Afet Yönetimi Bağlamında Örgütlerde Robotik Girişimcilik ve Bazı Uygulama Örnekleri

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Özet

Afet yönetiminde yapay zeka teknolojisinin amacı sadece hayatta kalabilmek için destek olmak değil, bunun yanında gelecekte yararlı olabilecek bilgilere ışık tutmaktır. Robotik araçlar her alanda olduğu gibi depremde ya da diğer afetlerde arama ve kurtarma dünyasında değerli bir rol oynayabilmektedir. Robot teknolojisinin dönüşümü, çalışanlar yerine sadece tehlikeli olay anında yardımcı olmanın yanında, hayat kurtarırken destek vermeye olanak tanıyabilmektedir.

Bu çalışmada afet yönetiminde uygulanmış yahut uygulanabilecek Drone Teknolojisi başta olmak üzere robotik varlıkların kullanımının yanında, robotik teknolojileri arama ve kurtarma operasyonlarına dahil etmeye dair uygulama örnekleri ile insan-robot iş birliğini sağlamak için robotik uygulamaların verdiği desteklere ayrıca afetlerin neden olduğu can kayıplarını ve hasarları en aza indirmek için önerilere yer verilmektedir.

Anahtar Kelimeler: robotik, yapay zeka, afet yönetimi, teknoloji.

Robotic Entrepreneurship in Organizations in the Context of Disaster Management and Some Application Examples

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Abstract

The purpose of artificial intelligence technology in disaster management is not only to support survival, but also to shed light on information that may be useful in the future. As in every field, robotic vehicles can other disasters. The transformation of robotics can allow workers to not only assist in the event of a dangerous event, but also to provide support while saving lives. In this study, in addition to the use of robotic assets, especially Drone Technology, which has been or can be applied in disaster management, application examples for incorporating robotic technologies into search and

rescue operations and the support given by robotic applications to ensure human-robot cooperation, as well as suggestions to minimize the loss of life and damage caused by disasters are included.

Keywords: robotics, artificial intelligence, disaster management, technology.

Introduction

Today, technology can be used in every field as well as at every stage of disaster management. Disasters do not only cause physical losses, loss of life and injuries. It is also to create negative effects on psychological, social and national economies. Population growth, urbanization and increasing environmental challenges add complexity to disaster decision-making (Meira and Bello, 2020). In this context, it is imperative that countries at high risk of encountering natural disasters invest effectively in disaster risk reduction strategies. In this study, in addition to the use of robotic assets in disasters, application examples of incorporating robotic technologies into search and rescue operations and the support provided by robotic applications to ensure human-robot cooperation are included.

Literature

Natural Disasters

When natural disasters around the world are considered, it is seen that meteorological disasters constitute 28 of the 31 types of natural disasters (Yılmaz, 2022).

Table 1. Natural Disasters

Slow-developing natural disasters	**Sudden Natural Disasters**	**Human Disasters**
severe colds	earthquake	nuclear, biological, chemical accidents
drought	floods	transport accidents
famine, etc.	landslides, rockfalls	industrial accidents
	avalanche	accidents caused by overcrowding
	gusts	migrants and displaced persons, etc.
	volcanoes	
	fires, etc.	

Source: *https://www.afad.gov.tr/afadem/dogal-afetler* (accessed on 13.02.2023).

Table 2. Types of Disasters Observed in the World

Geological Disasters	Climatic Disasters	Biological Disasters	Social Disasters	Technological Disasters
Earthquake	Heat Wave	Erosion	Fires	Mining Accidents
Landslide	Cold Wave	Forest Fires	Wars	Biological, nuclear, chemical weapons and accidents
Rock Fall	Drought	Outbreaks	Terrorist attacks	Industrial accidents
Volcanic Eruptions	Hail	Insect Invasion	Migrations	Transport accidents
Mudflows	Lightning			
Tsunami	Hurricane			
	Flood			
	Cyclones			
	Tornado			
	Blizzard			
	Avalanche			
	Excessive Snowfall			
	Acid Rain			
	Fog			
	Icing			
	Air Pollution			

Source: *https://www.afad.gov.tr/afadem/dogal-afetler* (accessed on 13.02.2023).

In 2020, millions of people around the world suffered great losses of life and property. It is shown in Figure 1 that 2020 is a year in which natural disasters with meteorological character are experienced intensively.

