

Exploring Responsible Use of Generative AI in Disaster Resilience for Indigenous Communities

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ABSTRACT

Tribal communities face unique challenges in disaster response, often lacking resources and infrastructure to effectively respond to emergencies. This study explores the potential of generative Artificial Intelligence (AI) to enhance disaster response within these communities. We designed a multi-modality generative AI system for disaster assessment from user-generated photos and organized reports with community in-kind cost sharing. We introduced the system prototype at the 2024 National Congress of American Indians (NCAI) conference with emergency department professionals from diverse tribal nations and other stakeholders. Through a workshop-focused group discussion, we discussed the perception, ideas, and concerns for introducing generative AI technology to tribal communities to increase disaster resilience. Our findings suggest considerations about developing strategies and possible governance models when introducing LLM-based models to marginalized local communities with limited resources. This research contributes to literature of the potential and limitations of AI in supporting disaster preparedness and response within indigenous communities, ultimately informing strategies for enhanced tribal disaster resilience and sustainable development goals.

CCS CONCEPTS

• Computing methodologies → Natural language processing.

KEYWORDS

Sovereignty, Sustainability, AI governance, Inclusivity

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1 INTRODUCTION

Tribal communities face distinct and compounded challenges in disaster response, stemming from limited resources, systemic barriers, and historical and environmental vulnerabilities [5]. Across the United States, from Alaska to the Southwest, Native American tribes are experiencing the effects of climate change - including coastal erosion, drought, and extreme weather events, which are further complicated by inadequate infrastructure and the legacy of forced relocation [5]. These environmental risks are exacerbated by indigenous people's continued reliance on traditional practices and their often marginalized status, leaving them disproportionately impacted by climate-related displacement and disaster events [16]. Tribal nations operate under their own constitutions and legal systems, integrating traditional governance within contemporary governmental structures and sovereignty [10].

In times of crisis, they rely on their own emergency response personnel, mutual aid agreements with neighboring communities [4], and long-established kinship networks that mobilize informal support systems such as - elders organizing care, neighbors making repairs, and volunteers moving supplies [17]. Although these practices are essential for immediate relief and recovery, they are often difficult to document in the complex forms required to request reimbursement of services and federal aid for recovery efforts. Systems such as the Federal Emergency Management Agency (FEMA) rely on standardized reporting to process assistance, but the burden of navigating intricate regulatory frameworks and producing extensive paperwork often exceeds the capacity of under-resourced and already overwhelmed tribal governments, hindering the release of much-needed federal aid [8, 12].

This study explores how generative Artificial Intelligence (AI) could improve disaster management workflows in tribal communities. We developed a multi-modality generative AI system for disaster assessment from user-generated photos and organized reports with community in-kind cost sharing. We presented the system prototype at the 2024 National Congress of American Indians (NCAI) conference, and with support from the conference organizer, we conducted a focus-group style discussion about the topic of perception on the system design and concerns regarding the use of generative AI in improving tribal nations' disaster resilience. The participants (N=10) included emergency department professionals from various tribal nations, representatives from FEMA and emergency managers, academic researchers, etc.

Our findings surface key sociotechnical challenges like tribal sovereignty, mistrust of federal systems, and bureaucratic hurdles in deploying AI in tribal emergency response. We identified critical design considerations for future system development to support disaster documentation in tribal communities where much of the response work is informal and often unrecorded, grounded in tribal autonomy. Significant potential was observed to reduce administrative workload and increase confidence in AI-generated reports. This paper represents an early step towards building responsible AI that aligns with distinct tribal governance and helps overcome systemic barriers to disaster aid, which we deem necessary for each tribe’s unique culture and circumstances. Our contribution lies in designing a generative AI-based system to turn oral accounts into formal documentation without losing the meaning or context of what actually happened. By aligning with informal recovery practices and governance structures distinct from mainstream U.S. systems, the prototype offers an early demonstration of how AI can facilitate personalized, culturally responsive workflows for federal aid reporting.

This work aligns well with the themes of LLM4Good, which calls for technology that respects human dignity, cultural differences, and local decision-making [15]. In aligning with tribal ways of working—such as oral accounts, kinship-based recovery, and local governance, our approach upholds human dignity by supporting communities on their own terms, rather than imposing external bureaucratic models. We reflect on how AI can be personalized and used responsibly in Indigenous settings, where data is shared through relationships, governance is local, and resilience is built through people rather than systems.

