Chapter 11
Environmental Disaster Management and Risk Reduction

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1 Introduction

The environment can be well-defined as all forms that surround both living elements (such as humans or animals, fishes and birds) as well as non-living elements, itself classified as both moving (such as air and water) and non-moving (such as mountains and forests). Human activities do interact with the bio-physical environment in a multifaceted manner connecting different geographical levels. The existence of all living forms on this planet gradually evolved to build a healthy and well-balanced environment throughout the space and time. The new economic demand should operate in a way that shields the biophysical environment to maintain the balanced and sustainable growth both at present and in the future. We must not merely consider the natural resources, such as forests, as carbon sinks. Rather, it is the time to reconsider them as vital resources that provide vital elements such as fresh air for our crucial survival. Human beings inhale oxygen from the environment and release carbon dioxide back while plants simultaneously absorb carbon dioxide and give out oxygen, thus maintaining a balance between the two. Another significant contributor to the GHGs is the livestock emission (mostly Methane) which many of us often ignore. Radical changes in
either of the consumption-release patterns can lead to an unmanageable environmental balance. Presently the world is facing enormous population growth and pressure. Capitalism has fuelled it by exploiting natural resources at a faster pace than ever. Formerly, nature itself used to check ecological balance through extreme events such as natural disasters as well as hazardous epidemics. The arrival of modern health care systems and advancements in the field of science and technology can control epidemics and diminish the effects of natural disasters today. At the same time, we are becoming increasingly susceptible to diseases and the rate is rapidly increasing. The complexity of the man-nature relationship has significantly altered in today’s world. In the past, nature was seen as necessary and beneficial on which amplification of human need in today’s world has left its footprint. Therefore, a minor environmental change nowadays puts significant impacts on human life. However, the perception of what constitutes a ‘hazard’ and ‘disaster’ changes over time (Paton and Johnston, 2001; Furedi, 2007). A hazard is a dangerous incident that brings a menace to humans, while a disaster is a stern disturbance striking over a shorter or longer duration that grounds extensive material and/or ecological loss for both human and natural environments that surpasses the capacity of the impacted community to survive back using its immediate own resources again. Hazards will be considered disasters once they affect humans, but if they occur in an unpopulated area, they will remain hazardous.

Since the man-nature relationship is not identical over different periods of time and at different places, the intensity of disasters or natural outbreaks are different accordingly (Zhao et al., 2006). Developing countries pay the most once a disaster hits. These fatalities in developing countries due to natural hazards are over 20 times bigger in terms of GDP than the industrialised countries (Peduzzi et al., 2002).

Therefore, the question remains whether development and environmental protection can be achieved together or whether there is a kind of dichotomy between the two. This is, however, not a simple question to answer. For example, urban areas are highly modified to suit human needs which results in the destruction of green spaces and formation of urban heat islands (Doick et al., 2014). However, in rural areas, although the natural environment is quite intact, unskilled agriculture and pressure on farmland causes serious land degradation, thereby leading to ecological and economic stress (Sudhishrf and Dass, 2012). A disaster or any natural outbreak has a cause and effect inter-relationship between nature and human societies. A disaster can be defined as a serious disturbance of the functioning of both biophysical and human societies, causing extensive environmental, human and material losses which surpass the ability of the affected communities to deal with using only its own resources (Asian Disaster Reduction Center, 2003). The impact of anthropogenic impact on the natural environment is directly co-related to population growth (Donner and Rodríguez, 2008), particularly in urban areas with a population density of around 30%, which may reach up to 60% by 2050 (Patel and Burke, 2009). Related factors include consumption patterns of populations as well as their innovative technology-intensive lifestyles. Humans consume resources from the healthy ecosystem, but in return they transform it into an unhealthy form of ecosystem.
From the prehistoric to the modern age, the idea of disaster has been influenced by such diverse factors as religious belief and scientific considerations. Disasters were often characterised as ‘acts of God,’ thereby implying that ‘nothing could be done about their occurrence’ (Quarantelli, 2000). Nevertheless, with the advent of Enlightenment thinking and the augmentation of scientific knowledge, the idea was shifted from ‘acts of God’ to ‘acts of Nature’ and consequently to ‘acts of Men and Women’ (Quarantelli, 2000). Post-1980, the perception of disaster has been considered through a sociological and ecological lens. Instead of focusing on natural phenomena such as tornadoes and tsunamis, research focus has now shifted towards the new acts of man-made toxic and technical disaster (Shaluf, 2007). With this anthropological turn in scientific research, such events have come to be related to human activities and their causes have accordingly been perceived as the consequences of human irresponsibility or malevolence (Park, 2016).

2 Disaster Vulnerability

The concept of ‘vulnerability’ emerged after the environmental movement of the 1970s (Kroll-Smith et al., 1997) which brought the central ecological perspective of disaster to the forefront (Trickett, 1995). The intensity of damage brought about by any disaster indicates to what extent the communities are vulnerable (Kelman et al., 2016) and what preventive measures should be taken to tackle future risks (Kunz et al., 2014). Besides the practical nature of vulnerability, Heijmans, noted that the concept of vulnerability is also a matter of perception (Heijmans and Victoria, 2001). One of the principal claims of this study is that the number of occurrences of disasters are dramatically increasing and thus communities are becoming gradually more exposed to their impact. Vulnerability or exposure to the disaster is here conceptualised as the natural state of being (Ewald, 2002). The terms ‘vulnerability’ and ‘risk’ are often interchangeably used where ‘risk’ denotes anticipated losses from a particular hazard to certain element(s) at a particular point of time in the future (Cardona, 2005). Increase in population is generally regarded as the core of the problem which increases vulnerability, and potential damage of biophysical environmental stability encompasses exponential growth in numbers.

The rising intensity of financial activities, exclusively its meditation in sporadic urban agglomerations, adds to this above mentioned issue. However, it is uncertain whether the correlation between the loss in ecosystem and growth in financial sectors is simple or direct. For instance, studies revealed that only 11% of the people vulnerable to natural hazards living in low human development countries comprise more than 53% of recorded losses. This implies that development rank and risks associated with disasters are meticulously linked (UNDP, 2004). Further, the intensity of any catastrophe may not be the same in different places, even catastrophic events usually differ from place to place, though the same event will inflict different degrees of damage in different places (Hewitt, 2007). These findings seem to indicate that historical, socio-cultural, and recent eco-political developments set some
groups of people at greater risk compared to others (Enarson and Morrow, 1998). While, the specific contexts are examined, the largest losses not only tend to accrue to relatively disadvantaged and powerless communities, but also reveal certain growths in human settlement, most visibly those in and around the rapidly increasing urban centres (Maskrey, 1989; Fernandez, 1999; Pelling, 2003a; Pelling 2003b). However, it should be pointed out that the incident of losses may not be an accurate assessment of how far communities are vulnerable to disaster, for such vulnerability is also affected by such factors as proper site selection for residential areas, carrying capacity, and, most importantly, level of modern safety standards (World Bank, 2001; Ozerdem and Jacoby, 2006).

