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How Emergency and Recovery Support Functions Failed to Address Short and Long-term Cascading Disasters after a High-Latitude Extratropical Bering Sea Cyclone Impacted Geographically Isolated US Indigenous Coastal Communities.

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Abstract

Purpose: From September 10-20, 2022, a central Pacific Ocean cyclone developed into Typhoon Merbok then transitioned into an extratropical post-typhoon where its remnants became stronger and impacted the 2100-kilometer (1300-mile) geographically isolated western coastline of Alaska. This research formally documented the immediate aftermath cascade disaster and what role Merbok played to exacerbate an ongoing cascading series of disasters by examining application of core emergency and recovery support function capabilities in both short- and long-term timeframes.

Methodology: Descriptive research using a collective case study was used.

Findings: While some successes were noted, the research found both the emergency and recovery support functions were overall ineffective and did not function which resulted in exacerbation of the cascading hazard event in short-term recovery and long-term resilience.

Unique Contribution to Theory, Policy, and Practice: This research looked beyond just disaster impact to examine how a storm exposed broader ramifications questioning where Indigenous villages were established, access to these locations, what was considered infrastructure compared to other US locations, how the emergency and recovery support functions failed to adequately implement their respective core functions, decimation of the ability to maintain an Indigenous subsistence lifestyle, and what was needed for recovery versus resilience for the people involved. The findings impact both response to major disasters and preparedness considerations for remote and geographically isolated locations.

Keywords: *Cascading disaster, Emergency support functions, Recovery support functions, Capabilities, Short and long term*

1. INTRODUCTION

No place on earth is devoid of disaster, but then disaster definitions vary. Wayne Blanchard captured 68 definitions of disaster, 16 for crisis, 14 for emergency, 12 for catastrophe, 8 for incident, and a 1996 Funk and Wagnalls dictionary definition of tragedy as "an intensely sad, calamitous, or fatal event or course of events" (Blanchard, 2007, p. 200). One combined definition said, "a disaster is when a community intersects the path of an event which creates a disruption to their society and requires resources beyond their capacity" (Schaffer, 2021, p. 246). The "Recovery Continuum" (FEMA, 2016a, p. 5) depicts how a society takes action to respond to a disaster and obtain resources afterwards with enactment of emergency support functions (ESFs) and recovery support functions (RSFs) throughout an event, noting individual enactment may vary depending on the incident.

Disasters can also create cascading - secondary or domino effect - incidents when one event directly causes or contributes to subsequent events (Alexander and Pescaroli, 2019; Chen and Greenberg, 2022; Kelman, 2018; Mizrahi, 2020; Pescaroli and Alexander, 2015). Cascading disasters make decision-making priority allocation of critically limited resources available for response more challenging (FEMA, 2019a; Su et al., 2016). Responders compete for the same emergency resources from already-thinned agencies - the same firetruck cannot be used simultaneously in two different locations for two different incidents (Su et al., 2016).

Long-term, slow-onset, or multi-generational disasters also exist, however, efficacy questions on mitigation and recovery remain (Alexander and Pescaroli, 2019; de Ruiter et al., 2020; Horn et al., 2021). Suwan Shen and E. Barrett Ristroph found a relationship between disaster declarations and vulnerability to the US high-latitude Alaska Indigenous communities from long-term changes in climate: 24.3% were exposed to sea level rise, 73.8% had erosion problems, and 100% were adjacent to rivers or coast (2020). A formative paper by Igor Krupnik collated Alaskan elder voices of "15 experienced hunters, resource managers, and community leaders" (2000, p. 35) to share their environmental knowledge, changes in climate, and sea ice - all said the environment has changed considerably since they were young. Disaster declarations by the US Federal Emergency Management Agency (FEMA) have specific start and end dates, thus, FEMA has not approved any long-term climate disaster declarations. Confined timespan cascading disasters can be directly attributed to one event, but some events expose multi-generational cascading disasters, which current response and recovery systems were not designed to address.

Short- and long-term cascading disasters were already recognized by researchers (Alexander, 2018; Chen and Greenberg, 2022; de Ruiter et al., 2020; Hanaček et al., 2022; Horn et al., 2021; Pescaroli and Alexander, 2015), Indigenous contributors (ANTHC, 2024; Ellam Yua et al., 2022; Korthuis, 2022; Krupnik, 2000; SNC, 2022; Thoman et al., 2023; Trainor et al., 2007), and emergency managers (Pennington, 2023; Schaffer and Pennington, 2023; Schwab, 2010; Wisner et al., 2012). Recognizing the multiple types of hazards in a location, to include short- and

long-term cascading disasters, affords emergency managers time to plan preparedness, mitigation, response, and recovery actions, thus developing community resilience to future events.

In 2022, with preparatory planning and mitigation efforts already conducted, these ESF response and RSF recovery strategies were on display in the US high-latitude Alaska Indigenous communities, which influenced not only recovery from a storm but short- and long-term resilience. A central Pacific Ocean cyclone developed into Typhoon Merbok from September 10-15, 2022 and did not cross any landmass. As an extratropical post-typhoon, Merbok moved into the Bering Sea, became stronger, and impacted the 2100-kilometer (1300-mile) geographically isolated Alaska west coast from September 15-20, 2022. An explanatory case study documented Merbok's lifecycle (Schaffer, 2025), but short and long-range impacts were not covered. Damage in multiple villages was more complex than just flooding or destroyed utilities. Merbok exposed broader ramifications, questioning where Indigenous villages were established, what was considered infrastructure, the decimation of subsistence lifestyles, and recovery versus resilience.

