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Espacios y Territorios

Investigating the effective consequences on the assets of an urban system in facing scenario-based hazards

Investigar las consecuencias efectivas sobre los activos de un sistema urbano al enfrentar amenazas basadas en escenarios

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Abstract

Urban assets are generated through physical elements in a city as part of critical infrastructure. To ensure a sustainable urban future, innovative businesses and people are also essential urban assets. In the possible occurrence of natural and manborne hazards, architecture, population density, gathering locations, and connected infrastructure systems in cities are efficient. Manmade hazards are accidents caused by people that happen in or close to human settlements. These are things that have a major impact on the quality of life, health status, and even mortality. The consequences of such hazards in the town will have to be analyzed. To this end, causal relationships between a town's assets against man-made and natural hazards have been analyzed using the Fuzzy DEMATEL method. According to the results of this research, physical elements have a more important effect on other assets in cities at risk from man-made hazards than any other factor. In the face of man's hazards,

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economic activity can be more closely linked to population and physical elements. Physical elements have a higher impact on the population and economic activities when confronted with environmental hazards. Physical elements interact more with population and economic activities. In line with the results, more important than physical elements are population and economic activities. Lastly, it is suggested that the risks of dangerous accidents should be assessed and their consequences determined by taking into account the worst-case scenario.

Keywords: man-made hazards, natural hazards, urban asset, scenario-based exposure, urban system.

Resumen

Los activos urbanos se generan a través de elementos físicos de una ciudad como parte de la infraestructura crítica. Para garantizar un futuro urbano sostenible, las empresas y las personas innovadoras también son activos urbanos esenciales. Ante la posible ocurrencia de peligros naturales y provocados por el hombre, la arquitectura, la densidad de población, los lugares de reunión y los sistemas de infraestructura conectados en las ciudades son eficientes. Los peligros provocados por el hombre son accidentes causados por personas que ocurren en asentamientos humanos o cerca de ellos. Estas son cosas que tienen un impacto importante en la calidad de vida, el estado de salud e incluso la mortalidad. Habrá que analizar las consecuencias de tales peligros en la ciudad. Para ello se han analizado las relaciones causales entre los activos de un municipio frente a los riesgos naturales y provocados por el hombre mediante el método Fuzzy DEMATEL. Según los resultados de esta investigación, los elementos físicos tienen un efecto más importante que cualquier otro factor sobre otros activos de las ciudades en riesgo de sufrir amenazas provocadas por el hombre. Frente a los peligros del hombre, la actividad económica puede vincularse más estrechamente a la población y a los elementos físicos. Los elementos físicos tienen un mayor impacto en la población y las actividades económicas cuando se enfrentan a peligros ambientales. Los elementos físicos interactúan más con la población y las actividades económicas. En línea con los resultados, más importantes que los elementos físicos son la población y las actividades económicas. Por último, se sugiere evaluar los riesgos de accidentes peligrosos y determinar sus consecuencias teniendo en cuenta el peor de los casos.

Palabras clave: Peligros provocados por el hombre, Peligros naturales, Activo urbano, Exposición basada en escenarios, Sistema urbano.