Water has been the lifeline for all the civilisations existing on earth and today water pollution is one of the major sources of vulnerability. For example, aquifer contamination is the artificially induced deterioration of natural groundwater quality. It is mainly caused by anthropogenic (mainly, industrial and/or agricultural) activities. These potential sources of contamination (pollutants) are responsible for the degradation of groundwater quality, consequently increasing vulnerability. The aquifer vulnerability is demarcated as the relative incident when a pollutant injected on or near the land-surface can migrate to the aquifer due to the certain land use management practices, the characteristics of the pollutants and conditions of the aquifer sensitivity (Aller et al., 1987).

Details of total fatalities accentuate the exposure of not only certain communities, sectors, and/or areas, but also of confusing and undesirable incidents. The special apprehension is looming for proficient responses such as official reports of modern safety standards that are sometimes, if not mostly, either ignored or unenforced. For instance, although there is fairly convincing evidence that the 2012 Kedarnath disaster in northern India was the consequence of flash flooding and cloud blast (Dobhal et al., 2013), the intensity of damage was mainly due to improper site selection for build-up area (Ray et al., 2016). The disaster could have been explained as a natural phenomenon only if the mountain valley was to be free from human residency (Rao et al., 2014). Therefore, it is evident that in both wealthy and developing countries disregard, catastrophes and public trusts are extensively stated in official regulatory systems (McClean and Johnes, 2000; Oliver-Smith and Hoffman 2001).

3 Types and Effects of Environmental Disasters

Disasters constitute one of the major reasons of inequitable and unsustainable growth in today’s world. Disasters can primarily be broadly classified into three specific categories, i.e., natural, anthropogenic, and mixed or hybrid. The natural disasters are those which are beyond anthropogenic control and therefore, necessitate our adaptation to them. Anthropogenic disasters, mainly, are caused by human themselves and are primarily the result of human greed, inefficient governance, and the poor civic sense among the different classes of society. The question of how
society makes sense of the associative link between an unexpected calamity and the resultant impact is related to disaster vulnerability (Fischer, 2002). Following the attacks on the World Trade Centre on 9/11 incident in the USA, there has been a new or emerging awareness and appreciation in the field of research on the impact of disasters on human societies. Disaster categories and definitions have been discussed in details by Turner and Pedgeon (1997), Richardson (1994), the World Health Organization (2003), the Federal Emergency Management Agency (2003a, b), and the Mid-Florida Area Agency on Aging (2003).

3.1 Natural Disasters

Natural disasters are hazards that are triggered by natural reasons and may be of hydrometeorological, atmospheric, geological, or even biological causes (World Health Organization, 2006). Common examples of these natural hazards include cyclones, earthquakes, tsunamis, and volcanic eruptions which are exclusively of natural origin. Together with climate change, natural disasters present considerable challenges to socio-economic attainment and sustainable development as they disturb a wide array of both social and ecological systems (IPCC, 2001). Even today, many societies are ill-prepared to cope with extreme events and climate change threatens to undermine many decades of effort in the spheres of development assistance, poverty reduction, and disaster risk management (Thomalla et al., 2006). The observations of the International Federation of the Red Cross and Red Crescent Societies in the World Disasters Report (IFRC, 2002, 2003, 2004a, b) reveal that the number of people killed by natural disasters continues to be elevated, as well as that the number of people or communities altogether affected and, most certainly, associated financial losses have augmented significantly since the 1970s (IPCC, 2001).

3.2 Anthropogenic Disasters

Anthropogenic disasters are hazards which can be caused due to direct human negligence or faults. These man-made disasters are linked with industries, agriculture or energy generation facilities and include pollution, leakage of toxic waste, bigger impacts such as dam failure and explosions, wars or civil unrest to name a few (Pidgeon and O’Leary, 2000). Man-made disasters are also labelled as socio-technical disasters (Richardson, 1994) that are caused by failures in different organisational sectors like transport, industrial as well as public places or fora. Although access to safe and enough water and air are indispensable for both health and overall development of human beings, which are currently at risk if we continue to deteriorate both of them. The food and health care industries are extinguishing natural bio-physical elements and destroying the environments for both human and other living beings across the world. Sporadic urbanisation, population explosion,
improper agricultural practices and unrestrained sewage discharge into rivers and wetlands are the main reasons behind the heavy increase in surface water pollution. Although groundwater is being used extensively, recent research which explores the fundamental structures that reveals current forms of human exposure to rapid and anthropogenic environmental transformation is not being considered (Kasperson and Kasperson, 2001; Turner et al., 2003; Pelling, 2003b). Studies also have improved our perception of how human influences and social constructions interact with physical environmental systems in creating hazardous conditions. Heavy industries, mining activities, and transport systems based on fossil fuels have been the major contributors to groundwater pollution. Across the globe, human civilisation developed on the banks of the rivers since water is necessary to sustain life. However, since the industrial revolution, with industrialisation concentrated mostly around urban centres, a major chunk of population from the rural-agricultural setup began to migrate to urban centres in search of better opportunities. This rise in migration together with improper agricultural practices contributed to the growth of pollution, thereby affecting not only the environment but also all existing living creatures on earth. Both, younger groups of people today convey a certain amount of more than 100 chemical residues that were absent in the bodies of their older generations. These harmful chemical substances accumulate slowly in their systems and are being transmitted to the next generation in very high concentrations. Water-borne diseases caused by the intake of chemicals and contaminated water affect around 3.4 million people globally.

Environment Institute (SEI) and Clark University in the US have illustrated both the complexity of, and interactions involved in, vulnerability analysis, drawing attention to how multiple socio-political and physical processes operating at different spatial and temporal scales produce vulnerability within the coupled human-environment system (Turner et al., 2003).

*Industrial pollution* can either be sourced from point sources or non-point sources of pollutants. Industrial pollution can be controlled either by legislative measures (such as the Water Act of 1974, the Air Act of 1981, the Environmental Act of 1986, the EIA Notification of 2006, and so on) or by the establishment of Pollution Control Boards. However, there are systemic weaknesses which complicate matters. The Bhopal gas tragedy serves as the perfect example to illustrate this point. The disaster could have been deterred if governmental departments had followed the specified norms as an alternative. However, residential or non-commercial houses were allowed everywhere in the factory, thereby resulting in the magnitude of the disaster. Further, urban water pollution has considerably reduced the availability of drinking water.

*Agricultural pollution* is mainly a non-point source of pollution and hence there are no fixed and universally accepted rules and regulations to control it. The only possible remedy can be inviting a change of technological methods applied or innovated. Although some farmers have made some effective attempts in this direction, most government authorities have not shown much interest. The Gulf of Mexico, for instance, has turned into a dead zone spreading over a considerably huge area with runoffs that contain residues of highly toxic (for marine aquatic organisms)
chemical fertilisers and sprays from agricultural farms carried through the waters of the Mississippi river in the USA.