1.1. Problem Statement and Research Question

FEMA doctrine established all-hazards disaster planning criteria (FEMA, 2016a, 2016b, 2019a, 2019b). An all-hazards approach identifies the different hazards for an area to create one unique mitigation, response, and recovery plan to address each incident. It uses available people and equipment to address that single event, but does not confront multi-faceted cascading disasters. In Merbok, these single-event plans did not account for simultaneous storm damage, curtailed access, loss of food storage, or critical transportation infrastructure destruction throughout a 1300-mile impact zone.

The identified gap was a lack of formal documentation of the short- and long-term cascade disasters, thus, the research question: What role did Merbok play to exacerbate an ongoing cascading series of disasters? Using descriptive research, this collective case study addressed the gap as no formal report had been conducted.

1.2. Terminology

After-actions, or lessons learned, compare a plan against what actually occurred to identify successes or areas for improvement and adjust the plan as needed. While some errors may be corrected, the reality has been lessons learned are not always learned lessons. When a single event becomes multiple events, after-action reports are ineffective evaluators (Kean and Hamilton, 2004; Ranghieri and Ishiwatari, 2013).

'All-hazards' became part of the Robert T. Stafford Act of 1988, 42 U.S.C. Chapter 68 *et seq* (Robert, 1988, §601) under the intent to create mitigation and response plans for each unique hazard identified for an area. President George W. Bush issued Homeland Security Presidential Directive (HSPD)-5 and HSPD-8 (Bush, 2003a, 2003b), which established the all-hazards doctrine to address "emergency prevention, preparedness, response, recovery, and mitigation activities" (Bush, 2003a, p. 232). Yet, individual plans did not account for resultant or multiple simultaneous

disasters (FEMA, 2019a). From accumulated after-action reports, FEMA recognized this total of single-event all-hazards approach was a misnomer by not addressing cascading disasters (FEMA, 2019a, 2019b).

1.3. Methodology and Methods

Prior research validated Merbok was a cascading disaster and "recommended a study be conducted on the long-term cascading effects" (Schaffer, 2025, p. 58). Collective case study methodology using descriptive research explained cascading storm impacts (Crowe et al., 2011; Harrison et al., 2017, Table 1; Mohajan, 2020; Noor, 2008; Priya, 2021). Derived from a longitudinal social science perspective, descriptive research provided a broad view to observe "a phenomenon over an extended period of time" (Priya, 2021, p. 97), which was ideal to review long-term cascading disasters. Descriptive research examined the how and what questions rather than why (Bouchrika, 2024) Merbok exacerbated long-term cascading disaster elements and where prescribed plans failed.

Hypothesis: ESF/RSFs conducted during Merbok were ineffective in both the short- and long-term. To evaluate this hypothesis, actions conducted in Merbok were contrasted against criteria in 86 core capabilities from the 15 ESFs (FEMA, 2019b, p. 21-22) and 6 RSFs (FEMA, 2016a, p. 36-40). For this research, the expected short-term initiation was one day for ESFs and seven days for RSFs with long-term initiation of one month for ESFs and one year for RSFs. As few impacted communities had emergency organizations, the State of Alaska emergency operations center coordinated most ESF/RSF work (J. Wallace, personal communications, March 26, 2024). Long-term actions looked at policies and activities which had multi-generational influence on coastal village living from the late-1830s when Russian and Euroamerican presence changed local Indigenous culture (ANTHC, 2024; Ristroph, 2022).

The FEMA Homeland Security Exercise Evaluation Program (HSEEP) was employed to evaluate an action's success or failure against an established standard. HSEEP provided "a common approach to…evaluation and improvement planning" (FEMA, 2020, p. v), measured whether an action met the criteria, and did not make recommendations. A descending four-point scale rated action-to-capability as: without challenges (3), with some challenges (2), with major challenges (1), or unable to perform (0). Capabilities were evaluated on critical tasks, impact, and timeframe as the measurable metric to achieve the target. Target initiation timeframes were:

- Short-term ESFs: <1 day (score of 3), <3 days (score 2), <7 (score 1), >7 days (score 0).
- Long-term ESFs: <1 month (score 3), <3 months (score 2), <12 months (score 1), >12 months (score 0).
- Short-term RSFs: <1 week (score 3), <1 month (score 2), <6 months (score 1), >6 months (score 0).

- Long-term RSFs: <1 year (score 3), <1.5 years (score 2), <2 years (score 1), >2 years (score 0).

A capability needed but not performed received zero (0), while a capability not needed was 'not applicable (N/A)' and excluded from calculation. The metric considered all impacted locations without weight for population difference. A mean was determined for each ESF/RSF, along with a cumulative mean of the means.

1.4. Challenges

FEMA doctrine divides locations into urban or rural and does not define remote or geographically isolated locations, which experience disproportionate impact during disasters (Schaffer, 2025). Some emergency management words or concepts have no translation into Indigenous languages (FEMA, 2022), which created problems in how policy was functionally applied (ICCA, 2020; Krupnik, 2000) and language translation of FEMA paperwork (Salvano-Dunn, 2023; Schwing, 2023). Barriers included long-standing hesitancy of outsiders reviewing the Indigenous way of life, then not respecting Indigenous input (Hanaćk et al., 2022; Noongwook, 2000; Pennington, 2023).

