



## Invited ViewPoint

# Building resilience against biological hazards and pandemics: COVID-19 and its implications for the Sendai Framework



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## ABSTRACT

2020 has become the year of coping with COVID-19. This year was to be the “super year” for sustainability, a year of strengthening global actions to accelerate the transformations required for achieving the 2030 agenda. We argue that 2020 can and must be a year of both. Thus we call for more utilisation of the health-emergency disaster risk management (Health-EDRM) framework to complement current responses to COVID-19 and the patent risk of similar phenomena in the future. To make our case, we examine current responses to COVID-19 and their implications for the SFDRR. We argue that current mechanisms and strategies for disaster resilience, as outlined in the SFDRR, can enhance responses to epidemics or global pandemics such as COVID-19. In this regard, we make several general and DRR-specific recommendations. These recommendations concern knowledge and science provision in understanding disaster and health-related emergency risks, the extension of disaster risk governance to manage both disaster risks and potential health-emergencies, particularly for humanitarian coordination aspects; and the strengthening of community-level preparedness and response.

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**1. Introduction: SFDRR and Health Emergency and Disaster Risk Management (Health-EDRM)**

COVID-19 has rapidly morphed into an unprecedented health, economic and geopolitical crisis. It surely underscores the imperative of accelerating the integration of multiple global policy frameworks, not least those at the centre of the 2030 Agenda. Prior to the emergence of COVID-19, the UN Secretary General had positioned 2020 as the “super year” for action on sustainability (UN, 2020). The Sustainable Development Goals (SDGs), Paris Agreement on Climate Change, and the New Urban Agenda, alongside the SFDRR were all adopted in 2015–2016. March 18th, 2020 marks the fifth anniversary of implementation of the 2015–2030 Sendai Framework for Disaster Risk Reduction (SFDRR). The SFDRR aims to enhance national and community capacity to cope with disaster risks. It emphasizes a comprehensive approach, to address multiple hazards (technological, biological and environmental) that impact at different scales, frequency, and intensity (UNISDR, 2015).

Human health cross-cuts all the global frameworks. The SFDRR explicitly includes epidemics and pandemics among biological hazards (UNISDR, 2015) [1–3]. Moreover, SDG 3 is devoted to “good health and well-being”, with an emphasis on “early warning, risk reduction and management of national and global health risks” (UN, 2015). For its part, the Paris Agreement and the Intergovernmental Panel on Climate Change Assessment Report highlights that climate change exacerbates health risks including pandemics (see e.g. [4,5]). The recently edited book by Chan and Shaw [6] on Public Health and Disasters is timely since it highlights the progress and importance of the Health-EDRM framework adopted by the WHO in 2019. Health-EDRM refers to the “systematic analysis and management of health risks, posed by emergencies and disasters, through a combination of (1) hazard and vulnerability reduction to prevent and mitigate risks, (2) preparedness, (3) response and (4) recovery measures” (WHO 2019). Health-EDRM is thus an umbrella term, which the WHO uses to refer to the broad intersection of health and disaster risk management (DRM). It also comprises such areas as emergency and disaster medicine, bolstered health systems and resilience, disaster risk reduction, humanitarian response, and community health resilience [7].

Against the backdrop of still-worsening COVID-19 impacts, this paper discusses resilience building for pandemics and related biological hazards. We examine ongoing efforts to respond to COVID-19 and these efforts' implications for the Sendai Framework. Our analysis reveals specific areas of rapid response to COVID-19. But we find lamentably few actions by DRR-related organisations, in spite of the SFDRR's call for building resilience to biological hazards. Moreover, the current WHO-led coordinated response reveals little implementation of the WHO Thematic Platform for Health-EDRM adopted in 2019. Existing mechanisms and strategies for disaster resilience, such as those detailed in the SFDRR, offer concrete means to respond effectively to epidemics and even global pandemics such as COVID-19. We thus put forward general and DRR-specific recommendations for short and long-term resilience.