2 LITERATURE REVIEW

AI ethics emphasizes designing systems that reflect the values and lived experiences of the communities they serve. Scholars highlight how bias can enter AI systems through imbalanced training data, lack of representation in development teams, and opaque algorithms that make discrimination hard to detect [2, 9]. These concerns align with the framework of digital humanism, which advocates for technology that upholds human dignity, cultural diversity, and democratic participation in design and governance [15]. Digital humanism challenges the notion of treating humans or societies as machines, emphasizing that responsibility remains with human agents, even as digital systems become more complex. Similarly, STELA (Socio-Technical Elicitation of Local Alignment), a community-centered framework, offers a participatory approach to norm elicitation [1]. While not specifically designed for generative AI, STELA’s principles of community engagement and local knowledge provide valuable guidance for designing culturally aligned LLM-based systems that serve diverse public needs.

In context of disaster response, there is a need for culturally informed design, particularly in how Tribal Nations interact with federal agencies like FEMA. Standardized protocols often overlook Indigenous governance structures and documentation practices, creating access barriers during times of crisis [8]. Frameworks like STELA offer a community-centered approach to AI design that

respects tribal knowledge systems while meeting institutional requirements, bridging cultural and procedural divides. These discussions informed that AI must be situated within the social contexts in which it operates. Whether through bias in training data [2] or rigid institutional assumptions, the consequences of poorly aligned AI can exacerbate the very inequities it intends to solve [15]. Approaches like digital humanism and STELA offer a shift in direction—toward systems that are shaped with, rather than imposed upon, the communities they serve.

Our research group has previously explored how Indigenous communities interact with digital technologies in emergency contexts [7, 12–14]. One study identified core limitations in generative AI responses—such as the exclusion of tribal history, misrepresentation of tribal names, and lack of cultural articulation—and proposed strategies rooted in tribal oral traditions, native publications, and government collaboration to address these issues [14]. Another study employed a think-aloud protocol to analyze how tribal emergency managers evaluate LLM outputs, offering insights into usability and culturally grounded decision-making processes [7]. We also conducted participatory design sessions with tribal governments, introducing AI tools like chatbots and drones to support disaster reporting and coordination. These studies revealed strong community support and emphasized the importance of sovereignty, trust, and inter-agency collaboration in technology adoption [12, 13].

Our prior research work and collaboration enable us to explore how generative AI can be used to support tribal emergency management, including formal documentation from disaster assessment and community-led efforts documentation for in-kind cost-sharing reporting [12–14]. This work contributes to the growing literature on LLM4Good by showing how generative AI can strengthen—not replace—community knowledge and ways of working, offering a pathway for responsible, culturally aligned AI adoption in public service domains.

3 METHODOLOGY

3.1 Scenario-Based Design

We adopted a scenario-based design method to simulate a situation where a devastating natural disaster strikes a Tribal Nation [3], where we deemed Gen-AI technology could play a vital role in streamlining disaster management efforts. The scenario was informed by the situation where the bureaucratic hurdles posed by other government entities, could be overcome through the integration of innovative technologies like generative AI and drones [12]. For instance, in the aftermath of a hurricane, tribal residents could swiftly assess damage and gather critical information, or impacted tribal community members could take a photo from their phone and submit it to the system, reducing the time gap between disaster occurrence and relief efforts from days to hours. Meanwhile, AI-powered emergency management systems could enhance the overall response to disasters by quickly identifying areas of need and allocating resources accordingly.

This real-world scenario informed our design decisions and ensured that our solutions were tailored to the unique needs of Tribal Nations. As we explored the potential of technology in disaster management, we recognized the importance of user experience and tribal sovereignty in ensuring that our solutions were accessible

(a)



•**Damage Source:** Fallen tree (likely due to a storm).
 •**Item in Image:** White Ford pickup truck.
 •**Damage Detection:**
 A large tree branch has fallen on top of the truck, mainly affecting the windshield, roof, and possibly the hood. The damage appears to be moderate to severe depending on the structural impact of the branch weight.