### 3.3 Hybrid Disasters

Since the relationship between human beings and nature is dynamic and complex, a new subset of anthropocentric disasters has been defined on the basis of the role played by both elements. This is called ‘hybrid disaster’ (Song and Park, 2017) and is based on the premise that both human error and natural forces collude to cause disaster. One of the examples of this type of disasters was Latur earthquake which happened on September 30, 1993. This early morning earthquake incident was one of the deadliest earthquakes the state of Maharashtra (India) has seen till date. In this intraplate-earthquake, about 52 villages were devastated and over 30,000 people were injured whereas nearly 10,000 people were dead. The earthquake left a massive hollow in Killari village, the epicentre of the earthquake, remains the same till date. The earthquake’s focus was around 12 km deep - relatively shallow causing shock waves to cause more damage. The inexplicable failure of India’s seismological network system, the untimely responses from the scientists fail to give necessary warning as well as the traditional building construction practices in the area led to unimaginable death rates and destruction of properties of poor people (Sinha and Goyal, 1994; Ravi, 1994).

### 4 Environmental Disasters in Social Context

If we overlook meteorologic issues it would be difficult to determine the increasing disaster risk. Even for meteorological hazards, the geophysical aspects of the worst cases of events in recent years had already been equalled or surpassed in the last centuries. With scientific agreement, considering anthropogenic activities as the main drivers of the current rapid climate change issues, the only way to effectively inverse the trend similarly depends upon gradual social transformations. At large, social assessments confirm the potential dangers that come mainly from more human exposure to the threats and, certainly, the lack of safety measures taken into serious account. In the meantime, for the last several decades and in almost everywhere in this world, the production of assets per capita and the obtainability of modern commodities have far surpassed even the growth of population. Accessibility and transformation of wealth could have had better and positive effects on safety measures, although wealthier countries often experience horrific disasters in recent times, such as the Fukushima disaster in Japan, which could have been controlled or even prevented more profoundly (Hewitt, 2013). According to McClean and Johnes (2000), the negligence in responsibility and preventive measures can act as a trigger to the greater exposure of risk, and damage to many selective groups of people or
communities that are already standing on the verge of vulnerability due to the absence of a proper regulatory framework of risk reduction or lack of equitable responsibilities.

Thus, presence of marginalities and internal power relations within the society(s) affect the vulnerability more selectively. The fatalities and impacts of any disaster are being seen in an inequitable way, more for some particular groups or parts of the population on the basis of their sex, gender or any other intersectional attributes. It is evident in cases of different disasters, such as tsunami of 2004. The countries along the Indian Ocean suffered the most and there was a high number of women fatalities among the deaths. It was also the similar case of the earthquake in Kobe during 1995, where the death toll was major among women residents of the area. According to Enarson and Morrow (1998), these unequal losses can be explained by the cultural history of social practices as it divided the society into groups and put some in greater exposure of danger.

Therefore, it is evident that due to the existing social divisions and selectiveness, differences in power and hegemonic roles, some groups are already in danger, whereas disasters or physical conditions do not discriminate between people, communities and societal practices (Hewitt, 2013). So-called wealthier nations do not avoid such situations, although not too substantial most of the times, but the losses found to be directly associated with inequitable and discriminatory social conditions for certain groups or communities. It can be linked with absence of serious institutional and technical preparedness for all. Detailed scrutiny of the specific concerns of threats could reduce the risk of disasters. Comprehensive reconstruction efforts show that many victims had been living in areas and buildings which violated basic safety rules and regulations. Pre-disaster investigations or surveys reveal the same. A majority of the victims were also reported to have already been suffering from a range of acute stresses and lack of basic support system, even before the disasters occurred.

5 Disaster Mitigation And Risk Reduction

5.1 Pre-Disaster Prediction and Risk Assessment

Preparedness is a shielding procedure that incorporates measures to enable governments, groups or communities, and individuals to respond fast to disaster conditions to deal with them as effectively as possible. It thus embraces the formulation of feasible plans for emergency supplies, the advancement of practical warning systems, the careful preservation of inventories, and the last but not the least, personnel training to cope. Further, it includes necessary investigation and rescue actions and evacuation plans, wherever necessary, to avoid the threat and impact from another surge of the disaster. Preparedness thus involves these important steps well in
advance of any possible disaster event to minimise the projected fatalities, trouble
in critical services supply and the direct structural damage.

5.2 Disaster Response: Monitoring and Assessment

Forecasting natural disasters is a budding area of research in recent years. However,
the measure of human anguish in post-disaster situations is rarely considered prior
to the occurrence of any disaster. Generally, this puts an instantaneous burden on the
already damaged environmental services for the provision of emergency supplies of
shelter, water, or waste management services. Nearly all disasters cause certain
environmental impacts, which lay extra adverse effects to the already impacted
communities. Considering the degrees of dangers in a disaster and its impacts on
both the environment and the society, the immediate requirements of the communi-
ties, and the consequences for the early recovery preventive plans is therefore an
essential need. Simultaneously, there are a number of philanthropic and relief-based
activities which are generally undertaken at the initial preventive stage that may
themselves have a serious impact on the state of the situation. Till date, post-disaster
preventive measures entail assessments that are being carried out primarily to iden-
tify the instant life-saving requirements. From the perspective of humanitarian
reforms, attention should be given to the immediate needs of the affected communi-
ties after the end of the emergency phase and before full-scale development starts to
fill the gap. This initial recovery stage of disaster management should be allocated
and provided according to the need of the people.

Efforts and measures taken at the early recovery phase by governments and other
intergovernmental actors in case of a larger disaster event ever so often suffer from
a combination of isolated initiatives and sporadic strategic leadership. This ulti-
mately takes the whole situation to the deficiency of a holistic strategy and frame-
work, resulting in a replication of efforts, a wastage of resources and, of course,
lives as well as a catastrophe to factor in risk reduction deliberations. This condition
makes the whole recovery in peril from the sustainable point of view. Therefore,
renewed effort is now being considered for supporting the necessary early recovery
phase of any post-disaster conditions by addressing the immediate needs and
chances across the board, taking an intersectoral consideration, and institutional and
community requirements into account, and consolidating necessary data into a com-
mon understandable format which can be instantly introduced into the available
measures for both immediate and future financial support. Monitoring and
Evaluation (M&E) are important as they: a) make operational activities more liable
to the affected and the supportive groups, b) validate the risk reduction activities to
the responsible authorities to demonstrate the efforts engaged and c) improve the
perception of the Disaster Risk Reduction (DRR) procedures in practice by identi-
fying the issues responsible for larger impacts.

The variations of M&E methods and frameworks for relief as well as further
recovery have been developed significantly over the past decades. This can partially
be determined by wide disparagement and pressure from the responsible donors but also because of the ongoing demand to demonstrate and aggravate the success and improved performance during and after disaster(s). Thus, a growing body of work is delivering governmental and non-governmental agencies the better-informed direction on M&E approaches for further development in disaster risk reduction, and emergency services. This is also supported by different humanitarian initiatives active throughout the world. Assessment of a M&E project should emphasise on the following features:

- **Inputs** which include the financial, technical and human resources arranged. Their critical effectiveness, profitability, and feasibility can also be assessed simultaneously.
- **Activities** include the performance of measures and their responsible factors.
- **Outputs** are the immediate outcomes or deliverables achieved by the project.
- **Impact** refers to significant deviations caused by the action(s) taken.

