

Serious Play for a Safer World: An Analysis of Geogames at the Nexus of Cybersecurity, and Disaster Management

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Abstract. In an era marked by rapidly evolving cyber threats and increasing disaster risks, geogames offer innovative approaches to education and training. Motivated by the need to understand the current landscape, this paper systematically maps the landscape of 92 geogames at the intersection of cybersecurity and disaster management. This study examines the availability of these games, their application areas, genres, target audiences, and other design characteristics, such as medium and publisher type. By categorizing games based on these criteria, we offer a comprehensive overview of what is currently available in this domain. Notably, this paper provides a structured resource that highlights trends and gaps in the market, thereby serving as a valuable reference for researchers and developers seeking to understand and enhance the role of geogames in cybersecurity and disaster management training.

Keywords: Serious Games · Geogames · Cybersecurity · Disaster Mangement · Critical Infrastructure

1 Introduction

Serious games have been increasingly used as powerful tools for education and training across diverse domains. Among them, geogames – games that real-world location or spatial context fundamentally shapes gameplay [10, 11] – demonstrates their unique advantages for addressing the complex interplay between cybersecurity and disaster management. These games have shown their effectiveness in awareness education and training for geographic exploration, cybersecurity, and disaster response [2, 3, 11, 16]. The rationale for connecting these seemingly disparate game categories stems from the increasingly interconnected nature of our world, where cyber threats can have tangible impacts on physical infrastructure and the effectiveness of disaster response efforts. Addressing complex real-world challenges requires interdisciplinary approaches, and

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2026
O. Gervasi et al. (Eds.): ICCSA 2025 Workshops, LNCS 15899, pp. 152–164, 2026.
https://doi.org/10.1007/978-3-031-97663-6_13

the integration of spatial, security, and disaster-related concepts within geogame environments offers theoretically grounded potential for enhancing systems thinking, spatial reasoning, and situated learning.

The integration of cybersecurity considerations and disaster management learning and training is becoming increasingly critical [17] due to the evolving threat landscapes and the growing dependence on interconnected cyber-physical systems [18]. Geogames can uniquely illustrate the place-based consequences of cyberattacks by embedding scenarios within specific urban environments, infrastructure systems, or policy ecosystems. This approach may support co-creation and localized learning, mirroring how disaster games emphasize community-level preparedness [2]. On the other hand, by leveraging spatial mechanics, geogames can translate abstract cyber scenarios such as network intrusion and data breaches into concrete, place-based consequences (e.g., localized power outages, disruption of geographically dispersed services), enhancing players' understanding of vulnerability and impact. For instance, a geogame may involve defending a city's power grid from a simulated ransomware attack or coordinating municipal services during a breach of emergency communication networks. Such designs can bridge the gap between abstract technical skills and tangible societal impact of cybersecurity, promoting both technical literacy and civic responsibility.

The growing convergence of these gaming applications highlights important considerations for game developers and educators. Geogames must address privacy and security challenges related to user location data [19]. Meanwhile, representations of critical infrastructure in disaster simulations provide valuable opportunities to demonstrate the cascading effects of security breaches across physical and digital systems [20].

This paper systematically analyzes 92 serious geogames across application areas including their characteristics, educational approaches, and accessibility. The goal is to map how these selected geogames are being utilized as teaching tools in cybersecurity, disaster management, and other risk-related domains, providing insights into effective design strategies for these increasingly interconnected educational contexts.

This rest of the paper is organized as following. Section 2 provides a brief overview of related work. Section 3 clarifies our research focus. Section 4 describes the methodology used in this paper. Section 5 presents the result of the data collection. Section 6 and 7 discuss and summarize the main findings and further research directions.