This viewpoint is structured as follows. In the introduction, we present the motivation for the paper along with brief reviews of the recent progress of SFDRR and Health-EDRM implementation. Section 2 reviews global responses to COVID-19 complemented with discussion of responses by agencies related to DRR. Section 3 elaborates our recommendations supported with examples and cases.

**2. Responses to COVID-19 from global to national level**

This section briefly investigates current responses to COVID-19 from the global, regional to national levels. We do not engage in an exhaustive review of approaches at any level, and instead use representative cases to demonstrate our key argument. That is, we focus our analysis on whether a given level - global, regional or national - includes significant input from DRR-related agencies. To us, the evidence suggests that COVID-19 has yet to elicit early and rapid action from the DRR-related organisations. We believe this passivity belies the SFDRR's call for building resilience against all hazards, including biological hazards.

*2.1. Global level*

The global level of response includes the UN's COVID-19 communications wherein the Secretary General has called for “coordinated, decisive, and innovative policy action” on COVID-19. The World Health Organization, under Director-General Dr. Tedros Adhanom Ghebreyesus, leads the coordinated response for COVID-19. On the 11th of March, the DG announced that COVID-19 is a global pandemic. As of March 20, WHO's front page focuses on the COVID-19 outbreak (<https://www.who.int/emergencies/diseases/novel-coronavirus-2019>) (Fig. 1). The WHO has called for at least US\$675 million to fund critical response efforts in countries most in need of help through April 2020.

The above and other content indicate that the WHO (2019) framework on Health Emergency and Disaster Risk Management (Health-EDRM) has no apparent role in the current response strategies. Certainly there is no mention of disaster at all within the WHO Coronavirus disease (COVID-19) technical guidance, particularly on the COVID-19 Strategic Preparedness and Response Plan, regarding Operational Planning Guidelines to Support Country Preparedness and Response (WHO, 2020).

Also at the global level, the UN Office for DRR [8] issued a press release on the 12th of March 2020 urging disaster management agencies to prioritize biological hazards. The UNDRR asked national disaster management agencies to continue with the development of their preparedness and response capacities to include health emergencies as a top priority, alongside earthquakes, floods, storms and other natural hazards (UNDRR, 2020). It also highlighted the importance of silo-breaking in disaster prevention and management, notably the silos between disaster management and health workers. The UNDRR reiterates that the Sendai Framework emphasizes the need for resilient health systems and the integration of disaster risk management into health care provision at all levels. After all, Sendai turns the focus from disaster response and management to preparedness, surveillance and disaster risk management in the health context (UNDRR, 2020). Yet it is not clear whether COVID-19 is leading to collaboration between the WHO and the UNDRR.

We appraise the speed and scale by which COVID-19 response funds are made available. International funding organisations, regional government bodies and private entities have proposed major financial measures. The International Monetary Fund (IMF) made \$50 billion in loans available to deal with the coronavirus, including \$10 billion of zero-interest loans to the poorest IMF member countries (IMF, 2020). The EU Commission President Ursula von der Leyen announced a €25 billion coronavirus investment fund for the health care sector, labour market and SMEs (EU, 2020). The World Bank Group increases COVID-19 Response to \$14 billion to help sustain economies and protect jobs. The Asian Development Bank

