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# GLOBAL OVERVIEW ON THE RECENT STUDIES OF GEOHAZARDS: A DYNAMIC POPULATION APPROACH

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## ABSTRACT

Geohazards are often present in highly populated areas. Dynamic changes in population exposure to geohazards have resulted from shifting population numbers, spatial dispersion, and mobility. In addition, the changing vulnerability distribution of the population is a crucial consideration when establishing an effective evacuation strategy. Therefore, exploring the link between geohazards and population exposure is vital to avert disasters. This paper reviewed geohazards around the world based on a dynamic population approach. It identifies and synthesizes evidence of links between certain parts of the dynamic population and geohazard risk management. The major search engine in this investigation was Google Scholar. "Geohazards", "dynamic population", and keywords related to geohazards like landslides, floods, drought, earthquake, and tsunami were used, followed by terms related to dynamic population. The review shows that geohazards based on a dynamic population approach include socioeconomic status; gender and gender relations; migration, residency, and mobility; education and knowledge; and religions and beliefs. Understanding those elements is essential to managing geohazard risks because it can assist the government in its financial commitment and allocation in the event of a disaster, constructing effective policies and adaptation plans, and including communities in managing geohazard risks.

***Keywords:*** *Geohazards, Dynamic population, Vulnerability, Adaptation, Risk management*

## 1. INTRODUCTION

Geohazards are geological, environmental, geomorphological, and anthropogenic characteristics or actions that may endanger human life, property, or the environment (Dikshit et al., 2021; Hidaayatullaah & Suprapto, 2022). Two main types of geohazards are natural hazards (earthquakes, volcanic eruptions, floods, landslides, and tsunamis) and human-induced hazards (land subsidence consequent to groundwater extraction, water contamination, and atmospheric pollution) (Tomás & Li, 2017). Although geohazards as a topic are extensive due to the numerous potential generators, earthquakes, landslides, floods, droughts, debris flows, and glacial lake eruptions are the six most devastating geohazards (Dikshit et al., 2021). In many cases, geohazards can be triggered and result in disasters with little to no warnings, emphasizing the significance of researching and monitoring the endangered areas for risk management objectives (Pappalardo et al., 2021). Furthermore, some geohazards have high-frequency rates or return periods, particularly large-scale geohazards that also have the potential to impact broader spatial extents. Such geohazards pose higher risks that are difficult to manage are widely spread and pose a higher risk; as a result, the risk is difficult to manage. It is critical and vital to examine geohazard conditions, including their relationship to spatial patterns (the distribution of settlement and socio-economic level) and human activities (Zhang et al., 2012).

Geohazards are often present in highly populated areas. The capacity to monitor geohazards from many locations could be an essential tool for determining the degree of hazard and, as a result, for predicting and preventing accidents and deaths (Prasetya et al., 2021). The world's population has exploded in the last two centuries, reaching over 7 billion people in 2011. The increased population has resulted in rapid urbanization and increased land occupation, as well as increased demand for primary resources (water, food, electricity, building materials, etc.), as well as increased anthropogenic impact on the environment (industries, traffic, wastes, pollution) (Gutiérrez et al., 2014). Furthermore, due to the tremendous increase in air pollution emissions caused by industrial and economic growth over the previous century, air quality has become a global environmental issue. A growing amount of evidence implies that massive changes occur in our environment, including changes in the atmosphere and temperature. These changes impact the biosphere, human environment, and biodiversity, particularly global warming caused by human activities. Mitigating and reversing the effects of these alterations are significant problems (D'Amato et al., 2015; Suprapto et al., 2022). Human activities supporting industrial and economic growth can also cause waste in the aquatic environment, such as heavy metal pollution (Agarin et al., 2021; Asih et al., 2022; Nolos et al., 2022), increase in turbidity and pH of water that is not suitable for daily needs (Zamroni et al., 2022). In addition, the development of coastal cities will also cause a groundwater deficit and trigger seawater intrusion (Zamroni et al., 2021). For instance, Deschênes and Greenstone (2011) found a statistically significant link between mortality and daily temperatures, with frigid and hot days being linked to higher mortality rates. Only a few studies document regional scale-to-global-scale effects, varying by climate zone, temperature measures, and geographical area. River and coastal floods have also been thoroughly examined in the future. However, these methodologies frequently overlook human vulnerability, reporting the population potentially affected (e.g., individuals living in flooded areas) without stating the fraction of people who could die. The lack of robust vulnerability models based on observation-driven statistics makes estimating human consequences difficult (Forzieri et al., 2017).