2. RESULTS

The purpose was to determine what role Merbok played to exacerbate a cascading disaster under the hypothesis short- and long-term ESF/RSFs actions were ineffective. Using the 4-point scale (3-0), the research found a mean for short-term RSFs was 1.222, short-term ESFs 0.756, long-term RSFs 0.722, and long-term ESFs 0.154. Thus, the 86 ESF/RSFs were deemed ineffective, which resulted in exacerbation of recovery efforts and overall resilience.

All ESFs were non-effective for long-term capabilities. Four ESFs (5, 8, 9, 15) received a score solely from external national resources. While some successes were seen, 6 significant failures were found:

1) Response capabilities, including standard mutual aid, were nonexistent or extremely limited with external assistance initially arriving over 72 hours post-impact;
2) Limited accessibility to locations greatly hindered availability and delivery of recovery support and supplies;
3) Infrastructure in geographically isolated Alaska Indigenous communities differed vastly from outside standards, precluding assistance eligibility;
4) Assumptions embedded in standard processes did not function for geographically isolated locations;
5) Standard eligibility model for federal recovery aid did not function as intended; and
6) Mid-1800s-1960s US Government and missionary directives forced Indigenous to settle in known high-risk areas, ergo, every locale was predestined for failure.

3. DISCUSSION

The 86 competencies contained 50 core capabilities from 15 ESFs for response and 36 critical tasks from 6 RSFs for recovery. For this research, the RSFs were numbered solely for tracking purposes.

3.1. Review of Emergency Support Functions (ESFs)

No policy set a timeline for enactment or completion of ESF work. For this research, short-term enactment of ESFs was considered when an asset arrived within the first 24 hours after impact. While certain ESFs were enacted within the first day at some hub locations, more than one day passed at remote locations before work was engaged. Long-term ESF initiation was considered one month, however, the same poignant problem affected every long-term ESF: No long-term actions were taken to alleviate this discrepancy during response.

3.1.1. ESF-1. Transportation

Mean rating - Short: 1.20. ESF-1 was required for all ESF/RSFs. ESF-1 failed due to three flawed external assumptions: 1) What is considered transportation infrastructure; 2) Ability to drive inland for evacuation; and 3) Deliver needed resources via a road system. Philip Berke et al. (2006) identified two basic community facilities for an infrastructure: 1) Collective school, water, and sewage systems; and 2) Motorized and non-motorized transportation conveyances. Village transportation, a boat on the water or personal all-terrain vehicle over tundra, was used for hunting, delivering food to elders, and taking kids to school, which is not the assumed federal-view infrastructure. An affected Indigenous leader said, “Ultimately, a community emergency plan without the resources and infrastructure on the ground remains useless” (Korthuis, 2022, para. 1.a). No roads or rails connect between villages nor to Anchorage or Fairbanks, a 1000-kilometer (600-mile) air flight from Fairbanks was 6 hours, and the 2500-kilometer (1600-mile) voyage from Anchorage was 8 days. Air transport was highly weather dependent and sea traffic limited to 3-4 ice-free months, which ceased 2-3 weeks post-storm, then resumed the following June (Hughes 2022). Inconsistent response saw populated villages receive more attention than smaller villages. The US Department of Transportation provided $9 million to Nome for road and bridge repair, which was previously damaged in 1974 and 2011 storms, and $50 million in federal grants (FHWA, 2022). Regular maintenance and repair solutions were not viable for the extreme conditions encountered (AKDOTPF, 2022; ANTHC, 2024; Kvapil, 2023; Loewi, 2022a; O’Malley, 2022; Rosen, 2022; SNC, 2022; Telford, 2022; Thoman, 2022).

Mean rating - Long: 0.00. US Government and missionary directives from the mid-1800s through the 1960s reduced the ability of Indigenous to traverse freely and forced settlements onto islands, spits, or permafrost areas known by Indigenous to be of high incident risk (ANTHC, 2024; Buzard, 2023; Griffin, 2023a), and all locations experienced a disaster. Outside views did not understand the land-water-ice-natural event interaction, which shaped where and how Indigenous lived. Passage of ANCSA in 1971 allowed reasonable considerations of transportation

infrastructure, but passage of the Stafford Act (Robert, 1988) resulted in a conflict of infrastructure ownership (Pennington and Schaffer, 2025). Past behavior and conflicts in law precluded Indigenous from pursuing a subsistence lifestyle while simultaneously benefiting from advances in technology (ACCAP, 2025; Pennington, 2023; Ristroph, 2022; Sobelman, 1985).

3.1.2. ESF-2. Communications

Mean rating - Short: 0.60. ESF-2, communication infrastructure, was key to all ESF/RSFs. Internet, wireless, and cable transmission systems were overwhelmingly unreliable or non-existent before Merbok, thus, not all locations received full details prior to the storm, nor transmitted reports afterward. National Weather Service notices and ocean conditions were repeated by local relay stations or community social media. Loss of power to communication and transmission systems resulted in delayed status reports and requests for resources. Satellite connection was made available for certain communities, but not all. Weather transmission locations failed during the storm or were knocked offline and had not come back to service 30 months post-storm (ARC, 2022; FEMA, 2022; Korthuis, 2022; Loewi, 2022a; Telford, 2022; Thoman, 2022).