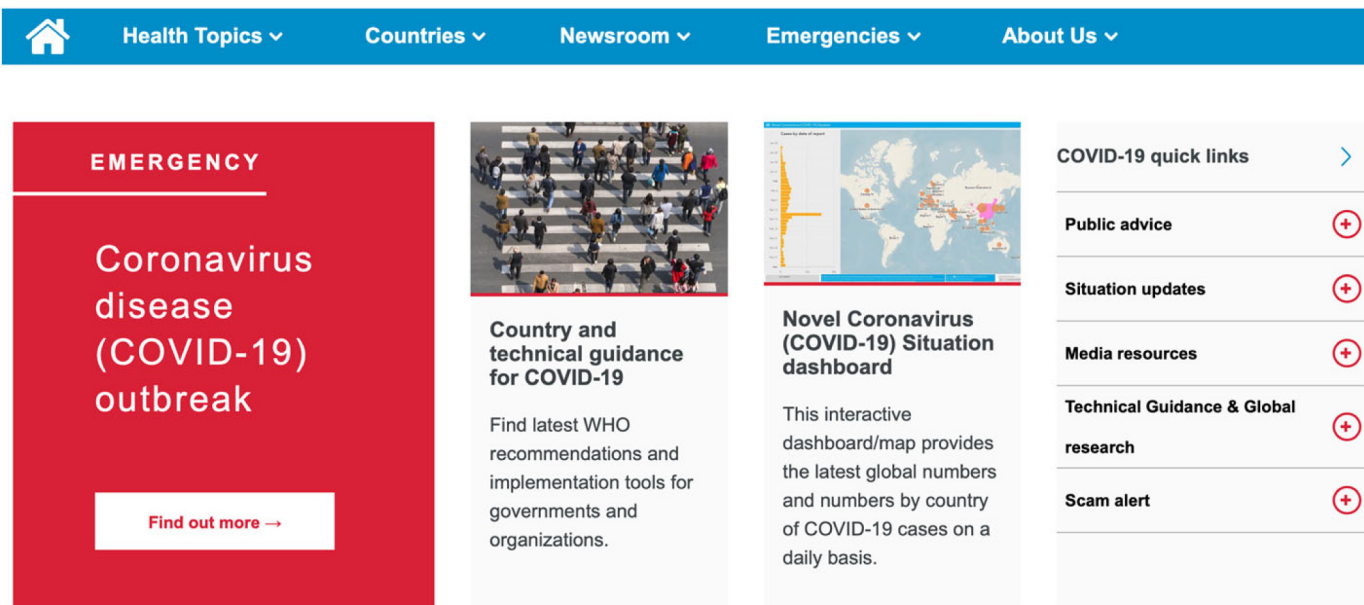


Fig. 1. Frontpage of WHO website on March 19th, 2020 (WHO, 2020).

(ADB) announces \$6.5 billion initial response to COVID-19 pandemic (ADB, 2020). The UN announced \$15 million dollars from the UN's Central Emergency Fund to help fund global efforts to contain the spread of the COVID-19 coronavirus, particularly vulnerable countries with weak health care systems (UN, 2020). It is important to note that in the SFDRR, investment and finance are at the core of Sendai Framework, in terms of the resilience investment needed for countries and communities.

## 2.2. Regional level

We separate the regional level into Europe, Asia, and Africa. Concerning the former, the European Commission (EC) leads the planning and implementation of European Union (EU) strategy, its role in setting priorities, and its implementation through EU policy. A dedicated website is [https://ec.europa.eu/info/live-work-travel-eu/health/coronavirus-response\\_en](https://ec.europa.eu/info/live-work-travel-eu/health/coronavirus-response_en). The EU has established a common European response to the outbreak of COVID-19, focusing on public health sectors and socio-economic impact particularly mobility and economy in the **European Union** (EU, 19th March 2020). Italy is the most severely impacted country in the EU. The EC support for the Sendai Framework identifies health as one of the issues interlinked with DRR (EC Web, 2020). Yet it is unclear whether the EU response to COVID-19 features coordinated involvement by DRR-related agencies and mechanisms. The opportunity for integration may be possible through the Integrated Political Crisis Response (IPCR). The IPCR provides a flexible crisis mechanism for supporting the presidency of the Council of the European Union in dealing with major natural or man-made cross-sectorial disasters, as well as acts of terrorism. The IPCR works through common Monitoring and Information-sharing (EU, 2016).