Risk reduction and natural hazards research explains the relationship between demographics and natural hazard risk management. Most articles, however, have emphasized cities in recent years, focusing on links between rising settlements and hazard exposure following the global urbanization trend. Despite the evident reality that urban and rural areas are vulnerable in different ways, areas experiencing population decrease and shrinking are frequently overlooked (Clar, 2019). The changing vulnerability distribution of the population is a crucial consideration when establishing an effective evacuation strategy. Many factors can influence population susceptibility, including population density, age, race, health, and other related aspects. Population density significantly impacts area vulnerability of all these factors, as more powerful concentrations of people mean more difficult evacuation. An evacuation plan's dynamic population density distribution should be given greater attention because it incorporates specific population characteristics such as the elderly, children, and the unemployed (Zhang et al., 2013). For evaluating and mapping communities' risk to geohazards, the calculation of social vulnerability is essential, with population exposure being one of the most critical factors and pre-assessment requisites. Although a quantitative assessment of geohazard risk is required to enable spatial planning and local governments to provide population protection, more work has gone into understanding geohazards than calculating possible impacts on people and infrastructure. As a result, the first stage in geohazard preparedness is identifying and mapping population concentrations (Freire et al., 2013). Dynamic changes in population exposure to geohazards resulted from shifting population numbers, spatial dispersion, and mobility. Therefore, exploring the link between geohazards and population exposure is crucial (Zhang et al., 2018). This paper reviewed geohazards around the world based on a dynamic population approach. It identifies and synthesizes evidence of links between certain parts of the dynamic population and geohazard risk management. Specifically, this review paper aims to answer the following questions:

1. What elements of the dynamic population are linked to managing geohazard risks?
2. How are the links between certain parts of the dynamic population and geohazard risk management?

## 2. RESEARCH METHOD

The major search engine in this investigation was Google Scholar (GS), which can provide access to a recognizable corpus of academic literature and so is a better tool for the objectives of this study than Scopus or Web of Science (WoS) (Nguyen et al., 2019). GS covers most subjects, and the findings from Scopus and WoS are relatively similar (Harzing et al., 2016). The library sector has done most of the research on GS as an educational information search tool. The search engine was excellent for an institution, person, journal, or other scholarly communication channels to access 100% of the online knowledge (Martín-Martín et al., 2017). GS indexes individual academic articles from journals and conferences, academic publications, theses and dissertations, abstracts, preprints, technical reports, and other scholarly material from various fields. This search engine is also accessible through a university library, allowing scholars to link to papers in GS using library resources. GS can link other articles that mention a specific theme, connect readers to comparable publications, set up notifications to track publications for research areas and preserve a personalized library of papers (Zientek et al., 2018). It is also a free service for retrieving scholarly journals (Halevi et al., 2017). In addition, a thorough grasp of this case study requires reviewing some initial research (Zamroni et al., 2020).

This investigation also used the keywords technique. It is user-friendly and straightforward, with reasonable retrieval precision, while semantically rich ontology solves the need for complete text retrieval descriptions and improves retrieval precision. Text retrieval, web page retrieval, summarization, text clustering, text mining, and other applications benefit from keyword extraction. Choosing which document to read is simple to learn the relationship between texts by extracting necessary keywords (Poulimenou et al., 2014). The main keywords represent an article's title and indicate that piece's content. It can make finding related publications easier for others, including scholars (Mohaghegh et al., 2018). "Geohazards," "dynamic population," and keywords related to geohazards like landslides, floods, drought, earthquake, and tsunami were used, followed by words related to dynamic population like demographic, socioeconomic, residency, migration, mobility, gender, gender relations, knowledge, education, religion, and beliefs. The kinds of literature used are only currently available (2011 to 2022). The authors sought a thorough search of data using these keywords, considering all study aspects. To exclude unnecessary records, publication titles, and abstracts were checked. Reading abstracts to comprehend the main idea of the previous study has been conducted to select references. It is essential to read the complete text to add more understanding (Suprapto et al., 2017).

