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An Analysis of India Position in Upholding the Human Rights in Combating Disaster with the Aid of Machine Learning

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Abstract:

Purpose: *In this paper, the authors focus on analyzing and examining the potential of Machine learning and Deep Learning technology for better and efficient disaster management before, during, and after hazards.*
Design/Methodology/Approach: *The authors would tend to gather the various practical implementation of such technologies across the world and offers guidance and recommendations to various disaster-prone areas of the states of India on how the leveraging of the technologies with infrastructures would enhance the better disaster preparedness and management and can be effective in protecting the human rights of victims of disaster.*
Findings: *The authors examine the presence of an effective policy environment for rewarding innovations and the effective regulatory measures that further enhance the implementation and development of such technologies and compare all the techniques which have been used for the disaster management.*
Practical Implications: *The internet access, smartphones, connected devices, cloud computing, artificial intelligence, and other innovations are reconstructing the course of action for measuring and monitoring the disaster risk and repercussions and bring forth the further comprehensive, accurate, timely risk analysis.*
Originality/value*: Research has been done to create ML/DL techniques that are applicable for various types of disasters. The most studied natural disasters are floods, earthquakes, hurricanes, general type (any disaster type), and landslides.*

Keywords: *Disaster management, machine learning, deep learning, human rights, law.*

JEL classification: *R10, R11.*

Paper Type: *Research study.*

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1. Introduction

According to the "*United Nations Office for Disaster Risk Reduction*" (UNDRR) the term hazard means a "*process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation*" (UNISDR, 2015). The hazards coupled with loss of life and property leads to disaster. It means the aftermath disastrous and fatal consequences of hazards lead to disaster.

Accordingly, term *"disaster has been defined by UNDRR as a serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts."*

The disaster, natural as well as man-made, proves to be fatal, sever and long-lasting (UNISDR, 2015). It affects all individual human being equally though the poorer may be affected by it for a longer period because of long term recovery process due to vulnerability and marginalisation. Both the developed as well as developing nation are equally affected by the disaster, though, the poorer bear the brunt (UNODRR, 2022).

"India's geo-climatic conditions exposed its large population, in varying degrees, to floods, droughts, cyclones, tsunamis, earthquakes, landslides, avalanches, and forest fire" (Data Collection Survey…, 2015). According to the Annual Report of NDMA (National Disaster Management Authority, 2020-21), "out of the total states and UTs in India, 27 states are disaster prone. Out of total landmass, 56% landmass are prone to earthquakes of moderate to high intensity while 15% of landmass are prone to landslides" (NDMA, annual report 2020-21).

According to the Extreme Weather Report, 2022 - "India 2022: An assessment of extreme weather events", prepared by the "*Centre for Science and Environment and Down to Earth*", "India has seen close to disaster every day in the nine months of this year – from heat and cold waves, cyclones, and lightning to heavy rains, floods, and landslides" and these disasters affected around 2,755 lives (Pandey and Sengupta, 2022).

The frequency and intensity of the disasters are further compounded due to climate change and environmental degradation along with increasing the vulnerability of key assets including people. According to the Report of UNODRR ("United Nation Office for Disaster Risk Reduction"), 2020, "globally there has been a sharp increase [in disaster] over the previous twenty years (UN Office of DRR, 2020)." As a matter of fact, "India ranks among the top three countries in the world that bore the maximum impact of the disaster in recent years due to its large population.

Disasters are not merely impacting the human and physical capital but also pose a serious threat to India's economic development" (Pandey and Sengupta, 2022). The Great Bengal Famine, 1770, Super Cyclone, Odisha 1999, Gujarat Earthquake, 2001, The Indian Ocean Tsunami, 2004, Bihar Flood disaster, 2007, and Uttarakhand Flash Flood, 2013 were some of the most disastrous disasters which causes number of deaths and serious threats to life, capital, and households in the affected areas (Piyoosh, 2013).

The recently occurred flash flood in the state of Uttarakhand in the Year 2013 affected twelve out of thirteen districts of Uttarakhand. As per the report, it claims that around 5,700 peoples were died in this massive flood and around one lakh pilgrims were trapped in the Kedarnath shrine (Piyoosh, 2013).

2. Global Frameworks for Disaster Risk Reduction

Disaster is a global concern. According to "*Global Assessment Report on Disaster Risk Reduction*", 2022 – "Disaster events reported per year have increased significantly in the last two decades. If the current trends continue, the number of disasters per year globally may increase from around 400 in 2015 to 560 per year by 2030 – a projected increase of 40% during the lifetime of Sendai Framework (2015-2030) (UNODRR, 2022)."

