INTEGRATING BIOLOGICAL HAZARDS (INCLUDING PANDEMICS) INTO DRR PLANNING

Annex

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Table of Contents

1. Background 1
2. Biological hazards 2
3. Content review 5
   3.1 Regional DRR and biological hazards/ public health response plans/ agreements 5
      3.1.1 The Association of Southeast Asian Nations (ASEAN) 6
      3.1.2 European Union (EU) 7
   3.2 National DRR and biological hazards/ public health response plans 11
      3.2.1 Germany 13
      3.2.2 India 13
      3.2.3 Japan 15
      3.2.4 Singapore 16
      3.2.5 South Korea 18
   3.3 Risk assessment frameworks 19
   3.4 Review of Guidance/ recommendations on integration of biological hazards to DRR and development planning 25
   3.5 Learning from past and current experiences 29
      3.5.1 Past outbreak/ pandemic 30
      3.5.2 Country specific response to COVID-19 40
4. Key steps and learning 47
5. Key sectors 49
   5.1 Sectors that help in mitigation 50
      5.1.1 Healthcare 50
      5.1.2 Non-Governmental Organisations (NGOs) 50
      5.1.3 Education 51
      5.1.4 Information and telecommunication (IT) 51
      5.1.5 Banking and financial 51
      5.1.6 Media and entertainment 51
      5.1.7 Public utility and other essential services 51
      5.1.8 Transportation 52
   5.2 Sectors that exacerbate transmission of infectious diseases 52
      5.2.1 Transportation 52
      5.2.2 Tourism and hospitality 53
      5.2.3 Education 53
      5.2.4 Livestock and animal husbandry 53

5.2.5 Healthcare 53
5.2.6 Housing and public utility services 54
5.3 Sectors impacted 54
5.3.1 Impact on the primary sector 55
5.3.2 Impact on the secondary sector 56
5.3.3 Impact on the tertiary/ service sector 56
5.3.4 Impact on the quaternary sector 57
6. Cross cutting issues 58
6.1 Human rights violation, domestic violence 58
6.2 Age, gender and disability 58
6.3 Disruption in public events and impact in socio-cultural identity 59
6.4 Impact on disaster response, preparedness and recovery 59
6.5 Supply chain 59
6.6 Human resources and mental health 60
6.7 Migration 60
6.8 Livelihood and Social Security 61
References 62

List of Figures

Figure 1: Bangkok Principles for Implementation of the Health Aspects of the Sendai Framework 1
Figure 2: Key observations from ASEAN 6
Figure 3: Key observations from EU 7
Figure 4: Key observations from Germany 13
Figure 5: Key observations from India 13
Figure 6: Key observations from Japan 15
Figure 7: Countermeasures against pandemic influenza 15
Figure 8: Key observations from Singapore 16
Figure 9: Three response phases in Singapore 17
Figure 10: Key observations from South Korea 18
Figure 11: Analytical interpretation of risk assessment frameworks and guidance 20
Figure 12: Suggestive comparative representation of variety of risk in the matrix 23
Figure 13: Timeline of Spanish Flu 32
Figure 14: Timeline of SARS 33
Figure 15: Timeline of Swine Flu 34
Figure 16: Timeline of MERS 36
Figure 17: Timeline of Ebola 37
Figure 18: Timeline of Zika 39
Figure 19: Basic steps and learning for biological hazard integration into DRR 48
Figure 20: The sphere of transmission of infectious diseases based on sectors 52
Figure 21. Sectoral impact of a biological hazard 54

Figure 22. Sectoral approaches for new and known biological hazard 55

List of Tables

Table 1: Comparative review of regional DRR and biological hazards/ public health response plans/ agreements..... 5
Table 2: Comparative review of national DRR and biological hazards/ public health response plans..... 11
Table 3: Comparative review of risk assessment frameworks 20
Table 4: Comparative review of past outbreak/ pandemic..... 30
Table 5: Sectoral impacts on different sector based on past health emergencies..... 58

List of Boxes

Box 1: Key observations from review of regional DRR and biological hazards/ public health response plans/ agreements..... 5
Box 2: Key observations from review of national DRR and biological hazards/ public health response plans 11
Box 3: Key observations from review of risk assessment frameworks and guiding documents..... 19
Box 4: Key observations from review of guidance documents/ recommendations on integration of biological hazards to DRR and development planning 25
Box 5: Case study of local response to Nipah Virus..... 46
Box 6: Summary of review of past cases and country specific cases..... 47

1. Background

COVID-19 pandemic is the worst biological disaster observed in recent past. Its unprecedented speed and spread have affected most parts of the world. The year 2020, which is supposed to be an important milestone year for SDGs (Sustainable Development Goals), Sendai Framework and Paris Agreement, is under the shadow of the pandemic, which has not only affected the global, regional, national and local economies, but also hindered the achievements of respective SDGs. A cumulative effect of COVID-19 has strongly affected national and local development planning.

The Sendai Framework for Disaster Risk Reduction 2015-2030 enhanced the scope of disaster risk management by including biological hazards such as epidemics and pandemics in addition to natural hazards as a key area of focus for disaster risk management. The Sendai Framework also places strong emphasis on resilient health systems through integration of disaster risk management into health care provision at all levels. In particular, it aims "to enhance cooperation between health authorities and other relevant stakeholders to strengthen country capacity for disaster risk management for health."

The International Conference on the Implementation of the Health Aspects of the Sendai Framework (held in Bangkok 2016) resulted in Bangkok Principles, which call for developing or revising multi-sectoral disaster risk reduction plans and policies to include the health sector. It also recommends greater participation of health sector representatives in disaster risk reduction platforms and committees at all levels[1].

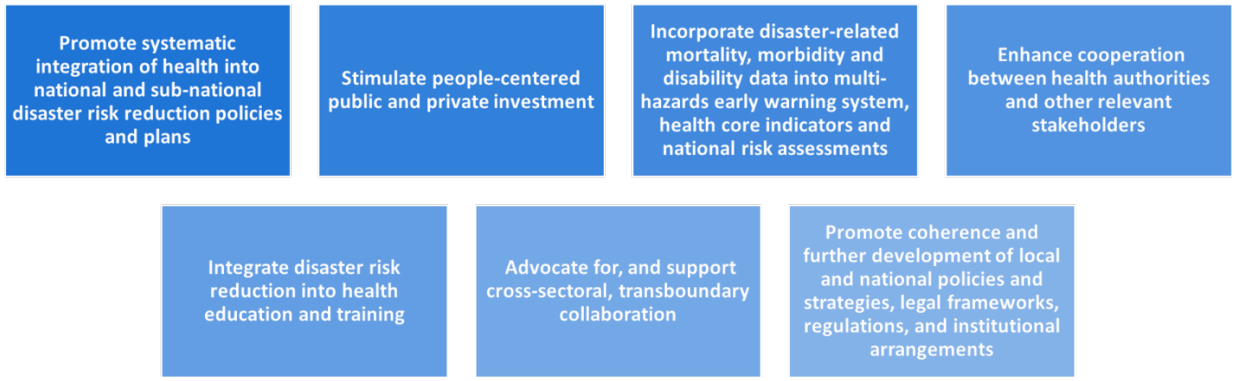

Figure 1: Bangkok Principles for Implementation of the Health Aspects of the Sendai Framework

To strengthen systemic planning and coordination, the UN Office for Disaster Risk Reduction (UNDRR) **is issuing guidance notes on integrating risks associated with biological hazards, including pandemics**, into: 1) disaster risk reduction planning at the national and local levels, and 2) UN Sustainable Development Cooperation Frameworks and Common Country Analysis and plans.

[1] Convened by the United Nations Office for Disaster Reduction (UNDRR) and the Royal Thai Government, in partnership with the World Health Organization and other governments

The guidance note will:

1. Provide the analytical basis for identification and analysis of risks associated with biological hazards;
2. Explore and document the interlinkages between biological hazards and diverse socio-economic sectors to enable prevention and mitigation;
3. Provide policy options and guidance on integrated risk management of biological hazards in line with the Bangkok Principles.

The purpose of the current document is **to provide basic review materials to facilitate the development of the guidance document.** This document is produced through:

- Reviewing existing guidelines and supporting documents on disaster risk reduction and biological hazards;
- Developing the analytical basis for identifying and mitigating risks associated with biological hazards across diverse sectors based on selected past disasters as well as COVID-19 pandemic

The document consists of two parts: 1) Technical Advisory document and 2) Annex to the technical advisory document. This is the annex document.

2. Biological hazards

UNDRR terminology[2] defines biological hazards as follow:

> "Biological hazards are of organic origin or conveyed by biological vectors, including pathogenic microorganisms, toxins and bioactive substances. Examples are bacteria, viruses or parasites, as well as venomous wildlife and insects, poisonous plants and mosquitoes carrying disease-causing agents[3]".

WHO classified biological hazards in the following categories.[4] The referred classification review mentions that "other hazards that were excluded from this review were those that that have routine measures in place to address and manage them" and explicitly refer to:

> *3.2 Hazards that are managed routinely and are not included in the hazard terminology review: Many hazards that are not usually considered as hazards but are classified for example as infectious diseases which can be treated with medication and do not post a high epidemic risk.*

These categories are originally derived from the International Health Regulation (2005).

- Airborne diseases
- Waterborne diseases

[2] Open-ended Intergovernmental Expert Working Group on Indicators and Terminology Relating to Disaster Risk Reduction and UNGA endorsement available at: https://www.preventionweb.net/drr-framework/open-ended-working-group/

[3] https://www.preventionweb.net/terminology/view/488

[4] WHO HEDRM (Health Emergency Disaster Risk Management) Framework 2019

- Vector-borne diseases
- Foodborne outbreaks
- Insect infestation (for example)
    - grasshopper
    - locust
- Animal diseases
- Plant diseases
- Aeroallergens
- Antimicrobial resistant microorganisms
- Animal-human contact
    - Venomous animals [snakes, spiders]

Given the vast number of different types of biological hazards (i.e. pathogenic bacteria, viruses and other hazards of organic origin), UNDRR technical guidance[5] on the reporting on progress in achieving the global targets of the Sendai Framework calls on countries to define which biological hazards will included in their reporting. It asks countries to focus on those biological hazards which have the potential to cause emergencies and disasters, which are relevant risks to its country context. The technical guidance recommends that countries consider those biological hazards for which data is regularly collected (e.g. list of notifiable diseases). It also suggests that some of the following diseases may be considered for inclusion in the indicator framework for measurement of the Sendai Framework Global Targets:

- Diseases which are unusual or unexpected and may have serious public impact and thus shall be notified: smallpox, poliomyelitis (due to wild- type poliovirus), human influenza caused by a new subtype, severe acute respiratory syndrome (SARS).
- Diseases which have demonstrated the ability to cause serious public health impact and to spread rapidly internationally: cholera, pneumonic plague, yellow fever, viral haemorrhagic fevers (Ebola, Lassa, Marburg), West Nile Fever, and other diseases of special national or regional concerns, .e.g. dengue fever, Rift Valley fever, meningococcal disease.
- Any event of potential international public health concern, including those of unknown courses or sources (other than those already listed) where criteria are assessed: is the public health impact of the event serious; is the event unusual or unexpected; and is there a significant risk of (national or) international spread.