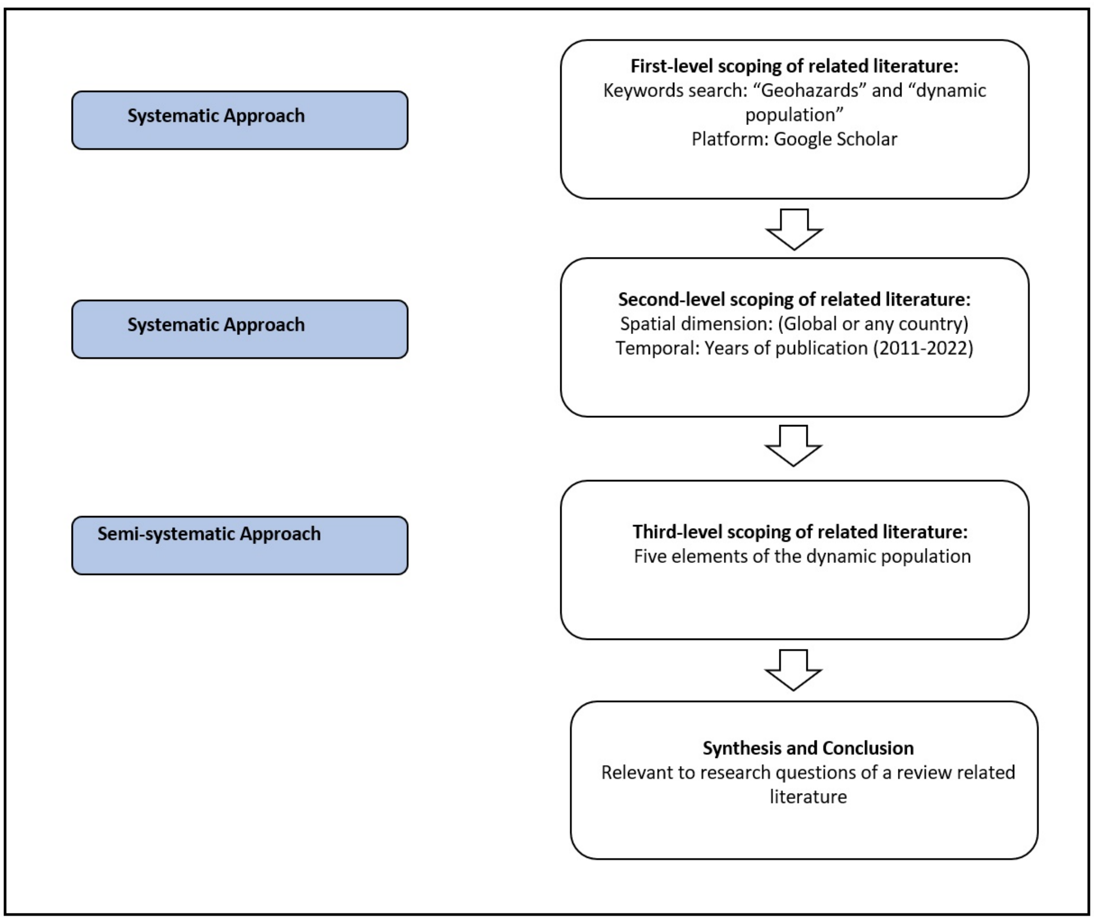


**Figure 1.** The methodological framework of the study

Figure 1 shows the methodological framework for this literature review, adopted from Snyder (2019). A systematic review approach aims to synthesize and compare literature evidence. This step is focused on the keywords search "geohazards" and "dynamic population" in the first-level scoping and the Spatio-temporal dimension in the second level.

Meanwhile, a semi-systematic review approach aims to overview the research area and track development over time. In this step, the authors focus on five elements of the dynamic population. The last stage is to conclude that it is relevant to research questions of review-related literature.

## 3. FINDINGS

### 3.1 Geohazards based on a dynamic population approach

According to Clar (2019), the dynamic population discussion includes "socioeconomic status; gender and gender relations; migration, residency, and mobility; education and knowledge; and religions and beliefs". These elements will be linked to the management of geohazard risks.

*1. Socioeconomic status*

Only two of the factors of vulnerability are society and the economy. Social vulnerability is a complicated and dynamic concept that changes through time and geography, making it difficult to represent with a single variable. It depicts the multidimensionality of catastrophes by emphasizing the entirety of interactions in each social scenario, which, when combined with environmental forces like geohazards, result in a disaster. The economic dimension of vulnerability is the propensity for financial loss due to physical asset destruction and business interruption (services, activities, or delivery of products). Another crucial factor to consider is the relationship between economic and social components (Contreras et al., 2020). Socioeconomic factors such as population characteristics, industrial structure, and spatial dispersion influenced geohazards (Ding et al., 2020). There is no indication of a link between disaster effects, such as the number of fatalities or the impacted population, and Gross Domestic Product (GDP) growth.

Nonetheless, it suggests that the extent of damage caused by a disaster will harm GDP growth. As a result, it is critical to combine the number of injuries and fatalities with the financial loss caused by a disaster (Contreras et al., 2020). Within the exposure index, land use and regional development inequalities are compatible with the spatial characteristics of population density in the presence of socioeconomic change. From the municipal and commercial building standpoint, a high population density signifies a dynamic economy and accelerated urban growth, leading to centralized disaster threats. As a result, regional vulnerability may increase. Hazards are not just a natural process; they also impact the distribution of economic resources. Government support becomes the principal source of resilience when a community's ability to cope with geohazards is insufficient. In such cases, the government's financial investment and allocation will directly impact the tenacity of personnel and assets regarding relief assistance, which might improve authorities' emergency response capacity regarding public health care and expertise. As a result, to meet a significant need for help, the amount of government funding available has become extremely important (Gao et al., 2021).

