

# Heralding Ideas of a Resilient Nation through Education of Disaster Science in 21<sup>st</sup> Century

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## Abstract

The world with vast continental landmasses and having diversified topographic structures is bound to face a multiplicity of natural hazards on local to regional scale. Natural events of such adverse effects on human property and life have led us to conceptualize these as disasters. The trend analysis of the last 100 years over the earth reveals the fact that much has been changed by natural disasters with an average occurrence of 7 in 1914 to 341 disasters in 2014 per continent on a global scale. The present study focuses on how frequent disasters have continued to harm our environment and up to what extent threatened the sustainability of humanity in the last ten decades. The available data on past natural calamities have been studied to gauge the intensity and effects of these hazards and realizing a better way to mitigate them by educating all for disasters and disaster management as this will ensure timely disaster preparedness in general. Each disaster occurs at the backdrop of some science in it. This necessitates natural disasters as a probable area of concern which awaits intrinsic study and investigations with enough scientific aptitude and inquiry in science education of our country. The origin of such events of unforeseen calamities is set in one country, but its effects on howsoever mild or severe are widespread trans-nationally. To understand, mitigate, and to manage them finally lies with the scientific community at our disposal.

**Keywords:** Natural hazards, Disasters, Disaster management, Sustainability and Science education

## Introduction

Our earth, with the present population estimates of 7.8 billion humans, has been a cradle to the evolution, transformation, and manifestations of many civilizations that ever existed on its surface. The time elapsed, and the human society proliferated with the development of science and technology through the modern thoughts brought about by three gigantic revolutions made in agriculture, industrial and information-technology sectors of income and human sustainability (Neal, 2005). The continuance of human life on earth is intricately intertwined with the sustainability of the earth on micro to macro scale. The sustainability of earth bears the imprints of all those catastrophes that affect its ability to guard human life on it (Twigg, 2004; Omelicheva, 2011). The sustainability approach over the earth's surface is taken in various forms, each having different meanings within a window of some contextual human undertaking. In its all forms, it measures a continuing supportive platform where the outputs of the support are always yielding. If the earth is taken as a plain where the human life dwells, evolves and develops then, its ability to provide such support in a continued state within a time range will give us how sustainable is our earth for the continuance of human life and its development

(Codreanu et al. 2014). Earth has diversified geographical conditions and is impacted differently by natural disasters of varying intensities across various regions of the world. Over the years, the earth's surface has kept on changing under the varied impacts of natural events occurring on it (Bernhardsdottir et al., 2016; Briceno, 2007). Initially, thought to be events of divinity occurring under the supremacy of the almighty creator the God, they are now found to be embedded in the fabric of science and within the framework of earth's physical phenomenon. Some incipient studies would thus, perhaps reveal that their definitions changed as the science progressed, and the man started to turn to investigations of inquiry into them (Aitsi-Selmi et al., 2016). They would have been substantially referred to as an event, a chance phenomenon, a physical disturbance, an imbalance in the state of earth's equilibrium, a calamity, a hazard and so on or the most accepted vocabulary of modern times as natural disasters (Bui et al., 2014; Omelicheva, 2011). As time elapsed, global interconnectivity grew, and the world shrank with increasing stresses, shocks, and risks, which once occupied a limited geographical space. Since time immemorial, people vulnerable to these disasters become victims resulting in huge loss of property and life (United Nations, 2019).

### **Literature Review**

Several studies were conducted on disaster events in time and space for their impacts on human society in terms of loss of property and life (Aitsi-Selmi et al., 2016; Lazzaroni and van Bergeijk, 2014; Omelicheva, 2011; Toya and Skidmore, 2007). They rose from few in numbers to their frequent occurrences witnessed by different parts of the world in a year (Galperin and Wilkinson, 2015; Lal et al., 2012). United Nations 2018 Annual report cited that nearly 60 million people were affected by extreme weather events around the world, and earthquakes, tsunamis, and volcanic activity perished thousands of lives in 2018 (United Nations, 2019; IFRC, 2016). Millions displaced by drought and storms and recurring floods (United Nations, 2019). These disaster events demonstrate and call upon for a human mechanism of reducing mortality, the number of affected people, damage to critical infrastructure,

and shattered economy. Earlier studies (Viscusi and Zeckhauser, 2006; Neumayer and Plümer, 2007; Achora and Kamanyire, 2016) suggested that the population acts as a key variable in determining the impacts of these disasters as mitigation reduces the number of vulnerable people in case if a disaster occurs. (Toya and Skidmore, 2007; Lazzaroni and van Bergeijk, 2014; Twigg, 2004) concluded that countries with institutional disaster framework and better institutions experience fewer victims and lesser economic losses from natural disasters. Nix-Stevenson, 2013 suggested a non-linear relationship between economic development and economic losses from disasters.