2 Related Work

Several studies have explored the landscape of serious games for both crisis/disaster management and cybersecurity education and training, providing valuable insights into the field. Loreto et al. [1] conducted an overview of collaborative serious games for crisis management, aiming to characterize crisis management and analyze existing games based on these characteristics. Their analysis focused on understanding the strengths and weaknesses of these environments. Solinska-Nowak et al. [2] provided an overview of 45 non-commercial serious games and simulations, analyzing their characteristics, target groups, and potential for developing disaster risk management (DRM) skills. While highlighting the promise of these tools for raising awareness and simulating disaster scenarios, their research also pointed to a lack of robust scientific evidence regarding their

effectiveness from the surveyed publications. In the domain of cybersecurity, multiple survey papers have examined serious games. Alotaibi et al. [3] reviewed the effectiveness of mobile gaming applications in raising cybersecurity awareness in Saudi Arabia. While most studies show positive results in using games for awareness and training, there is a need for more robust evaluations with larger sample populations and issue-specific games tailored to user needs. Jr., W. A. H. et al. [4] provides a survey of cybersecurity serious games targeting various audiences from K-12 students to college students and cybersecurity professionals. The study highlights that while many games focus on general cybersecurity awareness, some address more specialized technical topics. Hill et al. [5] examined twenty cybersecurity games and found that most games focus on cybersecurity awareness rather than technical topics, with privately developed games generally offering better interactivity and visual quality. The authors concluded that most publicly available options are either too basic for higher education curriculum needs or they lack the engagement value that makes game-based learning effective. Calvano et al. [6] reviewed 15 cybersecurity serious games and found that most games prioritize educational content over gaming elements, potentially reducing players' engagement and hindering learning outcomes. The research recommends a design approach using standardized methodologies that balance educational and gaming aspects to help educators select more effective training tools for cybersecurity education. Chattopadhyay et al. [7] presents a novel analysis of cybersecurity educational games by examining their alignment with established industry and academic standards and provides a reference that helps educators and industry professionals make informed choices about which games to use for specific educational purposes. Ng & Hasan [8] systematically analyzed 53 cybersecurity games development from 2014 to 2024 and identified several gaps of the research such as limited attention to common threats like social media scams, overreliance on quiz-style formats despite their limited effectiveness, and lack of customizable content to address evolving threats. Tioh et al. [9] surveyed serious games in cybersecurity training, emphasizing the need to educate users as they are often the weakest link. The authors concluded that current cyber security games and products show promise but lack rigorous, large-scale evaluation to show their effectiveness.

Previous studies reveal a well-established research landscape for serious games in both crisis management and cybersecurity domains. While the analysis of those games show promise for training and awareness, common limitations emerge across studies: insufficient evidence of effectiveness, imbalance between educational content and gameplay elements, and lack of rigorous large-scale evaluations. Many cybersecurity games focus primarily on general awareness rather than technical skills, and are often either too basic for higher education or lack engaging elements. Different from existing work, this paper specifically investigates the under-explored category of *geogames*, providing a systematic overview of how they are currently employed at the intersection of cybersecurity and disaster management education and training.

3 Research Focus

While previous research has provided valuable overviews of serious games within the distinct domains of crisis/disaster management and cybersecurity, highlighting aspects such as their characteristics, effectiveness, and alignment with standards, a significant

gap remains. Specifically, existing literature reviewed serious games for disaster management or cybersecurity separately, but not the combination within the specific category of geogames. Also, there was no systematic analysis on current state of development on such geogames in terms of game characteristics, learning objectives, audiences, and their sources. Therefore, this short paper aims to bridge these gaps by providing a comprehensive overview of the currently available geogames in these specified application areas from academic research, general education, and commercial game market. Our research questions are listed as below:

- What is the current landscape of available geogames at the intersection of cybersecurity and disaster management?
- What is the current state of development of geogames in cybersecurity and disaster management in terms of game characteristics, learning objectives, audiences, and their sources?

4 Methodology

The research methodology includes literature review, definitions of the selected types of games, identification of geogames that fall into the intersection of disaster management and cybersecurity.