Geohazards frequently result in fatalities and significant economic losses. Disaster risk reduction and societal resilience, and emergency response capability are concerns that must be addressed. The rapid expansion of society has accelerated environmental changes, which has increased the potential for natural disaster harm. As a result, academics are increasingly paying attention to social vulnerability (Miao & Ding, 2015). Communities' socioeconomic situation should be one factor examined while evaluating disaster management plans. Floods, for example, are inextricably tied to socioeconomic vulnerability. Flood damage to structures is more common among high-income people than low-income people. Lower-income people, on the other hand, have disproportionately higher death rates. Multiple vulnerability studies show that marginalized people cannot protect themselves from floods, return home or work after a flood, and access social safety nets before and after a disaster. Obtaining flood insurance modulates adaptive capacity and sensitivity, while mandated flood insurance is directly linked to exposure. Policy reforms to the national flood insurance program disproportionately affect low-income and minority groups (i.e., vulnerable populations) and have the potential to exacerbate pre-existing vulnerabilities (Frazier et al., 2020). In Bangladesh, middle-income families were more likely to migrate due to their awareness of disaster hazards. Although poorer village members migrate for income rather than safety, some from the unskilled and the better educated seek opportunities abroad, such as in India (Penning-Rowsell et al., 2013). However, several governments have given this subject significant thought. For example, Iran's disaster management system has seen significant advancements recently. Several laws and regulations have been passed at various levels, some of which are related to the socioeconomic aspects of disaster risk reduction. For instance, "the national Constitution was approved in 1979 and revised ten years later (Government of Iran, 1979, 1989). Articles 29 and 31 refer to the right to welfare and decent housing, respectively. These provisions refer implicitly to the government's responsibility to assist the population when disasters damage housing and render people destitute. Despite their importance to national life, the Constitution does not refer directly to disasters" (Amini Hosseini et al., 2013).

As a result, the influence of human activities on regional geohazards must not be overlooked. To continue rapid socioeconomic development in the future, it must adhere to a development strategy that places equal emphasis on development and preservation. As feasible, land development and use should avoid locations with a high risk of geohazards. Prohibited development zones should be developed in areas that meet various combination characteristics to safeguard the ecological environment, avoid increasing regional environmental deterioration, and induce geological risks. Ecological restorations are also necessary for locations with a significant danger of geological disasters to repair and rebuild regional ecosystem stability (Lin et al., 2021). Furthermore, comprehensive stabilization is not possible. In that case, installing monitoring and early warning systems in hazard zones, particularly for locations vulnerable to large-scale instabilities or inhabited regions, could be a solution. It is critical to have a broad understanding of the physical and socioeconomic circumstances of the target area while designing such systems. The relevant laws, rules, and organizational arrangements for decreasing geohazard consequences must also be addressed based on local socioeconomic situations, and appropriate risk reduction strategies should be offered accordingly. The results of these efforts can be reflected in master, comprehensive, and implementation plans that regional planners can employ in land-use planning (Amini Hossein & Ghayamghamian, 2012). The management of geohazards requires socioeconomic views. From a socioeconomic standpoint, the following factors can be considered throughout the post-earthquake recovery and reconstruction process: (1) the earthquake-stricken area's industrial and employment structures' compatibility and adaptation, and (2) the rate of economic development in the earthquake-stricken area. The employment structure represents the allocation and usage of regional labor resources, a significant determinant of macroeconomic development and growth (Liu et al., 2020).

*2. Gender and gender relations*

In the context of geohazards, gender, and vulnerability are crucial considerations. Natural catastrophes affect men and women differently around the world. Men's and women's adaptable capacity is governed by their access to capital assets and livelihood activities, and gender influences disaster adaptation. Examples are physical disparities, gendered societal roles and relationships, the domestic environment, and employment (Naz & Saqib, 2021). In this scenario, gender may play a function similar to that played while dealing with hazards. Women appeared more confident in recognizing the geohazards' local impact, like the broader tendency to be more concerned about risk's negative implications (Gioia et al., 2021). However, there is a significant gender disparity in fatality rates in catastrophe situations, with women at higher risk than men. Physical injuries, hunger, infectious diseases, reproductive tract infections, miscarriage, extended psychological stress, chronic weariness, and gender-based violence against women are all factors that contribute to high rates of death and morbidity among women (Fatouros & Capetola, 2021).

On the one hand, several quantitative and qualitative research in risk perception revealed that gender disparities in risk perception might differ among various risks. Males, for example, maybe more concerned about health and safety hazards, physical aggression, and industrial accidents. In contrast, females may be more concerned about environmental hazards, sexual assault, overexertion injuries, and infectious infections. On the other hand, several studies have consistently shown that females have higher risk perceptions than males in various environmental and occupational risks (Kung & Chen, 2012).