The UNDRR / ISC technical report[6] on hazard definition has characterized biological hazards into 95 specific hazards with several clusters as follow: aquaculture (marine toxin, biotoxin), insect infestation (locust etc.), invasive species (weeds), human / animal conflict / interaction (snake envenomation), food safety (foodborne parasites), infectious diseases (plant, human and animal,

[5] Technical guidance for monitoring and reporting on progress in achieving the global targets of the Sendai Framework, UNISDR, 2017

[6] UNDRR / ISC Sendai Hazard Definition and Classification Review TECHNICAL REPORT (2020, in preparation)

aquaculture). Infectious diseases are delineated into different types depending on how they spread.

Throughout the 21st centuries, countries have experienced epidemics, some of which are considered seasonal like Dengue fever. But there have also been several pandemics including SARS, MERS and currently COVID-19. Some countries have robust systems to deal with seasonal epidemics, although climate change poses new challenges in the nature and spread of these epidemics. However, global pandemics are posing a serious threat to lives and livelihoods globally, especially consider their strong socio-economic impact.

The WHO HEDRM[7] (Health Emergency Disaster Risk Management) Framework also defines biological hazards. It is important to distinguish between the two following types of biological hazards:

1. Regular / seasonal health hazards, which require risk-informed public health management advocacy and management.
2. Health emergencies, which require risk assessments, early warning, contingency planning etc. to inform prevention, preparedness and recovery

Some examples of recent large outbreaks, epidemics or pandemics due to biological hazards either on their own or following a disaster are:

- Outbreaks of Severe Acute Respiratory Syndrome – Coronavirus (**SARS-CoV**), a pandemic started in 2003
- Significant increase in **diarrheal disease** incidences following recurrent floods in most African countries or significant increase following the 2004 tsunami in Indonesia and Thailand
- Outbreak of **H1N1 Swine Flu**
- Outbreaks of Middle East Respiratory Syndrome – Coronavirus (**MERS-CoV**), an emerging disease identified in 2012
- The **Ebola Virus** Disease outbreak in West Africa in 2013-2016, the largest epidemic of its kind to date in the populations of Guinea, Liberia, and Sierra Leone
- Outbreaks of **yellow fever** in Angola, the Democratic Republic of Congo and Uganda in 2016
- The outbreak of **Zika virus** infection in the Americas and the Pacific region in 2016

In this document, specific focus is given on current pandemic (**COVID-19**). Lessons are drawn from other recent pandemics like **SARS (2003), MERS (2013)**, and selective cases of epidemics from the WHO declared PHEIC (Public Health Emergency of International Concern): **Swine flu of 2009 (H1N1), Ebola of 2014, and Zika of 2016**.

[7] WHO HEDRM (Health Emergency Disaster Risk Management) Framework 2019

3. Content review

3.1 Regional DRR and biological hazards/ public health response plans/ agreements

Box 1: Key observations from review of regional DRR and biological hazards/ public health response plans/ agreements

Aspects of biological hazards/ infectious diseases management are part of regional agenda/ planning, but often different sectors (health/ civil protection/ disaster management) are mandated for its management.

Identification of biological hazards in agenda or priority documents helps in building a dedicated mechanism for its management at the regional level.

A strong science-policy interface supported by a multi-hazard risk assessment helps in risk-informed decision making and planning for the region.

Coherent and comprehensive (including exposure and vulnerability) national multi-hazard risks assessments help in building a common understanding and seeking regional cooperation for management of disasters.

Table 1: Comparative review of regional DRR and biological hazards/ public health response plans/ agreements

	ASEAN	EU
Governance	• ASEAN Committee on Disaster Management (ACDM) • Each Member Nation has a Minister in charge of Disaster Management • Mechanism of ASEAN Ministerial Meeting on Disaster Management (AMMDM) and COP to AADMER • ASEAN Health Sector Cooperation	• European Union Civil Protection Mechanism (UCPM) • Emergency Response Coordination Centre (ERCC) • EU Cooperation through the Health Security Committee • European Centre for Disaster Prevention and Control
Relevant legislations, policies and plans	• ASEAN Agreement on Disaster Management and Emergency Response (AADMER) • ASEAN Post-2015 Health Development Agenda	• Decision No 1313/2013/EU on a Union Civil Protection Mechanism, and Decision (EU) 2019/420 amending Decision No 1313/2013/EU • Decision 1082/2013/EU on serious cross-border threats to health • Proposed Regulation activating the Emergency Support

	ASEAN	EU
		Instrument under Council Regulation (EU) 2016/369 • Action Plan on the Sendai Framework for Disaster Risk Reduction 2015-2030: A disaster risk-informed approach to all EU policies
Integration	• Disaster health management has been identified as one of priorities under Post 2015 Health Development Agenda. • AADMER of 2009 and institutional mechanisms under it do not explicitly integrate aspects of biological hazards	• Biological hazards are integrated under the Civil Protection Mechanism • Pandemic risk addressed in the 2017 Overview of Disaster Risks the EU may face • 23 of 34 National Risk Assessments across Participating States in the Union Civil Protection Mechanism address pandemic risk
Multi-sector response (to biological hazards)	Response to biological hazards is limited mostly to health sector	Biological hazards management cater to all pre-, during and post phase guided by multi-hazard and multi-risk assessments
Others	-	Strong science-policy interface in DRR

3.1.1 The Association of Southeast Asian Nations (ASEAN)

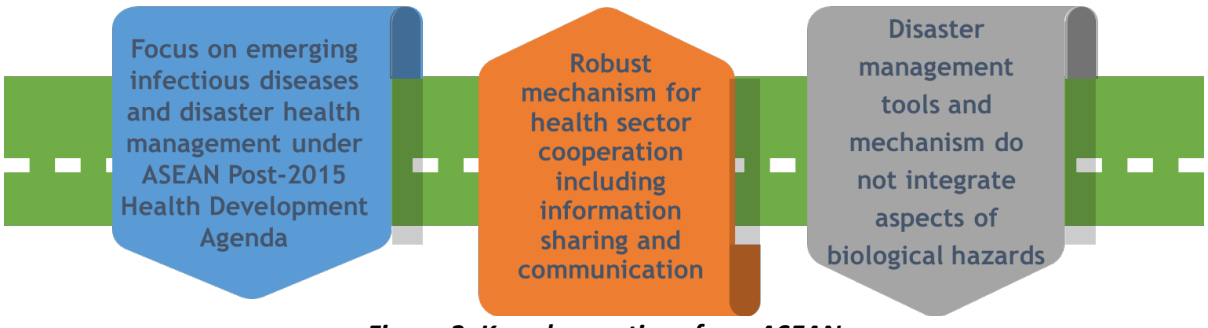

Figure 2: Key observations from ASEAN

ASEAN Post-2015 Health Development Agenda promotes a healthy and caring ASEAN community prepared to respond to future challenges. The Agenda puts forth four key clusters and set goals 2020 and health priorities under each cluster. Cluster 2 aims to achieve the goals of promoting resilient health systems for responding to communicable diseases, emerging infectious diseases and neglected tropical diseases, environmental health threats, disasters along

with effective preparedness for disaster health management in the region. Prevention and control of emerging infectious diseases is one of the health priorities set under the Agenda. Further, by setting disaster health management as one of the health priorities, the Agenda is one of those *unique guiding documents of health sector which strives to integrate and cater to health aspects of disasters along with alignment with sustainable development goals.*

The **ASEAN Health Sector Cooperation** includes robust platforms and networks led by different member states for active regional cooperation, information exchange and strategic networking for response and technical support. These include the ASEAN Emergency Operation Centre Network (ASEAN EOC Network) for public health emergencies, the ASEAN Plus Three Field Epidemiology Training Network (ASEAN+3 FETN), ASEAN BioDiaspora Virtual Centre for big data analytics and visualization (ABVC), public health laboratories network, etc. Some of these are currently playing a critical role during the current pandemic by actively supporting the exchange of information and technical efforts. The ASEAN Health Sector Cooperation is making great use of ICT in the functioning of some of these centres, including BioDiaspora. *ASEAN Health Sector Cooperation can be an example to other regional forums for its proactive and collaborative functioning in the management of emerging diseases and health sector in general.*

The **ASEAN Agreement on Disaster Management and Emergency Response (AADMER)**, in force since 2009, provides for effective mechanisms to achieve substantial reduction of disaster losses and to jointly respond to disaster emergencies through concerted national efforts and intensified regional and international co-operation. It has established the ASEAN Coordinating Centre for Humanitarian Assistance on Disaster Management (AHA) which has actively responded to various emergency and relief operations. ASEAN Member States adopted the vision of "**One ASEAN, One Response**" which is aimed at collective efforts for faster response and mobilization of greater resources. It binds the individual and collective strengths of different sectors and different stakeholders in ASEAN to effectively respond to disasters.

With respect to disaster management, ASEAN has institutionalized various tools, mechanisms and funds catering to humanitarian assistance on disaster management like emergency response logistics system, SOPs, a forum for simulation exercises, response assessment teams, a relief fund, joint operation and coordination centre, etc. *However, despite the existence of these multiple tools and mechanisms, they do not explicitly include the aspects of biological hazards in their functioning; thus leaving a potential gap in integration of DRR with health aspects of disaster management and management of health related disasters.*

3.1.2 European Union (EU)

Figure 3: Key observations from EU

The **European Union Civil Protection Mechanism (UCPM),** created in 2001, promotes cooperation in the field of civil protection and allows for stronger and more coherent disaster response, preparedness, and prevention among the 27 EU Member States and 6 Participating States. Through its various institutionalized mechanisms, and framed by the Union Civil Protection legislation[8], the UCPM anchors disaster risk reduction actions in the EU member states towards a more disaster resilient Europe. The mechanism has been activated for numerous disasters both in Member States and worldwide, including the Ebola outbreak in West Africa (2014) and in the Democratic Republic of the Congo (2018).

Regional cooperation and solidarity across prevention, preparedness and response priorities is ensured through the Union's Emergency Response Coordination Centre (ERCC), the European Civil Protection Pool (ECPP), dedicated prevention actions on risk assessments and disaster risk management planning, peer reviews, training programmes, simulation exercises, and lessons learnt initiatives.

In 2017, in response to devastating forest fires across Europe, the EU reinforced regional solidarity in managing disasters through the launch of **rescEU** – a reserve of response assets to support countries in the face of future overwhelming disasters. Alongside the European Medical Corps, the **rescEU** reserve is providing additional capacities of medical evacuation, medical teams trained for setting up a field hospital, and common stockpiling of medicine. These have strengthened EU's capacity to respond to all types of emergencies, including the CBRN.