In Asia, the response of the Association of Southeast Asian Nations, or **ASEAN**, is instructive. The ASEAN was established on 8 August 1967 in Bangkok, Thailand, with the signing of the ASEAN Declaration (Bangkok Declaration) by Indonesia, Malaysia, Philippines, Singapore and Thailand. The ASEAN now includes 10 member countries and coordinates regional action. Concerning COVID-19, ASEAN has issued ASEAN Health Sector Efforts in the Prevention, Detection and Response to Coronavirus Disease 2019 (ASEAN, 2020). Guided by the ASEAN Post-2015 Health

Development Agenda (APHDA) and its Governance and Implementation Mechanism (GIM), the ASEAN Health Sector Cooperation deployed and operationalized the established and existing health mechanisms for technical exchanges, information sharing, and updates on policy-related measures in responding to COVID-19. ASEAN specialised agencies involved are the ASEAN Emergency Operations Centre Network for public health emergencies (ASEAN EOC Network), ASEAN Senior Officials for Health Development (SOMHD) of ASEAN and China, Japan and Republic of Korea (Plus Three Countries), and ASEAN BioDioaspora Regional Virtual Centre (ABVC) (ASEAN, 2020). There is no indication that the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre) is involved in the ASEAN's response to COVID-19. AHA Centre is an inter-governmental organisation which aims to facilitate cooperation and coordination among ASEAN Member States and with the United Nations and international organisations for disaster management and emergency response in ASEAN region. Leadership is beyond the mandate of the AHA Centre (see <https://ahacentre.org/about-us/>). But its plethora of existing mechanisms can and should be used. These mechanisms include the Emergency Operations Centre (EOC), the Standard Operating Procedure for Regional Standby Arrangements and Coordination of Joint Disaster Relief and Emergency Response Operations (SASOP), the ASEAN Joint Disaster Response Plan (AJDRP), the Disaster Emergency Logistics System for ASEAN (DELSA), the Emergency Response and Assessment Team (ERAT), the ASEAN Regional Disaster Emergency Response Simulation Exercise (ARDEX), ASEAN-ERAT (ASEAN-Emergency Response and Assessment Team) and the AHA Centre Executive (ACE) Programme (REF). Globally, the ASEAN region is one of the most vulnerable to disasters, and the AHA Center has been praised for its role in strengthening DRM in the region (e.g. [9,10]). These competencies surely ought to be deployed in addressing the rapid emergence of COVID-19 as well as building resilience against a repeat.

Another item of note is the South Asian Association for Regional Cooperation (SAARC). SAARC is the regional intergovernmental organisation and geopolitical union of states in South Asia. Its member states are Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan and Sri Lanka. The SAARC leaders held a video conference on 15 March

2020 to discuss measures to contain the spread of COVID-19 in the region (GoI, 2020). India's Prime Minister initiated the conference, calling upon SAARC leaders to work collectively to fight the spread of the pandemic in the region. India called for the creation of a COVID-19 Emergency Fund, with voluntary contributions from all Member States. India itself pledged US\$ 10 million as an initial contribution. There is no further information available. To be sure, SAARC developed a Comprehensive Framework on Disaster Management and Disaster Prevention in 2005 and established a number of SAARC centres, chiefly the SAARC Centre for Disaster Management and Preparedness (SDMC) to implement the framework. Yet progress to build the DRM capacities of South Asian states through regional cooperation has been slow (Brookings-LSE, 2015). There have long been doubts about SAARC's effectiveness (e.g. [11]) and readiness [12], so it may not be up to the task of coordinating a regional response to COVID-19.

In Africa, WHO-African region coordinates the response, with its latest Situational Report announced as of 18 March 2020. A total of 345 confirmed COVID-19 cases have been reported across 27 countries in the region (WHO-AFRO, 2020). Financially, Melinda and Gates' foundation issued USD 115 million in aid for COVID-19 with USD 100 million pledged to Africa and South Asia.

### 2.3. National level

It is very clear that responses to COVID-19 centre on actions at the global and national level. We organise the review by the regions.