Figure 1: Disasters in 2020 and their consequences

Source: (EM-DAT/CRED-2020; as cited in Yılmaz, 2022) https://tatd.org.tr/afet/afet-yazi-dizisi/2020de-turkiye-ve-dunyada-en-sik-gorulen-dogal-afetler/ (accessed on 11.02.2023).

Technology and Disaster Risk Management Strategies

Many lessons on how technology and disaster risk management strategies interact can also be drawn from current experience with the COVID-19 pandemic. As a matter of fact, the use of technologies for such emergencies has once again been significantly revealed and activities in many areas such as business and education life have been transferred to the digital world (Meira and Bello, 2020). Using the best available technology can provide more focused disaster risk assessment, improve forecasts, prevent human losses with efficient early warning systems, build resilience and contribute to strengthening reconstruction strategies. On the other hand, by encouraging innovative approaches, they are able to uncover different ways of working collaboratively, and also need to define tools, data collection and analysis, risk communication and information sharing approaches. as shown in Table 3 appropriate technologies and innovative approaches can be used to support all five phases of disaster risk management (DRM) (Meira and Bello, 2020).

Table 3. Five Pillars of Action for DRM

	Pillars of action	Description	Examples of technology usage and innovative approaches
Pillar 1	Risk identification	Better identification and understanding of disaster risk through capacity building for assessments and analysis.	Exposure identification and mapping; Models; Databases: Participatory Risk Mapping (crowdsourcing), Big data.
Pillar 2	Risk Reduction	Avoiding the creation of new risks and seeking the reduction of existing risks by considering and accounting for disasters risk in the public policies and investments	Ecosystem based management and adaptation; Community based ecosystem and DRM; Hybrid solutions; Integrated water resources and coastal zone management; Earthquake-resistant constructions; Communication-network; Network analysis applications and software and system; Knowledge, communication, information, and education technologies.
Pillar 3	Preparation	Improved capacity to manage crises by developing disaster management and forecasting capabilities	Resource databases; coordination and resource allocation tools; Knowledge networks; Weather forecast: real-time tracking of storms; Home sensors (fire, and other emerging); Cluster approach and tools Mobile Response; Awareness raising technologies and tools; Social Media Technologies: UAVs and other search and rescue robotics tools; Sensors.
Pillar 4	Financial Protection	Increased financial resilience of governments, the private sector and households through financial protection strategies	Blockchain, Crowdfunding New insurance models Microinsurance schemes.
Pillar 5	Resilient Recovery	Faster and more resilient recovery through support for planning reconstruction processes	Unmanned aerial vehicle (UAVs); Coordination and resource allocation tools and technologies; “Build back better” technologies; Livelihood and disaster assessments; Improved sanitation technologies; Water access and purification technologies; Medical technologies.

Source: (Meira and Bello, 2020)

It is possible to state that risk analysis is a complex field that requires domain expertise. The group of systematic activities that can be used in the risk assessment is shown in Figure 2. This group of activities includes the following items:

• recognize and assess the potential failure of equipment and their impact;

•identify actions that may eliminate or reduce the likelihood of potential failure;

• document the process.

Objective: To be able to reveal the failure modes in the context of impact analysis (Simmons, Dauwe, Gowland, Gyenes, King, Riedstra, Schneiderbauer, 2017).

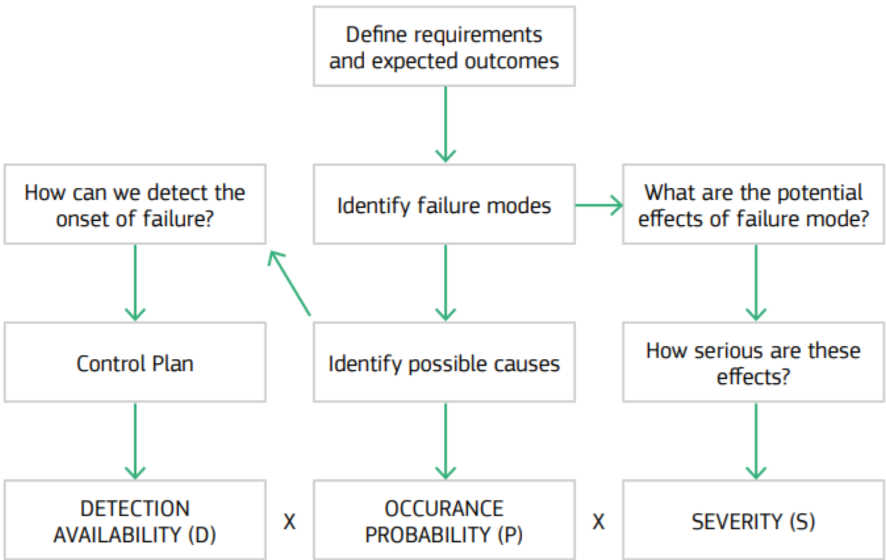

Figure 2: A graphic illustration of the FMEA process

Source: (Simmons et al. 2017).