UCPM lays dedicated focus on biological hazards including pandemic and emerging infectious diseases in not only their identification but also in their recognition of their direct and cascading impacts, cross-border dimensions, etc. Pandemic risk is also an integral part of an all-hazards approach to national risk assessments and disaster risk management planning: according to the European Commission's 2017 overview of disaster risk, 23 of the 34 participating Member States in the Union Civil Protection Mechanism address pandemic risk in national risk assessments[9]. *It is worth noting that strategies of EU regarding biological hazards management targets both the pre-disaster phase of risk assessment, preparedness research, capacity building, etc. and in the post-disaster phase by strengthening its response capacities.*

The EU has developed an **Action Plan on the Sendai Framework for Disaster Risk Reduction 2015-2030: A disaster risk-informed approach to all EU policies**. Furthermore, in its strive towards understanding risk and framing risk-informed policies, EU places huge emphasis on disaster risk management planning, multi-hazard risk assessments and mapping, peer learning, and a strengthened science-policy interface. The Union Civil Protection legislation requires EU Member States to develop disaster risk management plans – these plans are to be reported back to the European Commission every three years. Through the Mechanism, Member States are also required to undertake national risk assessments following a multi-risk approach, for which

[8] Decision No 1313/2013/EU on a Union Civil Protection Mechanism, and Decision (EU) 2019/420 of the European Parliament and of the Council of 13 March 2019 amending Decision No 1313/2013/EU on a Union Civil Protection Mechanism

[9] Overview of Natural and Man-made Disaster Risks the European Union May Face, European Commission Staff Working Document, 2017, https://ec.europa.eu/echo/sites/echo-site/files/swd_2017_176_overview_of_risks_2.pdf

summaries are reported back to the European Commission. The **Risk Assessment and Mapping Guidelines for Disaster Management, 2010** has been laid out to enhance coherence and consistency in the national risk assessments of the Member States and is currently being revised by the European Commission. *The guidelines are based on multi-hazard and multi-risk approach and are unique in their coverage of simultaneous occurrences of different and cascading hazards. Further, the coherence in national disaster risk assessments facilitate a common understanding and regional cooperation in management of risk, particularly those having cross-border risks and calling for cross-border interventions.* Regional risk assessments to support risk reduction and disaster management efforts at a European level are being explored[10].

Alongside the measures foreseen under the Union Civil Protection Mechanism/rescEU, the EU has set up the Coronavirus Response Investment Initiative to deploy European Structural and Investment Funds[11] to partly address the current public health emergency and to mobilize the Emergency Support Instrument to equip the EU with a broader toolbox commensurate to the large scale of the current COVID-19 pandemic[12].

In the health sector, Decision 1082/2013/EU of the Council of the EU on serious cross-border threats to health provides the framework to improve preparedness and strengthen capacity to coordinate response to health emergencies across the EU, caused by biological, chemical and environmental agents, and threats of unknown origin. Through this framework, the European Commission and its Member States cooperation within the Health Security Committee, including with relevant EU Agencies, such as the European Centre for Disease Prevention and Control (ECDC) and the WHO.

Efforts are made also to reinforce the science-policy interface: dedicated centres and partnership networks have been developed including the Mechanism's Knowledge Network and the European Commission's **Disaster Risk Management Knowledge Centre (DRMKC)**. Both of these provide a coherent interface between science and policy by contributing research on hazard modelling, forecasting and early warning systems, crisis management technology, critical infrastructure protection, risk standard setting and risk assessment methodologies. Similarly, the **Copernicus Emergency Management Service** provides timely geo-spatial information, such as satellite-based maps, for disaster preparedness, emergency response and recovery monitoring. *Such dedicated platforms form the backbone of risk-informed and science-based policy and disaster risk governance.*

[10] Strengthening EU Disaster Management: rescEU – Solidarity with Responsibility, Commission Communication, COM(2017)773 final, https://ec.europa.eu/transparency/regdoc/rep/1/2017/EN/COM-2017-773-F1-EN-MAIN-PART-1.PDF

[11] Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EU) No 1303/2013, Regulation (EU) No 1301/2013 and Regulation (EU) No 508/2014 as regards specific measures to mobilize investments in the health care systems of the Member States and in other sectors of their economies in response to the COVID-19 outbreak [Coronavirus Response Investment Initiative], of 13 March 2020 COM(2020) 113 final

[12] Proposal for a Council Regulation activating the emergency support under Council Regulation (EU) 2016/369 of 15 March 2016 and amending its provisions in respect of the COVID-19 outbreak, https://ec.europa.eu/info/sites/info/files/about_the_european_commission/eu_budget/com175final_-_en_-_proposal_council_regulation_activating_esi.pdf

The **Global Research Collaboration for Infectious Disease Preparedness (GloPID-R),** a network of research funding organisations and the World Health Organization in the area of infectious disease preparedness research, facilitates an effective research response within 48 hours of a significant outbreak of a new or re-emerging infectious disease with pandemic potential.

3.2 National DRR and biological hazards/ public health response plans

Box 2: Key observations from review of national DRR and biological hazards/ public health response plans

Active coordination and cooperation between national and sub-national units is the key for management of biological hazards/ disaster management in many countries.

A dedicated planning document for pandemic management is in place in most of the countries included in the review.

Most planning documents tend to miss the multi-sectoral lens while assessing the adverse impacts of biological hazards. Currently, they are mostly limited to impacts in the health sector.

Most countries fail to include considerations of the simultaneous and cascading occurrence of hazards in the planning documents for pre-, during and post-pandemic/ disaster management.

Table 2: Comparative review of national DRR and biological hazards/ public health response plans

	Germany	India	Japan	Singapore	South Korea
Governance	• State Government • Supported by Federal government and Ministries when needed	• State government • Ministry of Health & Family Welfare-nodal Ministry for Biological hazards • Supported by central government and ministries when needed	• Central government. Prefecture government has implementation power	Central government	• The Ministry of Interior and Safety mandated as the coordinating agency for all types of disasters • Provision of establishing ad hoc Disaster and Safety Countermeasures HQ during disasters
Relevant Legislations, policies and plans	National and state pandemic planning	• National and state legislation on epidemic diseases exist	National legislations and planning on pandemic	National planning for influenza and other acute	• National legislation on infectious disease in place

	Germany	India	Japan	Singapore	South Korea
		• Containment plan for COVID-19 • National legislation and planning on Disaster Management • National Guidelines on Management of Biological Disasters	influenza and new infectious disease in place	respiratory diseases	• Multiple national legislations on different aspects of disaster management in place.
Integration of biological hazards and DRR planning	-	In place	-	Missing	In place
Multi-sector response (to biological disasters)	-	Multi-sectoral approach of assessing impact is missing.	Multi-sectoral or 'beyond-health sector approach is present	Mostly limited to health and public health	Multi-sectoral approach is present along with pan-government response led by Prime Minister
Others	-	Simultaneous/ cascading disaster management approach is missing	Simultaneous/ cascading disaster not considered	Robust integrated surveillance system in place	Extensive use of ICT along with data protection and security regime

3.2.1 Germany

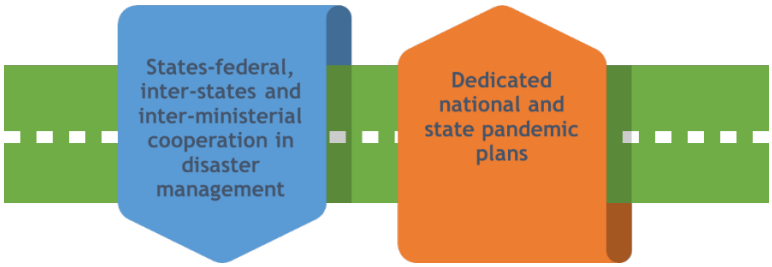

Figure 4: Key observations from Germany

The constitution of Germany makes the federal states (Länder) responsible for disaster management (including pandemics/ epidemics) while the Federation is responsible for civil protection and disaster assistance. The Federal Ministry of the Interior, Building and Community is mandated with aspects of civil protection. These functions are performed by the Federal Office of Civil Protection and Disaster Assistance (BBK). The states are provided federal support in case of large-scale disasters or those of national significance. Inter-ministerial Joint Crisis Task Forces are also set up for management of disasters requiring a nation-wide response or those affecting multiple states or concerning multiple ministries. Additionally, to assist the states in the management of specific emergencies relevant to a single federal ministry, specific crisis task forces like the Federal Ministry of Health Crisis Task Force have been set up by respective ministries. *Thus, disaster management in Germany is based on active coordination and cooperation between the states, between states & the federal level and also amongst relevant ministries through mechanisms like the Inter-Ministerial Crisis Management Coordination Group, Inter-ministerial Panel on National Crisis Management etc.*

The **Robert Koch Institute (RKI)** the government's central scientific institution in the field of biomedicine is one of key bodies safeguarding public health in the country and is mandated for identification, surveillance and prevention of diseases, especially infectious disease.

Further, National and State Pandemic Plans are in place for management of pandemics. As per the **National Pandemic Plan, 2017,** the strategy for pandemic management differs from disease to disease but is broadly guided by early detection and containment, protection of vulnerable groups, mitigation and recovery.

3.2.2 India

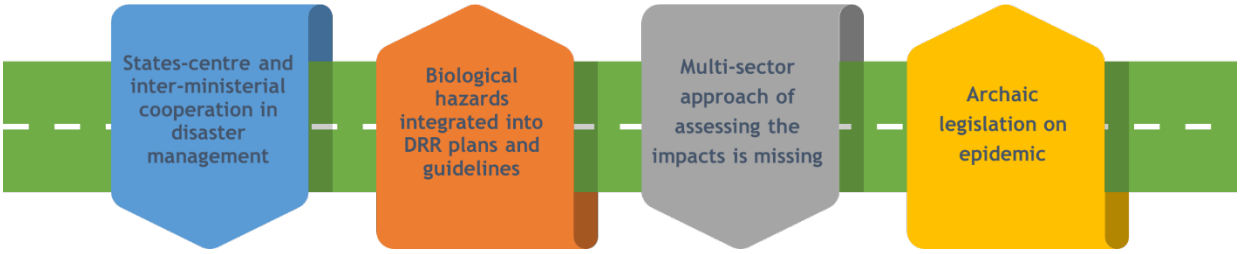

Figure 5: Key observations from India

The **Disaster Management Act, 2005** puts in a place an institutional coordination mechanism for disaster management in the country from the national to local level. Further, though the overall disaster management is under administrative jurisdiction of Ministry of Home Affairs, the Act

allows for delegation of powers to a suitable ministry or officer for effective management of the disaster. Further, the central government has various nodal ministries responsible for management and mitigation of different disasters. Under this, Ministry of Health and Family Welfare (MoH&FW) is the nodal ministry for biological emergencies and the Ministry of Agriculture and Farmers Welfares (MAFW) for pest attack. *Thus, management of disasters in India follows an approach of inter-ministerial cooperation and coordination along with states-centre coordination and support.*

Guided by the Act, almost all the states have put in place a near uniform institutional mechanism for disaster management at the state and district level. These mechanisms include planning and policy making disaster management authorities, training and capacity building institutes, response funds and response forces. *However, disaster management is an integral responsibility of the state government, providing each state an opportunity to develop plan and strategies which are best suited to the local needs.* In addition to this, the Act allows for institutions and mechanism at the national level to provide support and guidance to the states in all phases of disaster management including when the scale of disasters exceed the response capacities of individual states.