Monitoring discourses on the above mentioned inputs, activities, and outputs need to meet the timely data requirement of the associated project authorities and supply information related to developmental progress to the donors. Thus, these monitoring discourses must maintain a regularity and commence throughout the duration of the disaster management project. Whereas, evaluations generally focus on outputs, their impact, and degree of involvement of wider stakeholders even beyond the organisational setup. It is more infrequent and implied at any stage of the entire project cycle or, even beyond. Thus, monitoring is having an eloquent nature and evaluation is more investigative. Reviews are supplements for regular monitoring processes, in a less frequent manner and provide opportunities to identify key issues required in the project. They thus form a significant part of an internal managerial procedure, eventually engaging external stakeholders. Audits are important for assessing the project and to follow the compliance of the programme with already considered and existing agreed regulations, and mandates.

The evaluation procedure should be initiated at the design phase of the project where aims and objectives are being established and outcomes-based project frameworks are being developed. An array of evaluations should be there during and after the project ends to allow more profound assessment, although this practice is unlikely in reality. Evaluations should be programmed at those critical points within the project cycle whenever they are needed at the most, especially for the decision-making stages. Quantitative evaluation indicators are generally target oriented like the number of disaster-resistant structures built or disaster preparedness committees involving the community(s) established, sometimes using proxy indicators for this. Whereas, qualitative measurement indicators are more often necessary for the risk assessment, using inputs from the stakeholders through various workshops, interviews, engaging focus groups and semi-structured consultation based interviews. These qualitative measurement indicators can be crucial to provide proper measures of development and outcomes, therefore untangling insights into the processes undertaken. Participatory approaches have been proven to be delivering a decent qualitative information.
5.3 Post-Disaster Mitigation and Recovery

Mitigation holds measures to decrease both the direct impact of the hazard and the after math situations in order to reduce the degree of a future disaster. Mitigation measures can therefore focus on the hazard directly or on the exposure to the future threat. For example, water management can be a hazard specific mitigation measure applicable for drought-prone areas to relocate people from the affected areas, and reinforcement of infrastructures to mitigate damage once a hazard occurs. Apart from these physical mitigation measures, reducing the economic and social threats of the disasters in the future should also be another aim for mitigation. Unfortunately, due to the lack of proper governance system and awareness measures among the societies, socio-economic mitigation measures, generally, cannot show its full potentiality in most of the cases, such as disasters related to flood in most of the developing countries almost every year.

In the aftermath of a disaster, the pressure to rapidly restart the essential services increase the mitigation and rebuilding. In many communities, powerful right-wing alliances mainly, consisting of landowners, industry lobbies, and some governmental sectors attempt to maintain the previous capitalistic practices that results profit for this smaller group of higher powerholders, regardless of the impact on the less powerful groups and interests (Logan and Molotch, 1987). On the contrary, research as well as experiences recommend that proper planning and the use of public sector dispute resolution techniques can play a role in addressing the power imbalance and relations, and enduring requirements and concerns of the communities (Forester, 1987, 1989; Godschalk, 1992; Susskind and Cruikshank, 1987). The process of equitable disaster mitigation recovery is not always the best and possible approach. Disaster mitigation and recovery should consider the significant but limited scope of prospect to restructure the damaged services even stronger than their previous condition (before the event) by adjusting landuse pratices and its patterns, and reform the existing social sphere.

Many studies have revealed that disasters incline to variably impact individual persons and groups depending on their pre-disaster levels of existing social vulnerability (Blaikie et al., 1994; Bolin and Bolton, 1986; Bolin and Stanford, 1999; Peacock, Morrow, and Gladwin, 1997). Linking the status quo and captivating benefit of post-disaster prospects towards the positive change, inclusive actions taken in favour of less-powerful groups, it is obligatory for planners and other authoritative agencies to involve all stakeholders and pursue consensual approaches which elicit mutual benefits across the potentially disagreeing groups. Previous researches have also revealed that disaster mitigation and recovery policy are less prominent to local officials and authorities who tend to face disasters less frequently than the state itself and higher personnel, whereas the resistance to change may be overcome through a rapidly developed inclusive recovery measures (Wright and Rossi, 1981; Geipel, 1982). While researching on earthquake recovery strategies in Peru, Oliver-Smith (1990) found that sustainable recovery goals (e.g., tackling issues of existing inequality in the society and the adoption of best practices mitigating hazard) were
reached when planning strategies met local needs. In this case, local capabilities were taken into consideration by those responsible for the supply of external aid, and the community, on the other hand, understood the organisational requirements. Some recent studies suggest that individuals and organisations are both, perhaps, more considerable to changes in the status quo following the occurrence of disasters (Birkland, 1997), that include sustainable disaster recovery planning and reconstruction measures taken as an approval of leaders from various levels who advocate for this approach (Smith, 2004).

The efficiency of pre-disaster response planning for post-disaster emergency response not necessarily always complies with the impactful management of disaster response actions (Quarantelli, 1993). Similarly, some groups appeared to react more efficiently to a disaster once they failed to plan or ignored existing planning measures altogether (Clarke, 1999). Equitable recovery planning can be accomplished through an adaptive and methodical approach (Smith, 2004). Mileti (1999) mentioned the following features underlying effective recovery plans at the local level:

i. Impacted stakeholders (by post-disaster measures) should be taken into consideration for input generation and accordingly policy-makers should attain buy-ins from them as a preventive measure. This will not only reduce conflict but also help to aid in the developmental process of a rapid recovery plan reflecting the local needs.

ii. The usefulness of a plan is also driven by the data and information used for making the policy and immediate action. Specific data and information crucial to develop an effective recovery plan incorporates hazard characteristics too (for example, high wind or storm surge) and potentially vulnerable areas, population size, and its composition, and spatial distribution, local economic factors etc. Technology such as Geographic Information System (GIS) can be used to provide a meaningful investigative platform to graphically display and analyse collected data and, thus, is being, even more, used by local governmental agencies and emergency planners and managers in the decision making process to mitigate and recover the impacts of hazards and disasters.

iii. A recovery management strategy should identify the potentially relevant groups and organisations that can offer specific types of support. A recovery group can therefore lead post-disaster management efforts and regularly organise to engage in preventive planning and policy-making decisions. This organisational structure must involve governmental agencies as well as non-profits and emergent organisations which can be the most effective while trying to aid the marginalised and/or those remain heavily excluded following disasters.

iv. Recovery and mitigation plans should be pragmatic and applicable. In the post-disaster conditions, existing policy-making measures must be adapted to account for the requirement to make fast decisions. Thus, measures should include hazard mitigation for the recovery of damaged infrastructural facilities and the future development plans according to the acknowledged hazard-prone areas to be put on the exclusion list.
v. The recovery strategy should also clearly articulate the effective functioning tasks in regard to the mobilisation, distribution, and coordination within the operational groups to conduct impact assessments. The information should be collected in such a manner that it can be quickly integrated and used to weigh local needs and support in the execution of pre and post-disaster reformation planning and policies.

vi. Generally, major disasters can affect in financial loss significantly exceeding local governmental budgets. The ability to bridge the identified needs collected as parts of the impact assessment as mentioned above to existing financial resources and funding sources and properly planned policies is central to the successful execution of identified goals and objectives, where, even if, local needs may not be enough to match the certain eligibility criteria but the presence of alternative implementation strategies in the planning procedure. It helps to plan for the effective contingency budget as a part of the preventive measures.