Use of Robotic Tools

The purpose of robotic vehicles should not be to eliminate the need for human search and rescue workers. Instead, these robotic assets should be seen as another tool in the vast toolkit of human search and rescue workers to enable them to do their jobs better, faster, and safer (Cubber, Doroftei, Rudin, Berns, Matos, Serrano, Sanchez, Govindaraj, Bedkowski, Roda, Silva and Ourevitch, 2017).

Under the paradigm of danger, disasters are considered extreme physical events whose causes are accidental and have no human or cultural impact on their origin and scope; therefore, disaster management focuses on short-term post-disaster measures such as rescue, assistance and humanitarian assistance for those in need of assistance (Alexander, 1997; as cited in Vermiglio, C., Noto, G., Rodríguez Bolívar, M.P. and Zarone, 2022).

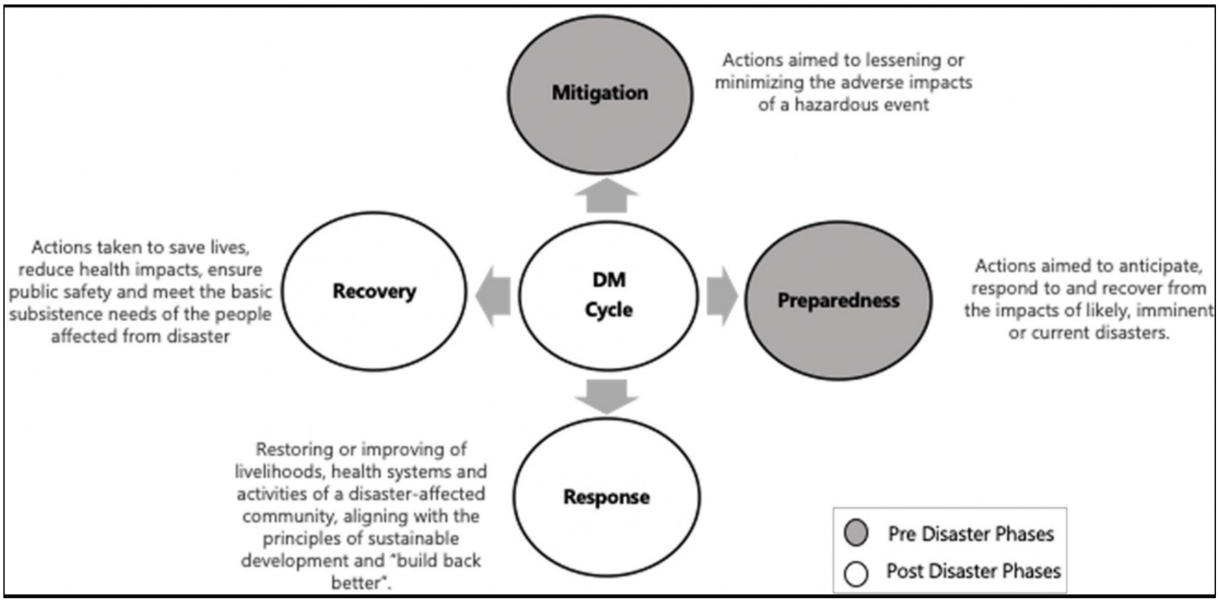

Figure 3. Disaster risk management cycle. "Elaboration"

Source: (Vermiglio, Noto, Rodríguez, M.P. and Zarone, 2022).