Through the **National Disaster Management Plan, 2019**, Biological and Public Health Emergencies (BPHE) has been introduced in national DRR planning. The Plan institutionalizes inter-ministerial and inter-agency coordination and networking for efficient management of disasters including BPHE. The NDMP lays down critical measures from strengthening integrated surveillance systems to establishing medical first responders and enhancing hospital preparedness. *However, the NDMP does not provide mitigation measures for impacts of BHPE that go beyond the health sector. The NDMP also fails to anticipate simultaneous occurrence of BHPE with any other disaster and strategy for operational management of such complex emergencies.*

The **National Disaster Management Guidelines: Management of Biological Disasters, 2008** forms the basis for central and state ministries and departments to develop respective action plans and programmes regarding biological disaster management (BDM). The Guidelines highlight various measures for institutionalizing the medical preparedness for BDM and encourages participation of the private sector in BDM through public-private partnerships. It also recognizes the need for provision of mental health services and psycho-social care after the outbreak of an epidemic. The Guidelines recommends undertaking vulnerability analysis and risk assessment at the macro and micro levels for existing diseases with epidemic potential, emerging and re-emerging diseases, and zoonotic diseases with potential to cause human diseases. It also recognizes the possibility of occurrence of epidemics in the aftermath of disasters like floods and calls for undertaking preventive actions for the same. *However, the Guidelines do not extend beyond the health and public health sector perspectives in the management of biological hazards. Another limitation of the Guidelines is that it is only recommendatory in nature and is only as effective as the action plans proposed to be developed on the basis of it.*

The **Epidemics Diseases Act, 1897** allows the state governments to take exceptional measures and prescribe regulations to limit the spread of the epidemic. The Act has also been invoked and amended to include some new provisions to meet current needs. *However, the Act is archaic and*

not inclusive of holistic understanding of current and emerging landscape of epidemic management like trans-boundary spread, inter-sectoral coordination, aspects of prevention and control, etc. Further, the Ministry of Health & Family Welfare, Government of India has developed the **Containment Plan for Large Outbreaks: Novel Coronavirus Disease 2019** to break the chain of transmission thus reducing the morbidity and mortality due to COVID-19. It lays down institutional mechanisms and aspects of inter-sectoral coordination at national, state and operational level. *Inclusion of some of these aspects in the DRR plan and public health response plans at national and local level can aid in making them more actionable.*

3.2.3 Japan

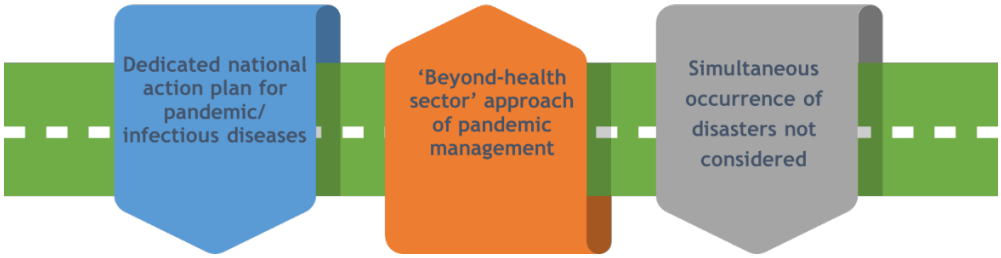

Figure 6: Key observations from Japan

The **Act on Special Measures for Pandemic Influenza and New Infectious Diseases Preparedness and Response, 2012** provides an institutional framework for crisis management of unexpected events. Together with the **Act on Prevention of Infectious Diseases and Medical Care for Patients Suffering Infectious Diseases, 1998, it** intends to establish a robust national system in Japan for dealing with pandemic influenza and new infectious diseases. Based on development in global guidelines and lessons learnt from various past pandemics like A/H1N1 (2009-10), the Japanese Government formulated the **National Action Plan for Pandemic Influenza and New Infectious Diseases, 2013**. It follows a pro-active approach in acknowledging that if an outbreak of pandemic influenza has occurred somewhere in the world, it would be impossible to prevent the spread of infection to Japan. The action plan aims to serve two purposes while developing and undertaking countermeasures against the pandemic influenza (Figure 7). First, it aims to limit the spread of infection to protect the lives and health of the people and to minimize the impact on life and economy. Relevant ministries and agencies have also been identified and made responsible to undertake the laid down measures concerning different sectors.

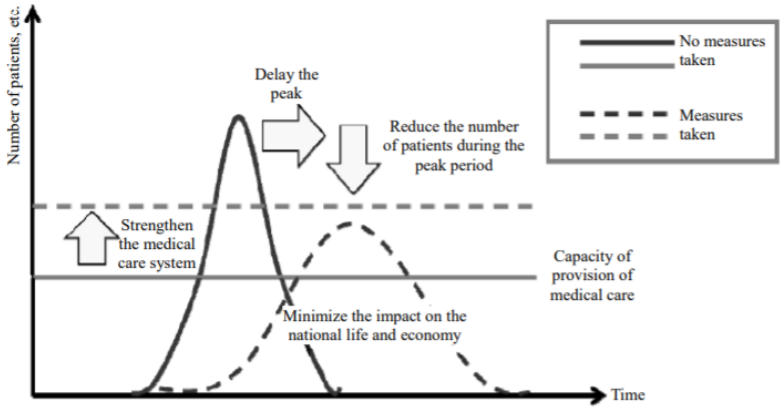

Figure 7: Countermeasures against pandemic influenza

Source: National Action Plan for Pandemic Influenza and New Infectious Diseases, 2013, Japan

Under the efforts to minimize the impact on national life and economy, it recommends formulation and implementation of business continuity plans (BCP) for ensuring continued provision of medical care and business operations that contribute stability of daily lives and national economy. It is also unique in anticipating the social impact including workplace absence, the need to stay home to care for children and elderly due to potential closure of schools, and reduction in welfare services and at-home treatment services, etc. *The National Action Plan is unique in its recognition of indirect socio-economic impacts of pandemic on daily lives and other sectors of national economy. Such a multi-sectoral or 'beyond-health sector' approach is often missing in the action plans of other nations.*

The Action Plan is also special in explicitly acknowledging the aspects of human rights, and national-prefectural and municipal cooperation and international cooperation during the implementation of the plan. Under international cooperation, it recommends conducting joint simulation exercises with other countries during the pre-outbreak phase. *Overall, the National Action Plan is comprehensive in its coverage from the pre-outbreak phase to the recovery phase which also makes it easier to integrate it with disaster risk management plan and strategies. It provides a multi-sectoral approach for the efficient and holistic management of biological hazards including pandemics. However, it does not deal with simultaneous occurrence of pandemic and any other disasters.*

3.2.4 Singapore

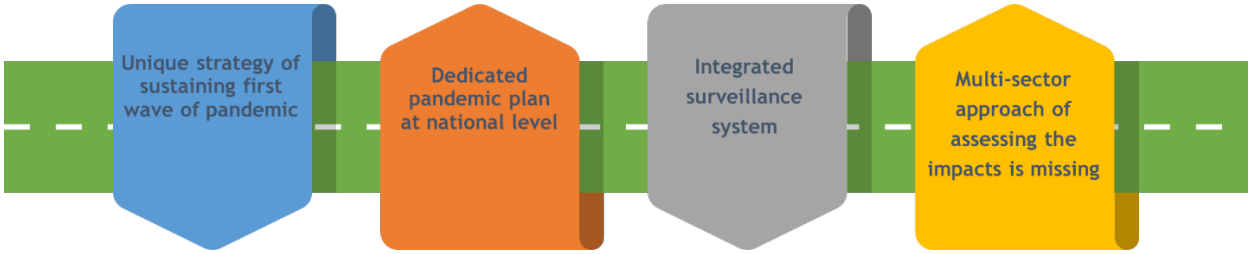

Figure 8: Key observations from Singapore

The national strategy for pandemic response aims to mitigate the consequences after the first wave hits. The strategy is based on an effective surveillance system to detect the importation of a novel acute respiratory pathogen with pandemic potential. The response to the first epidemic wave seeks to minimize mortality and morbidity by providing healthcare and early treatment of infected cases. It also aims to reduce the surge on the healthcare system by slowing and limiting the spread of diseases while maintaining essential services in the country and limiting community disruptions. *This strategy is unique and quite different from that of other nations as it does not involve extreme lockdowns. It is also guided by robust surveillance, early detection and treatment while seeking to ensure that health services are not overwhelmed during the first wave.*

The **Pandemic Readiness and Response Plan for Influenza and Other Acute Respiratory Diseases, 2014** recommends public health measures and response actions prior to and during a pandemic. The key components of the pandemic response in Singapore involves integrated surveillance system, management of suspect cases (triaging, referral, outpatient management); infection control in healthcare settings (use of PPE, respiratory hygiene); visitor control and temperature screening in hospitals (social distancing, no visitor rule); isolation and discharge

criteria of suspect and confirmed cases (isolation and quarantine orders); and handling of deceased persons. Apart from these components in the healthcare sector, other components of response include border control measures, temperature screening in institutions and buildings, contact tracing and quarantine, social distancing, risk communication to public and infection control in non-healthcare settings. *The dedicated Pandemic Response Plan helps the authorities in undertaking prompt measures and action. However, the plan being developed by the Ministry of Health, caters to the pandemic primarily from the perspective of health and public health sector. There is a potential scope for consideration of impacts on other sectors so that a holistic disaster response and recovery planning can be undertaken by the government. Further, simultaneous occurrence of disasters along with pandemics have not been considered in the plan.*

Learning lessons from the 2003 SARS pandemic which exposed the country's weakness in terms of epidemiological surveillance and healthcare systems for emerging infectious diseases, Singapore undertook several measures for strengthening its pandemic management capabilities. It has put in place an ***integrated surveillance system*** *which is not limited to only disease surveillance but is very comprehensive in nature by inclusion of varied facets of surveillance.* These include community surveillance, laboratory surveillance, hospital surveillance, disease notification, veterinary surveillance and external surveillance. Further, the Ministry of Health (MOH) has established the **Disease Outbreak Response System Condition (DORSCON) framework** which categorizes the outbreak in four levels of incremental severity based on risk assessment of the public health impact of the disease and the current disease situation in the country and helps in predicting the impact on the community and hence planning suitable response as per level of threat. For each level of severity, the response phases include alert, containment and mitigation with different recommended measures (figure 9). DORSCON also contains a public communications component to convey the health impact to the public and to advise them on how to respond; thus focusing on aspect of risk communication.