4.1 Definitions

Geogames. Geogames represent a compelling intersection of gaming and geography, fundamentally defined as games where a player's real-world location and spatial context directly influence the gameplay [10]. This initial definition of geogames has been recently widened to include all games that concentrate on the well-being and regeneration of planet Earth. They are designed with a purpose beyond mere fun and entertainment. Often, they are designed as teaching and learning tools [11]. Geogames can be analog, digital, or hybrid mixing analog and digital principles. Examples for geogames come from a variety of application areas such as architecture, urban planning, community engagement, geography, disaster management, cybersecurity, history, religious studies and more.

Cybersecurity Games. In this paper, cybersecurity games are geogames that span physical and virtual mechanisms in which the player explores and interacts with systems typically involving security education and simulation. For example, Cyber Ready Community Game is a strategy board game developed by FEMA in collaboration with cybersecurity experts to help communities understand and prepare for cyber incidents [12].

Disaster Management Games. Disaster management games are geogames designed to educate and train participants in various aspects of disaster preparedness, response, and recovery. These geogames simulate disaster scenarios to improve decision-making skills and enhance community resilience. They often focus on risk assessment, resource allocation, evacuation planning, and coordination among different stakeholders. Spatial awareness is a key component, as disasters inherently have geographical impacts. There have been many games created under this category [2].

4.2 Game Selection

The selection of games follows a systematic search process across multiple platforms to ensure comprehensive coverage of geogames in cybersecurity and disaster management. Searches were conducted through literature review of academic papers and online game platforms. The keywords used included "geogame", "cybersecurity game", "disaster management" and "risk management". Games were included in the ludography if they contain educational elements, cybersecurity or disaster management awareness learning or skill training.

4.3 Data Analysis Framework

To analyze all selected geogames, the following categories of information were considered: game characteristics [2], source, knowledge characteristic, and audience. Table 1 shows the categorized terms and their definitions.

Table 1. Data Analysis Framework.

Category	Term Name	Definition
Knowledge Characteristic	Application Area	The knowledge area this game is applied to
Game Characteristics	Genre	A category or classification of games based on their gameplay mechanics, themes, or style
	Medium	The format of the game
	Medium Type	Physical or digital
	No. of Players	The number of player(s) can play at the same time
Audience	Target Audience	The player groups this game is designed for
Game Source	Is Accessible	Is the game available for play by the date of collection
	Publication Type	The purpose of the game publication
	Publisher Type	The classification of the entity based on its primary role and function in producing or distributing the game

5 Results

Altogether 92 geogames were analyzed based on their application area, genre and platform used for the implementation. The full list of collected games is presented in Appendix A. Table 2 provides a summary with respect to the number of games found in each of the respective categories. The collection includes 47 games in cybersecurity &

digital defense and 45 in disaster management & resilience. All collected games were created for various audiences. Most frequently mentioned audiences include students and educators, cybersecurity and IT professionals, military and defense personnel, and business roles. The typical example of cybersecurity game is CIST, which is a single-player online game designed to raise awareness about cybersecurity threats within the hardware supply chain. Players analyze attack scenarios, categorize them using the CIST model, identify potential adversaries and vulnerable stages, and select appropriate defenses. The study found the game useful for learning and promoting self-study regarding supply chain threats [22]. DisCoord is a serious game designed as a public pedagogy tool for Disaster Risk Reduction (DRR). It functions as a collaborative space to connect diverse perspectives and knowledge from various DRR stakeholders who might be separated by location or socio-cultural differences. The study concluded that the game is a useful intervention for bringing different types of knowledge together and enabling co-learning among participants [23].

Table 2. Application areas of the games analyzed.

Application area	Number of games
Cybersecurity & Digital Defense	47
Disaster Management & Resilience	45

5.1 Game Characteristics

Genre. There are no unified definitions for the list of game genres. After analyzing the game types on our ludography, we identified following game genres: Role-playing, Strategy, Interactive fiction, Simulation, Puzzle, and Quiz. Table 3 demonstrates the numbers of games found in our dataset. Some games can be categorized into multiple genres. The result shows that the most frequently created game genres are strategy (39.13% of total) and simulation (55.43% of total).