#### 2.3.1. Asia

The first known case of COVID-19 emerged in the **Chinese** city of Wuhan on December 12, 2019 and was deemed an emergency in the third week of January 2020. WHO declared COVID-19 (the "new coronavirus") a Public Health Emergency of International Concern (PHEIC) on 31st of January 2020, and finally a pandemic on 11th March 2020. Based on Chinese newspaper, social media and other digital platform data, Hua and Shaw [13] analyse the timeline of key actions taken by the government and people over three months in five different phases: the very early phase (up to 31st of December 2019), the investigation phase (up to 20th January 2020), the early identification phase (up to 31st of January), the criticism, agony and depression phase (up to 14th February), and lastly the positive preventive and curative control phase (up to 29th February). Their analysis details the initial delay in responding, but also highlights key factors in China's efforts to combat COVID-19. These factors include strong governance, strict regulation, strong community vigilance and citizen participation, and wise use of big data and digital technologies.

**Japan** came under the spotlight in January 2020, when the luxury cruise ship *Diamond Princess* was docked in Yokohama, and symptoms of COVID-19 were detected in several persons. Complex issues of governance and strict regulation complicated the initial response, leading to a wide spread of the COVID-19 among the passengers and crew. Subsequently, COVID-19 began being reported in persons returning to Japan from abroad, mainly from China. The Hokkaido region is particularly affected. An epidemic cluster approach has marked the Japanese government's response, limiting testing. A strict government response followed, including school closures from early March, telework from home, flexible working time to avoid crowded trains, and an epidemic cluster approach. Communities and people followed this "request" from the government (which was not compulsory) apparently limiting the spread of COVID-19 and the number of deaths. Thus, the combination of government request and strong self-discipline within people and communities has evidently led to desirable results. The dedicated website <http://japan.kantei.go.jp/index.html> provides timely updates from the Prime Minister, with Japan having passed two packages of small business loans, one \$4.6 billion package in February, and a \$15 billion one on March 11, 2020.

In sharp contrast, **South Korea** was a surprise case of sudden high increase in affected people and high number of deaths (over 9,000 cases). Several cases of community spread, notably from religious organisations, which went out of control. However, through a strict screening and testing

system, aided with advanced technology, South Korea was able to bring down the number of affected people as well as number of deaths. The country allocated more than \$13 billion in emergency funds to stoke economic activity.

**Taiwan**, on the other hand, used 2003 SARS experience to prepare from the beginning through strict countermeasures as well as big data analysis of people's movement and thereby identifying the possible areas of spread of COVID-19.

**Singapore** is another case where an initial surge was observed in the number of affected people. The country took strict regulatory measures for quarantine, tracing infected people's movement. These measures succeeded in significantly limiting the number of newly infected people. Singapore has set aside 5.6 billion Singapore dollars (\$4.02 billion) in the coming year to help businesses and households.

Other ASEAN countries, including **Indonesia**, provide a promising example of integrating Health-EDRM. The Indonesian COVID-19 task force (*Gugus Tugas Percepatan Penanganan COVID-19*) has been formed to coordinate the national COVID-19 response. A single coordinated source of information in Indonesia is presented through its dedicated website [www.covid19.go.id](http://www.covid19.go.id). This task force is led by the chief of the National Disaster Management Agency (BNPB), General Doni Monardo. Beyond that, it remains unclear whether there is a deeper coordination of different agencies/ministries, and whether this extends to response mechanisms from the national, provincial and local governments. The Indonesian government has prepared a budget of Rp 1 trillion, or around \$70 million, to be channelled through the Health Ministry to try to contain the Covid-19 outbreak and care.

**India**, with the second largest population in the world, has taken early precautionary measures through travel and visa bans on foreigners from certain countries, mandatory health checks and self-quarantine for 14 days. The Indian Prime Minister, in a national address, encouraged citizens to observe self-curfew and community vigilance at the initial stage. These actions appear to have limited community spread in this highly populated country. While PM Modi has announced India's contribution to SAARC, information for the national fund is not available.