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Introduction

Urban systems are interconnected systems of micro-climate, buildings, means of transportation, electricity, water, and people (Berkeley Lab 2019; Hong et al., 2020). Urban assets are known as a part of vital infrastructure consisting of physical elements in the city and are related to the quality of life. Innovative businesses and people are also critical urban assets that are essential to ensure a sustainable urban future (Eyles, 2007). Creating a sustainable urban future requires advances in technology, planning, and management, and international participation involving citizens, industries, researchers and policymakers, etc. The availability of water and public services in cities, infrastructure maintenance, inequalities and contradictions and long-term patterns of material and energy consumption are among the sustainability issues that lead to more complex issues (Smith & Wiek, 2012). One of the greatest challenges facing humanity today, particularly as regards population aging and climate change, is to achieve a sustainable future for our cities (Han et al., 2012). Policies and projects aiming at reducing greenhouse gas emissions in cities and strengthening their resilience are currently the city's greatest challenge. Climate change mitigation and adaptation to climate change should be helped by the city. In an integrated way, it is crucial to address climate change (Galderisi et al., 2016). Features such as architectural structures, population concentration, gathering places, and interconnected infrastructure systems in the city are effective in the probability of floods, earthquakes, storms, and terrorist attacks (Godschalk, 2003). Natural hazards can become disasters because of insufficient infrastructure and services, unsafe housing, or inadequate health facilities. For example, water and sewer networks can become clogged with poorly managed solid waste, which can lead to waterlogging and flooding (UNDRR, 2013). Cities often develop at the cost of changing natural landscapes and changing ecosystem dynamics, which leads to more exposure of people to hazards caused by nature and creates new hazards (United Nations University - Institute for Environment and Human Security (UNU-EHS), 2023). The frequency and intensity of the hazard, as well as its vulnerability to society or an element at risk, are both factors that lead to negative consequences from natural hazards. In order to reduce these consequences and thus natural hazards, vulnerability assessment is therefore an important step. The ability to identify and understand the sensitivity of risk factors is required in vulnerability assessment (Fuchs et al., 2012). Although, by examining and searching different databases, it was determined that there is extensive research in the field of assessing urban risk and vulnerability in the face of a specific hazard; however, the lack of studies in the field of accidents and crisis management that evaluate the consequences of hazards on urban assets in the face of man-made accidents is obvious. New scientific approaches and methods for assessing the risks and vulnerabilities of citizens are needed to cope with an increase in natural and human emergency frequency, as well as a larger scale of their consequences such as fatalities, injuries or long-term negative effects on society's development. Due to the large population concentration, major cities and metropolitan areas are at increased risk (Badina et al., 2022). Therefore, in this research, the effect of natural and man-made hazards on the city's assets is studied and the effective consequences on the city's assets are determined.

Urban system

Cities are complex systems that are composed of highly heterogeneous and interconnected subsystems that lead to the connection of these subsystems through numerous non-linear relationships. In case of danger, the sub-systems of this complex system are disconnected and do not work normally. In this case, the components of the system and the relationships between them become vulnerable to disasters and there is a possibility of this system being disrupted. At this time, it is necessary to analyze the vulnerability of the system. However, before an event occurs, it is not possible to predict in full detail how a disturbance of the subsystem will affect the urban system (Atun, 2014). In order to investigate the risk of natural hazards in systems, it is necessary to model the cumulative consequences of the occurrence of hazards in an urban system and human behaviors in an environment with multiple hazards. Therefore, the entire relationship between the risks of the system and its exposures can be studied in a multi-hazard risk assessment model, and the result provides the possibility of reducing risks and increasing resilience against risks. One of the most important elements in risk assessment is to understand the city's vulnerability to natural hazards. In the traditional evaluation of exposure, it is assumed that the components of exposure are constant, and the relationships between the components are not investigated in this evaluation (Dai et al., 2020; Shabou et al., 2017).

Estimating the consequence of urban hazards

In this model, the consequence is the total negative social, environmental and economic effects that can occur in the vulnerable urban component (Roozbahani et al., 2013). The quantity or quality of water and public health and safety issues in a community may be affected by the consequences of a hazard, such as in the urban water supply system. The number of users affected by a specific hazard is usually considered to be the basis for estimating consequences. In order to determine the consequences of any hazard that may occur due to a single component, group of components or total disruption of urban water supply systems, four general criteria shall be established (inadequate or unsafe water supply, economic loss, negative social impacts, human casualties), and these criteria were aggregated to calculate the overall consequence of each hazard in each part of urban water supply systems (Roozbahani et al., 2013). Yang et al. (2022) stated that to determine the relative risk of each pipeline and to reduce dependence on the subjective opinions of experts or the calculation of probability of events in the Bayesian decision-making method, the traditional risk assessment model based on the Kent index method and the hierarchical analysis method is used, a model based on Data based on graph embedding and clustering algorithm are suggested. The Graph Convolutional Network technique is used in order to obtain the topological features of a pipeline network. A case study on a real gas pipeline network with over 6500 lines confirms the efficiency of the proposed model. In order to quantify natural hazards such as volcanoes, the probability of the occurrence of a volcano is evaluated, which indicates the uncertainty of the magnitude and consequences of volcanic activity. By evaluating the probability of volcanic hazards, a planning can be made to reduce the effects of volcanic eruptions (Connor et al., 2001).