Table 3. Game genres of the games analyzed.

Genre	Number of games
Role-playing	15
Strategy	36
Interactive fiction	2
Simulation	51
Puzzle	11
Quiz	4

Game Medium. In our collection, 40 games are browser-based, taking 43.48% of total 92 games. 18 are board games, 16 are card games, 13 of them are live events, and desktop and mobile downloadable has 5 and 2 games, respectively. In summary, 48 games have digital mediums, and 49 has physical medium. Among all of them, 5 games include both digital and physical mediums (Table 4).

Table 4. Game mediums of the analyzed games

Game Medium	Number of games
Browser-Based	40
Board	18
Card	16
Live Event	13
Desktop Downloadable	5
Mobile Downloadable	2

Number of Players. To better understand scale of game play, the minimum number of players supported by each game was examined. For 86 games it was possible to identify the number of players, out of which 46.51% are single-player games and 58.14% are multi-player games. This includes four games supporting both single and multiple players. Most multi-player games need at least 2–8 players play at the same time, and seven need nine or more players. It is worth noting that several games support very large group of learners play together. For example, PHUSICOS NBS Simulation supports up to 40 players [13], Extreme Event allows maximum of 48 players [14]. Table 5 summarizes these statistics.

Table 5. Minimum number of players required to play the game.

Min. No. of Players	Games
1	44
2–8	33
9 and more	7
Multiple players not specified	7
Unknown	6

5.2 Game Sources

Finally, the source of the games was analyzed. As shown in Table 6, among all analyzed geogames, 68 are still available on the date of date of data collection. In this section, the

type of publisher and the purpose of the game publication was analyzed. Most games, about 65.22% games were created for public education, 31.52% were created as part of academic research. In addition, 30 game, taking 32.61% games were commercialized in forms of purchased copies or paid training sessions. In addition, several games were created in the research project, then later successfully implemented for public education or commercial game publication.

Table 6. Purposes of the games.

Purpose	Game Count
Public Education	60
Academic Research	29
Paid Training Session	11
Commercial	19

Publisher Type. This breakdown is useful for understanding the landscape of educational game development and which types of organizations are most active in creating educational gaming content. As shown in Table 7, 28 games were published by non-education organizations, leading publishers, followed by private company. Most publishers are non-profit entities, which take 72.94% of all 85 known publishers. Amount 67 games that are still accessible, 21 of them are paid games in forms of digital, physical, or in person activities, and 46 games in our collection are free to play.

Table 7. Publisher types of games

Publisher Type	Game Count
Non-profit Organization	28
Private Company	23
Educational Institution	16
Government Agency	13
Individual/Research Team	5
Unknown	7

6 Discussion

The analysis of knowledge characteristics revealed a significant disparity between games focused on awareness learning and those on skill development. As shown in Table 8, 79 games provide focus on awareness education, while only 17 games emphasize the

practice of technical skills, including four that provide both awareness education and practice of technical skills. This strong emphasis on risk awareness suggests that the current landscape of serious geogames in this intersection prioritizes educating a broad audience about the potential threats, vulnerabilities, and consequences associated with cybersecurity and disaster management [3]. A potential reason for this imbalance is that knowledge learning may be technically easier to implement and evaluate than skill learning. On the other hand, the training of technical skill practice requires more sophisticated simulation environments and feedback mechanisms [15]. Researchers and designers may benefit from emerging technologies to address this gap. For instance, the Metaverse offers significant potential as a platform for more dynamic, realistic, and immersive environments for teaching and learning how to handle diverse threats [21]. Such virtual environments could provide scalable and engaging settings for practicing complex decision-making in both cybersecurity breach scenarios and simulated disaster response situations, potentially bridging the gap between abstract knowledge and practical application.