Mean rating - Long: 0.00. Communication infrastructure was overwhelmingly unreliable or non-existent. All villages were beyond the reach of traditional land-based communication transmission systems, and few companies invested funds to reach remote and geographically isolated villages. Regional satellite-based communication was cost-prohibitive from a company perspective (Pennington and Schaffer, 2025; Schaffer, 2025).

3.1.3. ESF-3. Public Works and Engineering

Mean rating - Short: 0.75. Infrastructure influenced most ESF/RSFs. Most villages had extremely isolated, independent, and vulnerable public works infrastructure, if any even existed. Power generation and distribution, water delivery, sewage treatment, roads, sidewalks, levees, seawalls, and transportation are not the same as other parts of the country. Loss of power “wiped out subsistence stores, while damaging water and sewage systems, homes, and roads” (Horn-Muller, 2022, para. 2). Multilateral facility ownership was an impediment to addressing emergency aid. One village’s revetment wall remained unfinished since 2009, which left homes and infrastructure exposed (Mittal, 2009), while another lost its berm exposing homes and fresh water supply to inundation. Physical structures - individual homes to public buildings - need special foundations which were highly subject to failing due to permafrost melt from water inundation. Villages had no or minimal heavy equipment capable of removing debris (AKDoC, n.d.; Canny, 2023; Korthuis, 2022; Loewi, 2022a; Mittal, 2003; Rosen, 2022; Schwing, 2024; Thoman, 2022).

Mean rating - Long: 0.00. Army Corps of Engineers noted 55 communities had ongoing sewage management issues, yet their contracting could only work on single-ownership facilities, not multi-jurisdictional (D. Allard, personal communications, April 10, 2024). Relocation costs escalated above acceptable governmental cost-benefit views (Korthuis, 2022; Mittal, 2003, 2009; O’Malley, 2022; Schaffer and Pennington, 2023; Schwing, 2024).

3.1.4. ESF-4. Firefighting

Mean rating - Short: 2.00. Firefighting relied on inherent local resources, mutual assistance from neighboring departments, intra/interstate agreements, and federal assets. Only three impacted villages had full-time fire departments, 57 had volunteers, and others had none (AKDPS, 2024). Mutual assistance was nonexistent due to geographic isolation and no roads between villages. One structure in downtown Nome burned, with neighboring buildings saved by the volunteer fire department (Haecker, 2022; Korthuis, 2022; Telford, 2022).

Mean rating - Long: 0.00. The primary point from the short remained: Due to geographic isolation and lack of road system between villages, mutual assistance was non-existent (Schaffer and Pennington, 2023).

3.1.5. ESF-5. Information and Planning

Mean rating - Short: 0.50. The storm track was known three days prior, but was insufficient time to conduct evacuation due to limited transportation. The greatest failure, a FEMA-contracted translation of information into Indigenous Alaskan languages (Schwing, 2023), was described as “unintelligible and culturally insensitive” (Salvano-Dunn, 2023, para. 2). It remained unclear if language translation resulted in fewer individual assistance applications - 870 packages approved out of 35,000 impacted residents. Extensive post-storm high-water marks were collected for analysis and modeling. Limited success was noted in some larger communities (FEMA, 2022; Haecker, 2022; Korthuis, 2022; Loewi, 2022a).

Mean rating - Long: 0.50. Extensive outside entities attempted to address issues, but limited functional results were enacted. Two Government Accountability Office reports (Mittal, 2003, 2009) reported nine villages in imminent danger and needed relocation; only one had begun moving, and all were severely damaged. Buzard (2023) showed a coastal erosion rate for one village at 5 meters per year or 250m (273 yards) in 50 years. A regular theme noted was “Due to a lack of communication…” (M. Bahnke, M. Johnson, V. Korthuis, and A. Philemonoff, personal letter to National Science Foundation, March 19, 2020, p. 5) and one abatement never happened “because of miscommunication” (Buzard, 2023, p. 32). This sentiment was especially poignant as outside entities proposed a solution but did not ask locals, include locals in option development, or follow through on agreed solutions (Cochran et al., 2013; Ellam Yua et al., 2022; Jojola, 2008). For Alaska Tribes, “planning is not a new concept” but “as communities react to climate-related catastrophes it limits their capacity for strategic long-term planning” (Herrmann, 2024, p. 5). Adaptation takes time to implement. Boundary spanning (Bednarek et al., 2018; Chapin et al., 2016) and Indigenous co-production of knowledge (Brugger et al., 2016; Carlo, 2020; Ellam Yua et al., 2022) were critically missed points and attempts to address this fell extremely short (Lezak and Rock, 2024; Mittal, 2003, 2009; Monet, 2022; Trainor et al., 2007).