Immediate Action Required:
1.Ensure Safety:
 Do not attempt to remove the tree or move the vehicle until you confirm it's safe. (Omitted)

(b)

Man-Hours:

Hourly Rate:

Estimated Amount:

Generate Report

Damage Assessment:
 A tree branch fell on a car, damaging the hood and windshield.
Repair Cost Estimate: \$2,800
In-Kind Labor Cost Estimate: \$1,000
Total Estimated Damage: \$3,800.00

(c)

Figure 1: The proposed system workflow: (a) a user can input an image into the Gen-AI system, which is then submitted to a large language model for damage assessment; (b) the user can also input in-line labor information along with their final damage report; (c) both the AI-proceeded damage repair cost and the labor cost will be integrated into the final damage assessment.

and effective for those who needed them most. We also took into account the cultural practices that tribes tend to follow with their own response personnel and some have agreements in place for mutual aid and support with surrounding local communities, such as labor costs being seen as in-kind cost sharing [6]. We began developing prototype systems to test the feasibility of using Gen-AI technology in enabling tribal leaders and emergency responders to quickly and easily access critical information and resources.

Following the proposed scenario, we first tested the accuracy of using multimodality large language models to detect sample property damage from a wind storm. We used ChatGPT 4o and input an image along with a prompt like "Based on the given image, please generate the following information: damage source, item in this image, and a short damage detection along with the immediate action required for the participant in the disaster." The output was promising, as shown in Figure 1(a). We then created an input box on the web app that allowed users to input the in-kind labor cost to restore the damage and loss, such as the hours spent removing the tree from the owner or neighbors, reflecting how recovery often unfolds in tribal communities through informal, in-kind support, shown in Figure 1(b). The output from Figures 1(a) and 1(b) was then sent to the Damage Assessment module, which combined the two pieces of information into a damage report with both repair cost (estimated by the LLMs) and in-kind labor cost (input by the users). While the system currently requires manual entry for the in-kind labor cost, its design anticipates a workflow where emergency managers can collect oral accounts during field visits—especially in areas with limited connectivity and later use the system to formalize these records. This design choice was made to keep the prototype simple and feasible to use while still aligning with the communication practices and infrastructural realities of tribal emergency response. By automating report generation, the system aimed to

reduce the administrative workload for tribal emergency responders, providing them with immediate, useful information directly from the image. This process helps improve decision-making and speeds up recovery efforts for tribal communities. We tested and prepared two use cases, one for roof damage from hail and the other presented in Figure 1 as vehicle damage due to a storm.

3.2 Community-centered Discussion

The prototype we introduce in this paper aims to prompt discussion from stakeholders and understand the impact of using generative AI technology in this realm and its perceptions. To prompt discussion from tribal stakeholders, we created a website to present the interaction and sample damage reports. With support from the 2024 National Congress of American Indians (NCAI) conference at Las Vegas, Nevada, USA, held from October 27 to November 1, 2024, we reserved a one-hour conference session (with the approval from the conference organizer) for presenting our system and invited conference attendees to join a focus group discussion after our presentation. A total of 10 participants joined the session, including 2 federal government representatives, 4 tribal leaders and members, 1 non-governmental organization (NGO) participant, and 2 university faculty/researchers. All participants joined voluntarily without recruitment and with no compensation or obligation to attend the entire session. The presentation and system demo took about 15 minutes, after which three co-authors of this paper served as moderators to prompt discussion about adopting Gen-AI in tribal disaster management. The discussion lasted approximately 45 minutes. A qualitative thematic analysis was conducted using the meeting notes from the discussion as the primary data source. Two researchers from this study engaged in weekly meetings to review, discuss, and iteratively refine the emerging themes, ultimately informing the findings presented in this paper. Due to page limitations, all identified themes were highlighted in *italic font*.

4 FINDINGS

Climate change is driving more frequent and severe disasters, making preparedness and response efforts more critical than ever. Alaska, in particular, is Ground Zero for climate change impacts, with rising temperatures, melting ice, and more frequent storms becoming the new norm. The historical neglect of tribal lands, coupled with a lack of infrastructure, has worsened the vulnerability of many communities to these effects. The absence of radars on tribal lands is a stark example of the systemic inequities that have perpetuated this vulnerability. As climate change intensifies, it is essential to prioritize the development of resilient and adaptive disaster management systems that can respond to the unique needs of each tribe. By considering the broader context of climate change, it is possible to create more effective and sustainable solutions that address the root causes of these challenges.