Identification of man-made dangers and threats

The complex urban socio-ecological system witnesses the accumulation of the effects of floods, heat waves, traffic congestion and smog. They also face threats such as earthquakes, hurricanes, and other natural disasters in addition to man-made disasters caused by the strong environmental impact of urban development (Gasper et al., 2011). The response of urban systems to different severities of disasters and development problems is very different. After a crisis, some cities are declining and others begin to recover from the negative impact of disasters so that they can improve their development in the longer term. The level of urban resilience is a major factor behind this difference (Osman, 2021). There's a lot of concentrated population, industry, and wealth in a city (Bloom et al., 2008). Incidents related to the release of hazardous substances are important in the risk assessment of industry and transportation. They can lead to major consequences, as hazardous clouds can spread widely over kilometers and be dangerous to human health and the environment. Dangerous gases can exist in urban areas. This is because, with the increase in the size of the cities, a large number of industries enter the city limits, and through the transportation of dangerous substances from the industries, they enter the city limits, and it is a serious risk in terms of safety and security. People in areas such as hospitals and schools that have vulnerable populations have transportation facilities. In addition, the consequences of such incidents in urban areas are very serious and aggravated by the high level of population density that exists in these regions (Pontiggia et al., 2010).

Urban physical assets

Today, natural hazards have a wide range of impacts on society and the economy in cities due to urbanization and economic development leading to increased concentration of people and assets in areas at risk. Due to the intensification and diversity of land uses, cities are subject to some impacts from various types of natural hazards. The potential threat to human life and property comes from natural events: if people and their physical and financial assets are living or working in its path, this will be a disaster. As a result, hazards related to the population and the exposure of its physical and economic assets create risk (De Lotto et al., 2019). Exposure refers to the quantity and quality of individual individuals in a given geographical area whose condition or functioning may be impaired or changed due to nature's disasters, according to numerous authors (De Lotto et al., 2018). In this sense, the number of people, activities and buildings refers to quantity. Relationships between physical elements and territorial systems are functional or strategic aspects that refer to quality. Settlement system, infrastructure network and population are considered human elements. The two dimensions include the following: The physical dimension is the amount of goods or people exposed in the territory. The functional role of physical elements includes economic, historical and strategic cultural heritage in facing risks. The definition of a general and structured method is necessary given the very diverse nature, data volumes, and characteristics of interest. For the physical dimension, the main features can be easily identified (through classical geographic analysis). It is not so easy for the functional dimension: It is necessary to take into account, analyze and study the territory itself, its structure and development over time of existing relationships between individual parts in order to gain an understanding of the functional role played by exposed elements. Therefore, the three major categories of potential elements at risk are: The population includes students, employees, tourists and users of local services and residents in the city. Physical elements include strategic equipment and collective interests, cultural heritage or historical buildings, technology networks and housing. Economic activities include production and industry. The national, regional, metropolitan and urban levels are among the main scales of analysis that are related to the statistical information related to the distribution of goods in the desired territory. The possibility to define values for urban density levels of M3/m2 is provided by the use of satellite images and maps. Local-scale with databases that provide information at the city level. Analyzing the type and function of the building is essential: Exposure values of the appropriate category are drawn from this data over time and space. Mapping systems and direct on-site survey are among the methods that collect data such as the number of floors of each building and the percentage and gross area of each urban function. The definition of congestion leads to the number of people in a particular urban function. Specifically, for population classification, it is essential to use multiscale assessment and consider temporal, spatial, dimensional, and functional variables (De Lotto et al., 2019). Assets or elements at risk is a general term that refers to anything that may be at risk, including populations, buildings and engineering structures, infrastructure areas and lines, public services, and economic activities (Papathoma et al., 2007). In asset-free zones, hazards are not considered a problem. The more assets at risk, the more difficult the hazard appears to be. All assets have a "value" which can be expressed in monetary terms, the number of people affected, or in less measurable units such as cultural significance or environmental quality. Assets can be identifiable objects such as people, buildings, and cars, but also include systems and services such as society, utilities, and the economy. Some assets remain fixed in space and others are dynamic and vary in time and place. Assets can be directly affected by this risk or indirectly due to service interruptions, road closures, and factory closures. Assets that can be seen and touched are considered physical assets. Buildings, Land, factories, machinery, gold, silver, tools, equipment, vehicles, or any other form of tangible economic resource are examples of such physical assets. Physical assets refer to things that can be disposed of when an entity ceases to be profitable from an accounting point of view. Physical assets have an economic useful life, when their age is determined they may be discarded. They usually experience a decrease in value as the asset wears out through continuous use, known as depreciation or they may lose their value by becoming obsolete or too old to use. Assets such as flowers or apples that are perishable should be sold as quickly as possible to preserve their value (Birla Institute of Technology & Science (BITS), 2023).