3.1.6. ESF-6. Mass Care, Emergency Assist, Temporary Housing, & Human Assist

Mean rating - Short: 0.50. Local communities handled initial care, yet shelter facilities remained susceptible to storm erosion (Cochran et al., 2013), and no secondary evacuation locations were available other than congregating in neighbors' homes (ANTHC, 2024). Transportation and logistical challenges precluded arrival of external assistance. Rhonda Schneider, Nome Community Center director, said, "It would be impossible to transport mobile homes and temporary trailers to remote Alaska, where villages are serviceable only by air or barge" (Schwing, 2022). Villages had no hotel for displaced families nor incoming aid workers. Cascading food insecurity was most prominent with individual and community food storage losses. Emergency food distribution did not consider local cultural food sources (Horn-Muller, 2022). Airfield damage delayed external aid to the nearly 90% historically underserved vulnerable population (Canny, 2023; Hughes, 2022; Korthuis, 2022; O'Malley, 2022; Rosen, 2022; Schaffer and Pennington, 2023; Telford, 2022; Thoman, 2022).

Mean rating - Long: 0.00. Indigenous populations were restricted in their ability to continue a traditional lifestyle, thus food security became critical (Lezak and Rock, 2024). Federal guidance, primarily for health care (Hueffer et al., 2019), housing, and education, limited what local populations could do. Over 50% of Alaska was designated "Health Professional Shortage Areas and Medically Underserved Areas, where many Alaska Native elders reside" (Graves et al., 2010, p. 5). Weather-inappropriate building materials were not adequate, durable, safe, or healthy for temporary or permanent sheltering but were used because of low initial costs (ANTHC, 2024). Smaller communities lacked specialized workers to build to industry standards, and high costs limited contracting outside workers. Pre-storm homes were considered uninhabitable, thus ineligible for FEMA aid, conflicting bureaucratic issues precluded preparedness eligibility for housing renovation, and there was no mass care or temporary housing capability (Buzard, 2023; Loewi, 2022a; Ruscio et al., 2015; Schwing, 2024).

3.1.7. ESF-7. Logistics

Mean rating - Short: 1.00. ESF-7 was critical to all ESF/RSFs. The hub-and-spoke model was used, however lack of transportation caused delays to many villages. Obtaining information on what an affected village needed further delayed delivery (ARC, 2022). A military joint task force provided airlift capability and debris removal at two hubs. US Coast Guard (HST, 2022; Shapiro, 2022; USCG, 2022) and National Guard units (DoD, 2022; Korthuis, 2022; Operation, 2022) built a pre-storm rapport with some villages and were able to initiate debris removal to afford supply deliveries to certain locations. In geographically isolated villages, there was no Walmart or grocery stores to drive a car to. With boats and all-terrain vehicles damaged or destroyed, people were unable to subsistence harvest or gather food needed to survive (Korthuis, 2022).

Mean rating - Long: 0.00. With no local resources, all support and repair people, food, products, and services needed to be brought from outside the area. Ocean-based barges stop delivery of products and construction equipment by the fall (ACCAP, 2025; Kvapil, 2023;

Thoman, 2022). "The season is short, in large part because fall storms make the Bering and Chukchi Seas difficult to navigate" and winter freeze inhibits further construction work (Schwing, 2022). Road repairs begun in 2022 were delayed until 2023 so construction crews could reassess damages and finalize projects (Kvapil, 2023). Lack of transportation and logistics was not functionally addressed for remote and geographically isolated locations (ANTHC, 2024; Schaffer, 2025).

3.1.8. ESF-8. Public Health and Medical Services

Mean rating - Short: 0.40. Due to minimal public health and medical services before the storm, ESF-8 effectiveness was negligible. Some communities had a small clinic, while most had no medical facility (ANTHC, 2024; Canny, 2023; Korthuis, 2022; Schwing, 2022). A shipping container with new medical clinic equipment was washed away, but a private foundation donated funds to fly replacement equipment to the island (Loewi, 2022b). Kivalina city administrator Colleen Swan commented on the community's resilience, "We're an adaptable people, but since 2004 we just can't adapt this fast" (Griffin, 2023b, para. 11). A mental health team developed a post-disaster behavioral health workshop, but food insecurity remained questionable (ARC, 2022; Thoman, 2022).

Mean rating - Long: 0.25. Same rationale as ESF-6 (Graves et al., 2010; Hueffer et al., 2019; M. Bahnke et al., 2020; Sobelman, 1985).

3.1.9. ESF-9. Search and Rescue

Mean rating - Short: 0.33. The US Coast Guard conducted fixed-wing overflights (HST, 2022; USCG, 2022), but with no west coast small-boat stations and a 400-800 mile helicopter trip from Kodiak, responsibility for initial response was entirely local. Close-knit village concerns were expressed as "the volunteers worry about not only their own families but their whole community" (Korthuis, 2022, para. 5), pointing towards greater regional search and rescue capabilities. No deaths were directly related to Merbok (Griffin, 2023a, 2023b; Loewi, 2022a).

Mean rating - Long: 0.50. The USCG maintains operational jurisdiction of ocean waters, while land-based search and rescue falls under local or state law enforcement jurisdiction. There were no immediate plans for permanent year-round USCG presence at any western Alaska village, although development of a deepwater port could include a USCG presence (Shapiro, 2022).