6 Environmental Disaster Management

6.1 The Role of Geospatial Sciences in Environmental Disaster Management

Geospatial sciences which complies Geographic Information Systems (GIS), Remote Sensing (RS), and Global Positioning Systems (GPS) together have gained much attention in recent years for the practical and on-time applications in disaster mitigation and management planning and are progressively being employed throughout the total cycle of disaster management system as a tool to support decision-making. GISs, are in many cases, recognised as a standard key tool for supporting decision making in disaster management (Mileti, 1999). Policy-makers, disaster managers, and the mass are gradually taking these Geospatial sciences seriously for their visualisation capabilities. Disaster management entails complex coordination within existing resources, necessary and available equipments, required skills, and possible human resources from different agencies. This multidimensional process therefore requires robust decision support systems for fostering cooperation and help disaster loss reduction (Assilzadeh and Mansor, 2004; Pourvakhshour and Mansor, 2003). While spatial queries have long been of core of concern for both the disaster researcher groups and practitioners in the field of policy and decision making similarly, the inclusion of GIS has essentially augmented the capacity of the disaster-research-community for incorporating geographic approaches. The locational knowledge regarding the hazard zones and understanding existing inter-relationship with the distribution of various groups and sub groups of the people is crucial to develop planning and policies for mitigation and strengthen preparedness with proper strategies. Real-time locational information can effectively improve the distribution of essential resources as a part of the mitigation
response. Despite the complexity regarding the, geographic approaches and technology oriented functional ability in Geospatial sciences, these modern technology is rapidly and effectively being used in recovery strategies for mitigating disaster risks and hazard management.

The spatial decision support system for disaster management (SDSS) incorporates technical dimensions in organisational issues. A decision support system, thus, meets the requirements of the practitioner simultaneously integrating existing physical and social factors. SDSS supports the inter-operability of emergency services essential during response and relief stages (Zlatanova, van Oosterom, and Verbree, 2004). The SDSS thus has a crucial role in mitigation and recovery planning phases of disaster management strategies. Advanced SDSS must be able to perform sophisticated tasks wherever and whenever needed, which involve right from the defining the problem and selection, identification and evaluation of the potential alternative solutions (De Silva, 2001). At the same time, GIS must be taken into the decision making process in accordance with decision-makers, disaster managers and policymakers as well as the public to create a robust system altogether.

The assessment of aquifer vulnerability (pollution potential of an aquifer) is a study pertaining to a combination of hydrogeologic factors, anthropogenic impacts or influences, and contamination sources in a given area. Mapping of aquifer vulnerability is based primarily on the percolation factors and diffusion of contaminants factors. The contaminants present in the aquifer system may be linked to the naturally absorbed components of the host rock or brought by the human activities during infiltration or percolation process of water from the surface of the ground above. Considering the accuracy, frequency of availability and accessibility of the data, aquifer vulnerability assessment method can be regarded as advantageous or with limited merits while application. Aquifer vulnerability assessment methods can be, therefore, categorised into the following:

- **Statistical analysis methods** measure groundwater quality and its pollution level through the study of statistical correlations and associations between the observed pollution data, circumstantial environmental conditions and land use-land cover patterns on the ground above.
- **Computer simulation method** requires more complexity and prerequisites of the details pertaining to the vulnerability assessment. Thus, the computer simulation method examines both physical and chemical properties and processes with greater distinction.
- **Descriptive ranking methods** classify or categorise the vulnerability or the intrinsic susceptibility of the groundwater table into different low, medium and high categories of vulnerability to help the managerial decisions.

Among these models, the most comprehensive and commonly used model for assessing groundwater vulnerability is the DRASTIC model (Aller et al., 1987). DRASTIC methodology was originally developed by the United States Environmental Protection Agency (USEPA) and is one of the worldwide used standardised systems for evaluation of groundwater vulnerability (Merchant, 1994; Lobo-Ferreira and Oliveira,
DRASTIC model is comprehensive in nature, and has the worldwide acceptance and application for assessing aquifer vulnerability.

6.2 Planning and Operational Decision-Making

Strategic geographical planning has always been set and executed under uncertainties. Planners used to deal with the uncertainties by overlooking the complexity. The strategic spatial planning can be regarded as a study of possible potentialities (Balducci, 2008; Hillier, 2005). This spatial planning also involves “encouraging the emergence of particular development trajectories” (Healey, 2008). The emergent trajectory proposes a shift from previously set targets to a flexible method which seeks to substitute beneficial change. Many suggest involving people in a debate on alternative futures must be important “through the creation of arenas for transparent, inclusive, democratic debate of foresighted potentialities” (Hillier, 2007). Post-disaster recovery planning has to deal with the complexity that arises over the time. Maximum strategic decisions need not to be presented in convenient ways. At the same time, problems and potential opportunities must be identified from “streams of ambiguous, often conflicting subjective opinion” (Mintzberg et al., 1976). The decision-making procedures of identification, prototypes, and negotiating adaptation strategies for disaster managers are still not very clear and universally accepted. Little attention has been paid to the initial diagnosis step which is a prerequisite for necessary actions to be taken.

Quarantelli (1969) observed that recovery suggests an attempt to take the post-disaster condition to some stages of acceptance which can be similar to the pre-impact stage. Recovery may decipher a form of stability rather than a return to any recognisable pre-event order (Hills, 1998). Right after WWII, planning became progressively rational, following a recognised pattern of consideration of all possible alternatives by decision-makers, the identification and assessment of the costs of each course of action, and the subsequent selection of the one which was the most desirable. One characteristic of this rational model of planning was the incorporation of the evaluation stage into the existing planning process. Recently, this model had been defied. Now, planning can be regarded as a frame of reference and an instrumental strategy for decision-making and at the same time, integration of uncertainty in the system, thus making planning process more flexible (Faludi, 1987).

Decision-making, on the other hand, can be viewed as a problem-solving action concluded by a solution deemed to be satisfactory (Schacter et al., 2011). Thus the decision-making appears as a process of selection which can be rational or irrational and based on explicit assumptions. Rational choice theory represents the notion to maximise benefits while minimising costs. Nevertheless, it should also consider that some, if not the most, decisions are made unconsciously, without thinking much about the decision process (Nightingale, 2008).

Rational theories of reasoning reveals how the reasoning should help to make proper judgments, and take decisions accordingly. These theories such as
probability theory or decision theory suggest guidelines to follow. All rational choice models agree with preferences, for example, motivations, affect, desires, values, tastes, and beliefs such as cognition, ideas, knowledge, information, as the systematic driving forces behind the actions taken (Sun-Ki Chai, 1997). Kinicki (2008) suggests that rational decision-making denotes a structured and stepwise approach to decision-making which follows a rational four-steps order:

1. Identification of the problem
2. Generation of alternatives
3. Solution selection
4. Implementation and evaluation of the outcome.

The main benefit of this rational choice approach lies in its ability to support in the prediction of the act, either at the individual or the collective level. However, there are crucial limitations associated with this model for disaster decision-making, like unacceptable delays in the pursuit of an ideal solution, inadequate information, and the swiftly-changing nature of the issues. In contrast, the ‘irrational’ model proposes that decision-making is considered by inadequate information and its processing capacity, using critical heuristics and shortcuts to simplify decision-making, and by picking solutions meeting the minimum requirements to be good enough.