Education is the biggest strategy for human development and is a force that pushes the nation towards perpetual growth (Bentri, 2017; Komac et al., 2013; Singh, 2007). Recent studies accorded for Disaster science education as a universally applicable tool for future progress in reducing these disaster losses (Achora and Kamanyire, 2016; Viscusi and Zeckhauser, 2006; Takahashi et al., 2015; D Selby and Kagawa, 2012). The scientific study of disasters provides the government a monitoring system to mitigate and seek an early response to disaster preparedness (Viscusi and Zeckhauser, 2006; Briceno, 2007; Takahashi et al., 2015). Disaster management strategically prepares people for reacting and recovering against risks of small or large scale, frequent and infrequent, sudden, and slow disasters (Nix-Stevenson, 2013). Past researchers (Sauerborn and Ebi, 2012; Toya and Skidmore, 2007; United Nations, 2019; Achora and Kamanyire, 2016) drew the idea that an effective disaster planning includes an introduction about them at school level and preparing children to combat and sensitize about disasters. Some authors (Takahashi et al., 2015; Viscusi and Zeckhauser, 2006; Shiwaku and Fernandez, 2011) advocated for stronger participation of disaster victims in reconstruction activities to reinforce communities and empower their resilience against disasters.

Few workers (Nix-Stevenson, 2013; Lal et al., 2012; Komac et al., 2013) opined for the development of methods that impart more information to the community and enable personal decisions for mitigative or preventative actions

under a state of disaster stress. (Toya and Skidmore, 2007; Omelicheva, 2011; D Selby and Kagawa, 2012) supported a stronger resilience by adopting the strategy of investing today and saving lives tomorrow. Few authors demonstrated that the best actions are people-centered and that pre-disaster investments are essential as the first step in reducing chronic vulnerability to disasters (Karnawati et al., 2015; Khorram-Manesh et al., 2015; Erdur-Baker, 2015). Some studies (Komac et al., 2013; Takahashi et al., 2015) emphasized on building and maintaining relationships between and within communities, between governments and organizations, across departments, and so on to enhance the accessibility of resources, services, and information under an integrated disaster management system. Previous literature (Sauerborn and Ebi, 2012; Toya and Skidmore, 2007; D Selby and Kagawa, 2012) asserted that risks are communicated by education in ensuring that families and communities prepare for a disaster and reduce their risks. People react prudently when a disaster hits with no early warning only when they are aware of recovery mechanisms and ways to access them (Nix-Stevenson, 2013). The Sendai Framework for Disaster Risk Reduction (DRR) 2015-2030, set a development agenda for member states (187 UN member States) to protect development gains from disaster risks (United Nations, 2019; IFRC, 2016; D Selby and Kagawa, 2012). It proclaimed that local populations represent the first and last actors in crisis response recovery and building resilience is not possible without education and mass awareness of DRR.

Decision-makers (D Selby and Kagawa, 2012; Khorram-Manesh et al., 2015; Yamori, 2008; Komac et al., 2013) asserted for DRR as a cornerstone of policy making and programs implementation for all national governments. An increase in public awareness through a national education plan effectuates the mechanism of disaster management in terms of outreach to children and youth (Singh, 2007). Educating people on disasters prevent new and reduce existing disaster risk. Earlier writers (Lal et al., 2012; Komac et al., 2013; Bentri, 2017) stressed for an efficacious disaster plan based on the accurate understanding of disaster risks in all its dimensions of exposure to people and assets, hazard

characteristics, vulnerability and capacity-building response in an area. The role of disaster science education thus becomes undeniably crucial in understanding disasters and their risks (Viscusi and Zeckhauser, 2006; Achora and Kamanyire, 2016; Codreanu et al., 2014). Few researchers (D Selby and Kagawa, 2012; Adiyoso and Kanegae, 2012) recommended the extension of DRR education from schools to communities with the involvement of parents and to reach out to children who are out of school, including children with disabilities. (Galperin and Wilkinson, 2015; Bernhardsdottir et al., 2016; Takahashi et al., 2015; D Selby and Kagawa, 2012) emphasized the importance of establishing a national-level comprehensive school disaster management plan for child safety and protection. The Bangkok Action Agenda of 2007, recommended encouraging education departments to form a concrete policy of integrating disaster risk reduction into school science curricula with adequate participatory mechanisms in formal and non-formal education for DRR (Bentri, 2017).