The European project 'Methods for the improvement of vulnerability assessment in Europe' (MOVE) developed such a concept, which attempts to represent the multifaceted natüre of vulnerability (Figure 4). In its central part, it identifies six thematic dimensions of vulnerability: the physical, the ecological, the social, the economic, the cultural and the institutional Dimension

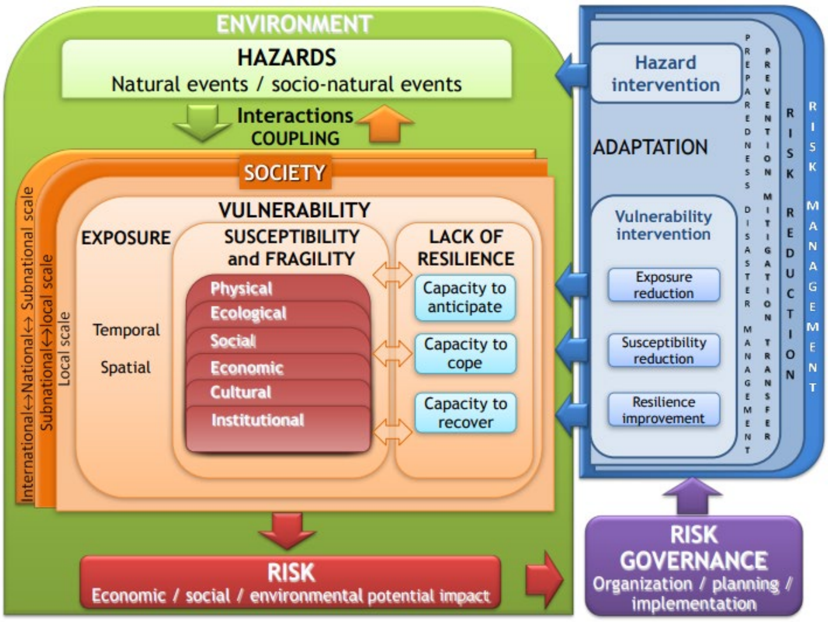

Figure 4: The MOVE framework to conceptualise vulnerability

Source: (Birkmann et al., 2013; as cited in Schneiderbauer et al., 2017)

Zuccaro et al. (2008), Marzocchi et al. (2012), Garcia-Aristizabal et al. (2013) and Selva (2013) gave the example of the seismic vulnerability of buildings loaded by ash due to volcanic activity (Figure 5, below) Schneiderbauer et al. (2017).

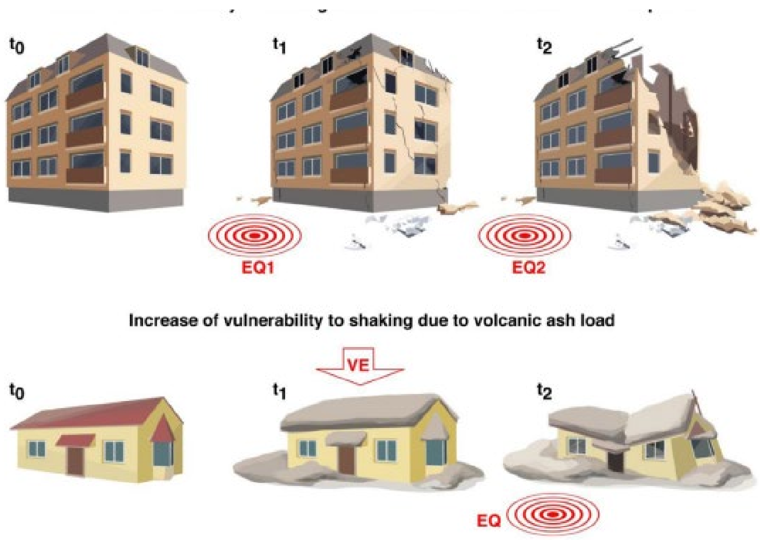

Figure 5. Two examples of state-dependent seismic vulnerability: pre-damage-dependent vulnerability (above) and load-dependent vulnerability (below)

Source: Mignan (2013; as cited in Zschau, 2017).

"The development of robot technology allows the creation of unique automated systems that not only perform dangerous work instead of humans, but also save lives. The main purpose of their development is to increase the safety of rescue teams and expand the technical capabilities of the team. In the context of the statistical scheme used, fire, bomb fighting, surveillance and (civil) security group refers to civilian robot applications. Most of these robots are remotely controlled or semi-autonomous, so this section discusses robotic devices with limited levels of autonomy as well as real robots. A classification scheme of rescue and security robots by disaster types can be as follows: meteorological, geological, man-made (terrorist) and mining." (Leotronics Blog, 2022).https://leotronics.eu/en/blog/search-rescue-and-security-robots-disaster-relief

Picture 1. Search, Rescue and Security Robots: Disaster Relief,

Leotronics Blog (2022). https://leotronics.eu/en/blog/search-rescue-and-security-robots-disaster-relief (accessed on 05.02.2023).