The effects of a city's assets in facing man-made hazards

The most critical causal factor has the highest D-R (Alavipoor et al., 2024; Sohankar, 2024). This means that physical elements more than any other factor affect other assets of a city in the face of man-made hazards. It also has relatively high D values. This means that this factor has a significant effect on the other two factors. The influence of physical elements and economic activities on the population is the same when faced with man-made hazards. The getting effect of population and economic activities on physical elements in facing man-made hazards is also the same. Economic activities have more interaction with the population and physical elements in facing man-made hazards. The D-R and D+R values indicate that population is the main problem to be considered. However, population is an effect that cannot directly affect the other two assets of the city when facing hazards (Table 1, Figure 1).

Table 1. Causal and effectual components of the urban assets in the face of man-made hazards

	D	R	D+R	D-R	Causality
Population	18.67	19.48	38.15	-0.81	Effect
Physical elements	19.48	18.67	38.15	0.81	Cause
Economic activities	19.48	19.48	38.96	0.00	Cause

Source: Own elaboration

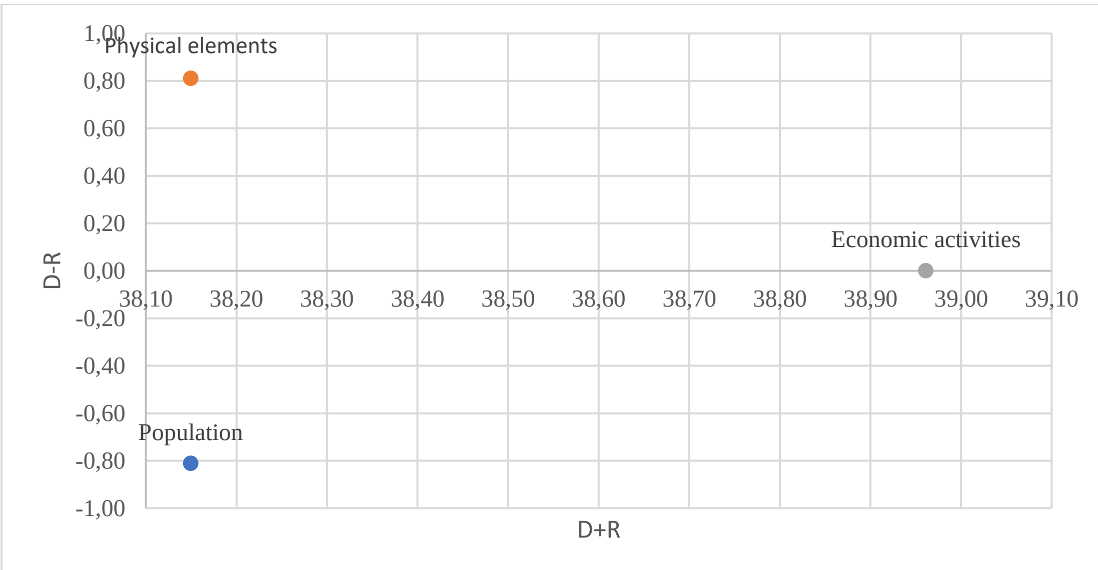

Figure 1. Cause and effect relationships between urban assets in the face of man-made hazards

Source: Own elaboration

The effects of a city's assets in the face of Natural Hazards

When faced with natural hazards, physical elements have a greater effect on the population and economic activities. Population and economic activities interact more with physical elements. Based on D-R and D+R values, population and economic activities are the main problems. However, these are properties of the effect type that cannot be improved directly. Population and economic activities are more important than physical elements (Table 2, Figure 2).

Table 2. Causal and effectual components of the urban assets in the face of man-made hazards

	D	R	D+R	D-R	Causality
Population	3.24	4.01	7.25	-0.76	Effect
Physical elements	4.01	2.48	6.48	1.53	Cause
Economic activities	3.24	4.01	7.25	-0.76	Effect