Gender-based inequalities in time usage (concerning housework, employment, and care activities), varied access to assets and credit, and limited access to policymaking venues can all affect vulnerability to natural disasters (Strambo et al., 2021). According to previous studies, women are far more vulnerable to disasters than men, and women are always regarded as the worst victims, making them the most vulnerable group in society (Paul & Routray, 2011). The gender and age of the household head are particularly linked to non-land loss during natural disasters. Given that only 2% of household heads are female, the link between gender and environmental risks may not be substantial. According to the findings, female-headed households and homes with older heads have a more significant risk of experiencing loss than male-headed households and households with younger leaders. This finding is consistent with prior research showing that women in the Indian Sundarban are more exposed to the adverse effects of natural disasters because they have fewer options for livelihood, earn lower earnings, and have less control over their income and assets (Hajra et al., 2017). Women are disproportionately affected by natural catastrophes in communities where "women and girls have less access to and control over resources".

On the other hand, men are less likely to evacuate because they believe they can effectively guard their homes, putting them at risk. This may also be true for women responsible for the household and children, particularly in developing nations. In addition, there is a strong link between the female gender and fragility, owing to the more significant percentage of females living to be old. Females also have a more robust risk perception and readiness to act than males (Werg et al., 2013). Female survivors also reported more anxieties and threats to their lives and more financial loss than male survivors. According to the risk-as-feelings theory, the results could indicate the effect of the "early-warning/experiential" system, which translated unclear and frightening components of the environment into affective reactions. Survivors affected by earthquakes were more sensitive to the risk of earthquakes and hence expressed increased sensitivity to earthquakes and their harmful effects (Hidaayatullaah & Suprapto, 2022; Kung & Chen, 2012).

Women in developing nations like Bangladesh are frequently involved in occupations that rely on natural resources. These jobs do not generate consistent and steady income. Inequitable rights to and access to land, resources, and capital exacerbate this instability. These inequities and marginalization are essential in differential access to resources that cause gender-based vulnerability (Naz & Saqib, 2021). The intersection of gender and disaster is particularly evident in Bangladesh, a country regularly dealing with gender difficulties and various natural disasters. Bangladesh's unique geographic situation of extreme population densities overlaid on a low-lying deltaic and coastal landscape interacts with the country's range of environmental and social transitions: issues of democracy, rural-urban divides, poverty, government corruption, and gender equality, as well as problems related to multi-hazard risk, looming effects of climate change, and environmental justice, all of which predispose specific demographics to heightened levels of vulnerability. As a result, the confluence of gender and natural disasters is a rich resource for practical and academic study. It provides a space where these transformations coexist, producing and revealing vulnerability (Juran & Trivedi, 2015).

*3. Migration, residency, and mobility*

Land abandonment and island nation loss, large-scale population movement, and sweeping changes in cultural traditions are all possible human reactions to the current geohazard circumstances that are already driving environmental change around the planet (Knight et al., 2012). Population displacement is difficult to describe, whether permanent or temporary, domestic or international, forced or voluntary. The reasons for migration vary widely, making it difficult to pinpoint the core causes of population shifts (Mallick & Vogt, 2014). In a broader sense, the five drivers of migration are concerned with the impact of environmental change on human movement. Demographic, political, economic, social, and environmental forces are five drivers that influence migration decisions. Employment possibilities and wage disparities between locations are two economic factors. The number and structure of populations in source areas and the incidence of diseases that affect mortality and morbidity are all demographic factors. Family or cultural expectations, the hunt for educational options, and cultural rituals such as inheritance or marriage are all examples of social drives. Exposure to geohazards and the availability of ecosystem services are two environmental drivers of migration. These five drivers rarely operate in isolation, and movement specifics are determined by their interaction. These drivers apply to both international and domestic migration, emphasizing the importance of human agency in migration decisions, particularly the interaction between family and household characteristics on the one hand and movement barriers and facilitators on the other, in translating drivers into actions (Islam et al., 2016). Female-headed families had more excellent migration rates than male-headed households. According to educational background, there were also differences in rates, with better-educated households sending family members to the next town for temporary shelter. They explain this by saying that more educated people can better comprehend weather forecasts (Penning-Rowsell et al., 2013). While seasonal migration is an adaptation technique in rural regions, more extensive and planned migrations of entire cities necessitate far more resources. They would exceed cities' and communities' capacities. As a result, the role of political and administrative units in adaptation and funding must be addressed. Although migration and relocation are divisive adaptation techniques that frequently cause conflict, the forecast for climate change consequences, such as sea-level rise in the Mekong Delta, Vietnam, suggests that planned movement may become unavoidable (Birkmann, 2011). Understanding mobility characteristics is essential for developing policies and effective adaptation plans. People relocate for several reasons: work, education, religion, and environmental concerns. There is no commonly accepted definition for human movements triggered by climate-related dangers. It refers to population mobility caused by abrupt or gradual changes in weather or climate, especially those caused by geological disasters caused by extreme weather occurrences. The literature uses terms like migration, displacement, and planned relocation (Tan et al., 2022). Each evacuee's coping capacity must be considered. People with high mobility and adequate coping capacity can rescue themselves by picking an appropriate shelter or following the proper evacuation route. Others may perish as a result of the geohazards.