With the increasing frequency and severity of disasters (Alexandru et al., 2019; as cited in AlHinai, 2020) and the associated social and economic impacts on all countries, the international community has made improving the ways in which disasters are managed a key priority.

The Sendai Disaster Risk Reduction Framework 2015–2030 aims to mitigate disaster risks, addressing current challenges and preparing for the future: Monitoring, assessing and understanding disaster risks, sharing this information and how they are created; strengthening disaster risk governance and coordination between relevant institutions and sectors, and the full and effective participation of relevant stakeholders at appropriate levels; investing in the economic, social, health, cultural and educational resilience of individuals, communities and countries to disasters and the environment, including the use of technology and research; development of multiple hazard early warning systems, disaster preparedness, response, recovery, rehabilitation and reconstruction (The Sendai Disaster Risk Reduction Framework 2015–2030).

Seba, Nouali-Taboudjemat, Badache, Seba (2019); as cited in AlHinai, 2020) explored security concerns arising from the use of wireless technology in disaster situations and how these networks solve the urgent need for the exchange of sensitive and real-time information in chaotic situations.

Diwakar et al. (2015) ; as cited in AlHinai, 2020) has discussed how the use of space technology has improved disaster mitigation and response in India.

Vermiglio et al. (2022) aims to analyse the impact of emerging technologies (ETs) on improving performance in disaster management (DM) processes and, concretely, their impact on performance according to different stages of the DM cycle (preparedness, response, improvement and mitigation). In their research, they used VOS viewer software for a systematic review, text mining and cluster visualization. As a result, they highlighted how (emerging technologies) ETs improve the readiness and resilience of specific systems when dealing with different phases of the Disaster management (DM) cycle.

In his research, AlHinai (2020) states that he fills this gap by integrating interdisciplinary concepts from different research fields such as Disaster Management, Information Systems and Business Management to understand the impact and determinants of digital transformation in National Disaster Management (NDM) systems. To achieve this, it used the Technology-Organization-Environment (TOE) framework and conducted semi-structured interviews with UK NDM experts. In conclusion, he noted that the impact of digital transformation on NDM shows that it is profound, paradoxical, multifaceted and driven by a multitude of driving forces. Theoretically, this research extends the TOE framework beyond its original foundations by revealing a new set of disaster context determinants. It also offers an innovative Layered Cake FAST (Fundamentals-Approach-Strategy-Technology) Model that provides a unique roadmap for NDM on how to handle the digital transformation journey.

Figure 6. Asset-Relationship Network for NDM (AlHinai, 2020).

As shown in the figure above, this process affects a large number of stakeholders.

> *"Robots can scan avalanche areas, enter burning buildings or enter safe city streets contaminated with toxic chemicals, saving lives and improving the effectiveness of rescue missions. The latest research projects, such as NIFTi, WALK-MAN and SHERPA, are changing the way rescue services approach disaster situations. The EU-funded NIFTi project uses a ground robot and a robotic helicopter to help with urban rescue scenarios. In the event of an avalanche, robots can scan the sky and slope, leaving a human savior to think strategically. This is the idea behind the EU-funded SHERPA project, in which two aircraft and a ground vehicle are working to support the so-called 'busy genius' human rescuer. Most importantly, technology should not get in the way of a human rescuer's efforts to find a missing person. In other words, commands are not given by joystick, but by gesture and voice with the help of electronic glasses" . (Massy-Beresford, 2014, https://ec.europa.eu/research-and-innovation/en/horizon-magazine/robot-rescuers-help-save-lives-after-disasters)*

Picture 2. NIFTi robot on a reconnaissance mission at the Duomo in Mirandola, Emilia Romagna region, mission July 2012 NIFTi Team NIFTi robot on a reconnaissance mission at the Duomo in Mirandola, Italy in the Emilia-Romagna region in July 2012 *(Massy-Beresford, 2014, https://ec.europa.eu/research-and-innovation/en/horizon-magazine/robot-rescuers-help-save-lives-after-disasters)*