(Komac et al., 2013; Sauerborn and Ebi, 2012; United Nations, 2019) substantiated the claim that long-run disaster reduction policies require efforts to improve the disaster education for a foolproof DRR. Field-workers (D Selby and Kagawa, 2012; Khorram-Manesh et al., 2015; Erdur-Baker, 2015) suggested for imparting systematized training to schools and communities based on the lessons drawn from past disasters. Investigators (Neal, 2005; Neumayer and Plümper, 2007; Komac et al., 2013; Bui et al., 2014) concluded that a meaningful and essential disaster science education in schools and colleges fosters an attitude of stronger resilience in people. It provides good opportunities for DRR, with emphasis on renewed participatory and community-oriented approach, involving each one teaches one on disasters (Takahashi et al., 2015; Viscusi and Zeckhauser, 2006; Chou et al., 2015; Codreanu et al., 2014; Muttarak and Pothisiri, 2013; D Selby and Kagawa, 2012). The paper focuses thus, on a meticulously imparted disaster science education towards increasing preparedness for response and recovery and strengthening resilience in a susceptible state.

## Equation of Risk Governs the Concept of Sustainability

The disasters in their scientific constitution follow a worldwide accepted equation of risk, which is given as

$$\text{Risk} = f_n (\text{Hazard} \times \text{Vulnerability} \times \text{Exposure})$$

### Equation (1)

The equation implies that disasters as a natural phenomenon have a dynamic of risk or the danger for the human sustainability which is always dependent on variables of hazards, vulnerability attached with that hazard and the time for which a part of the land is exposed to the hazards (Twigg, 2004; Neal, 2005). A hazard shall mean the potential to disrupt human society and its environment with a magnitude beyond the coping capacity of the affected community. Vulnerability states the extent of being getting damaged, which can take place in the affected area in terms of social or economic loss or both. However, the severity of such a disaster would be realistically related to the ultimate factor of exposure time in its occurrence period (Chou et al., 2015). The aforesaid discussion makes it clear that disasters have an inherent component of risk in the form of danger for human society (Toya and Skidmore, 2007). The question is how it relates to the concept of sustainability.

## How Sustainability Co-relates with Disasters

The promise of sustainability is deep-rooted and upheld for a simple underlying fact that earth should provide us our all basic needs for all times at the same pace and up to a similar extent of requirements existing currently. A disaster is such a huge impact factor of sustainability assessment that it can slow down the pace as well as the extent of this proposed sustainability (Muttarak and Pothisiri, 2013; Codreanu et al., 2014). Human society dwells with a constant equilibrium which he maintains with the environment within a framework of prerequisite ecological inter-relationships. Since the disasters are known to greatly disrupt this steady state of natural equilibrium by their impacting magnitude, exposure time, and arrival frequency, the land's carrying capacity is attenuated (Clerveaux and Spence, 2009) and hence, forming a limiting factor in sustainable human development.

## The Manifestation of Human Distress by Aggregate Statistics

Any naturally occurring adversity will be qualified for being called a disaster only if it crosses over a threshold value set and calibrated by the government of the affected country.

**Table 1: Trends and Figures of Natural Disasters and their Effects in 1912-2019 Period**

Years	Total Number of Disasters		Total Affected (Number of persons in thousands)	Total Deaths (Number of persons in thousands)	Trend in Number of Disasters (Percentage factor increase or decrease over last shown data)	
	Global	Asian	Global	Asian	Global	Asian
1912	7	4	99.09	52.09	--	--
1922	7	2	11.00	101.24	0.00	-50.00
1932	9	4	36.88	73.29	+28.00	+100.00
1942	9	6	183.10	1608.23	0.00	+50.00
1952	24	9	1001.73	8.95	+1.66	+50.00
1962	28	12	143.26	17.35	+8.33	+33.33
1972	64	30	219154.82	20.03	+128.57	+150.00
1982	160	68	151118.61	13.95	+150.00	+126.67
1992	233	101	68609.27	18.89	+45.63	+48.53
2002	505	175	659261.17	21.32	+116.74	+73.27
2012	369	143	111425.29	11.60	-26.93	-18.29
2019	396	160	94900.00	11.76	+7.32	+11.89

