



An Overlooked Catastrophe: Near-Earth Objects and Emergency Management Doctrine



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Introduction

Near-Earth objects (NEOs) are low probability-high consequence hazards. Limited modern impacts and theoretical response tactics hinder our understanding of this extreme event. Emergency response to an asteroid impact is traditionally viewed from the global perspective. This limits the perspectives from local and state stakeholders, as disasters are primarily localized issues. A global impact, therefore, will result in increased complexity and command and control. Research has already identified that local emergency management plans scantily include space hazards, revealing a poignant regional gap in disaster response and recovery.

How are near-Earth objects represented in emergency management literature?

Methods

This study utilized a **qualitative** research design informed by **interpretivism**, an **inductive** system of logic, **secondary data collection**, **meta synthesis**, and **thematic analysis**. A search of the literature was conducted from August-November 2025 in several online databases. Journals were excluded if they were unrelated to emergency management, which was broadly defined as topics relating to climate, hazards, disasters, risk, mitigation, and sociology. 164 articles were included for the first phase. A second screening level was conducted to ensure relevancy to the research question, which excluded 41 studies. 123 manuscripts were imported into Atlas.ti for thematic analysis. They were systematically reviewed for familiarization. Codes were generated using a three-step sweeping process from lower to higher levels of abstraction. The resulting themes cohesively describe the asteroid impact risk perception in the emergency management field.

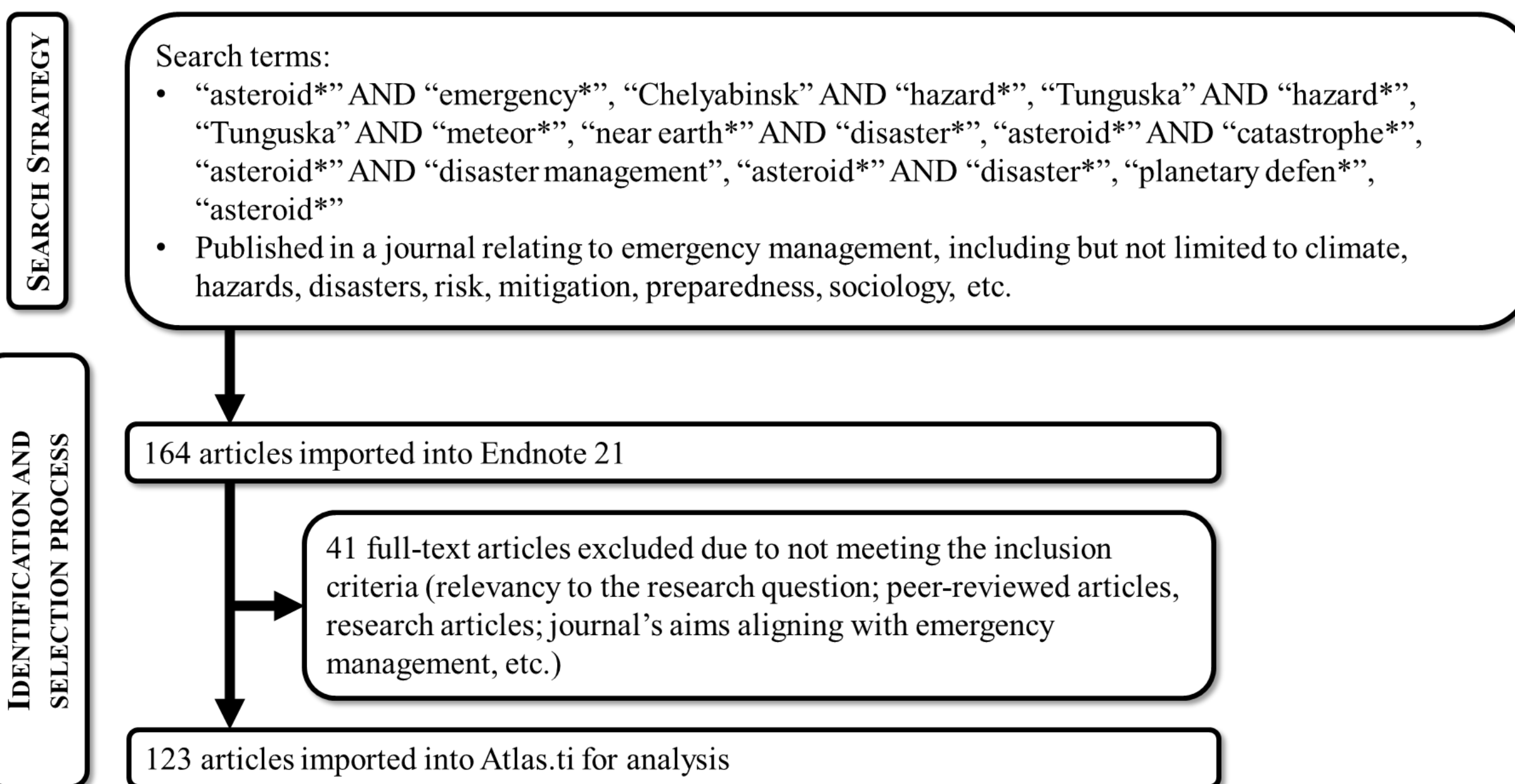


Figure 1. Flowchart of the article selection process



Results

One hundred twenty-four studies met the inclusion criteria for the thematic analysis. The studies ranged from 50 different journals and were published from 1986 to 2025. Thematic analysis identified 481 quotes, 42 codes, and four categories that inform two overarching themes.