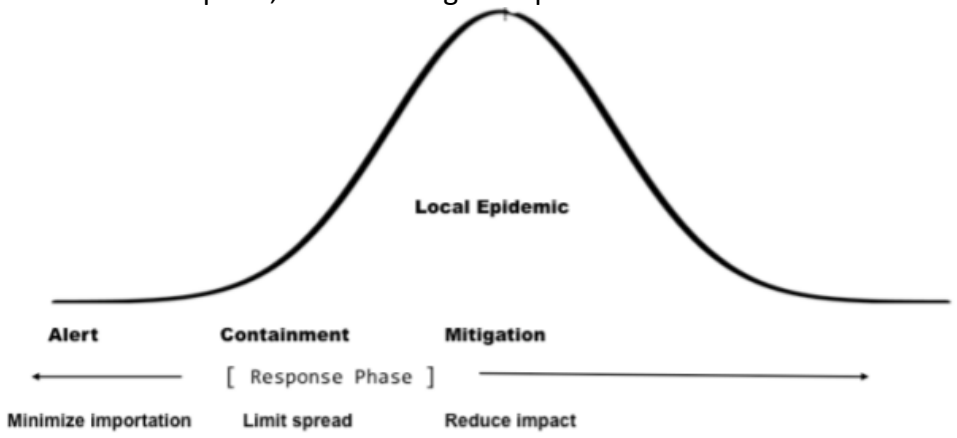

Figure 9: Three response phases in Singapore

Source: Pandemic Readiness and Response Plan for Influenza and Other Acute Respiratory Diseases, 2014, Singapore

3.2.5 South Korea

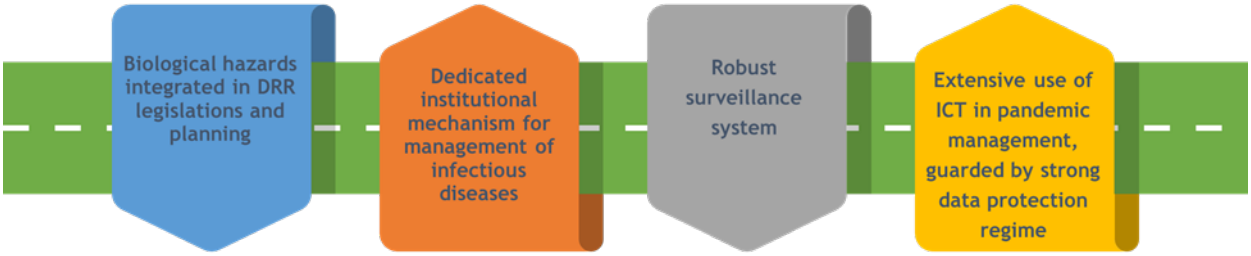

Figure 10: Key observations from South Korea

The **Ministry of Interior and Safety (MoIS)** is mandated to manage all types of disasters in Korea. In case of a disaster, an ad-hoc organization, the **Central Disaster and Safety Countermeasures Headquarters (CDSCHQs)**- headed by the Minister of MoIS or the Prime Minister only when a pan-government response is deemed necessary, is formed and is decreed as the managing agency for the response and recovery plan and the execution of all the necessary measures. Currently a CDSCHQs to handle COVID-19 has been formed under the same guidance. Further, various legislations are in place to deal with the different aspects of disaster management including the Natural Disaster Countermeasures Act, 1995, the Act on Countermeasures against Agriculture and Fishery Disasters, 1995, the Disaster Relief Act, 1962, the Disaster and Safety Management Basic Law, 2004. In particular, the Disaster and Safety Management Basic Law regulates the disaster and safety management basic plan and the crisis management manual for a comprehensive approach of integration of all the types of hazard including biological hazard into disaster risk management.

The Infectious Disease Control and Prevention (IDCP) Act allows the government to seek information concerning infected or likely to be infected persons from public police agencies, telecommunications operators, medical institutions, pharmacies, corporations, individuals. The IDCP Act provides for epidemiological investigation teams to be established at the lower level of administration which can be supported/ overtaken by central teams when required. *Through national legislation like IDCP and dedicated institutions like Korea Centers for Disease Control and Prevention (KCDC) and specialized centers and systems under it, the country has institutionalized the management of public health emergencies including infectious diseases.*

In the aftermath of MERS outbreak of 2015, **KCDC** had established an **Emergency Operation Centre** under the **Centre of Public Health Emergency Management** as a control and command centre during outbreak of infectious diseases. It operates 24*7 and collects and analyses domestic and international infectious disease information in real-time to detect emergency situations at an early phase and effectively controls them by sending an emergency reaction team for early response. Further, a system of surveillance for infectious diseases exist under the **Integrated Disease and Health Management System** and comprises a Mandatory and Sentinel Surveillance System. Using the existing system, COVID-19 is legally classified as a new infectious disease subject to Mandatory Surveillance System where all obligated to notify must report to a health center when an infected person is identified. *Thus, a robust system of surveillance*

streamlines the reporting of cases right from the local public health clinics to the city or provincial offices and ultimately to the KCDC and aids in better planning.

Another noteworthy aspect of the country's management of pandemics lies in its extensive leverage of ICT tools for various aspects along with enhanced security regime for data protection. These include the Smart Quarantine Information System to identify persons coming from high-risk regions and to monitor them during the incubation period of the infection, the City Data Hub- an urban cloud-based big data integrative platform for collecting, storing, processing, analysing and publishing the cross-functional data covering the domains of mobility, healthcare safety, etc. and using Google Timeline for recording whereabouts of citizens for contact tracing in remote locations.

3.3 Risk assessment frameworks

Comprehensive risk assessment of biological hazards forms the basis for effective emergency risk management of health, helps in understanding risk by supporting risk communication and acts a backbone for risk-informed decision making, planning and development. This calls for whole of government and whole of society approach.

Box 3: Key observations from review of risk assessment frameworks and guiding documents

Due to their intrinsic characteristics, biological hazards call for specialised methodologies and expertise for hazard assessment.

There is a need for engagement of multi-sectoral, inter- and trans- disciplinary experts for assessing the risk of biological hazards, especially in unpacking exposure and vulnerabilities of individuals, organisations, systems ex ante.

The severity of an emerging hazard needs continuous assessment over the course of a pandemic as the accuracy and precision of severity-linked information keeps changing; thus, highlighting the dynamic nature of risk assessments of biological hazards.

The impact of biological hazard risks on other sectors and different groups associated with the sectors are mostly not considered while assessing the risk.

Aspects of a multi-hazard approach with simultaneous and/ or cascading occurrence of natural/ biological/ technological hazards are mostly not taken into consideration while assessing the risk. In the absence of this, not only the assessed risk tends to be skewed but also the subsequent planning remains limited in its scope.

A generic framework which allows flexibility in selection of factors and allotting weightage can be useful for the assessing disaster risk suiting local contexts.

Qualitative risk assessment frameworks like Threat and Hazard Identification and Risk Assessment (THIRA) can help in laying down sectoral priorities and identifying gaps for capacity building.

Capacity assessment tools like the Joint External Evaluation (JEE) tool of World Health Organization (WHO) can be effective in identifying the existing gaps and bottlenecks in capacities to support efforts to build national capacities for better prevention, detection and responding to biological hazards and health emergencies.

Review of some of the existing risk assessment frameworks and guidance documents brings forth some pertinent considerations regarding the four key components of risk – hazards, exposure, vulnerability and coping capacity as summarized in Figure 11.

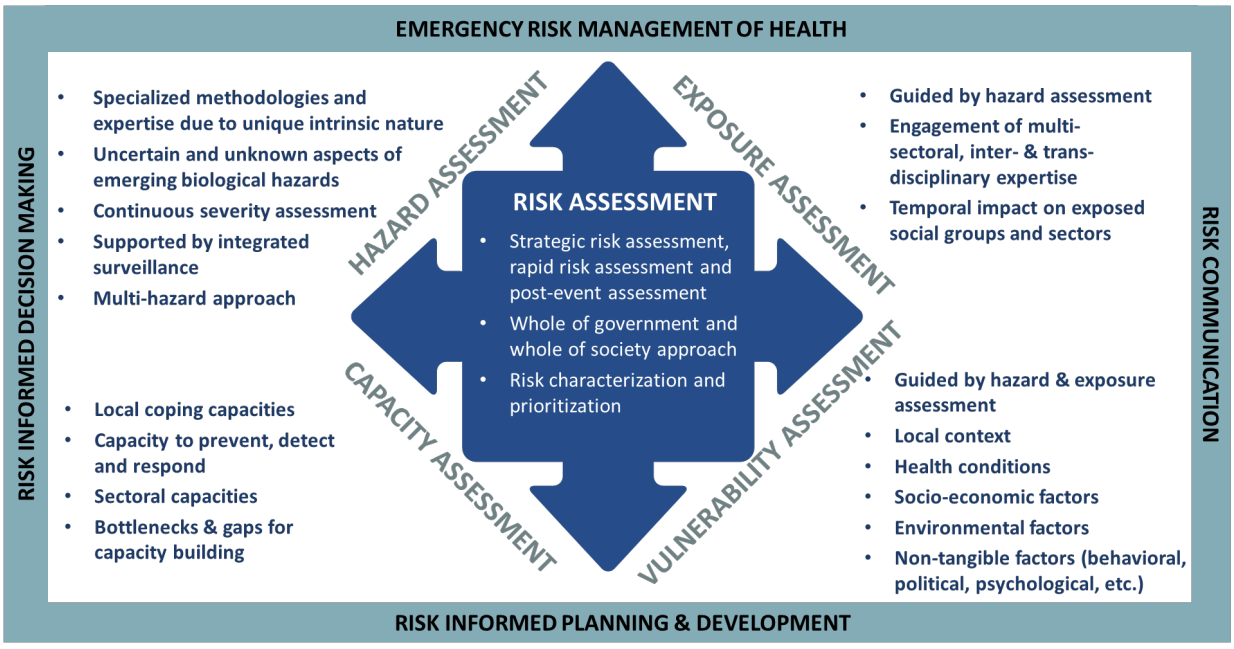

Figure 11: Analytical interpretation of risk assessment frameworks and guidance

Table 3: Comparative review of risk assessment frameworks

	Risk analysis framework, Germany	Threat and Hazard Identification and Risk Assessment (THIRA), United States	Health Risk Assessment (HRA), West Virginia	Health Risk Assessment (HRA), Western Australia
Quantitative vs qualitative	Quantitative	Majorly qualitative	Quantitative	Semi-quantitative/ mixed
Speed	-	Time taking as involves multiple stakeholders including community	Time taking as involves multiple stakeholders from the health sector	-

Simplicity	Simple to comprehend	Involves aspects of multi-stakeholder consultations and brainstorming	Simple as using pre-designed electronic tools	Technical as involvement of actors like hazard dose-response, exposure, etc.
Scenario planning	Included	Included	-	-
Multi-hazard vs health hazard	Applicable to any hazard	Multi-hazards (Also considers multiple threats together)	Assess multi-hazards risks to the community related to health systems	Applicable to any hazard, mostly used for chemical or biological agents
Others	Flexibility to use relevant factors and weightages	Sets an informed foundation for planning and preparedness activities	Mostly help in setting health sector priorities and planning	Requires inter-disciplinary expertise

Risk assessment of biological hazards is a challenging exercise by the virtue of intrinsic traits of each of these hazards which make them very different from each other and thus probably requiring specific considerations. Therefore, a uniform methodology for assessing risk of different biological hazards may not be suitable. The **Technical Guidance for Monitoring and Reporting on Progress in Achieving the Global Targets of Sendai Framework for Disaster Risk Reduction, 2017** lays down that each epidemic prone disease has a threshold which is often context specific. In particular outbreaks of infectious diseases are dynamic events and are dependent on various factors that can propagate or contain the spread. This challenge is further underscored by the **Words into Action Guidelines: National Disaster Risk Assessment, 2017 (Biological Hazards Risk Assessments).** Some of their unique characteristics include diversity of the agents of transmission; routes of transmission; their pathogenicity and virulence; inability to identify the hazard with naked eyes, sensitivity to climate, environmental or land use changes, make them very different from each other and thereby change human exposures and susceptibility to these hazards.