The impact of the disaster in one region/areas can have an impact on risks in another region. The height and feat achieved by the states got damaged due to the disaster, more particularly, an individual's survival, livelihood, and dignity comes to a risk. To overcome disaster loss, the various global framework has been adopted for disaster risk reduction, which provides for commitments and priorities, for reducing disaster risks, through better policy, legislative and institutional framework.

In the Year 1979, after six years of R&D, the UN Disaster Relief Coordinator, Mr. Faruk N. Berkol, convened "an Expert Group Meeting which was attended by group of experts from UN's and scientist and planners specialized in major natural hazards of meteorological, geological, and geophysical origin, from 9 to 12 July, 1979 to review UNDRO works in vulnerability analysis" (Report of Expert Group Meeting, 1980). By then, it was realised, that disasters are more destructive and ever affects larger populations and the response of international community is only limited to relief action, now that the much greater emphasis will have to be given to "*pre-disaster planning and prevention*".

It was observed that the pre-disaster planning should be based on a sound knowledge and understanding of hazards and the underlying risks involved. It was also observed that the new reliable and straightforward methods and techniques need to be developed for assessing the vulnerability which can be readily made applicable to disaster prone areas (Report of Expert Group Meeting, 1980).

Bearing in mind that the international communities, should pay special attention to provide international cooperation to develop "appropriate framework" in the field of "*Natural Disaster Reduction*." Therefore, the UNGA vide resolution no. 44/236 dated 22nd December, 1989 proclaims the "*International Decade for Natural Disaster Reduction (1990-2000)*", beginning on 1st January, 1990 (Resolution No. 44/236, 1987). Also, the *"Second Wednesday of October"* to be observed, annually, as "*International day for natural disaster reduction*" (Resolution No. 44/236, 1987).

Their intention was to minimize, through "collective action of international communities, the loss of life, property damage, and social and economic disruption caused by natural disasters," especially in developing countries by: (a) devising appropriate guidelines and strategies for applying scientific and technical knowledge; (b) developing manoeuvres for assessing, predicting, preventing, and mitigating through technical assistance, demonstrated projects, and education and training, tailored to specific disasters; (c) formulating natural disaster mitigation programmes; (d) collaborative participation of government, non-governmental organizations, international organizations, local and regional communities in the programmes designed for creating awareness, or for preparedness or mitigation of the natural disasters (Resolution No. 44/236, 1987).

They contributed by facilitating global multisectoral and interdisciplinary dialogue which resulted in the adoption of two major documents which contains the deliberations regarding disaster reduction issues that is the Strategy "A Safer World in the Twenty First Century: Risk and Disaster Reduction (1999) (IDNDR, 1999)" and the "Geneva Mandate on Disaster Reduction".

The "*International Strategy for Disaster Reduction*" (ISDR), the successor to IDNDR, was adopted by the UNGA as guidelines for natural disasters. They had also adopted "Yokohama Strategy" and "Plan of Action for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation" in the year 1994 at the World Conference on Natural Disaster Reduction" (Review of the Yokohama Strategy…, 1005).

The "Yokohama Strategy" was adopted at the "World Conference on Natural Disaster Reduction" from 23rd May to 27 May, 1994 in association with "the non-governmental organizations, international organizations, scientific community, business entity, and the media", in which "the concern was raised regarding rising world toll on human and economic losses due to natural disasters, and the adoption of an effective mechanism for disaster management, stressing the importance of role of human actions in reducing the vulnerability of societies to natural disasters."

This "Yokohama Strategy" formed the basis for the formulation of the "Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters (HFA)." The "Hyogo Framework for Action" was adopted at the "World Conference on Disaster Reduction" from 18th to 22nd January

2005 “with unique opportunity to promote strategic and systematic approach to reducing vulnerabilities and risks to hazards and to pursue the substantial reduction of disaster losses, in lives and in the social, economic and environmental assets of communities and countries” (Hyogo Feamework…, 2005).

The Hyogo framework has adopted the following priorities for action: (1) “Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.” (2) “Identify, assess and monitor disaster risks and enhance early warning.” (3) “Use knowledge, innovation and education to build a culture of safety and resilience at all levels.” (4) “Reduce the underlying risk factors.” (5) “Strengthen disaster preparedness for effective response at all levels.”

In order ensure “the continuity of work done by the States and other stakeholders under the “Hyogo Framework”, the “Third UN World Conference” in Sendai, Japan dated 18th March, 2015 has adopted the Sendai Framework for Disaster Risk Reduction 2015-2030” (Resolution adopted by the General Assembly…, 2015).

The “Sendai Framework” “shifts its focus on disaster risk management instead of disaster management, the reduction of disaster risk, focusing on new risk prevention, and casting of responsibility of States to prevent and reduce disaster risk, with all-of-society and all-of-state institutions engagement” (UNISDR, 2015; Proccedings on Third UN World Conference…, 2015).