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Limited understanding in research & policy

Our knowledge of NEOs as hazards stems from limited, historical and modern events and theoretical understanding, which narrow our perception of risk. In modern history, only two significant bolide events have been recorded: Tunguska in 1908 and Chelyabinsk in 2013. This also influences our policy, which can lead to repeated disruptions that ultimately undermine resilience. Furthermore, asteroid impacts are frequently perceived by the public as negligible hazards due to their low probability and exaggeration in popular media, which hinders risk perception.

- "The current understanding of the potential hazards owing to a collision of the Earth with a comet or asteroid is substantial but clearly incomplete" (Solem, 1999, p. 142)
- "For many organizations and their respective host nations, a HILP event like a NEO impact has not been part of their traditional disaster preparedness and response strategy" (Ravan et al., 2022, p. 152)
- "Thus, one of the greatest elements of risk associated with NEOs is the public expectation that governments will provide protection against any threat from NEOs [...]" ("The National Research Council on Hazards from Near-Earth Objects," 2010, p. 861).

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Hazard-focused

Research describes asteroid impacts through its associated hazards, such as tsunamis, thermal radiation, earthquakes, and fires. However, while asteroid and comet hazards are present within the literature, a vast majority only offer a cursory mention of their potential threat.

- "[...] the primary effects include blast waves, fireball, and ignition from thermal radiation. For asteroids that strike the ground, the primary effects also include crater formation and seismic waves" (Reinhardt et al., 2016, p. 247)
- "If it hit an ocean, it would cause a devastating cycle of gradually diminishing tsunamis" (Bucknam & Gold., 2008, p. 142)
- "Of the various immediate effects of an asteroid impact, the blast wave is typically the most damaging and usually determines the expected casualties and (or) the area that would need to be evacuated prior to impact" (Titus et al., 2023, p. 1360)

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Gaps within EM

NEOs in the emergency management context is framed in existing doctrine concepts, such as response capabilities, preparedness, cascading effects, and international cooperation. There are attempts to categorize a low probability-high impact hazard comparable to more frequent hazards; however, this apples-to-oranges comparison leads to vague descriptions and theoretical practices.

- "The primary focus of the asteroid risk analysis literature has been on the concept of a threshold collision size above which global catastrophe would occur" (Baum, 2018, p. 764)
- "Apart from the realization that our natural history has to make conceptual room for such catastrophes [...]" (Munevar, 2019, p. 39)
- "Many of these more common natural hazards are part of the cascading effects that one may expect from a medium-sized impactor. If we can connect these effects, mostly through models, we can start to answer some key questions, [...] What are the effects that emergency managers should be planning to mitigate? What will be the timescale, cost, and level of effort for long-term recovery of the region?" (Titus et al., 2023, p. 1357)

Table 1. Frequency of the included articles by journal

Journal(s)	Frequency
Natural Hazards	16
Risk Analysis	13
Natural Hazards and Earth System Sciences	11
Science of Tsunami Hazards	9
International Journal of Disaster Risk Reduction	7
Futures	4
Journal of Risk Research; Journal of Homeland Security and Emergency Management	3
Disasters; European Journal of Risk Regulation; Homeland Security Affairs; International Journal of Environmental Studies; Journal of Contingencies and Crisis Management; Natural Hazards Review; Population and Development Review	2
Advances in Geosciences; Agriculture; Climate Change; Decision Analysis; Defense & Security Analysis; Disaster Prevention and Management; Earth's Future; Environment Systems and Decisions; Environmental Toxicology; Food and Bioproducts Processing; Foresight; Geoenvironmental Disasters; Global Environmental Change; Global Food Security; Global Policy; International Journal of Environmental Research and Public Health; International Journal of Science Education; Journal of Applied Volcanology; Journal of Climate; Journal of Disaster Research; Journal of Environmental Management; Journal of Extreme Events; Journal of Risk and Uncertainty; Landslides; Progress in Disaster Science; Risk Management; Science & Global Security; Seismica; Social Studies of Science; Survival; Sustainable Production and Consumption; The Australian Journal of Emergency Management; The Communication Review; Traumatology	1

Applications

- Inform emergency management doctrine by identifying gaps in preparedness, response, and recovery planning for low-probability, high-consequence NEO hazards.
- Support development of risk communication strategies and research for asteroid impact scenarios at local, state, and international levels.
- Provide a foundation for integrating NEO hazards into hazard mitigation plans and cascading disaster frameworks alongside earthquakes, tsunamis, fires, and other complex hazards.