Despite these challenges, the guidelines underscore an estimated 75 per cent of emerging infectious diseases of humans that have evolved from exposure to zoonotic pathogens warrant risk assessments for health threats at the interface between animal, human and ecosystem. It suggests three approaches of assessing the risks of biological hazards catering to three different purposes. These are ***strategic risk assessment*** which caters to pre-event phase and aids in planning for prevention, preparedness, capacity development and medium- to longer-term risk monitoring and evaluation. ***Rapid risk assessment*** is used for planning response interventions based on risk associated with detected events. ***Post-event assessment*** is used for planning recovery, updating and strengthening the overall risk management system.

As per the **World Health Organization's Pandemic Influenza Risk Management Guidance, 2017**, various measures under the Emergency Risk Management for Health (ERMH) should be based on the national and local risk assessment, also taking into account the global assessment by WHO. Thus, the information and knowledge management category of ERMH has risk assessment as one of its essential components. As per the Guidance, the national pandemic influenza risk assessment should involve a multi-disciplinary team representing whole of government, stakeholders and relevant decision-makers.

The key component of risk assessment under this ERMH are hazard, exposure and context coupled with risk characterization. The hazard assessment tends to identify and review virological and clinical information about the influenza virus and ranks them by pandemic potential and possible consequences. The exposure assessment seeks to define the groups of individuals exposed or likely to be exposed and delineates their susceptibility in terms of immunity and disease severity using factors like epidemiological and susceptibility factors such as travel history, incubation period, and potential for transmission. The hazard and exposure assessments are then complemented by a context assessment which is an assessment of the environment where the event takes place. Context assessment examines socio-economic, technological, scientific, ethical, policy and political factors that affect risk. Based on these, risk is characterized to determine likelihood and impact of each risk. In the context of pandemic influenza, risk characterization seeks to evaluate pandemic potential, degree of impact on society and the urgency and scale of risk management actions to be implemented.

The Guidance highlights the assessment of the severity of the pandemic as a critical component of overall pandemic risk assessment. It also highlights the need for continual severity assessments over the course of a pandemic as the accuracy and precision of severity-linked information is dynamic. The risk assessment, inclusive of severity assessment through indicators of transmissibility, seriousness of disease and its impact. helps in policy makers in undertaking risk-informed decision making.

The framework for risk analysis for civil protection by the **Federal Office of Civil Protection and Disaster Assistance, Germany** provides a comparative representation of a variety of risks, caused by different kinds of hazards, in a risk matrix as a basis for the planning process in civil protection. The matrix corresponds to the international standard of ISO 31010 (2009) and allows the analysis of any kind of risk at all administrative levels (national, state, district, municipality). It takes into account broad factors of reference area (categorized into human/ population, environment, economy, supply and immaterial), type of hazard, assessment of likelihood and assessment of impact. This is in addition to accounting for various non-tangible aspects like public safety, political, psychological, cultural, etc. Based on these elements, the comparative risk matrix for various scenario can be developed (figure 12).

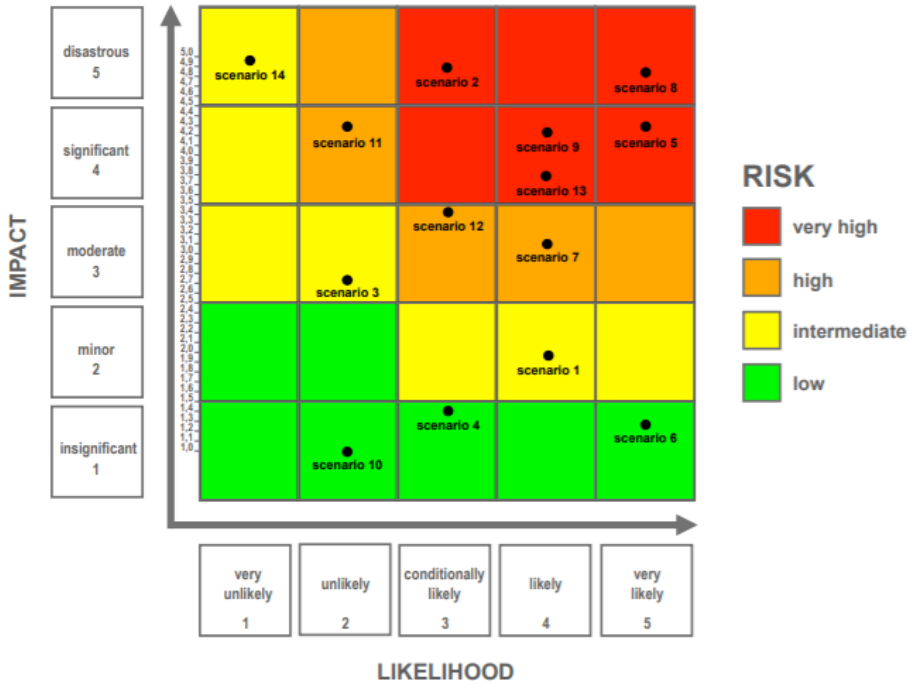

Figure 12: Suggestive comparative representation of variety of risk in the matrix

Source: Method of Risk Analysis for Civil Protection, Federal Office of Civil Protection and Disaster Assistance, Germany

The advantage of such a framework is that by means of scenario planning, it allows the user to identify and use various parameters as per the need of the local context. The reference categories can be contextualized to include key sectors of the economy, cultural assets and can be used for identifying risks to businesses or essential services. by giving them a suitably high weightage as impact values. Further, the indexed catalogue of hazards provides a methodologically uniform survey of potential hazards to state, district, community and economy of the country and can be developed based on its hazard profile.

Despite the global call by the Sendai Framework for putting in place multi-hazard early warning systems and for making disaster risk information and assessment available and accessible to the public, many of risk assessment tools still tend to assess the risk in silos without acknowledging the cascading nature of disasters risk, possibility of simultaneous occurrence of multiple disasters, or risk disasters pose to diverse sectors of the economy. Most risk assessment tools used by DRR policy makers and practitioners usually do not include aspects of biological hazards or pandemics. For example, InaRISK (Indonesia Disaster Risk) is a disaster risk assessment portal which makes use of GIS and assesses the ten major hazards for calculating the risk index but does not include biological hazards. This is despite the fact that there is a possibility of an occurrence of a health emergency or disease outbreak in the aftermath of disasters like floods, cyclone, etc.

The Threat and Hazard Identification and Risk Assessment (THIRA) Guide, 2012 by Department of Homeland Security, United States, strives to fill this gap of applying an approach designed for a single threat to landscapes prone to multiple threats and impacts by broadening the factors considered in the process. These factors include incorporating communities throughout the

entire process and accounting for important community-specific factors. THIRA is a five-step qualitative process of conducting risk assessments and sets an informed foundation for planning and preparedness activities across prevention, protection, mitigation, response, and recovery.

The **Health Risk Assessment (HRA) tool by the Centre for Threat Preparedness (CTP) at the West Virginia Bureau for Public Health** is a fully electronic tool comprising of three key steps of hazard prioritization, impact indicators discussion and preparedness and a mitigation survey to engage preparedness stakeholders in risk data collection and analysis (professionals from public health, health care, behavioral health, emergency management and other sectors) . *It is quite unique in its approach of being a public health-focused risk assessment which seeks to identify potential hazards, vulnerabilities, and risks to the community related to the public health, medical, and mental/behavioral health systems and services. In other words, the focus of this assessment is assessing multi-hazard risk to a community vis-à-vis public health and the health sector. This kind of assessment can aid in setting sector–specific priorities and investments.*

Another tool that focuses specifically on assessing public health capacity is the **Joint External Evaluation (JEE) tool of World Health Organization (WHO)** developed under the Technical Framework for Monitoring and Evaluation of International Health Regulations (IHR), 2005. It seeks to evaluate a country's capacity to prevent, detect and rapidly respond to public health threats. It follows a mixed methodology and is used by countries, external and peer-to-peer evaluators to document a country's existing IHR capacities, gaps and challenges. It assesses the level of capacities (i.e., no capacity, limited capacity, developed capacity, demonstrated capacity and sustainable capacity) across 19 technical areas assisted by indicators for each. The technical areas include national legislation, policy, financing, IHR coordination, communication and advocacy, Antimicrobial resistance (AMR), zoonotic diseases, food safety, biosafety and biosecurity, immunization, laboratory system, surveillance, reporting, human resources, emergency preparedness, response operations, risk communication, linking public health and security authorities, chemical events, radiation emergencies, etc.

While the JEE tool is not a risk assessment tool, it does provide detailed insights into one of the critical aspects of risk assessment, namely capacity assessment. Its coverage of technical areas is holistic, and it can be an effective tool in identifying the existing bottlenecks and thus building capacities for better prevention, detection and response to biological hazards and health emergencies.

The **Health Risk Assessment process used by the Department of Health of Western Australia** is a tool for assessing health impacts across four key factors: issue identification, hazard assessment, exposure assessment and risk characterization. One of the aspects of the hazard assessment is the dose-response assessment which examines the dosage of a particular hazard and its adverse impact on human health. This may vary for different age-group, persons with different pre-existing health conditions, etc. The exposure assessment involves examining the type and duration of exposure, route of exposure, etc. The risk characterization is based on the estimated incidence of adverse health effects in a given population, comparison of exposure assessment with established environmental health criteria, etc. *This is different from the other existing methodologies in that it does not explicitly factor in the capacity aspect while assessing the risk. Further, factors of dose-response and exposure assessment from the perspective of*

biological hazards requires detailed knowledge of the characteristics of the biological agent and thus may not be user-friendly for DRR professionals who lack a health background.

The hazard assessment component of the risk assessment focuses on biological hazards (related to the biological agents) and requires technical expertise in epidemiology and related backgrounds, while the vulnerability component may require experts from socio-economic, environment and health backgrounds. This highlights the need for multi-sectoral and inter- and trans-disciplinary engagements when undertaking risk assessments. In the absence of such multi-sectoral expertise, a very technical risk assessment from the perspective of the health sector could neglect the impact of risk on other sectors. Though the direct impacts of biological hazards do require a medical response, its indirect medium- and long-term impacts on other sectors cannot be overlooked and should reflected in risk assessment frameworks.

3.4 Review of Guidance/ recommendations on integration of biological hazards to DRR and development planning

Box 4: Key observations from review of guidance documents/ recommendations on integration of biological hazards to DRR and development planning

Key policy and planning documents call for multi-hazard and multi-sectoral management of risk. However, this approach has not yet been fully translated into action plans at sub-national levels.

The World Health Organization's shift from a 'prepare-respond-recover' approach to pandemic planning to a proactive 'emergency risk management for health (ERMH)' approach for pandemic influenza risk management aligns closely with disaster risk management mechanisms already in place in many countries and can play a key role in bringing about the integration of biological hazards into DRR and development planning.