> *"Another EU-funded project, WALK-MAN, is developing a human-like robot that will operate in realistic locations, such as buildings damaged by natural disasters or man-made disasters. Dr. Nikos Tsagarakis, the scientific coordinator of the project, said: "Recent events show the need for reliable and effective robotic systems that can be deployed quickly after a disaster to help with tasks so dangerous that humans cannot perform them." The robot will have manipulation skills strong enough to be able to lift collapsed walls, walk and crawl over obstacles and in disheveled areas, and be sturdy enough to operate tools such as drills or cutters. To achieve these goals, the WALK-MAN project will develop technology that allows whole-body movement and manipulation – that is, all body parts of the robot will help ensure balanced movement". (Massy-Beresford, 2014, https://ec.europa.eu/research-and-innovation/en/horizon-magazine/robot-rescuers-help-save-lives-after-disasters)*

Based on these statements, it is possible to state that technology provides support in a way that minimizes the danger and helps in the context of its role in the disaster.

"Weather Robots: *Assess damage in real time, increase situational awareness through high-resolution mapping, and deliver items faster, cheaper, and more efficiently. The Global Nonprofit We-Robotics*

Program Assistance Robotics, for example, identifies local human needs and provides robotic solutions through regional flight laboratories. ***Social Media Solutions****: Results in faster, more effective responses that ultimately help beneficiaries. For example, the World Food Programme (WFP) Mobile Vulnerability Analysis and Mapping (mVAM) uses mobile technology to overcome barriers to data collection.* ***Predictive Policies:*** *This can be developed from previous disaster management; authorities and response teams can gather insights that help predict future events and identify vulnerable social segments. Sensors are used specifically for data collection and storage, which is then analyzed and extracts useful data.* https://unacademy.com/content/upsc/study-material/disaster-management/role-of-technology-in-disaster-management/ (accessed on 03.02.2023)".

Community-based approaches, initiatives and continuous awareness campaigns to prepare that encourage local ownership of risk reduction are also important. Networks, including social media, are essential tools to increase the resilience of a population through awareness-raising (ITU, 2019; as cited in Meria & Bello, 2020).

RESULTS

In order to identify potential hazards in the risk analysis, input from expert opinions should be provided. It is very important that the modeling associated with the risk assessment is done correctly. Natural disasters increase the existing awareness of what science has to offer. As it is understood from the researches, robotic vehicles play a valuable role in the world of search and rescue. Future research on robotics in the context of disaster management will fill the gap in the field. Although the researcher cannot give the requirements for the use of robotics in disaster management in depth, he believes that this research will raise awareness.

REFERENCES

Alexander, D. (1997). "The study of natural disasters, 1977–97: some reflections on a changing field of knowledge", Disasters, Vol. 21 No. 4, pp. 284-304.

Alexandru, A., Ianculescu, M., Marinescu, I.A., Popescu, T.D. (2019). 22nd International Conference on Control Systems and Computer Science (CSCS) University Politehnica of Bucharest; Romania: Shaping the digital citizen into a smart citizen on the basis of IoT capabilities; pp. 707–714. (IEEE)

AlHinai, YS. (2020). Disaster management digitally transformed: Exploring the impact and key determinants from the UK national disaster management experience. Int J Disaster Risk Reduct. Dec;51:101851. doi: 10.1016/j.ijdrr.2020.101851. Epub 2020 Sep 14. PMID: 32953438; PMCID: PMC7489232.

Birkmann, J., Cardona, O. D., Carreno, M. L., Barbat, A. H., Pelling, M., Schneiderbauer, S., Kienberger, S., Keiler, M., Alexander, D., Zeil, P. Welle, T. (2013). Framing vulnerability, risk and societal responses: the MOVE framework. Natural Hazards 67(2), 193-211.

Diwakar, P., Dadhwal, V., Rao, G.S. (2015). Challenges in Using Remote Sensing Technology for Disaster Management India: National Remote Sensing Centre (NRSC) and Indian Space Research Organisation

EM-DAT/CRED (2020). The international disasters database. https://www.emdat.be/

Garcia-Aristizabal, A., Di Ruocco, A., Marzocchi, W. (2013). Naples test case. European Commission project MATRIX, Project No. 265138, D7.3.