**Iran**, on the other hand, has seen a drastic rise in the number of affected people and deaths, the largest in Asia (outside China). The Iranian outbreak has mainly been attributed to a lack of initial responses by the government, limited public awareness of the risk of contagion, and lack of mandatory self-quarantine. Public attitudes are a key issue underlying Iran's high death rate (roughly 10% of globally infected people, as compared to China's 30%).

#### 2.3.2. Europe

In Europe, **Italy** is the worst hit with a comparatively high percentage of deaths among the infected. This outcome has been attributed to lack of regulation and testing, which prompted the community spreading. Gradually, stricter government regulation and vigilance systems have been implemented and enforced, along with social distancing among the people. However, the open border among the EU countries has helped in spreading the disease to Spain, France, Germany and Switzerland, as well as to the UK. The European Union (EU) has been surprisingly slow in coordinating a response to the outbreak. High rates of infection and deaths eventually prompted the European Commission to coordinate a common European response to the outbreak. The response includes resolute action to reinforce the country's public health sectors and mitigate the socio-economic impact in the European Union. In terms of funding, the French announced \$49 billion, Italy announced a \$28 billion plan on March 11 to be divided over two separate spending packages, while the UK announced a £5 billion COVID-19 fund (UKGov, 2020).

#### 2.3.3. North America

The impact on North America was delayed and the threat taken quite lightly. The most significant action for some time was airlift of infected passengers from the cruise ship in Japan in February 2020. However, no travel ban was imposed. This policy resulted in free travel to Europe and Asian

countries, leading to a sudden increase in the number of infected people in both Canada and the USA. Once WHO declared COVID-19 a pandemic in the second week of March, the USA also declared a national emergency, although some of the states declared state emergency at an earlier stage. Travel bans have since been imposed and screening, testing, mandatory quarantine practices are in place. The US government's website on COVID-19 is <https://www.usa.gov/coronavirus>. US President Trump signed an \$8.3 billion spending bill, currently called "Phase One" of stimulus efforts, and up to \$50 billion in aid to states, cities, and territories (USAGov, 2020).

In **Canada**, the Prime Minister convened an Incident Response Group on coronavirus, which has been meeting since the end of January. On March 5, he created a Cabinet Committee on the federal response to the coronavirus disease (COVID-19). Chaired by the Deputy Prime Minister and vice-chaired by the President of the Treasury Board, the committee meets regularly to ensure whole-of-government leadership, coordination, and preparedness to limit the health, economic and social impacts of the virus. The Canadian federal government released \$1.1 billion in emergency response, with a larger fiscal stimulus planned (Gov of Canada, 2020).

In summary, countries took dramatically different approaches in managing the pandemic. The variation is marked by prior experiences and preparation, early reinforcement of strict vigilance, testing and isolation, late law enforcement, strong vs weak public awareness, self-restraint, commitments, and other factors. Some aspects of risk perception, awareness and response is a cultural issue, and powerfully linked to the socio-economic structure of the country and community. But in a strongly interconnected world, there surely needs to be a global standard and protocol for regional and national response. It is imperative to build mechanisms that decrease risks of infection and enhance community safety and resilience.

### 3. Recommendations on how current strategies for disaster resilience can contribute to responses to COVID-19

In this section, we put forward some recommendations on how current strategies for disaster resilience can contribute to responses to COVID-19. These are grouped into DRR-related health emergencies and recommendations in general.

#### 3.1. General responses and societal adjustments

##### 3.1.1. Legal aspects

There is an urgent need for global protocols, agreed and signed by the governments, to respond to global pandemic. A global pandemic is not merely a health issue, but also demonstrates a profound influence on the global economy. The lack of science-based decisions, resort to ad-hoc travel bans, and other uninformed and uncoordinated responses, worsened this pandemic both as a health crisis and an economic crisis.