Guided by ERMH and considering the non-linear nature of how biological hazards move from one phase to another, it is desirable that recovery measures for the first outbreak be inclusive of risk reduction and prevention and preparedness measures to account for subsequent outbreaks of a similar and different nature.

Assessments of impacts of biological hazards on different sectors of the economy can also be a good starting point for the integration of biological hazards management into DRR and development planning.

A two-way integration of health sector planning into DRR and vice-versa is desired for ensuring that both the health sector is disaster-resilient and that DRR and development planning are informed by health risks.

The simultaneous or sequential occurrence of a biological hazard induced disaster along with other disasters should be considered while working on the integration of biological hazards into DRR and development planning.

The management of baseline databases and making them available to multiple sectors can aid in better planning and mitigation of the impacts of biological hazards on different sectors.

Existing preparedness protocols, emergency SOPs and capacities should be upgraded to include specific actionable measures (like disaster evacuation plans during lockdowns, management of relief shelters by practicing physical distancing norms, the inclusion of hygiene and PPEs in relief kits, etc.) for the integration of biological hazards into DRR planning in the field.

Risk communication can also play key role in driving a 'whole-of-society' approach of DRR.

The **Sendai Framework for Disaster Risk Reduction 2015-2030** has significantly expanded the scope of disaster risk reduction to include not only natural and human-made hazards but also related environmental, technological and biological hazards and risks. It aims to provide guidance for the multi-hazard management of disaster risk in development at all levels and within and across all sectors*. However, based on the review of national DRR plans and biological hazard response plans, it seems that for most countries disaster risk reduction and biological hazards are being handled by different agencies without much convergence. Understanding the nature of biological hazards requires medical knowledge, but their management involves both medical and non-medical interventions. In the absence of this integration with DRR and development planning, it would be difficult to address critical non-health sector considerations such as the indirect impact on livelihoods, transport, nutrition, education and other sectors of economy; the impact on social protection of vulnerable groups (women, old aged, children, persons with disabilities, LGBTQIs, marginalized minorities, daily wagers, migrants and informal workers, etc.); and the impact on progress of long term development goals. This can further aggravate underlying vulnerabilities and the exposure of these groups and sectors to future disasters.*

By calling for a shift from the 'prepare-respond-recover' approach of planning for pandemic influenza, **the WHO** in its **Pandemic Influenza Risk Management Guidance, 2017,** and through its **Checklist for Pandemic Influenza Risk and Impact Management, 2018,** advocates for an emergency risk management for health (ERMH) approach to pandemic influenza risk management that is based on proactive assessments and management of pandemic influenza risk. The ERMH continuum includes range of measures to manage risks through prevention, mitigation, preparedness, response and recovery and emphasizes prevention and mitigation of health risks before they develop into health emergencies. ERMH aims to strengthen capacities to manage health risks from all hazards; to embed comprehensive emergency risk management in the health sector; and to enable and promote multi-sectoral linkages and integration across the whole of government and whole of society.

Based on the seven principles of comprehensive risk management, all-hazards approach, multi-sectoral approach, multi-disciplinary approach, community resilience, sustainable development and ethical basis, the ERMH approach aligns closely with disaster risk management mechanisms already in place in many countries and can provide a basis for its integration with DRR and

sustainable development planning, not to mention it fits well with the 'whole-of-society' approach of DRR. *It is also crucial to make this paradigm shift from 'prepare-response-recover' to ERMH because of the non-linear nature of the transition of biological hazards from one phase to another which makes the boundaries between response and recovery dynamic due to tendency of resurgences. In the backdrop of this, it is desirable that recovery measures for the first outbreak be inclusive of risk reduction and prevention and preparedness measures to account for subsequent outbreaks of a similar and different nature.*

Further, **the Pandemic Influenza Preparedness and Response: A WHO Guidance Document, 2009,** also recognizes 'whole-of-society' responsibility in the preparedness and response to pandemics. It has laid down critical roles to be played by non-health sectors and the communities and calls for the identification of key impacts on business, essential services, organizations; thereby preparing continuity policies for different sectors and building capacities for the same. *Thus, assessing these potential impacts and planning for mitigating them can be a good point to start the integration of biological hazards into development planning and strengthening the 'whole-of-society' approach of DRR.*

For ensuring a multi-sectoral and inter-departmental approach to the management of biological hazards along with the integration of health-related risks and priorities with those of disaster management, the **Health Emergency and Disaster Risk Management Framework, 2018 by WHO** calls for strong representation of and advocacy for the health sector in the respective national disaster (Risk) management agencies and other national and international forums to effectively represent the needs of the sector in policy, planning, resource allocation and operational coordination at all levels. The framework further recognizes that health of the community is both an underlying factor of its vulnerability and a foundation for its resilience. *Taking this further, it is crucial to acknowledge that while health infrastructure and services are critical lifeline resources in aftermath of any disaster, including biological hazards; there have been cases where these lifeline resources have themselves been affected during a disaster. Hence, a two-way integration of aspects of health emergency into DRR planning and that of DRR into health planning and the development of health infrastructure and services is required for ensuring* that both the health sector is disaster-resilient and that DRR and development planning are informed by health risks.

The importance of strengthened coordination to reduce the risk of biological hazards is further underscored by the **Bangkok Principles for the Implementation of the Health Aspects of the Sendai Framework for Disaster Risk Reduction, 2016**. The principles recognize the shared needs of both disaster and health risk management, namely, risk assessment, surveillance and early warning systems, resilient infrastructure and coordinated incident management. Calling for enhanced coherence between disaster and health risk management, the principles recommend seven measures and related actions for the prevention and/ or reduction of health emergencies including pandemics. *In the backdrop of the Bangkok Principles which calls for the integration of biological hazards into disaster risk management, it is pertinent to include in DRR planning, the possibility of the simultaneous occurrence of a biological hazard induced disaster along with any other disaster like an earthquake, floods, etc.* The recent cases of Tropical Cyclone Harold in the

Pacific, causing widespread destruction the Solomon Islands, Vanuatu, Fiji, Tonga; flashfloods in Spain, and pest attacks in various parts of Horn of Africa, Middle East and South Asia, creating risks of food insecurity, demonstrate the possibility of such simultaneous occurrences. *For such a scenario, strategies for disaster management and pandemic management should plan for the provision of PPE for response forces, establishing temporary hospitals or surging the treatment and surgical capacity of hospitals, establishing more relief camps and toilets due to restrictions like physical distancing , provision of relief kits that include essentials like masks, sanitizers, etc., ensuring a strategic fiscal balance between the pandemic and the disaster response, and most importantly responding to the emergency with a reduced workforce and restricted supply chains.*

The **Public Health System Resilience- Addendum to Disaster Resilience Scorecard for Cities, 2018,** aims to addresses some of the key public health issues and consequences of disasters which were not adequately emphasized in the UNDRR Disaster Resilience Scorecard for Cities. These include their immediate and longer term consequences on health and other sectors. The addendum has recommended the integration of the varied aspects like governance, finances, societal and institutional capacity, etc. with the Public Health System Resilience Assessment. *A critical aspect in the addendum is the inclusion of potential health impacts from other disasters. This is very important as health related risk and disease outbreak are common in the aftermath of disasters like floods, cyclone, tsunami, etc. due to disruptions in basic services and overwhelmed facilities post-disasters. Often these are not well reflected in DRR planning regarding post-trauma care, relief measures, management of relief shelters, provision of health care to populations living at home with pre-existing conditions, etc.; thereby further aggravating the pre-disasters vulnerabilities and health conditions of the community.*

The **Technical Guidance for Monitoring and Reporting on Progress in Achieving the Global Targets Sendai Framework for Disaster Risk Reduction, 2017** recommends that member countries identify and define biological hazards, with a focus on those having the potential to cause emergencies and disasters, for inclusion in respective reporting of Sendai Framework in consultation with respective Ministry of Health. It further lays down some of the considerations for the inclusion of the hazards in the indicator framework for the measurement of Global Targets. *As a precursor to monitoring and reporting of biological hazards, it is important to identify the kind of databases that need to be in place with different agencies of the government, so that accurate reporting of the progress made can be assessed.* For example, for biological hazards like an epidemic, while it may be comparatively easier to record the number of deaths (disaggregated into gender, age, disability, etc.) based on medical records, the recording of indicators like the number of affected people, number of people whose livelihoods were disrupted or destroyed, etc. are more difficult to gauge in the absence of robust registration and databases concerning daily wagers, migrant workers, slum dwellers, etc. *This calls for a multi-sectoral and integrated approach to envisage both direct and indirect impacts of biological hazards in respective sectors and the development and management of relevant databases to support assessments and reporting.*

The current pandemic has further highlighted the importance of the whole-of-society approach and their active participation and support in varied aspects like physical distancing, practicing

proper hygiene, avoiding stigmatization and discrimination, ensuring respect of human rights, to flatten the curve, support delivery of essential supplies, and ensure continuity of essential services like waste management. In the backdrop of this, it is very necessary that the whole-of-society is well informed of their risk and duly prepared for managing it. *Thus, aspects of risk communication should be strengthened for driving the implementation of risk-informed people-centred initiatives for DRR.*

3.5 Learning from past and current experiences

This century has been witness to major pandemics that have affected millions of people and crippled socio-economic dimensions of various nations across five continents. A special mention of the Spanish Flu is made in this section due to its link to many of the recent outbreaks. Since then, there have been advancements in the field of health diagnostics, disease surveillance and risk assessments. This section gives an overview of the outbreaks in the last two decades that have affected the world and notes the various countermeasures implemented. Further, this section focuses on the current measures in selected countries that have been effective in controlling COVID-19 mortality.