Compiled from Recorded Data by the Centre for Research on the Epidemiology of Disasters in its Emergency Events Database (EM-DAT)

Under this definition, we broadly classify three categories of natural disasters, namely geological, hydrological, and meteorological disasters (D Selby and Kagawa, 2012; Twigg, 2004). However, the definition also extends to some less discussed disasters of wildfires, health disasters in the case of an epidemic, and those rarely seen space disasters created by impact events and airbursts (Galperin & Wilkinson, 2015; Wand et al., 2015). The study can be best illustrated and exemplified for the ongoing Corona Crisis in 2020 when the Covid-19 creates a local to a global threat to human existence and offers multitudes of devastating episodes of causality and nature's fury. Many of the disasters in the earth's history are traced through their global evidence collected by avenues of discoveries where the findings are inappropriate for any quantified assessment (Galperin and Wilkinson, 2015). From an available database, the quantifications are met out in the form of aggregate data since the beginning of the last century.

The various kinds of disasters of varying magnitudes and each sub-type having distinctive scales of destruction were taken in aggregate form, and the data was put under study at an interval of ten years period starting from the year 1912. The recorded data about 2019 was also taken to gauge the current state of disasters. At the beginning of the twentieth century, we faced 7-9 hazards per continents in a year, with no significant rise in the world population. However, the reported number of affected people and the resulting deaths were more at the end of 1942 or the World War II period. A time scale study revealed that the numbers recorded maxima from 1972-1982 with a gain of 150 percentage points. This period marks the age of sudden population rise and change with more technological upbringings in India and worldwide and, therefore, seemed most accountable to a greater number of people affected and the resulting number of deaths (Khorram-Manesh et al., 2015; Nix-Stevenson, 2013; Omelicheva, 2011).

### **Impact Studies of Natural Disasters**

The compiled data on natural hazards provide us the numerical facet of damages regarding their increase in numbers and frequency with the advancement of time. We study through these

numbers their impact over the land in general and on human life in particular. Their impact studies require a step deeper approach of assessment and evaluation (Codreanu et al., 2014; Sauerborn and Ebi, 2012). From 1912-1915 there was a negligible increase in the number of disasters per year globally in its early half-century up to 1942 and after it, they rose in bigger numbers till 2002 by almost doubling every ten years. The trend was most visible in the Asian continent, where our country holds a key position. After 2002, we account for an abrupt drop of 26.93 and 18.29 percentage points in the number of these disasters both at global and Asian continents respectively in the last ten years. However, post-2012, up to 2019, a net increase in the number of disasters were recorded with similar large-scale mortality figures of 11,700 deaths worldwide (IFRC, 2016). The reasons for such timely variations are manifold but culminating at one focal point of the study. After 1972, the global population grew enormously with more and more exploitation of resources, and the sustainability of the earth has been tested from this time onwards (Codreanu et al., 2014; Erdur-Baker, 2015). Better technologies came, more industrial clusters and agglomerations sprawled, industries dominated with persistent agriculture to feed a huge population of 7.8 billion humans as of March 2020. The earth provided the same land earlier with similar dimensions as it is offering today. Still, man as the sole judge of using resources has ultimately disrupted the state of equilibrium in nature as witnessed through intensified and frequent natural hazards post year 2000 (Adiyoso and Kanegae, 2012; IFRC, 2016).

### **Measures to Mitigate Natural Disasters: A Critical Governance Issue**

It is evident from the facts that with further rising population and greater ecological imbalances, our lands will lie more prone to disasters (Karnawati et al., 2015; Neal, 2005; Wand et al., 2015). For a country like India having sub-continental dimensions feeding nearly 18% of the world's population, India is projected to be the world's most populous country by 2022, surpassing China and is bound to face disasters in the form of catastrophes (Galperin and Wilkinson, 2015; Bui et al., 2014). This was already felt by us, and our government planned to enact



Disaster Management Act in 2005, which provided us institutional, legal, financial, and co-ordination mechanisms at the national, state, district, and local levels. The Indian government places its vision to build a safe and disaster resilient India by adopting a holistic and integrated approach towards disaster management where community participation, capacity building, and co-operation with agencies at national and international levels are sought out. In the formulation of the objectives of such a national policy on disaster management (Aitsi-Selmi et al., 2016), we have proposed culture of prevention, preparedness and resilience at all levels through knowledge and education by encouraging prevention from disasters based on technology, traditional wisdom, and environmental sustainability. It forms the cornerstone of all efforts of the government to understand, reduce, and manage risks.