##### 3.1.2. Health and science aspects

It is imperative to strengthen information sharing and other coordinating mechanisms for health-related humanitarian issues. This includes sharing examples and experiences of preventive and treatment systems, new vaccine and preventive medicine information, means to protect the community from spreading through breaking the line of infection, and also basic awareness on sanitation. Future complexities and uncertainties on global health, along with environmental and societal changes will only increase in the future. The scientific methodologies to deal with uncertainties are being developed and should be utilised further in decision making. As stated in a March 17 editorial in *Nature*, it is critical to "Follow World Health Organization advice, end secrecy in decision-making and cooperate globally" [14].

##### 3.1.3. Lifestyle aspects

First, good hygiene and a robust immune system are key to coping with any virus, and COVID-19 is no exception. Thus healthy lifestyles are prominent in enhancing resilience. Also, telework, the use of AI and other new

technologies for work which can be done remotely needs to be promoted. These measures are consistent with emergent means of collaborating and producing science. These include working from home, collaborating online, online meeting and teaching, social media engagements by scientists, and engagement of social science. This diffusion of cooperation can also help behavioural science understand societal responses, foster risk communication experts, science-policy advice.

##### 3.1.4. Learning from prior experiences makes a difference

Some countries and regions such as Singapore, Vietnam, Taiwan learned from the bitter experience of SARS of 2003. The recent past incentivised them to act promptly and no doubt inclined their citizens to cooperate, which paid off in reducing COVID-19's spread.

#### 3.2. DRR-specific recommendations

##### 3.2.1. Stronger knowledge and science provision in understanding disaster and health-related emergency risks

Disaster Risk assessment is a standard approach in DRR. Core methodologies for disaster risk assessment include hazard and vulnerability assessment. These methods can be utilised for COVID-19 risk assessment. In addition, the health sciences should be more involved in the community of disaster risk management, to advance our understanding of outbreaks and pandemics, the health impacts of all hazards, and improve data collection [15]. Science is recognised especially in modelling disease spread, data on affected people, and the rush for vaccines. Open data, Open Science and Open Map are being advocated. Existing spatial and remote sensing capacity for disaster can be used for mapping pandemics. The UN-SPIDER (Space-based Information for Disaster Management and Emergency Response) knowledge portal recognises epidemics as a source of hazard. The existing regional tsunami early warning systems can also be tasked for health-related emergencies. The systems include the Pacific Tsunami Warning Center (PTWC); the Indian Ocean Tsunami Warning System (IOTWS); and the North Eastern Atlantic, the Mediterranean and connected Seas (NEAMTWS). There is strong recognition for integration on DRR and CCA and appropriate adaptation can greatly reduce the health burden resulting from climate change and disasters [16]. The Sendai Framework takes an interconnected and pluralistic approach to understanding risk (UNDRR, 2019). The nature of current risks is complex and systemic, and can also be compound, interconnected, infracting and cascading risks [17]. Natural, technological and biological hazard disasters can occur in these fashions, as shown in the triple disasters of earthquake, tsunami and nuclear power plant failure in March 11, 2011 in Japan. Countries like Japan, or Indonesia, despite having to respond to current COVID-19, they also need to be ready should an earthquake or tsunami occur.

##### 3.2.2. Mobilise existing disaster risk governance structure to manage disaster risk and potential health-emergencies

Multi-stakeholder engagements have been established, especially in disaster vulnerable countries. The same engagements can be utilised for addressing pandemic risks. One key agency is the International Federation of Red Cross and Red Crescent Societies (IFRC). The IFRC combines a wealth of knowledge on disaster risk reduction, with expertise in fighting the spread of diseases, combat discrimination and violence, and promoting human rights and assistance for migrants. For example, the IFRC issued an Appeal for Global COVID-19 Outbreak, and the IFRC, UNICEF and WHO issued new guidance to help protect children and schools from transmission of the COVID-19 virus (IFRC, 19 March 2020).

