with thematic areas emerging from the interviews iteratively referenced with respect to topics identified from our review of publications. For example, audio clips where interlocutors discuss preparations for the storm were categorized according to themes such as weather forecasting, evacuation, and risk communication, which we interpreted as specific examples of broader themes identified in the media analysis including storms, typhoon prediction, disaster risk reduction, and communication and social media. In this manner, episodes were constructed to be thematically consistent, self-contained modules.

## Data availability

The text corpora used for topic modeling can be obtained from the LexisNexis Web Services API and the WoS databases following the procedures described in this manuscript. The podcast, Carried by Water, is available on all streaming platforms, as well as on a companion website containing photographs, maps, and text transcripts (<http://bluelabmedia.org/projects/multimedia/carried-by-water-super-typhoon-haiyan-10-years-on/><sup>40</sup>).

## Code availability

Code supporting the findings of this study was adapted from published code by Roberts et al.<sup>66</sup> and Weston et al.<sup>68</sup>.

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## Author contributions

M.S. conceptualized the project and performed the computational analysis. M.S., P.J., and B.C. conducted fieldwork and produced the podcast. R.M. and A.C. were responsible for conceptualization, methods development, public dissemination, project supervision, and funding acquisition. M.S. created the figures and initial draft of the paper. All authors edited the manuscript and approved the submission.

## Competing interests

The authors declare no competing interests.

## Additional information

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