Source: Own elaboration

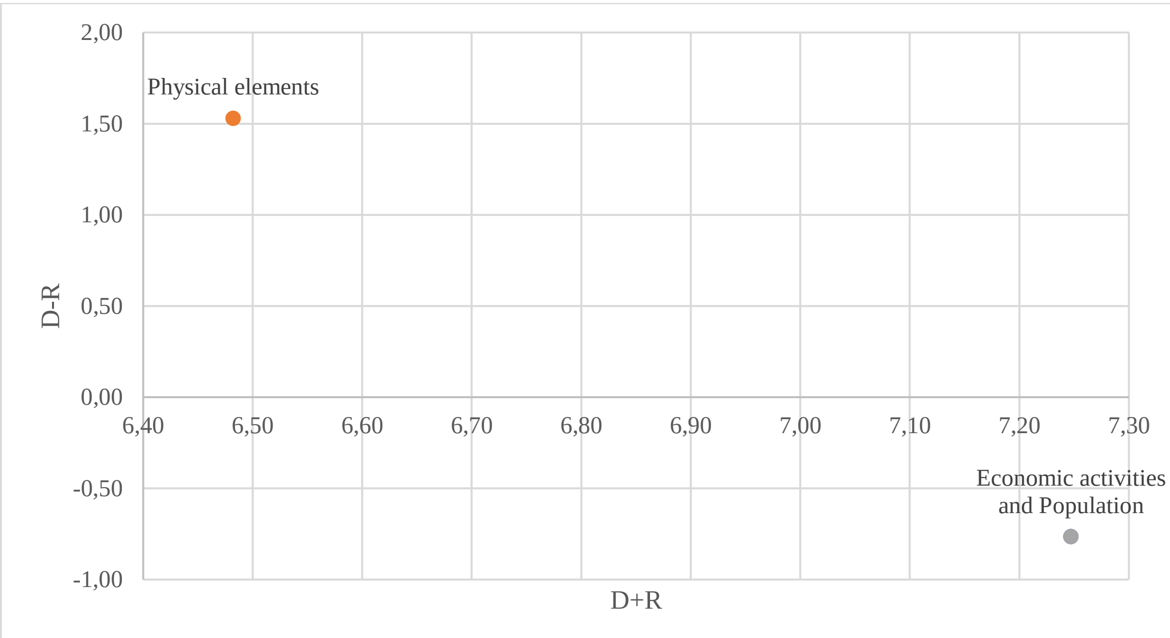

Figure 2. Cause and effect relationships between urban assets in the face of natural hazards

Source: Own elaboration

The approach of writing the scenario

The creation of a strategic plan is an important part of scenario planning (Othman, 2008), and Integrating diverse information requirements for emergency response and recovery planning and preparation is considered to be one of the key approaches (Alexander, 2000; Hayes et al., 2020). To develop a consequence scenario from an event scenario, it is necessary to know where vulnerable assets are located and where they will be in the future. The particular advantage of consequence scenarios is that, to accommodate this uncertainty, their areal extent can be extended accordingly where the location of a landslide event scenario is not certain. The effects of landslides are difficult to predict. One must know the size of the landslide and its location to predict the amount of sedimentation and determine the assets and people affected by it. As a basis for the event scenario, the specific volume and location can be assumed to be scientifically valid, but the consequences of this specific scenario must be extended to the entire area that any landslide could affect. Also, the highest probability of occurrence of the event is very attractive in regional planning. But it should be noted that although this event is indeed the most likely, its probability is small and the probability of something different happening is much greater (Davies, 2015). Determining the risk scenario is done by combining the spatial scale, time frame, man-made risk factors and the type of disaster, and these scenarios are the same consequences. Large, medium and small spatial scales, time frame and return period represent spatial and temporal scenarios. The type of disaster, such as storms, heavy rains, floods, water shortages, etc., is referred to in disaster scenarios. Man-made scenarios include economic, population, land use change, etc. Scenario-based analysis of disaster risk takes into account the fact that various types of disasters and groups of disasters are situated within specific time and place conditions, looking at their possible demographics, economic, and social risks (Liu et al., 2012).