Disaster mitigation planners and managers are needed to take a range of reactive decisions to respond to the crisis events. Many of these operational decisions, in case of well prepared nations, would have been practised in advance and there would be well-established strategic protocols in place for most contingencies. Time is limited after a disaster and there is an imperative need to transport relief and to return to normalcy starting from clearing up the debris, repairing the damage happened, rebuilding livelihoods. Hence we must consider the fact that decision-making process needs to be prompt and under severe pressure than normal.

6.3 Building Capacities through Environmental Training and Awareness Building and Communication

Capacity refers to the total strengths, attributes, and available resources that a society, community or organisation possess in order to cope and decrease the risk from disaster and increase resilience (UNISDR, 2017). It emphasises capacity of the individual more to predict, manage, resist, and improve the loss, impacted from disasters, despite of focusing on the limiting vulnerability. Capacity also depends on other performing assets that economy, political stability or instability, presence of good governance, psychological conditions and, certainly the bio-physical environment offer (DFID, 2004). Capacity can also be designated as the opposite of vulnerability, nevertheless, even vulnerable people have some degrees of capacities too (Wisner et al., 2012; Shepard et al., 2013). Undeniably, the initial stage of capacity development is the composite of traditional or indigenous knowledge, powers,
qualities, and other material assets that individuals, organisations, and/or societies altogether already have. Capacity may also incorporate collective infrastructural, institutional, knowledge and skill oriented qualities like social cohesion, leadership, and management capabilities (UNISDR, 2017). Thus, developing capacity can be defined as a concept that extends the ambit of building strength to encompass all the aspects of creating and sustaining growth over time involving learning and training opportunities in order to develop institutional, political, financial and technological awareness and resources as a comprehensive system for enabling environment widely (UNISDR, 2017).

Disaster risk reduction requires empowerment as well as comprehensive, accessible, and equitable participation (UN Report, 2015). Capacities are generally endogenous to communities at the household level, implying that people are more regulatory than communities (Wisner et al., 2012). Instead of making an effort to lessen vulnerability, strengthening capacity may be an easier strategy for the people themselves as most drivers of vulnerability remain unchanged at the household level, although economical, and political conditions can alter them (Wisner 2007). Most of the countries in the Global South, the disasters’ impact with wide-ranging risks are commonly absorbed by the low-income groups at the household level, sustaining and increasing poverty intensities and weakening developmental consequences. Augmenting capacity may offer those vulnerable communities the prospect to diminish their risk from the disaster as well as develop and adapt to ongoing threats from the rapidly changing climate. An integrated capacity development always transforms the mindsets and, as a result, attitudes more than simply performing duties or tasks given. Nevertheless, measuring these transformations and consequential effects are no less than a major challenge (UNDP, 2009).

An aiding environment, that is, robust political will and commitment at the maximum levels of authority, all-embracing participation, and transparent public accountability is crucial for deciphering capacity at the performance level. For disaster risk reduction, capacity building offers the foundation of a pragmatic strategy that begins with the development of awareness, evaluation, reduction as well as prevention of potential risk and possible adaptation of mitigation measures (UNISDR, 2008). Organisations offer the comprehensive platform for individuals for working together towards a common set of goals with a shared vision (UNDP, 2008). Organisational capacity may thus be improved and evaluated from the management aspects of financial, administrational, governmental and human resources (USAID, 2012).

Capacities need to be developed through the process of formal education and practical training rather than just depending on the reflexion and performance at the individual level (UNDP, 2009). In addition, networking, leadership development and multi-stakeholder platforms also augment these capacity development processes (Datta et al., 2012). Capacity building should also be established on the essential traditional knowledge of local indigenous communities, which they possess through generations of experiences to deal with the disasters. Capacity-development strategies, hence, at the local level should include:
• Anticipate through raising the awareness, education, participation and implementation of risk assessments;
• Manage by providing essential first aid-training, learning to swim, and so on;
• Resist through preventive measures such as early warning systems, evacuation strategies, storing emergency equipment; and
• Mitigation through providing alternative means of income and social protection etc (Hagelsteen and Becker, 2014).

Capacity building is not just the development of technical measurements but need to be associated with specialised disciplines and precise sectoral requirements and, therefore, required to collectively promote the leadership and other managerial capabilities (UNDP, 2009). These incorporate the capacity to:

• Involve stakeholders
• Evaluate a situation
• Set a goal
• Design policies and related strategies
• Budget, manage and implement
• Assess impact

Cases of applying capacity development process for disaster risk reduction could present various unknown challenges. As of now, there is a considerable degree of uncertainty in the formal terminology used related to disaster risk reduction, capacity building and ownership in both literature and practice. Notions are also different while considering the local context, capacity assessment together with the distinction of roles and responsibilities at different levels of application (Hagelsteen and Becker, 2014). A culture of resilience could develop if we can enhance the disaster risk reduction capacity of individuals as well as organisations.

7 Examples

7.1 Example 1: Brownfield Regeneration and Impact on Human Health: Developed World

Land is a finite resource which is transformed over time with human intervention through production, settlement, and other associated socio-economic activities. Among these economic activities, industry and mining are primarily associated with the depletion of land resources. The term ‘Brownfield’ refers to the industrial wasteland within an Indian perspective, but this term is also used in parts of Europe, the United Kingdom, and the United States (Bambra et al., 2014). The US Environmental Protection Agency (EPA) defines Brownfield as abandoned, idle, or under-used industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination. The terms
‘Brownfield,’ ‘Greyfield,’ and ‘derelict sites’ are all related to each other (Maantay, 2013; Litt and Burke, 2002; Shortt et al., 2011) and they are interchangeably used in literature. The primary similarity between these lands is that they are vacant contaminated sites in urban or suburban areas (Bambra et al. 2014) which have the potential to become a health hazard (Catney et al., 2007) and are located within a 5-25 km radius from the centre of each capital city (Newton, 2010).

The Environment Agency estimates that approximately 300,000 Ha of land in England is regarded as land affected by chemical and radiological contamination. Scotland as a whole accounts for a large number of (Hanlon et al., 2005; Mitchell et al., 2005; Taulbut et al., 2009; Walsh et al., 2010) Brownfield and derelict sites that serve as triggers for the inequalities of health (based on the degree of deprivation) as compared to other parts of the UK and Europe, but even within Scotland, Glasgow leads with the highest number of derelict and Brownfield sites, worst overall health, and higher inequalities (Gray, 2008). Nonetheless, it is questionable why Glaswegians tend to have lower health outcomes even when compared with a few developing world cities (Hanlon et al., 2005; Mitchell et al., 2005; Taulbut et al., 2009; Walsh et al., 2010). Even after making allowances for a similar industrial and cultural history, people in Glasgow have poorer health and higher deprivation compared to other cities in the UK (Gray, 2008). In this regard, Fairburn et al. (2004) noted that given the contingencies of industrial pollution and land contamination as well as deteriorating air quality and water quality in rivers, there is a strong interrelationship between environmental degradation and high deprivation in Glasgow as people living in the most-deprived areas are far more likely to be living near the sources of potentially hazardous environment.