3.1.10. ESF-10. Oil and Hazardous Materials Response

Mean rating - Short: 1.00. Within the first seven days, USCG conducted "damage assessments to bulk fuel storage facilities and marine headers" in 32 remote villages (USCG, 2022). Local authorities in Koyuk handled a minor spill, and USCG coordinated a 1000-gallon spill in Chevak. All communities had concerns with potential damage to their fuel oil storage units and vulnerability to further erosion in the next storm. No short-term actions were taken to alleviate this discrepancy (HST, 2022; Hughes, 2022; Loewi, 2022a; Rosen, 2022; Schwing, 2022).

Mean rating - Long: 0.00. Since 2019, USCG has continuously worked with villages on bulk fuel storage facility inspections and oil spill containment operations. Locations for initial placement of these oil and hazardous material facilities were a vulnerability, and the risk remained extremely high due to extreme erosion surrounding the infrastructure (ANTHC, 2024; Buzard, 2023; Shapiro, 2022).

3.1.11. ESF-11. Agriculture and Natural Resources

Mean rating - Short: 0.50. Efficacy was minimal as services were minimal before the storm. Entire subsistence stores needed for winter were destroyed as traditional ice cellars were inundated with storm flood waters or power outages knocked out modern freezers (O'Malley, 2022). Cascading food insecurity was most prominent in loss of individual or community food storages. Emergency food distribution did not consider local cultural food sources, as Rick Thoman noted, "hunting in the Lower 48 is a recreational activity. In western Alaska, it's how you feed your family" (Horn-Muller, 2022). Donated food from lower-48 states does not meet the nutritional or cultural needs of the local Indigenous populations (Canny, 2023; Korthuis, 2022; Loewi, 2022b; Schaffer and Pennington, 2023).

Mean rating - Long: 0.50. Sarah Sobelman (1985) wrote on the history of wild resource economics use in one Alaska village and how Indigenous were restricted in their ability to continue a subsistence lifestyle. From around 1890, that ability was even further restricted to the point where food security reached a critical level for some villages (Lezak and Rock, 2024). A cascading cultural identity and food insecurity disaster was ongoing when Merbok arrived (ANTHC, 2024; Buzard, 2023; Hueffer et al., 2019; M. Bahnke et al., 2020; Ruscio et al., 2015; Trainor et al., 2007).

3.1.12. ESF-12. Energy

Mean rating - Short: 0.67. Most villages had extremely isolated, independent, and vulnerable power systems and were a known single-point-of-failure risk. Ownership between private, public, city, borough, state, and tribal corporations significantly impeded recovery aid funding (ANTHC, 2024; Mittal, 2003; Schwing, 2024). Many systems were collocated with other critical assets and located in vulnerable locations (Lezak and Rock, 2024, Table 1; Mittal, 2003, 2009; O'Malley, 2022; Telford, 2022). Power outages were subsequently restored in nearly every village, but damage to the food storages was immense (Horn-Muller, 2022; Loewi, 2022a). Internet and outside connectivity did not exist without power, impacting execution of nearly all ESFs (Korthuis, 2022; Thoman, 2022). No short-term actions were taken to alleviate this discrepancy (AKDoC, n.d.; Griffin, 2023a; Rosen, 2022; Schaffer and Pennington, 2023).

Mean rating - Long: 0.00. The primary points from the short remained: Extremely vulnerable power systems, single-point-of-failure risk, and multilateral ownership impeded recovery.

3.1.13. ESF-13. Public Safety and Security

Mean rating - Short: 0.33. No broad ESF-13 enactment was needed. Low-population villages had close ties with their emergency services but had inadequate space to work. Ongoing erosion caused instability of community buildings and infrastructure. Only 8 out of 100 west coast villages had full-time police departments, 50 utilized volunteer public safety officers, and the rest had no law enforcement (ANTHC, 2024; Korthuis, 2022).

Mean rating - Long: 0.00. Remote and geographically isolated Alaska locations did not align with conventional security sector practices. No long-term actions were taken to alleviate this discrepancy (Baldwin, 1997; Berke and Godschalk, 2008; M. Bahnke et al., 2020; Monet, 2022).

3.1.14. ESF-14. Cross-Sector Business and Infrastructure

Mean rating - Short: 0.00. ESF-14 addressed "entities that are not aligned to an ESF or have other means of coordination" (FEMA, 2016a, P. 14-1). Enactment was not compatible under multilateral arrangements between city, village, state, and tribal consortia established by the ANCSA (1971). ESF actions did not recognize Indigenous ways of living nor local infrastructure, mixed-income modes did not align with conventional business sector practices, and multilateral critical infrastructure ownership impeded recovery (ANTHC, 2024; Pennington, 2023; Schaffer and Pennington, 2023).

Mean rating - Long: 0.00. Historically, Alaska Indigenous were semi-nomadic, self-sufficient cultures moving seasonally with marine or land subsistence food sources, with some tribes returning to semi-permanent structures after a hunting expedition. Russian and Euro-American presence began a long-term cascading disaster by overharvesting whale and walrus, introducing disease and alcohol consumption, and disrupting traditional economies with mineral finds and fur trade. Late 1890s societal change by US government and religious institutions forced relocation to where a seasonal barge could land, but was a known hazardous location, to establish multi-level governance which "enables consideration of relationships" (York et al., 2024, p. 76). While multilateral ownership of modern critical infrastructure diversified costs, it failed to acknowledge the long-range risks of such diversification (M. Bahnke et al., 2020; Monet, 2022; Ristroph, 2022).