Man-made hazard scenarios

The nature of disaster response often reflects the type of disaster (Leider et al., 2017). The catastrophic events that result from human decisions are man made disasters. Sociotechnical and war disasters are human disasters. Transportation accidents, technological disasters, production failure and damage to public places are considered human disasters. Subsequent disasters occur as a result of man-made or natural disasters (Mohamed, 2007). In every part of the world, there is a possibility of technological disasters that lead to injuries, deaths, economic, social and physical consequences (Shen & Hwang, 2018). The consequences of transportation network disruptions can also be multifaceted. Infrastructure collapses and terrorist attacks may directly or indirectly result in injuries and fatalities. A road route may be blocked; some trains may be forced to stop or some air flights may be canceled for a certain period. Such events will increase travel times for passengers and delivery times or lead to trip cancellations. This will lead to direct social or economic costs. The costs of reoperating the transportation system and repairing or rebuilding the infrastructure may also be significant (Mattsson & Jenelius, 2015). The more factors such as city electricity, gas pipe network, and flammable and explosive chemicals cause fire in urban areas, the risk of urban fire will be greater and accordingly, fire incidents are more dangerous (Zhang, 2013). The possibility of burns is related to urban environments and crowded places (Xin & Huang, 2013). Due to the high population density and the high economic value of buildings and their contents, fires in high-rise buildings and apartment buildings are one of the major urban disasters (Wang et al., 2015). In the event of a fire, large numbers of people and property make it very difficult to fight fires and evacuate (Guang-wang & Hua-li, 2011). The importance of fire crisis management is highlighted by the economic value of the building itself, as well as its construction and owners' property (Moshashaei & Alizadeh, 2017). In the whole process of assessing fire risks, a fire scenario is an important parameter. The sum of fire location, possible size of fire, availability of fire extinguishing system, building environment, combustible characteristics, etc., is the fire scenario of very tall buildings (Sun & Luo, 2014). Building collapses have been attributed to weak foundations, poor quality building materials, poor mixing of materials by construction workers, excessive loads on building strength, and poor testing of building strength in many low to middle income countries (Figueroa, 2014). Structural defects, poor supervision and workmanship, faulty design, or negligence of approved plans are also the cause of building collapse (Windapo & Rotimi, 2012). Human loss, business losses, and environmental damage are some of the consequences of Structural Failure (Hingorani et al., 2020). Crowd crush occurs when too many people press into a limited area on the way in and out. People can be pressurized to the point where they can no longer inflate their lungs and suffer asphyxiation. Most of the people who die in a crowd crush are the ones who get pushed into the wall. Strategies for promoting disaster resilience can be informed by current evidence on the relevant stages of prevention, preparedness, response, and recovery but there is still a lack of knowledge as to how to address increasingly complex problems related to more than one disaster exposure (Gibbs et al., 2022). Escalated hazard scenarios increase the complexity of coping with the aftermath of a disaster due to the fact that the participants may experience the stages of preparation, response and recovery from multiple other hazards with an increased risk of poor mental health outcomes and well being (Leppold et al., 2022). The largest non-nuclear explosion occurred on August 4, 2020, in Beirut when 2,750 tons of unsafely stored ammonium nitrate exploded. The physical and social effects of this event at the same time as the Corona epidemic were very high (El Sayed, 2022). Gye et al. (2019) concluded that in densely populated and highly congested cities, risk assessment was performed on a high-pressure hydrogen refueling station. Leakage from the pipe-trailer and distributor as well as the possible explosion of the pipe-trailer were reported as the main hazards.

Natural hazard scenarios

The scenario of natural disasters is very complex and dynamic and is associated with emergency incidents. Much of the existing research in this field is based on data extracted from real-world emergency evacuations (Johnson et al., 2012; Olsson & Regan, 2001; Pan et al., 2006; Shields et al., 2009) or physical experiments (Hughes, 2003; Johnson et al., 2012; Lee et al., 2004). But for planning and testing, these studies and experimental methods are either not appropriate or extremely costly (Dou et al., 2014). Damages that occur to people, their property, and their social and economic status as a result of natural phenomena and processes indicate the occurrence of natural hazards (Williams et al., 2019). Natural hazards are classified: 1) Geophysics including earthquakes, landslides, tsunamis, and volcanic eruptions; (2) hydrological including avalanches and floods; (3) Climate that causes extreme temperatures, drought, and forest fires; (iv) weather, including tornadoes or severe storms and storm surges; and (5) Biological, including disease epidemics and insect or animal plagues. They may also be classified as rapid onset, for example, earthquakes, flash floods, and landslides, or slow onset, for example, sea level rise, temperature rise, and drought (Cremen et al., 2022; Tosun & Howlett, 2021). By quickly replacing capital, disasters can have positive economic consequences (Hallegatte & Dumas, 2009). They may also be classified as rapid onset, for example, earthquakes, flash floods, and landslides, or slow onset, for example, sea level rise, temperature rise, and drought (Cremen et al., 2022; Tosun & Howlett, 2021). To demonstrate that e-waste may represent only a small fraction of the waste generated in disasters, a theoretical case study was used for flooding on the Rhine River in Germany. If not well planned and addressed, it can have many disproportionate health, economic, and environmental consequences (Leader et al., 2018).