With the help of a comprehensive literature review by Brender et al. (2011), it is evident that there is a correlation between environmental pollution and its threat to human health and the disproportionately large magnitude of its effect on poor and minority populations. The concept of Environmental Justice (EJ) refers to the distribution of equal environmental benefits among all population groups (Bullard et al., 2005). However, it should be noted that distribution patterns may be unequal as a consequence of the patterns of human settlement, income levels, racial traits, and cultural differences (Craig, 2010). Although it is evident that lower income groups and immigrant communities suffer significantly as a consequence of problems brought about by environmental pollution (Smyth, 2000), this connection is highly standardised with respect to racial traits, ethnicity, and poor environmental components in the United States (Maantay, 2001; Maantay, 2002). In Glasgow, there are approximately 927 individual sites of Brownfield land which account for about 4% of total land area in the city and 12% of the entirety of Scotland’s Brownfield land (Scottish Government, 2012). More importantly, about 60% of Glasgow’s city population resides within a 500 metre radius and over 92% live within a 1,000 metre radius (Chakraborty and Armstrong, 1997; Neumann et al., 1998; Sheppard et al., 1999). With the assistance of the base map (Scottish Government, 2012) of Glasgow City, Maantay (2013) noted that zones separated by radii of 100 metres from the contaminated sites are regarded as ‘sacrifice zones’ where even city planners are not
interested in investing money because these zones have already crossed the threshold of re-development. These contaminated sites (mainly coal tar/creosote, phenols, cyanide and sulphur, heavy metals such as cadmium, lead, barium, and chromium, phytotoxic metals, and so on) have high incidences of foetal death, heart disease, various cancers, low birth weight of infants and, more importantly, respiratory disease (Malik et al., 2004; Ding, 2006; Kuehn et al., 2007; Wang, 2011). About 69% of the population in Glasgow is regarded as ‘highly deprived’ and does not have access to proper hygiene facilities such as drinking water, air, and food (Greenberg et al., 1998).

Glasgow’s environmental degradation is not, however, only due to the presence of Brownfield sites but is rather a consequence of a larger complex of associated issues which are responsible for poor health and deprivation in the city. For example, individual behavioural issues such as excessive smoking, drug abuse, alcohol consumption, and poor diet (Craig, 2010) are also responsible for poor health and depression among communities. Moreover, the issues regarding EJ have only recently come under the attention in parts of the UK. Although EJ in Scotland has been discussed in scholarship, inequalities of health among different communities or within a particular community in the city has not hitherto been the major focus (Dunion, 2003; Scandrett, 2010). Therefore, it is imperative to tackle these health-related inequalities and deprivation through proper policy-making. Although planning has usually failed to effect significant change in the face of a continuing downward spiral, this is not so much the result of negligence on their part but rather due to realistic and pragmatic considerations about the limits of available resources.

### 7.2 Example 2: Contaminated Site Management

Improper management of waste, particularly industrial waste, may contaminate environmental components such as soil, surface water, groundwater, and air. Both natural as well as anthropogenic factors influence the physico-chemical properties of soil depending on natural and anthropogenic factors, and acting together across different spatial and temporal scales. Heavy metal content in many soil types is often significantly influenced by the parent material, and sometimes significantly influences the heavy metal content in many soil types, with concentration levels sometimes exceeding the critical values (Palumbo et al., 2000; Salonen and Korkka-Niemi, 2007). Some rock types of volcanic and metamorphic origin contain several heavy metals such as Ni, Cr and Mn. These are trace elements in some rock types of volcanic and metamorphic origin (Alloway, 1995). During the weathering processes of rocks the primary crystalline structure breaks down and consequently the relevant chemical elements are released from the rocks. Furthermore, these either get absorbed into the topsoil or move towards surface water or groundwater. Prolonged excessive use of pesticides in agricultural land results in the concentration of heavy metals such as copper, nickel, zinc, and cadmium accumulating in the topsoil
(Nicholson et al., 2003). In such cases, the presence of different sources of contamination and the widely divergent patterns of distribution of products make soil pollution assessment overly complex in the presence of different sources of contamination and the widely divergent patterns of distribution of products (Parth et al., 2011).

Disposal sites of Hazardous Waste (HW) are one of the major prime sources of elevated levels of metals in the soil environment (Bozkurt et al., 2002). Hazardous waste is typically defined as a solid, semi-solid, or non-aqueous liquid waste which, because of its chemical composition and characteristics, may pose a substantial human health hazard or environmental hazard if not managed properly or released accidentally. A piece of hazardous waste can be defined by one or more of the following properties:

- **Ignitability**: Waste is considered ignitable if its flashpoint is < 60° C, is an oxidiser, and is capable of causing fire through friction, absorption of moisture, or spontaneous chemical changes under normal conditions of temperature and pressure. Examples include waste oils, organic solvents, paint wastes, epoxy adhesives and resins, spent inks, degreasing agents, white phosphorous, and so on.

- **Corrosivity**: Although not every waste material is corrosive in nature, if it has a pH < 2 or >12.5 then it can be corrosive. For example, spent acids, alkalis, and solids that can form strongly acidic or basic solutions when mixed with water (ferric chloride, sodium hydroxide, etc), solutions that are strongly acidic or basic (ferric chloride, sodium hydroxide, etc).

- **Reactivity**: Waste may be considered as reactive if it is unstable or undergoes rapid or violent chemical reaction when exposed to air, water, or other materials at normal conditions and generates toxic gases or vapours when mixed with water or when exposed to pH conditions between 2 and 12.5 (as is the case with cyanide or sulphide-containing materials). Examples include wastes containing white phosphorous, acetyl chloride, chromic acid, cyanides, hypo-chlorides, organic peroxides, perchlorates, permanganates, sulphides, some plating materials, and bleaches.

Currently, India generates about 6.23 Million Metric Tonnes Per Annum (MMTPA) of hazardous waste. Significantly, most of such HW is produced by the industrialised states, of which Gujarat (28.76%), Maharashtra (25.16%), and Telangana (8.93%) constitute the top three. At the same time, environmental components are highly contaminated in a few states, such as in Gujarat where the air quality is severely degraded and is a direct contributor to serious airborne diseases (Basha et al., 2010). More specifically, the coastal marine atmosphere surrounding large industrial centres can be highly affected by pollution emissions, resulting in the high concentration built-up of pollutants in the ambient air (Chester et al., 1994; Ondov et al., 1997; Scudlark et al., 2002). Levels of trace metals in ambient air were also found to be higher than those in industrial areas of Tita Scalo and Ispra in Italy and Daejon in Korea (Rizzio et al., 1999; Ragosta et al., 2006; Kim et al., 2002). The heavy usage of chemicals in agricultural land in Punjab has been found to contaminate groundwater. Levels of F, NO₃, SO₄, Ca, Na, and Mg higher than
permissible have been reportedly found in the groundwater in certain villages of the Bhatinda district (Kochhar 2000). There appears to be a correlation between these high values in groundwater and high uranium and radon activity (Kochhar and Dadwal, 2004). To assess the role of certain elements in causing cancer in the Jajjal and Gyana villages of Bhatinda district, the groundwater characteristics and radon activity including levels of F, NO$_3$, SO$_4$, U, Pb, Cr, and Ni were monitored in certain parts of southwest Punjab (Kochhar et al., 2007).