### **Science in Disasters: An Essential Feature of Science Curriculum**

One major cause of greatest disasters in the last 30-40 years has been the climate change phenomenon not by nature itself but by the triggering effect of man's rising population (Galperin & Wilkinson, 2015; Adiyoso & Kanegae, 2012). Therefore, human-induced climate change accelerates several natural disasters if the human population grows uncontrollably at the present rate with further degradation of the environment (Chou et al., 2015). Further, any disaster is an event in the outcome, but its development, progression, and dissipation are governed by physical laws just like a phenomenon in other natural and applied sciences (Briceno, 2007; Sauerborn and Ebi, 2012). A disaster can never be explained and estimated in its chance probability with a scientific commitment to its study by way of the usage of empirical, observational, and analytical research methods in it. The scientific community has made several strides to locate the cause of them and have successfully given both quantified and qualitative assessment of disasters (Sauerborn and Ebi, 2012; YAMORI, 2008). If at one end lie, are the causes of natural hazards then, their assessment, risk evaluation, monitoring, control, and preventions are the other major objectives of science at the other end (Chou et al., 2015; Erdur-Baker, 2015; Karnawati

et al., 2015). This sufficiently justifies that disasters have science in them, and this science forms a bridge of human response to natural disasters between their causes and measures of mitigation and management.

### **Disseminating Disaster Science Education: A Way to a Better Living**

Disaster mitigation and management effort aim to achieve its objectives through six levels of imparting education and training, namely as prevention, mitigation, preparedness, response, rehabilitation, reconstruction, and recovery (Erdur-Baker, 2015; Khorram-Manesh et al., 2015; D Selby and Kagawa, 2012). What is provided by the earth is destroyed by disasters, thus interrupting the sustainable development process and downgrading sustainability (Sauerborn and Ebi, 2012)? Without understanding the essentials of science in disasters, we shall not meet effective community participation and their co-operation at all levels in the time of crisis (YAMORI, 2008; Singh, 2007; Achora and Kamanyire, 2016). Just like an elementary knowledge of computer application is essential for every countryman for digital India, preliminary sound knowledge of disaster science shall render each one of us to act in a timely way towards mitigating a disaster through a self-preparatory response (Chou et al., 2015; Wand et al., 2015; Lazzaroni and van Bergeijk, 2014). Many-a-times, when science fails to deliver, the prevention only delivers a cure. Who can teach better a human and a civilized society at large, none better than the Corona 2020 pandemic? To make our earth a better place to live on the lines of ensuing sustainability and well-being, a strategy to educate each one in disaster sciences shall yield fruitful results at the national level in the long run (Aitsi-Selmi et al., 2016; Galperin and Wilkinson, 2015). Such science education reiterates the need to identify a more unified approach to address early disaster preparedness under the integrating concepts of development and resilience of human society at large.

### **Conclusion**

Every country runs from the risk of disasters, and these disasters are inevitable because they are naturally arriving with great spatial-temporal

variability, without giving an early warning and range in magnitude from feeble to devastating. Their effects may be completely catastrophic to ruin crores of human property and a multitude of life. The progress and the wholesome development of the country will inter-relate to its capability to cope up with the situation when a disaster strikes its land and people. To fight back from any economic pitfalls and environment degradation impacting national sustainable goals, disaster education offers us an indispensable scientific tool to mitigate disasters. Natural disasters though a comprehensive theme to work upon is still a phenomenon least understood in our education system. Without realizing scientific spirit and rationalizing thoughts associated with disaster literature and integrating science behind disasters by each one of us, the goal to manage our earth resources and to prove a nature worthy of being called sustainable and hence, the notion of all-round sustainable development remains devoid of reality. The science of disasters, if rendered through an effective approach encompassing a national curriculum, shall cater to standard procedures for managing critical situations. With the goal of assuring development and ultimately building a resilient community, disaster education shall substantially strengthen disaster risk governance in the nation. This framework of action provides ample opportunity for national actors to push for any changes to address gaps in disaster response. Exploration and dissemination of disaster science as a mandatory part of the science curriculum is the need of the hour in the country and a national aspiration for a country like India with varying geographies.

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