3.1.15. ESF-15. External Affairs

Mean rating - Short: 2.00. The glaring lack of care - translation into non-Alaskan Indigenous languages (Salvano-Dunn, 2023; Schwing, 2023) - infected all RSFs. Awareness by Alaska Senators and Representative reduced cost-share requirements. Local tribal leadership trust proved more effective than any external entity (ANTHC, 2024; FEMA, 2024; Haecker, 2022; Korthuis, 2022; Loewi, 2022b; Monet, 2022; Pennington, 2023).

Mean rating - Long: 0.67. Long-standing paralysis by the federal government to address known risks and vulnerabilities was displayed (ACCAP, 2024, 2025; Buzard, 2023; Canny, 2023; M. Bahnke et al., 2020; Mittel, 2003, 2009; Ristroph, 2022; Thoman et al., 2023).

3.1.16. ESF Summary

ESFs were not designed for enactment in long-term disaster cases as they primarily address immediate issues, which long-term disasters may not exhibit until the issue becomes urgent. A strong finding was short-term ESF-15 response, which involved public and Congressional affairs. The Alaska delegation to Congress were highly engaged to ensure disaster funding was provided to affected locations. The State conducted press briefings to keep the public informed and coordinated on behalf of many affected Tribal nations. A second category, ESF-4 firefighting, was considered artificially high as no outside fire assistance was needed, however, the geographic isolation and lack of road infrastructure in the area precluded mutual assistance.

3.2. Review of Recovery Support Functions (RSFs)

No specific policy set a timeframe for the enactment or completion of RSF work. The challenge for determining RSF initiation or application hinged on the preceding status of each RSF focus area and whether any actions were specifically enacted to address the issue of the capability of that focus area. For this research in the short-term timeframe, a reasonable expectation for initiation of RSFs was considered when recovery assets were enacted within the first week after an incident. For the long-term, a reasonable expectation for initiation of RSFs was considered one year. Under these time delimiters, the HSEEP scoring identified a measure for each of the 36 capabilities. While short- and long-term scores were obtained, a single paragraph commentary was provided as all short-term deficiencies were indicative of the same poignant long-term problem: 'No actions were taken to alleviate this discrepancy.'

While an appreciation of outside assistance was generally noted, the overall essence for short- or long-term RSF actions was summed up by Chevak, AK resident Earl Atchak as he expressed a greater effort was needed "long after the damage assessors and volunteers have left" due to extensive damage and clean-up effort (Hughes, 2022). The west coast of Alaska had been vulnerable to ongoing environmental hazards before Merbok. A statement in the Unmet Needs of Environmentally Threatened Alaska Native Villages report encapsulated what was not addressed in the aftermath for both the short- and long-term actions of all RSFs:

The need to improve support for Alaska communities striving to address environmental threats has been reported numerous times over the last several decades. The US Government Accountability Office, State of Alaska, and academic researchers have brought attention to the issue through various initiatives and publications. This effort is unique in that it also offers specific solutions that have been reviewed and endorsed by more than 27 of the most threatened communities (ANTHC, 2024, p. 2).

Recovery is on a continuum, each location has its own timeline, and no two communities recover the same way. Vivian Korthuis, Chief Executive Officer for the Association of Village Council of Presidents in the affected southwest Alaska region, testified succinctly, "To rebuild a community

is not an easy task" (Korthuis, 2022, sec. 3), embracing the goal for local and outside entities to work together.

3.2.1. RSF-1. Community Planning and Capacity Building

Mean rating - Short: 1.13; Long: 0.75. RSF-1 included planning, public information and warning, and operational coordination. Shishmaref Incident Commander Stan Tuckoo expressed, "We've been lucky, but we're gonna run out of luck one of these times" (Loewi, 2022a). Multiple communities have been identified in studies as being at risk and highly vulnerable to devastation in another storm, with many locations identified in plans for mitigation or relocation based on Indigenous input. Reports following the storm provided localized or individual updates to specific circumstances, villages, or situations for limited or temporary short-term solutions (ANTHC, 2024; Kvapil, 2023; Latulippe and Kienk, 2020; Lezak and Rock, 2024; Loewi, 2022b; Mittal, 2003, 2009; Monet, 2022; Shen and Ristroph, 2020; Trainor et al., 2007).

3.2.2. RSF-2. Economics

Mean rating - Short: 2.00; Long: 1.33. RSF-2 included economic impact, recovery, and resilience. The move for individuals or communities from economically self-sufficient to reliance on mixed income has become more volatile. Decreased fishing stocks have reduced natural and historic subsistence supplies, which were recognized as food disaster declarations, yet monetary compensation cannot replicate the nutritional value nor cultural significance of the actual subsistence activity. "Rural Alaska fishing communities provide a poignant example of how climate impacts compound persistent poverty, geographic isolation, lack of economic diversity, and resource dependence" (USGCRP, 2023, p. 11-22). Variations in weather cycles, sea and land temperatures, sea ice, marine life, and land-based food sources have severely impacted the Indigenous ability to retain subsistence food sovereignty. There is no capability for greater wage payment jobs in the villages, and without food sovereignty there is no self-sufficient economy to sustain (ANTHC, 2024; Hueffer et al., 2019; Sobelman, 1985; Trainor et al., 2007; York et al., 2024).