The generative AI technology was not currently in use in the communication or data processing between the government and the tribes. The participants emphasized the need to address **bureaucratic hurdles** and advocate for change in disaster management processes. A key challenge identified was the requirement for preliminary damage assessments for FEMA, which can hinder timely relief efforts. To mitigate this, efforts are underway to streamline the process. Moreover, the participants stressed the importance of advocacy and support for tribal nations. Indigenous-led initiatives and organizations are often best equipped to respond to the unique needs of their communities and, therefore, deserve greater recognition and support.

The participants emphasized the unique relationship between indigenous communities and their native lands holds valuable insights that can inform the development of effective response strategies. Recognizing and respecting this knowledge is essential for crafting disaster management efforts that are tailored to the specific needs of these communities. Furthermore, respecting tribal sovereignty is crucial in all aspects of disaster management, including the critical issue of **data sovereignty**. Participants expressed concern that sharing images or data with external entities such as OpenAI or Google could lead to unintended use, including incorporation into broader model training. While such use may be subject to permissions in practice, the fear of losing control over tribal knowledge and intellectual property was a prominent theme, underscoring the importance of personalized systems that ensure data sovereignty and local governance.

The use of indigenous data in external AI systems raises significant **ethical concerns**, particularly with regards to ownership and control. To address these concerns, it is essential to develop AI systems that prioritize data sovereignty and respect the autonomy of tribal nations. Moreover, practical challenges must also be considered, such as balancing simplicity with technological sophistication. While a system may be technologically advanced, it may not necessarily be usable or accessible to these communities. By prioritizing user experience and involving community members in the design process, it is possible to create systems that are both effective and practical.

The development of effective disaster management systems for tribal nations relies heavily on **collaborative and educational approaches**. By working in close partnership with community

members, it is possible to create tailored solutions that address their unique needs and requirements. The involvement of younger generations is particularly crucial, as they will ultimately bear the consequences of climate change. To address this, youth engagement initiatives are being implemented to educate and raise awareness about climate change, disaster management, and AI technology among young people. These initiatives aim to equip the next generation with the knowledge, skills, and tools necessary to respond to disasters, while also preserving the traditional knowledge and practices of their elders. It not only promotes a sense of community and shared responsibility but also ensures that the solutions developed are culturally sensitive, effective, and practical. Furthermore, it recognizes the importance of intergenerational knowledge transfer and the role that young people can play in driving positive change and promoting community resilience.

The development of **long-term sustainable solutions** that outlast funding cycles is critical in creating effective disaster management systems for tribal nations. While grants and funding can provide initial support, they are often limited in duration, leaving communities vulnerable to gaps in service, including the technical resources needed for AI. There is a need for solutions that can be sustained over the long term, even after funding has ceased. A holistic approach to disaster management, integrating tribal knowledge with technology, is essential in creating comprehensive and sustainable solutions. This long-term vision requires a commitment to sustainability, flexibility, and adaptability, as well as a deep understanding of the complex issues affecting tribal nations.

In conclusion, developing effective disaster management systems for tribal nations using Gen-AI requires a deep understanding of the complex issues affecting these communities. By prioritizing cultural sensitivity, sovereignty, and community engagement, tailored solutions can be created to meet the unique needs of each tribe. Addressing bureaucratic barriers, advocating for change, and promoting sustainability can also help build more resilient and adaptive disaster management systems capable of responding to climate-related challenges.

5 CONCLUSION

This study highlights the potential for integrating generative AI into tribal emergency management systems. While tribal members strongly prioritize sovereignty and trust in their own leadership, they are also open to utilizing generative AI solutions for disaster preparedness and communication. These technologies could contribute to sustainable development by enhancing community resilience, improving access to resources, and facilitating more effective emergency responses. However, concerns related to privacy, data security, and interactions with external entities must be carefully addressed to ensure that these technologies are effective and aligned with the values of the community and the available resources. We argue that the responsible use of AI requires incorporating principles of inclusivity, privacy protection, education, and respect for tribal AI sovereignty. By exploring the intersections of technology, governance, and cultural identity, our work aims to contribute to a deeper understanding of the challenges and opportunities that AI presents for Native American tribes and other sovereign nations [11].

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