3. Disaster Management Using Machine Learning and Deep Learning

Disaster operations are critical and complex, and this necessitates strong decision-making that is aided by information technology, particularly Artificial Intelligence (ADB and OECD, 2020; Altay and Green, 2006; Pham *et al.*, 2022). Advances in Machine Learning (ML) and Deep Learning (DL) have been utilised in recent years to address the scale and impact of disasters through effective and informed disaster management (Sun *et al.*, 2020; Thalassinos *et al.*, 2022). Over time, disaster management addresses them (Van Wassenhove, 2006). Mitigation, preparation, response, and recovery are the four distinct phases that have been widely adopted (Altay and Green, 2006; Van Wassenhove, 2006).

Activities that will either stop a disaster from happening or lessen its effects are referred to as mitigation. The term "preparedness" refers to a range of actions that communities can take in advance of a disaster, including emergency planning, stockpiling of supplies, community education and training, and prepositioning of resources to be used as needed. Implementing the plans made to protect people's lives and property, the environment, and the neighbourhood’s socioeconomic structure constitutes response (Altay and Green, 2006).

Artificial intelligence (AI) is not only playing a larger role across industries, but this expansion is also greatly accelerating economic development. Data that is readily

accessible, rising digitization, capital flows, and efficiency gains from AI use are the main drivers of this. The State, businesses, consumers, and workforces are just a few of the stakeholders that are impacted by AI's broad and varied effects. ML and DL are the AI subfields that have made the biggest contributions to many aspects of managing natural disasters (Sun *et al.*, 2020; Dwarakanath *et al.*, 2021; O'Connor *et al.*, 2021) in a time when natural disasters are on the rise, in part because of rising human activity (Yu *et al.*, 2018; Velinov *et al.*, 2023).

Numerous ML and DL techniques are used in conjunction with AI to support disaster management throughout all its phases. "Support vector machines (SVM), Naive Bayes (NB) techniques, decision trees (DT), random forests (RF), logistic regression (LR), and the K-nearest neighbour (KNN) clustering algorithm are examples of machine learning (ML) techniques.

Convolutional neural networks (CNNs), multi-layer perceptron (MLP), recurrent neural networks (RNNs), long short-term memory neural networks (LSTM), generative adversarial networks (GANs) and transformers architecture are some examples of ANNs used in deep learning (DL) methods (Altay and Green, 2006; Dwarakanath *et al.*, 2021; Yuan and Moayedi, 2020; Shirzadi et al., 2017)". Table 1 presents the different techniques of ML & DL used in disaster management along with their performance metrics.

Table 1. *Performance metrics of different techniques used in disaster management.*

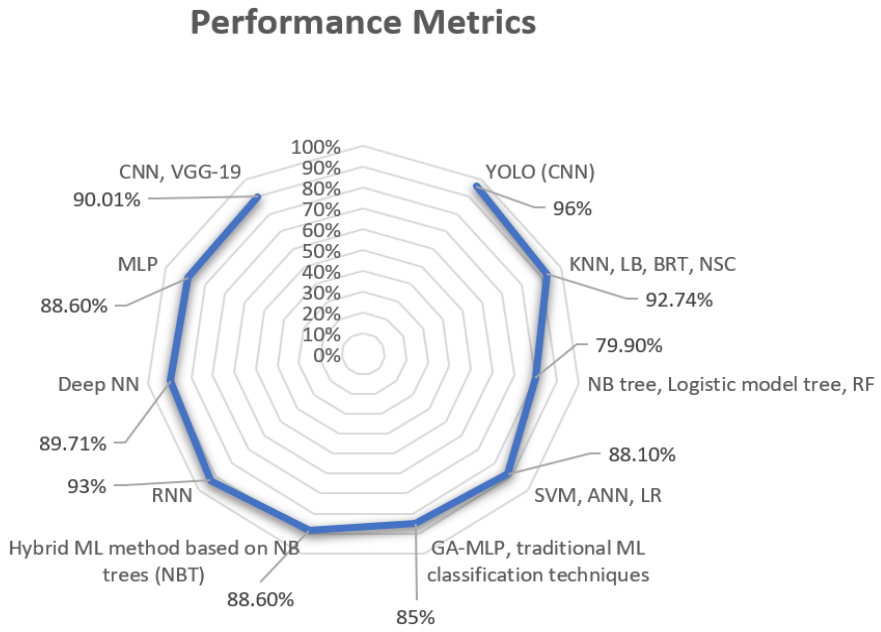
Reference No.	Disaster type	Techniques	Performance Metrics	Year
[26]	Earthquake	YOLO (CNN)	96%	2021
[27]	Flood	KNN, LB, BRT, NSC	92.74%	2021
[28]	Landslide	NB tree, Logistic model tree	79.90%	2020
[24]	Landslide	GA-MLP, traditional ML classification techniques	85%	2019
[29]	Landslide	MLP	88.60%	2017
[30]	Landslide	RNN	93%	2017
[25]	Indian Flood	Deep NN	89.71%	2020
[31]	Landslide	Hybrid ML method based on NB trees (NBT)	88.60%	2017
[32]	Landslide	SVM, ANN, LR	88.10%	2018
[33]	Nepal Earthquake	CNN, VGG-19	90.01%	2018