### 7.3 Example 3: Recent COVID Pandemic

The world is currently facing an unprecedented threat from the coronavirus disease 2019 (COVID-19), a respiratory illness, pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), infection, a novel (new) coronavirus first identified in Wuhan, China in December 2019. COVID-19 is a respiratory illness caused by SARS-CoV-2 infection. The looming crisis in the developed as well as developing countries threatens to devastate economies and further ramps up inequality. According to the latest report and guidelines published by WHO/UNICEF (2020), ‘the provision of safe water, sanitation, and hygienic conditions is essential to protect human health during all infectious disease outbreaks, including the COVID-19 outbreak. Ensuring good and consistently applied WaSH and waste management practices in communities, homes, schools, marketplaces, and health care facilities will help prevent human-to-human transmission of the COVID-19 virus’. COVID-19 has crucially induced the deployment of identification and confinement measures, the drawing of boundaries, and exclusionary strategies which have unsurprisingly re-ignited the contested question of intersectionality and social exclusion in terms of water, food, and energy nexus securities. The provision of safe water, sanitation, and hygienic conditions is absolutely necessary to protect human health during any infectious disease outbreaks, including corona virus pandemic (WHO/UNICEF, 2020). According to the UN Report (2020), in least-developed countries up to 75% of people lack access to soap and water. The recently published UN Water Report (2020) mentions that about 4 billion people live in severe conditions of physical water scarcity for at least one month per year. Around 1.6 billion people—almost one fourth of the world’s population—face economic water shortage, which means that they lack the necessary infrastructure to access water. According to the FAO (2020), a pandemic has significant impacts on both food supply and demand, and thus, pose a risk of an impending food crisis. Currently, about 820 million people around the world are experiencing chronic hunger, that is, not consuming enough caloric energy to live a normal life. Of these, 113 million are coping with acute and severe insecurities—hunger so severe that it poses an immediate threat to their lives or livelihoods and renders them reliant on external assistance to survive. These people can hardly afford to have any further potential disruptions to their livelihoods or access to food that COVID-19 might bring. If
COVID-19 cases—already present in most regions of the world—proliferate in the 44 countries that need external food assistance or in the 53 countries home to 113 million people experiencing acute and severe food insecurities, many of whose public health and social protection systems face capacity constraints, the consequences could be drastic and catastrophic.

The energy sector has already felt the impact of COVID-19. The outbreak has contributed to a sharply reduced demand for oil, resulting in plummeting prices and declining production, especially in the wake of the Russia-OPEC price war. According to the IEA Oil Market Report (2020), global oil demand is expected to fall by a record 9.3 mb/d year-on-year in 2020. Demand in April is estimated to be 29 mb/d lower than what it was a year ago, down to a level last seen in 1995. COVID-19 has also accelerated the sustained drop in gas prices. A similar trend of falling demand and price reduction can be observed in the electricity sector. At this moment, it is difficult to predict the consequences of these changes in the water, food, and energy sectors. Although these changes depend upon the ultimate trajectory of the virus outbreak itself which cannot be mapped with certainty having the distinct indications that scenarios will worsen much more for poorer nations (UNCTAD, 2020). In addition, according to the recent UN Report (2020), income losses are expected to exceed $220 billion in developing countries. With an estimated 55% of the global population having no access to social protection, these losses will reverberate across societies, impacting education, human rights and, in the most severe cases, basic food securities and nutrition within (intra-urban) and/or on the fringes (peri-urban) of a city or metropolis in the Global South where the density of population is currently the highest in the world.

Since the discovery of SARS-CoV-2 in December 2019, its geographic distribution continues to evolve (World Health Organization, 2020). UNICEF’s Water, Sanitation and Hygiene (WaSH) interventions have contributed to the formulation of government strategies designed to control and terminate the transmission of the disease. The WHO has formulated a standard Strategic Preparedness and Response Plan (SPRP) to be used at country level. The SPRP outlines the public health measures that need to be taken in order to support countries to prepare for and respond to COVID-19.

The eight pillars of the COVID-19 strategic plan (WHO/UNICEF, 2020):

1. Country-level coordination, planning, and monitoring
2. Risk communication and community engagement
3. Surveillance, rapid response teams, and case investigation
4. Point of entry
5. National laboratories
6. Infection prevention and control
7. Case management
8. Operational support and logistics

Over the past few days, a series of stimulus packages, unique in both scale and scope, have been declared by China and the major developed countries to combat
the escalating economic damages and the deteriorating crisis at the health sectors. Even though many developing countries had already registered slow economic growth in the last quarter of previous year with several inflowing recessions, the rapidity at which the pandemic has dealt an economic shock to even the most advanced economies is comparable to the global financial crisis of 2008. The economic effect of the COVID-19 pandemic is ongoing and gradually becoming difficult to predict, although there are straightforward indications that things will deteriorate considerably for developing economies even before any further preventive step is taken. Nonetheless, the full impact of the current health crisis has not yet been felt in many poor and middle income countries, and the ‘end of the beginning’ of the economic crisis has not yet been reached in advanced economies. The strong recovery in trade between developing countries that happened in 2010 appears less likely to be repeated this time around. Even if the impairment to global supply chains is retrievable, the entire global business model will have a permanent trait of change from top to bottom in order to recover the predicted damage. Moreover, China has gradually reduced its dependence on exports in its supply-chains increasing its domestic production of intermediate goods. Apart from the economic downfall and predicted global health crisis, the socio-cultural status and morphology in the developing world, especially in a country such as India, can be a vital input for further disaster. Although ‘social distancing’ is the key strategy for preventing further spread of COVID-19, it is questionable how far such a strategy would be possible in countries such as India, Indonesia, Pakistan, and China. In the case of India, for instance, marginalised communities are entirely dependent on daily wages to sustain their livelihood. Given this financial contingency, how would it be possible for them to follow the ‘stay-at-home’ protocol? Further, factors such as illiteracy, high population density (414 people per square kilometre), together with moderate-to-poor medical infrastructure will further compound the severity of this pandemic.

8 Concluding Remarks

Apart from the natural hydrometeorological hazards, environmental disasters are very likely during the current century as a result of years of exploitation of environmental resources as well as the absence of social securities for vulnerable groups of people especially in the lower and middle income countries. A range of solutions is, therefore, needed, including access to technologies, early warning systems for disaster management, as well as increased stakeholder capacities at every level. The interlinked nature of the risks posed by natural disasters and climate change is well documented. The urgent need to reduce the disaster risks has been recognised and reaffirmed in the 2030 Agenda for Sustainable Development. It was emphasised that thinking and action must be through managing systems to mitigate disaster risks
and build resilience. The most effective means of reducing disaster risks include strong actions on climate change mitigation and adaptation. Otherwise, the frequency and intensity of, and the vulnerability to, disasters will only escalate in the future. Last but not the least, the role of good governance and imbibition of lessons learned from traditional knowledge are also necessary.

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