##### 3.2.3. Utilise existing disaster coordination mechanisms at regional level to inform epidemic response

The regional bodies like ASEAN, SAARC, European Union (EU) need to enact regional protocols, coupled with information portals on pandemic risk. Traffic is quite high within the region, especially among countries with land borders. Thus proper protocol on human movement information sharing is required. The information sharing needs to be open and

transparent, which enhances safer regional, cross border as well as global movement.

### 3.2.4. Understand COVID-19 economic implications and resilience

COVID-19 and its effects afford ample evidence of the imperative of bringing health into DRR. The economic fall-out from COVID-19 appears to be profound, at least \$20 trillion in a few short weeks, and may exceed the 2008–2009 Great Recession. The direct costs of COVID-19 travel bans, social distancing, and other responses are merely one aspect. Far more devastating is the uncertainty that has gripped capital markets. Declining economic activity and large drops in capital markets have a mutually reinforcing impact, undermining the capacity of heavily indebted businesses and households to cover their debts. Uncertainty is the primary driver of such crises, and stems in large measure from lack of close coordination and science-based decision-making. Were there more certainty, households, investors and other economic agents would be less inclined to panic. COVID-19 appears certain to become a very costly lesson that DRR does indeed save many more multiples in avoided costs than its initial investment. An additional point in this regard is that health is a critical infrastructure. The resilience of critical infrastructure is well identified in DRR literature (e.g. [18,19]). Resilience is fostered not just by science-based decisions and coordination, but also via redundancy to ensure buffer capacity when a particular system collapses [20]. Disaster-illiterate economic policy tends to see redundancy as inefficiency. But in order to cope with COVID-19 and alleviate - if not prevent - future emergencies, supply chains for at least some critical items need to be more local. In tandem, governments and private businesses will have to broaden their crisis planning to ensure timely availability of items essential to limiting pandemic risks.

### 3.2.5. Prepare inclusive early recovery plans

At present, the data suggest that in some countries, including China, Korea, Japan, and a couple of other Asian countries, the peak of the COVID-19 may be over. It is imperative to continue taking precautions, including screening, isolation of suspected cases and social distancing. However, it is also important to start developing early recovery planning, which needs to be gender and disability inclusive. The socio-economic fall-out from this crisis is already high, and quite literally rising by the day. Concerns about preventing a protracted global recession, if not outright depression, are leading to focused intervention in capital markets and other areas. Aviation, energy, hotels, and other concerns that appear - to their investors and to policymakers - to be too big to allow to fail seem about to be given relief. Yet pandemic risks increase when general community health and well-being weaken. Thus it is critical that measures also be taken to identify the most vulnerable and include them in recovery packages.

### 3.2.6. Strengthen community-level preparedness and response

Methods from Community-based DRM can be used for COVID risk assessment. Community-based disaster preparedness and management [21,22] is crucial in reducing disaster deaths and losses. The last mile approach in disaster EWS, where community networks, communication systems, can be utilised for pandemic EWS at the community level. In disaster literature, risk perception strongly influences willingness to prepare for emergencies. Social linkages in communities may play an important role in focusing risk perceptions [23], while disaster type, gender, and previously experienced disasters are good predictors of victims' attitudes toward natural disasters [24].

In summary, we have examined current and unfolding responses to COVID-19 and their implications for the Sendai Framework. Core to our argument are strategies for resilience building against biological hazards and pandemic. We reiterate our assertion that there is a lack of early and rapid actions from the DRR-related organisations, despite the SFDRR's call for building resilience including from biological hazards. The SFDRR's ultimate goal is a substantial reduction of risk and losses, coupled with laying the essential foundations for rapid and sustained recovery and sustainable development. We hope the evidence we have added shows the crisis of COVID-19 could be used to make 2020 a “super year” of great progress on these goals.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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