Table 8. Learning Focuses of Collected Games

Learning Focus	Game Count
Awareness Education	79
Technical Skills	17

In our collection, 25 of all games are not accessible, taking 27.17% the total numbers. All of them were created for public education or academic research. This indicates the sustainability issue of such geogames that might limit their accessibility to their audiences. This attrition rate raises concerns about the long-term viability of such initiatives. Non-profit projects, while ideally positioned to deliver free resources, often depend on unstable funding streams, volunteer labor, or short-term grants, which may impede ongoing maintenance, updates, or server hosting.

A further challenge identified in the analysis is the lack of language and cultural adaptability across the geogames. Natural disaster games are often highly localized, designed to reflect the specific risks, infrastructure, and response systems of a particular region or city. These geogames incorporate local hazards such as floods, earthquakes, or wildfires and often embed community-specific emergency planning into gameplay. This localized approach enhances relevance for players and strengthens context-specific risk awareness. In contrast, cybersecurity games are typically designed with a universal user in mind. They focus on globally recognized threats like phishing, malware, and system breaches, and generally avoid references to specific national or institutional settings. This broader framing reflects the transnational nature of cyber threats and supports wider applicability across organizational and geographical boundaries.

7 Conclusions

This study provided an initial overview of 92 geogames at the intersection of cybersecurity and disaster management based on the selected characteristics. Given the importance of safety and security in critical infrastructure, designing a safe and secure geogame requires the consideration of cybersecurity principles. This study shows that disaster management games tend to be localized, often incorporating community-specific emergency planning and reflecting regional hazards, while cybersecurity games are more universally applicable, focusing on global threats like phishing and malware. This difference reflects the place-based nature of disaster response and the transnational nature of cyber threats.

Moving forward, this research will deepen the analysis of game implementation, learning objectives, and narrative structures, with a focus on how location-aware design and place-based scenarios can enhance the educational value of both cybersecurity and disaster management games. Additionally, while this short paper focuses on mapping the current landscape based on readily available characteristics (genre, medium, audience, etc.), exploring functional characteristics like customization and collaboration potential would also be beneficial. Furthermore, we will investigate the potential of immersive technologies like the Metaverse in creating dynamic learning environments to bridge cybersecurity and disaster management games.

Appendix A

- CyberProtect by Department of Defense
- Crypto Go by Universidad Carlos III de Madrid and Universidad Rey Juan Carlos
- Sticker Heist by Sinclair College
- Cyber Threat Defender by Center for Infrastructure Assurance and Security (CIAS), UTSA
- Cyber Awareness Challenge by Defense Information Systems Agency (DISA) - U.S. Department of Defense (DoD)
- The Cyber Challenge by Department of Defense
- Targeted Attack: The Game by The Fugle Company
- CyberEscape Online by LivingSecurity
- Cyber Attack (Publisher is not clear)
- LUXO Interactive (Publisher is not clear)
- CyberCIEGE by Naval Postgraduate School
- Be-aware by Taif University, Al-Ha
- Agile App Security Game by BCS, Secure Development Initiative, and Lancaster University
- Decisions & Disruptions by Ben Shreeve and Awais Rashid (University of Bristol Cyber Security Group)
- CyberStart by SANS Institute
- Cyber Crisis Simulation by Cyberbit
- Cybersecurity Lab by PBS
- Game of Threats by PwC France