Furthermore, people's mobility is discovered to be significantly related to their age. The elderly had poorer mobility and a negative perception of their health. Because people only sometimes react immediately when they become aware of an emergency, a speedy emergency response is typically determined by age. Because either communicating with neighbors to check a scenario or bringing family members may impair evacuation efficiency, flight behavior is considered. Decisions about which exit to use define evacuation routes and impact evacuation efficiency (Zhang & Zhang, 2014). Transportation network closures during and after geohazard occurrences can significantly impact citizens' mobility and access to essential services. Flooding, for example, can damage the road network and restrict people's movement, including their ability to obtain healthcare services. Other infrastructure failures, such as the collapse of a healthcare facility's infrastructure (e.g., lack of water and electricity), can also play a role. As a result, having a functioning infrastructure network following a geohazard incident is critical (Balomenos et al., 2019).

One of the most challenging difficulties in geohazard-affected areas is population outflow. Population exodus makes it harder to revitalize disaster-affected towns and local economies, leading to a vicious cycle of more population outflow (Kawawaki, 2018). It is critical to have an effective warning system for tsunami-prone areas to alert residents in vulnerable coastal areas to evacuate to designated safe zones at higher elevations (Lin et al., 2014). Previous analyses of population migration resulting from the Great East Japan Earthquake and Tsunami of 2011 captured the scale of population movement that crosses municipal boundaries; however, these macro-level analyses lack information on migration factors such as why residents chose to relocate, which is critical information for the development of recovery policy. On the other hand, completing an individual data analysis is difficult due to the difficulty of organizing adequate surveys that capture information from catastrophe victims who are dispersed over multiple locations after the event. In some nations, such as Indonesia, the extent of tsunami destruction boosted mobility rates in Sumatra across socioeconomic and demographic lines. Still, seismic shocks and volcanic eruptions lowered migration rates and, in the long term, improved the livelihood of local populations (Kawawaki, 2018). Another issue that may arise due to population migration is the increase in construction activities (both residential and common-use infrastructure), which may exacerbate geohazards such as landslides. One of the essential issues in terms of water demand and drought effects in recent decades is the change in rainfall regime owing to cloud seeding, which may lead to increased precipitation. Unfortunately, the cloud seeding strategy is solely focused on regional water shortages; yet, due to a lack of attention to systematic studies that include landslide hazard evaluation, it may cause irreversible damages in landslide-prone areas (Alimohammadlou et al., 2013).

To assist the millions of people who may be displaced, risk management measures are required. Stakeholders should assist communities in geohazard-prone locations that leave their original site, where geohazards occur regularly and are significant safety threats. They should help with the transition to the new resettlement, which has a high-quality and comprehensive security management system, including full coverage of electronic equipment and daily security patrols, increasing safety (Pan et al., 2021). There are limits to accommodating such dangers, and structural protective measures (such as levees) come with significant maintenance costs, environmental damage, and increased development in risky areas (Hino et al., 2017). In addition, proper land-use rules must also limit urban expansion in zones indicated as potentially vulnerable by the catastrophe assessment research, which may put segments of the population in danger. Additionally, government agencies must establish evacuation plans, post warning signs, and provide clear instructions to the public. Property and business owners could be informed on voluntary measures they can take to preserve their investments if they are in high-risk locations (Pararas-Carayannis, 2021).

*4. Education and knowledge*

Risk communication relied heavily on public awareness and knowledge of geological hazards (Pan, 2016). Education, especially for local communities around disaster areas, is essential given by the relevant institutions (Rachmawati & Zamroni, 2020). Education programs should be prioritized to encourage a shift in citizens' and authorities' perceptions of the threats posed by significant geohazards and help realize the issues these hazards offer to society. Disseminating geohazard information to appropriate governmental agencies and residents would enable transparent decisions on what to build and how to build it, and were to lessen the vulnerability of existing structures to future disasters (Plag, 2014). Furthermore, properly and quickly transmitting and disseminating warnings and instructive information demands the mass media's commitment and active engagement. Although tremendous success has been achieved in integrating the media in such collaborative efforts, much more needs to be done to improve public awareness of geohazards and maintain long-term civil preparation programs (Pararas-Carayannis, 2014). A unique understanding of geohazards may provide valuable information about people's readiness to adopt preventive measures and identify the critical reasons for present disaster management systems' poor performance levels. To fully comprehend and handle hazard risks, it is vital to investigate the causes of such events by looking at the built environment's susceptibility and how such causes are viewed (Roder et al., 2016).