Consequences of earthquake

Ansal et al. (2010) presented the seismic micro zoning and damage scenario of the Zeytinburnu earthquake in Istanbul. First, ground shaking parameters such as flood direction, magnitude, fault geometry are identified and different micro-zoning maps are produced to create a selected earthquake scenario. To assess the seismic vulnerability of buildings, they calculated the spectral accelerations and peak ground accelerations of short periods (T=0.2) and long periods (T=1). For the estimation of building damage in Zeytinburnu, Area Specific Vulnerability Curves have been applied. Estimation of damage to natural gas pipelines is done by peak ground speed versus pipeline damage and gas pipeline inventories. Landslides are one of the greatest dangers in nature and have serious consequences, which include loss of life, injury or damage to property (Ha et al., 2020). "A landslide is the movement of a mass of rock, debris, or soil down a slope." Landslides are one of the greatest dangers in nature and have serious consequences, which include loss of life, injury or damage to property (Mertens et al., 2018). Public service buildings, infrastructure, residential, and commercial properties as well as residents and users of these facilities are elements at risk (Winter & Bromhead, 2012). The city can be affected by an earthquake. In an earthquake, a higher frequency wave may be absorbed by rigid facilities such as buildings or bridges and damaged. The city can be affected by an earthquake. In an earthquake, a higher frequency wave may be absorbed by rigid facilities such as buildings or bridges and damaged. Ground motion may cause damage to roads and highways (Anbazhagan et al., 2012). The risk of pipelines in water distribution systems is also high as a result of ground movement, which makes the city more vulnerable (Nazif et al., 2021).

Consequence of flood

Both ground structures and underground infrastructure such as tunnels and subway stations are seriously damaged by severe floods. In the underground space, flooding water may also cause contamination which would reduce its business value (Lyu et al., 2019; Peng & Peng, 2018; Qiao et al., 2017; Shen et al., 2016; Shen et al., 2015a; Shen et al., 2015b; Shen et al., 2017; Wu et al., 2017; Zhao et al., 2016). The impact of flooding is dependent upon the length of time and can be classified as temporary or longer lasting. During a sudden flood, short-term effects can be seen. Damage can include death, injuries, damage to businesses, loss of

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infrastructure, fisheries, livestock, agricultural products and property, and disease, long-term effects from rebuilding homes, infrastructure and roads, insurance costs, from Loss of jobs and industry and other property (Chan, 2015). Barredo and Engelen (2010) modeled a land use scenario to reduce flood hazard. Their study does not consider the range of factors that can affect the effectiveness of disaster risk reduction efforts or provide a mechanism for incorporating the complexities of disaster risk that could allow decision-makers to unravel the knots associated with disaster risk. These approaches represent the combination of general one- or two-dimensional scenarios to predict the future of disaster risk components. However, it cannot provide a risk assessment that captures the range of uncertainties and associated complexities that affect risk, or a way to assess the effectiveness of risk mitigation options (Barredo & Engelen, 2010). Dependence on the reliability of the data can be seen in the consequence evaluation models. Impact assessment is related to data such as land use, elevation, flood magnitude, and infrastructure data. Height data is used for damage modeling and flood simulation. Difficulty in collecting accurate land elevations has been reported by several researchers (Bhuyian & Kalyanapu, 2018; Nardi et al., 2008). Elevation data sources are used for flood modeling studies. In this case of water bodies, it is not possible to display bathymetry, so it is of little use in hydraulic modeling (Bhuyian et al., 2015).