3.2.3. RSF-3. Health and Social Services

Mean rating - Short: 1.20; Long: 0.60. RSF-3 included health and social services capabilities and networks, behavioral health, and well-being of the whole community. The 2023 National Climate Assessment (USGCRP, 2023) and the 2024 Unmet Needs report (ANTHC, 2024) both noted displacement or forced migration from original Indigenous lands had resulted in significant upheaval of social networks, decreased housing security, and caused negative mental health among Indigenous people from either governmental directive or climate variations. Overcrowded homes due to housing shortages exacerbate the issue. Suicide continued to be a significant problem among Indigenous people. Gender-based violence of Indigenous Alaskan women, as primary caregivers and main food-bearers in multigenerational households, has increased due in part to changes affecting food sources (M. Bahnke et al., 2020; Ruscio et al.,

2015) and limited external income for males (Canny, 2023; Hueffer et al., 2019; Trainor et al., 2007; York et al., 2024).

3.2.4. RSF-4. Housing

Mean rating - Short: 0.50; Long: 0.25. RSF-4 included affordable, resilient, and sustainable housing markets. Housing shortage has been an ongoing problem for many years, which resulted in overcrowding of a single home in some communities. No mass care or temporary housing capability existed in nearly all villages. Smaller communities did not have trained specialized workers to build to industry standards, and high costs limited contracting outside workers. Many homes were considered uninhabitable before the storm, thus were ineligible for FEMA individual assistance to repair; a 2023 change in the FEMA habitability definition made homes in disrepair before a storm eligible for individual assistance, but was not retroactive for this storm (Schwing, 2024). Conflicting bureaucratic issues precluded eligibility for renovation of some housing to achieve higher levels of preparedness (ANTHC, 2024; Canny, 2023; Cochran et al., 2013; Hueffer et al., 2019; Toomey, 2016; USGCRP, 2023).

3.2.5. RSF-5. Infrastructure Systems

Mean rating - Short: 0.75; Long: 0.00. RSF-5 included restoration and sustainment of essential community services and redevelopment of systemwide infrastructure. A pointed statement said, "[m]uch of Alaska's infrastructure was built for a stable climate" (USGCRP, 2023, p. 29-23), which was a position destined for failure. Due to a combination of initial poor location selection and subsequent extensive storm erosion, most coastal villages - to include the entire infrastructure, health care, education, housing, cultural, and livelihood systems - would need to be relocated for continued survival. Projections range from USD 28-280 million per village (USGCRP, 2023) up to USD 4.3 billion for mitigation, adaptation, or relocation of village infrastructures, potentially averting up to "USD 25.8 billion in emergency response and recovery costs" (ANTHC, 2024, p. 7). A lack of basic sanitation capability continued to cause extended health issues. Less than half of Alaska communities did not have any internet connection, and some paid up to USD 500 monthly costs with usage limits (M. Bahnke et al., 2020; Toomey, 2016).

3.2.6. RSF-6. Natural and Cultural Resources Recovery

Mean rating - Short: 2.25; Long: 1.50. RSF-6 included protection of records and documents of cultural and natural resources. RSF-6 drew the highest evaluations for both the short- and long-term assessment, primarily on the strength of cultural knowledge of each capability, however, fell short on initiation and delivery to achieve the ideals. Western Alaska Indigenous have shown high resilience with more than 4000 years of known habitation of the area (ANTHC, 2024). Unfortunately, external forces over recent centuries caused undue pressure on this resilience. The 2023 National Climate Assessment had an entire chapter (USGCRP, 2023, ch. 29) just on the extensive and continued degradation of Alaska issues, including food sources, ecosystems, natural and cultural elements, housing, infrastructure, mental and physical health, social and racial

behavior, economic impacts, and overall livelihood of the Indigenous people. The Unmet Needs report (ANTHC, 2024) was solely focused on Alaska Native communities and addressed all six RSFs (Canny, 2023; Hueffer et al., 2019; IAWG, 2009; M. Bahnke et al., 2020; Sobelman, 1985; Toomey, 2016; Trainor et al., 2007; York et al., 2024).

3.2.7. RSF summary

RSFs were designed to facilitate a return to a safe condition, which is ideal in addressing long-term disaster issues. The executed RSFs attempted to facilitate short-term issues, such as economics (RSF-2), but did not fully address exposed long-term issues, specifically, ongoing infrastructure needs (RSF-5), inadequate housing (RSF-4), and food security (RSF-3), with safe locations to live (RSF-1) also poorly conducted.

4. CONCLUSIONS

While some successes were noted, all ESFs/RSFs were overall ineffective and did not function, which resulted in exacerbation of the cascading hazard event in both short-term recovery and long-term resilience.

5. RECOMMENDATIONS

Three items are recommended for further action. First, the ‘All-hazards’ meaning should be revised from the ‘totality of individual hazards’ into the ‘interconnection of all the hazards’ to ensure relevance between plans. This will directly impact the practical ESF/RSF usage. Second, specific changes to the ESF/RSF framework are needed to work in remote and geographically isolated communities. Third, specific research is needed to better understand and define the roles of the responsible agencies within the ESF/RSF construct to ensure lead agencies are adequately equipped with resources to actually do the designated job and functional counterparts are capable at the subordinate or tribal levels of government.

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