Education levels are crucial indicators of citizens' income, quality of life, career prospects, and other factors. Education accounts for 20% of the entire variation in social risk. A society's average educational level can reveal its development potential. More education translates to a better ability to respond to, cope with, and recover from natural disasters (Chen et al., 2013). It means that the higher one's level of knowledge, the easier it is to comprehend and interpret early warning and evacuation decisions (Ainuddin & Routray, 2012). Furthermore, lesser levels of expertise may compromise the ability to understand warnings and gain access to recovery information (Martins & Cabral, 2012).

If 60% of the population has completed high school or higher, they may be more prepared to deal with earthquakes (Ainuddin & Routray, 2012). The impact of educational level on the scientific explanation of what an earthquake was most significant in Turkey. The highest level of education was linked to increased knowledge about earthquake risk, followed by the home's location (Tekeli-Yeşil et al., 2011). According to a study conducted in Pakistan, populations with higher educational levels have a more remarkable ability to return to their everyday lifestyles following an earthquake than communities with lower academic levels. People's earthquake education is weak, and most respondents had no idea what to do during and after an earthquake. Most people are still uninformed of the risks associated with potential seismic hazards in the area due to a lack of awareness campaigns, resulting in low community resilience (Ainuddin and Routray, 2012). Furthermore, research in Bangladesh found that higher-educated households had sent family members to a safer location to take temporary shelter in a disaster in their neighborhood. According to this study, the better one's educational level, the greater one's capacity to interpret weather forecasts, save money, and store preventative food, reducing disaster risk (Paul & Routray, 2011).

### *5. Religion and beliefs*

Religious beliefs may influence how people react to geohazards and how they deal with the repercussions. For example, if people perceive threats as "acts of God," it may be easier to bear losses and more challenging to implement adequate preventive measures. However, religiously based place connection influences risk management behavior far less (or not at all) than economic or social factors (Clar, 2019). Religion strongly influences whether people will prepare for disasters. According to a recent study, those with religious views are more likely to qualify for calamities (Bian et al., 2021). Religious beliefs can influence how people perceive disaster risk and how they react to disasters and recover. Studies on the role of religion in disasters have increased in recent years, from a topic of relatively little scholarly interest. According to studies on religion and disasters, religious beliefs can influence how people respond to disasters, how they feel and interpret risk, and how they influence resilience and vulnerability while meeting hazards and suffering disasters (Holmgaard, 2019). Natural disasters are viewed as God's punishment in religious doctrines, particularly in Judaism, Christianity, and Islam. Because of human sin, Islamic leaders frequently say that tragedy is God's punishment. They are referring to a tale in the Holy Qur'an about a non-believer being punished by God through a natural disaster. Many accounts in the Holy Qur'an claim that God punished humanity for rebelling against Him. On the other hand, many verses in the Holy Qur'an advise people to make emergency preparations. "O you who have believed, strive and endure and remain stationed and dread Allah so you may be successful," says Qur'an (Ali 'Imran) 3: 200. Qur'an (An'aam) 6:131 and (Al-Hasyr) 59:18 highlight another requirement for preparation. These passages can be construed to mean that those in catastrophe-prone locations must be ready for disaster (Adiyoso & Kanegae, 2015).

People in underdeveloped countries assess threats based on their cultural and religious beliefs rather than current science. In Indonesia, the belief that God's punishment for human crimes causes natural calamities persists (Adiyoso & Kanegae, 2012). Indonesia is a multicultural and religiously diverse country. Religious and community leaders play critical roles in disaster management in such situations. This is the situation in some parts of Indonesia, where religious or community leaders are the most effective conduits for communication between government scientists or disaster management and the general public. For example, communication has been more effective through local religious leaders during Sumatra's ongoing Sinabung volcanic crisis. However, communication through other community leaders was beneficial during recent problems at the Merapi and Kelud volcanoes in Java (Andreastuti et al., 2017).

Furthermore, because Aceh is an Indonesian province that follows Islamic law, understanding tsunamis will help determine the student's perception of tsunami tragedies. The importance of religion in interpreting natural occurrences is demonstrated by many school children's answers on the cause of tsunamis in schools. The concept that God's retribution causes disasters should be carefully considered while designing disaster risk reduction materials in a country where most Moslems live, such as Indonesia. However, if people are willing to take sufficient precautions, such beliefs will have little impact on successful catastrophe risk reduction. It is critical to build catastrophe knowledge based on religious ideas (Adiyoso & Kanegae, 2012). As a result, religious teaching is one of the most successful ways to communicate a message. It can be an effective risk communication method after and before a disaster (Adiyoso & Kanegae, 2015).