Source: *Own study.*

Figure 1 shows the radar graph of the performance matrices of different ML & DL techniques. Figure 2 displays the breakdown of research studies by type of disaster

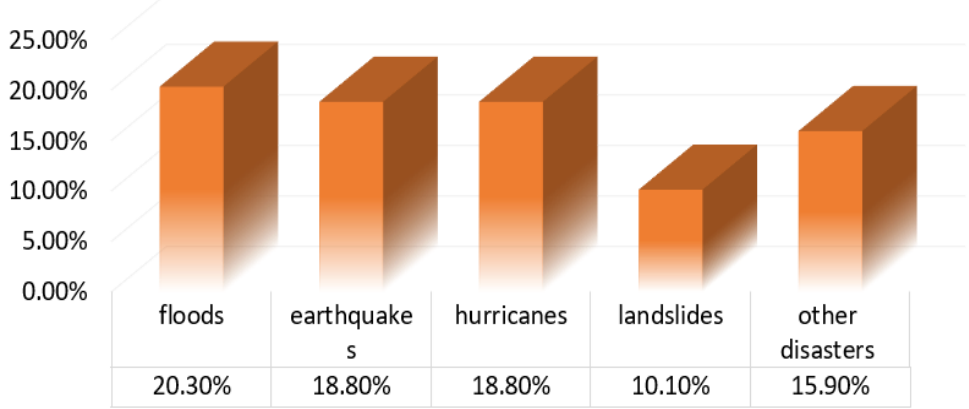
in terms of percentage. As seen in Figure 2, research has been done to create ML/DL techniques that are applicable for various types of disasters. The most studied natural disasters are floods (20.3%), earthquakes (18.8%), hurricanes (18.8%), general type (any disaster type) (15.90%), and landslides (10.1%). Disasters caused by (heavy) rainfall, typhoons, volcanoes, wildfires, avalanches, and tsunami are among the other types that have been studied.

Figure 1. *Radar graph of performance matrices of different ML & DL techniques*



Source: *Own study.*

Figure 2. *Bar graph of disaster along with uses of ML & DL (in %)*



Source: *Own study.*

4. Discussion and Conclusion

The intersection of human right and disaster management tries to reduce or curb the human rights violation in disaster. The fundamental human rights include rights to adequate housing, food, water and sanitation, health, work/livelihood, land, security of the person and home, information, participation, and education are violated in disaster.

These violations will be aggravated in case of poorly planned and executed relief and rehabilitation measures by the government. Poorly planned means the relief measures has not been taken up on timely basis and the specific need of women, children, and other marginalized and vulnerable groups within the affected areas has not been appropriately taken.

It is the duty of the nation and national/international humanitarian organizations to ensure the disaster risk reduction based on the human rights approach. The relief and recovery of an individual from the aftermath consequence of disaster shall be devised based on the human rights approach. The disaster preparedness and rehabilitation are the basic human rights recognized internationally.

Therefore, the relief and the rehabilitation must be carried out in such manner that the special need and care must be bestowed to the women, children, and differently abled persons. The interventions carried out by the government must guarantee respect to the dignity and human rights of all the survivors as well as of the non-survivors.

Machine learning is transforming every aspect of human life and is helpful in building resilience and improved efficient delivery of outcomes including the prediction of hazards at the earliest and aftermath consequences of hazards. Such technological development tends to increase the scope of managing and controlling the disasters and its associated risks either before or during the hazards or after the hazards.

Machine learning will play a vital role in all the four phases of a disaster. At the first phase, that is, the preparedness phase, it enables early warning systems; in the second phase, that is, response during disaster, it helps in the optimization of resources, personnel and routes for quick response; in the third phase, that is, in rehabilitation phase, it ensures worldwide reach for relief and aid by ensuring continuous data flow worldwide; and in the fourth phase, that is, in mitigation phase, it provides solutions to strengthen our existing infrastructure such as buildings designed to sustain higher cyclonic loads.

Also, the internet access, smartphones, connected devices, cloud computing, artificial intelligence, and other innovations are reconstructing the course of action

for measuring and monitoring the disaster risk and repercussions and bring forth the further comprehensive, accurate, timely risk analysis.

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