Geert De Cubber, Daniela Doroftei, Konrad Rudin, Karsten Berns, Anibal Matos, Daniel Serrano, Jose Sanchez, Shashank Govindaraj, Janusz Bedkowski, Rui Roda, Eduardo Silva and Stephane Ourevitch (2017). DOI: 10.5772/intechopen.69489, https://www.intechopen.com/chapters/56152)

ITU (2019). Disruptive technologies and their use in disaster risk reduction and management.

Meira, L. Fontes de and Bello, O. (2020). “The use of technology and innovative approaches in disaster and risk management: a characterization of Caribbean countries’ experiences”, Studies and Perspectives series-ECLAC Subregional Headquarters for the Caribbean, No. 93 (LC/TS.2020/106-LC/CAR/TS.2020/3), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC), 2020.

Marzocchi, W., Garcia-Aristizabal, A., Gasparini, P., Mastellone, M. L., Di Ruocco, A. (2012). Basic principles of multi-risk assessment:a case study in Italy. Natural Hazards 62(2), 551-573.

Mignan, A. (2013). MATRIX -CITY user manual. European Commission project MATRIX, Project No 265138, D 7.2.

Seba A., Nouali-Taboudjemat N., Badache N., Seba H. A (2019). Review on security challenges of wireless communications in disaster emergency response and crisis management situations. J. Netw. Comput. Appl.126:150–161

Sendai Afet Riskini Azaltma Çerçevesi 2015–2030. [Sendai Disaster Risk Reduction Framework] https://uclg-mewa.org/uploads/file/748e86d91ae4409e9188794ddb6c004d/Sendai_TR.pdf

Selva, J. (2013). Long-Term Multi-Risk Assessment: Statistical Treatment of Interaction among Risks. Natural Hazards 67(2), 701-722

Simmons, D.C., Dauwe, R., Gowland, R., Gyenes. Z., King, A.G., Riedstra, D., Schneiderbauer, S., 2017. Qualitative and quantitative approaches to risk assessment. In: Poljanšek, K., Marín Ferrer, M., De Groeve, T., Clark, I. (Eds.). (2017). Science for disaster risk management 2017: knowing better and losing less. EUR 28034 EN, Publications Office of the European Union, Luxembourg, Chapter 2.1, doi: 10.2788/688605.

Schneiderbauer, S., Calliari, E., Eidsvig, U., Hagenlocher, M. (2017). The most recent view of vulnerability. https://drmkc.jrc.ec.europa.eu/portals/0/Knowledge/ScienceforDRM/ch02/ch02.pdf

Vermiglio, C., Noto, G., Rodríguez Bolívar, M.P. and Zarone, V. (2022). "Disaster management and emerging technologies: a performance-based perspective", *Meditari Accountancy Research*, Vol. 30 No. 4, pp. 1093-1117. https://doi.org/10.1108/MEDAR-02-2021-1206

Zschau, J. (2017). Where are we with multihazards, multirisks assessments capacities? https://drmkc.jrc.ec.europa.eu/portals/0/Knowledge/ScienceforDRM/ch02/ch02.pdf

Zuccaro, G., Gacace, F., Spence, R., Baxter, P. (2008). Impact of Explosive Eruption Scenarios at Vesuvius. Journal of Volcanology and Geothermal Research 178(3), 416-453.

Internet Sources

Leotronics Blog (2022, April 17). https://leotronics.eu/en/blog/search-rescue-and-security-robots-disaster-relief (accessed on 05.02.2023).

Massy-Beresford*,* H. (*2014 March 19)*. Robot rescuers to help save lives after disasters, Horizon the EU Research Innovation Magazine https://ec.europa.eu/research-and-innovation/en/horizon-magazine/robot-rescuers-help-save-lives-after-disasters) (accessed on 12.02.2023).

Yılmaz, S. (2022, January 15). 2020'de Türkiye ve Dünyada En Sık Görülen Doğal Afetler . Afet Yazı Dizisi. [The Most Common Natural Disasters in Turkey and the World in 2020. Disaster Writing Series] https://tatd.org.tr/afet/afet-yazi-dizisi/2020de-turkiye-ve-dunyada-en-sik-gorulen-dogal-afetler/ (accessed on 11.02.2023).

https://www.afad.gov.tr/afadem/dogal-afetler (accessed on 13.02.2023).

https://unacademy.com/content/upsc/study-material/disaster-management/role-of-technology-in-disaster-management/ (accessed on 03.02.2023).