In November 2013, 21 bishops from Manila's Catholic ecclesiastical province wrote to the president to express their opposition to the plans for additional reclamation of Manila Bay. The letter lays out their case's scientific, legal, and moral arguments. First, the bishops mention two consultant geologists who found that the Manila Bay Reclamation Project will bring geological risks and raise the risk of storm surges and liquefaction during earthquakes in their project analysis. Second, they oppose the idea on legal grounds, claiming that a Presidential Proclamation prohibits commercial or residential usage of the Manila Bay area. Third, they claim that Manila Bay is located inside the region of internationally significant wetlands, making it the state's responsibility to protect it from sale or settlement. This synthesis of scientific, legal, and moral foundations with religious teaching exemplifies an epistemic posture that accepts the compatibility of these several modes of reasoning. The legitimate and transparent response of religion to modern science, secular morality, and positive law already includes integrating these grounds (S. Aduna, 2015).

## 3.2 Links between certain parts of the dynamic population and geohazard risk management

The elements of the dynamic population are essential to the management of geohazard risks. Data on community socioeconomic situations will be critical since it is linked to government help as the primary source of resilience when a community's ability to cope with geohazards is inadequate. The government's financial commitment and allocation will directly impact the tenacity of relief workers and assets, potentially improving authorities' emergency response capabilities in public health care and expertise. As a result, the quantity of government financing available has become vital to addressing a substantial need for assistance. Furthermore, because marginalized people are less able to protect themselves from geohazards, return home or work after a disaster, and access social safety nets before and after a disaster, the socioeconomic situation of communities should be one of the factors examined when evaluating disaster management plans. Understanding mobility characteristics is critical for designing effective policies and adaptation plans. People move for various reasons, including work, education, religion, and environmental concerns. The ability of each evacuee to cope must be considered. People with good mobility and coping skills can save themselves by finding a suitable shelter or following the proper evacuation route. As a result of the geohazards, others may perish.

Communities in geohazard-prone areas should be assisted in abandoning their original location, where geohazards occur frequently and everyday safety dangers are considerable. They should help transfer to the new resettlement, which has a high-quality and comprehensive security management system, including full coverage of electronic equipment and daily security patrols, resulting in increased safety. Because it creates a space where these transitions coexist, producing and disclosing the vulnerability, the intersection of gender and geohazards is a rich resource for practical and academic study. Men's and women's adaptable capacity is governed by their access to capital assets and livelihood activities, and gender influences disaster adaptation. Examples include physical differences, gendered societal roles and connections, employment, and the domestic environment. Levels of education are essential indications of residents' income, quality of life, employment opportunities, and other things. The average educational level of society might reflect its potential for progress. More education means better preparedness to respond to, cope with and recover from natural disasters. It indicates that the more knowledge one has, the easier it is to understand and interpret early warning and evacuation decisions. Lastly, religious beliefs can influence how people respond to catastrophes, how they experience and understand risk, and how religious beliefs exploit resilience and vulnerability when confronted with hazards and disasters. Therefore, religious or community leaders are the most effective conduits for communication between government, scientists, and the general public.

## 4. CONCLUSIONS

## 5.

The review shows that geohazards based on a dynamic population approach include socioeconomic status, migration, residency, and mobility; gender and gender relations; education and knowledge; and religions and beliefs. The economic dimension of vulnerability is the propensity for financial loss due to physical asset destruction and business interruption such as services, activities, or product delivery. In contrast, social vulnerability is a complicated and dynamic concept that changes over time and space, making it difficult to represent with a single variable. In a larger sense, the five drivers of migration are concerned with the impact of environmental change on human movement. Five drivers influencing migration decisions are identified: demographic, political, economic, social, and environmental variables. Men's and women's adaptable capacity is governed by their access to capital assets and livelihood activities, and gender influences disaster adaptation. Examples are physical differences, gendered societal roles and connections, employment, and the domestic environment. Levels of education are essential indications of residents' income, quality of life, employment opportunities, and other things. The average educational level of society might reflect its potential for progress. More education means better preparedness to respond to, cope, and recover from natural disasters.

Moreover, religious views can have an impact on how people perceive catastrophe risk, as well as how they respond to and recover from disasters. The management of geohazard risks requires an understanding of those factors. Understanding those factors has several advantages, including

1. assisting the government in its financial commitment and allocation in the event of a disaster,
2. assisting in the construction of effective policies and adaptation plans, and
3. including communities in the management of geohazard risks.

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