Consequences of lightning

Lightning strikes are a natural event that causes Natech incidents in atmospheric storage tanks (Misuri et al., 2020). Future scenarios of lightning are one of the most important open questions in Earth's climate science. Currently, the ability to anticipate future climate changes in worldwide lightning activity is very weak due to a better understanding of the climate system and its impacts on human activities as well as external factors like Solar Activity that are affecting it (Pinto, 2013). The development of national lightning detection systems, which are much more reliable than traditional methods of counting lightning days, which are still used in many countries that do not have such systems, has provided early indications of changes in lightning patterns around major cities. The coverage of satellite lightning platforms such as OTD and TRMM/01LIS systems has enhanced this capability (Yair, 2018). Westcott (1995) reported a 40% to 85% increase in summer lightning density around 16 central US cities for the period 1989–1992. Based on this, Westcott (1995) attributed this result to several factors, such as the increase in the concentration of urban density cores, as well as population and city size, which interact in complex ways. In an unstable atmosphere of convective storms, this increase is likely to occur in the afternoon hours. The results of her research showed that larger cities had higher annual values of PM10 concentrations and showed a greater increase in thunderstorms, with some exceptions. According to a study by Orville et al. (2001) found a 4-fold increase in summer lightning density east of Houston compared to west and south of the city (4 flashes/km2 compared to 1 flash/km2). Convergence of surface winds due to heat island effect and high levels of air pollution from humans were the reasons for this rise (Yair, 2018). Salimi and Al-Ghamdi (2020) also mentioned that storm surges can damage the entire information and communication technology infrastructure on Earth, and an increase in the number of lightning strikes can damage transmitters. Electric companies are also concerned about the possibility of damage to underground power distribution cables due to lightning striking the ground. Evaluating such events is important in designing appropriate protection plans and mitigation strategies. Based on a study Zeqing et al. (2002), a complete model is proposed by linking the elements of existing models. This model provided information about input current and overvoltage on bumped cables with soil characteristics and geometric configuration as parameters. The noteworthy point is that topographical factors may affect the failure rate of protective wires in different locations. Souto et al. (2023) explain these effects and how they change in different locations. For this purpose, they calculated the probability of failure related to asset condition management. They used the same parameters and settings for transmission towers to calculate. The possibility of failure was considered in the design of the lightning protection system. In locating, they paid attention to the best and worst case scenarios for transmission lines. To examine best practices in the design and maintenance of power systems as well as grid modernization, this framework can be effectively applied by energy system planners. To reduce the likelihood of power interruptions due to lightning strikes, this framework may also be used by electricity system operators for implementing smart operating measures like grid configuration.

Consequences of land subsidence

Geological disaster called land subsidence occurs due to natural and human factors (Lixin et al., 2010; Lyu et al., 2020; Shen et al., 2013; Shen & Xu, 2011; Wang et al., 2019; Xu et al., 2019) due to land mismanagement, overexploitation of groundwater, and urban and agricultural development (Rahmati et al., 2019). Underground construction, long-term operation of urban facilities, and soil creep may occur. Through groundwater recharge and discharge, underground construction causes changes in geoenvironmental conditions (Lee & Park, 2013; Shen et al., 2017; Wu et al., 2019). In case of land subsidence, infrastructure in a metropolis may be damaged (Lyu et al., 2019). Land subsidence can exacerbate flooding by reducing flood control structures (Dixon et al., 2006), changing floodplain boundaries, and base flood drainage (Shirzaei & Bürgmann, 2018; Wang et al., 2012). Peng et al. (2016) concluded that in Xi'an, active Quaternary faults and pre-existing fault plates predispose intervening sedimentary blocks to rift formation, and intensive groundwater extraction has accelerated subsidence and rifts in the past 50 years. Groundwater extraction, land subsidence, and land rifts occur gradually, forming a disaster chain concerning urban hazards in Xi'an.

Consequences of the volcano

Displacement of populations is the most frequent consequence of a volcano eruption; many people are often forced to flee the flow of lava. Temporary food shortages and volcanic ash landslides are often the result of volcanic eruptions. The consequences of volcanic eruptions that occurred worldwide from 1933 to 1999 are summarized by Collins (2000) (Mohamed, 2007).

Conclusion

Hazards are factors that lead to harm to humans. Due to the existence of hazards, disasters occur, and when a disaster occurs in a specific place, risk is raised. There are three types of hazards including natural, man-made, and technological hazards, each of which will have consequences. Many studies have been conducted on the consequences of natural hazards, but limited studies have been conducted on the consequences of man-made hazards. This can be caused by the various ways that humans can damage the assets of a city, including residents, infrastructure, and specific businesses of a city, which will have consequences. Disorganization, feelings of insecurity, lack of well-being, health problems for other people, and political decline can be the consequences of damage to the city. To evaluate the effective consequences on the assets of an urban system, a comprehensive view of man-made and natural hazards is needed because there are various and complex connections in an urban system. According to the results of this research, physical elements have an effect more than any other factor on other assets of a city in the face of man-made hazards. Economic activities have more interaction with the population and physical elements in the face of man-made hazards. The D-R and D+R values indicate that population is the main problem to be considered. However, the population is an effect that cannot directly affect the other two assets of the city when faced with man-made hazards. When faced with natural hazards, physical elements have a greater effect on the population and economic activities. Population and economic activities interact more with physical elements. Based on the results, population and economic activities are more important than physical elements. Therefore, the use of scenario writing makes it possible to conduct an in-depth review of all possible outcomes. The complexities and connections within the city are identified and the consequences of damage to these assets are correctly understood. Because of this, it allows managers to test decisions, understand the potential impact of certain variables, and identify potential risks.

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