- Jack Voltaic by Army Cyber Institute at West Point
- CIST: A Serious Game for Hardware Supply Chain by Hart, Halak, Sassone
- Elevation of Privilege (EoP) Threat Modeling Card Game by Adam Shostack
- Backdoors and Breaches by Black Hills Information Security
- OWASP Cumulus by TNG Technology Consulting
- CIA: Collect It All by Diegetic Games (co-designed with Techdirt)
- Cybersecure: Contingency Planning by Office of the National Coordinator for Health Information Technology USA
- Data Heist by Dataprotectionpal
- LINDDUN GO by DistriNet, KU Leuven
- Cyber Security by JeopardyLabs
- Power Surge: Cyber Security Academy – The Card Game by ZmYchE
- Cyber-Ready Community Game by FEMA (Federal Emergency Management Agency), CISA, UTSA
- Anti-Phishing Phil by Wombat Security
- Exploited In The Wild by WIZ Research
- FTC Phishing Scam Game by Federal Trade Commission
- Safe Online Surfing by FBI
- NOVA Cybersecurity lab by PBS NOVA
- Interland by Google
- HackShield by Flavour and KraBé Academy
- HackTale by Komodo Consulting
- Control-Alt-Hack by University of Washington
- Phishing IQ Test or Phishing Simulator by PhishingBox, LLC
- Enter The Spudnet by Potato Pirates
- World of Haiku by Haiku Inc.
- Data Breach by Three Hundred Spears
- Cryptomancer RPG by Land of NOP
- [d0x3d!] by Gamewright
- Byte Club by Michael Novack
- PASDJO by Seitz and Hussmann
- Squally by CS420 Team
- Ekos: The Path to resilience by Urban Systems Lab
- Information meeting about evacuation scheme Greenwood by FLOODsite
- Disaster in My Backyard by Campus Vesta, Belgian First Aid & Support Team
- Disaster Imagination Game (DIG) by Japan International Cooperation Agency (JICA)
- Beat the Quake by Southern California Earthquake Center (SCEC)
- Battle of Flooding Protection by Hwa Hsia University of Technology, Taiwan
- Disaster Awareness Game (DAG) by Gunma University, University of the West Indies
- Decisions for the Decade by Red Cross Red Crescent Climate Centre
- Cultural Memory Game by Centre for Systems Solutions
- Disaster Master by FEMA, Department of Homeland Security
- Before the Storm by Red Cross Red Crescent Climate Centre
- Cards Against Calamity by Environmental Law Institute, NOAA Sea Grant
- Rolling the dice (Infrastructure resilience in Cabo Verde) by Global Facility for Disaster Reduction and Recovery, Government of Japan

- Earthquake Response by Save The Children Australia, Enabled Solutions
- Disaster Hero by American College of Emergency Physicians
- Game of Floods by Marin SLR / The Game Crafter
- DisCoord – The Disaster Coordination game by Visayas State University
- Downpour! by Playfuel & Oropendola Productions
- Bosai Duck by T. Kikkawa, K. Yamori
- PRECINCT Serious Game by PRECINCT Project (EU Funded)
- Shaping your Shelter: A game on post-disaster reconstruction of homes by Red Cross / Red Crescent Climate Centre
- Flood Resilience Game by Centre for Systems Solutions & IIASA
- Disaster Master Game by U.S. Department of Homeland Security
- Be a Hero… build a kit! by Ready.gov
- Dice & Disasters by Emergency Management Division Washington
- inSIGHT by ICCROM
- Stop Disasters! by UNDRR
- Storm Struck: Protect Your Home Against Natural Disasters by FLASH
- Sai Fah! The Flood fighter! by UNESCO Bangkok
- The Disaster Response Game by International Science Reserve
- Master that Disaster by Red Cross Red Crescent Climate Centre
- Riskland by UNISDR
- Story Go Round by Red Cross; Jane Friedhoff, Mike Susol, Kelly Tierney
- Ready! by Red Cross Red Crescent Climate Centre
- Inside the Haiti Earthquake by PTV Productions Inc.
- Extreme Event by LabX
- Pandemic by Z-Man Games
- Meltdown 2020 by SimplyFun
- Hazagora: Will You Survive the Next Disaster? by Vrije Universiteit Brussel
- Evacuation board game by Flood Site Project
- Hurricane Strike! by National Hurricane Center
- ERU: Emergency Response Unit by Big Fish Games
- Act to Adapt by Red Cross Red Crescent Climate Centre
- Disaster zone by Christian Aid
- PHUSICOS NBS Simulation by Centre for Systems Solutions (CRS), funded by EU Horizon 2020

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