3.5.1 Past outbreak/ pandemic

Table 4: Comparative review of past outbreak/ pandemic

Outbreak/ pandemic	Timeline	Surveillance and RA	Sectoral impact	International cooperation	Post event
Spanish flu	1918-20	No surveillance and risk assessment tool	Health care, Army, Retail grocery business, Manufacturing sector, mining, Transportation (rail, water), telecommunication, Education, Entertainment industries, Agriculture	Individual response by countries	Established heath organization in 1923 under league of Nations becoming WHO in 1948
SARS	2002-03	GOARN, GPHIN, GEIS, DORSCON	Education, Tourism, transport (Aviation, rail, taxis), hospitality, entertainment and retail sector	Japan extended Global Cooperation for WHO's assistance	SARS alert mechanism, CDC's Public Health Guidance for Community-Level, IHR in 2005
Swine Flu	2009-10	IHR, EWRS, WHO's Interim guidance for the surveillance	Health care, Tourism, transportation, Hospitality, food, livestock and livelihood	Production of vaccine, non-pharmaceutical measures	
MERS			Health care, Tourism, transportation, Hospitality, food, retail	The CDC of the United States of America used public advisories to risk communication, Saudi Arabia made guidelines for hajj pilgrims, lack of evidence-based policy	In 2018 WHO came up with travel-related recommendations, Environmental Contamination Protocol, Outbreak investigation protocol: Case control study to evaluate risk factors for infection in high risk populations

Outbreak/ pandemic	Timeline	Surveillance and RA	Sectoral impact	International cooperation	Post event
EBOLA	2014-15	WHO Ebola outbreak response plan, surveillance guide, ECDC risk assessment tool	Health care, Tourism, transportation, Hospitality, food, retail, Mining, agriculture, Education, manufacturing	United Nations Security Council, Global Alliance for Vaccines and Immunization (GAVI), The Vaccine Alliance	Coordinated approach involving GOARN, EDPLN, EDCARN, and EMT
ZIKA	2014-16	ArboNET, US Zika Pregnancy Registry, Birth Defects Surveillance and Zika Local Health Department Initiative (LHDI)	Health care, Tourism, transportation, Hospitality, health care and public sector	ZIKA strategic framework for response	CDC collaborative projects VEZ in Colombia and ZODIAC in Brazil

3.5.1.1 Spanish Flu

The Spanish Flu followed immediately after World War I affecting a population of around 500 million and causing 40-50 million deaths globally. Three waves of infections were identified between 1918 and 1920 in three waves. The curve of influenza deaths by age at death was W shaped (peaking for 3 age groups 0-4 yrs, 25-34 yrs, and 80 yrs and above) against the common U shaped one (peaking for infants and old age). A unique character of the Spanish Flu as stated in a US Center for Disease Control (CDC) report is that individuals with the strongest immune systems were more likely to die than individuals with weaker immune systems. The more recent outbreaks of H1N1, H2N2, H3N2, H5N1, H7N7 are all decedents of the Spanish flu.

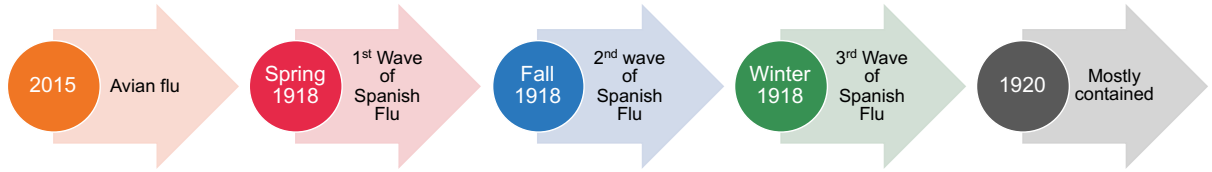

Figure 13: Timeline of Spanish Flu

Timeline of the pandemic

The pandemic started as an avian flu outbreak in 1915, and by March of 1918, the first wave of the pandemic swept across the globe. The second wave was the most severe of the three waves with the highest mortality. By 1920, the pandemic was mostly contained with cases being reported with less virulence.

Surveillance and risk assessment tool

There was no surveillance and risk assessment tool for the Spanish flu.

Public policy

As there was no vaccine to protect against influenza infection and no antibiotics to treat secondary bacterial infections, control efforts worldwide were limited to non-pharmaceutical interventions such as isolation, quarantine, good personal hygiene, use of disinfectants, and limitations on public gatherings, which were non uniform especially in the aftermath of World War I[13].

Post Spanish Flu pandemic developments

Post Spanish flu there have been advancements in three major fields namely; virus isolation and identification, vaccine development, and strengthening of global health diplomacy[14]. The League of Nations, the first global political system, was founded in 1919, which established a health organization in 1923 that was later replaced by the World Health Organization in 1948.

[13] https://www.cdc.gov/flu/pandemic-resources/1918-pandemic-h1n1.html
[14] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5198166/pdf/pathogens-05-00066.pdf

3.5.1.2 *Severe Acute Respiratory Syndrome (SARS)*

The Severe Acute Respiratory Syndrome (SARS) started in 2003 by a coronavirus, called SARS-associated coronavirus (SARS-CoV). As per the WHO, a total of 8,098 people globally become infected with SARS and of these 774 died in 26 countries spread over five continents.

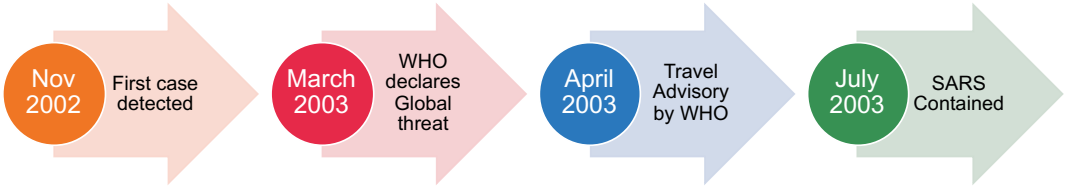

Figure 14: Timeline of SARS

Timeline of the pandemic

The first case of SARS was detected on the 16th of November 2002 in the Guangdong province of China. By 27th November 2002, the Global Public Health Intelligence Network (GPHIN), an electronic warning system that is part of the World Health Organization's Global Outbreak Alert and Response Network (GOARN), picked up the flu-like outbreak. By mid-March 2003 SARS was recognized as a global threat by World Health Organisation (WHO) and a travel advisory was issued on the 2nd of April 2003. The US Center for Disease Control (CDC) and Canada's National Microbiology Laboratory identified the SARS genome in April 2003[15]. The WHO declared the pandemic contained in July 2003 (Cheng et al., 2007). Further, some sporadic cases were reported between 2003 and 2005 mainly due to laboratory transmissions.

Surveillance and risk assessment tool

The Global Outbreak Alert and Response Network (GOARN) through its partners, the Canadian Global Public Health Intelligence Network (GPHIN) and the U.S. Global Emerging Infections Surveillance and Response System (GEIS), got early knowledge of the outbreak in China (Heymann and Rodier, 2004). The Government of Singapore came up with the Disease Outbreak Response System Condition' (DORSCON)[16], a colour-coded framework that shows the nature of the disease, its impact and a public advisory.

Sectoral impact of SARS

The span of global spread was for a period of 4 months from March to July of 2003 but had considerable direct and indirect economic impacts. A major fallout of SARS was the reduction in international tourist travel in China and Singapore, the worst affected destinations due to the WHO's travel warnings. Three linked sectors were impacted, namely tourism, transport (Aviation, rail, taxis), hospitality, entertainment and the retail sector (Beutels et al. 2009). Specific to SARS, a behavioral trend of infection avoidance was noticed (Brahmbhatt and Dutta 2008). This led to the closure of schools and high absenteeism from work thus putting stress on livelihoods in the

15 https://www.cdc.gov/about/history/sars/feature.htm

16 https://www.gov.sg/article/what-do-the-different-dorscon-levels-mean

education and service sector. The unemployment rate particularly, in Hong Kong grew from around 7% in 2002 to 8.7 % in 2003 (Siu and Wong 2004).

International cooperation and public policy

Countries like Japan, which was not highly impacted, offered bilateral assistance to highly impacted countries like China and Vietnam by means of medicine and human resource. Further, Japan extended global cooperation for WHO's assistance and to other countries. During SARS, travel restrictions and quarantines were widely used by various national governments (Balinska and Rizzo 2009). Specifically, in Beijing, students were requested by the government has requested not to evacuate to other locations.

Post SARS developments

The WHO in August 2003 came out with a SARS alert mechanism for the post-outbreak period by either laboratory confirmation or the segregation of persons under surveillance. The CDC in January 2004 came up with the Public Health Guidance for Community-Level Preparedness and Response to Severe Acute Respiratory Syndrome (SARS). Further, in October 2004, the WHO revised its SARS surveillance, response, and risk assessment guidelines for member countries. The International Health Regulations (IHR 2005) introduced new operational concepts for surveillance, collaborative risk assessment and response, among others.

3.5.1.3 Swine Flu

The novel pH1N1 virus, a descendent of the 1918 Spanish flu was first detected in spring of 2009 in Mexico and the United States. Younger populations, primarily affecting children, young adults, and pregnant women were at higher risk. The total number of reported deaths is 18,500 globally among approximately 700 million to 1.4 billion who were infected in around 60 countries.

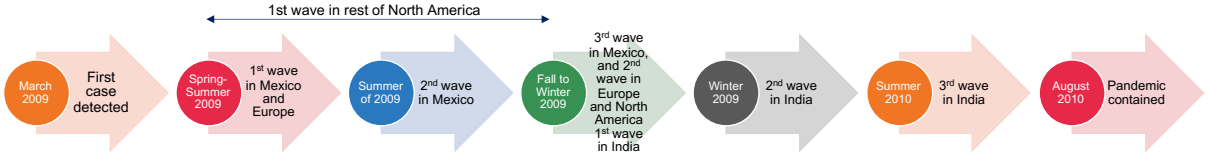

Figure 15: Timeline of Swine Flu

Timeline of the pandemic

The swine flu was detected in Mexico and the United States in April 2009 and in June 2009 the WHO declared it a global pandemic. There was variation in infection waves geographically. In Mexico and India, three waves were detected while in the rest of North America and Europe two waves were detected. The WHO declared the pandemic contained in August 2010.

Surveillance and risk assessment tool

The International Health Regulations (IHR) focal point was used for reporting of cases to the WHO by member nations. On the 27th of April 2009, the WHO came up with interim guidance for the

surveillance of human infections with swine influenza A (H1N1) virus[17]. European nations started submitting detailed case-based reports to the European Center for Disease Control in May 2009, using an ad hoc database hosted on the Early Warning and Response (EWRS) platform. This was supported by epidemic intelligence gathering and targeted science watch activities, which helped set the parameters leading to a dynamic scientific risk assessment tool that was revised ten times in 2009[18].

Sectoral impact of Swine Flu

Swine flu had a significant impact on the economy of the affected countries. The direct impact of the Swine flu was on governments as a result of a rise in the cost of pandemic response and on the health sector. The WHO observed a burden on the outpatient, emergency and intensive-care services during the peak of the swine flu outbreaks in some countries. The education sector was affected due to the closure of schools, which led to absenteeism among working adults who stayed home to care for their children. Travel restrictions impacted the transportation, tourism and hospitality industries[19]. Mexico being a hotspot of Swine flu, suffered from travel restrictions that were imposed by different countries which impacted its tourism sector and the consumption of pork and linked foods fell drastically[20]. New Zealand saw reduced consumption demand and reduced supply of labour as a result of 200 odd deaths due to swine flu[21].

International cooperation and public policy

National Governments were indecisive about the virulence of pH1N1 leading to non-pharmaceutical interventions (e.g. hand hygiene, school closure, aggressive containment campaign and voluntary isolation)[22]. In Egypt, the culling of pigs was done to ensure no animal to human transmission. The swine flu response blended both vaccination and antiviral use. Production of the vaccine was accelerated and a fast pacing of standard US Food and Drug Administration (FDA) approval process was done. High-risk groups were prioritized for the vaccine. India was one of the hardest hits by Swine flu. A national Action Plan for Pandemic Preparedness and Response was prepared by the Ministry of Health, Government of India, in 2009 detailing early detection, appropriate case management and public health measures based on guidelines, protocols and Standard Operating Procedures (SOPs)[23]. Further a state level Contingency Plan for Management of Influenza was made by the state government of Maharashtra.

Post Swine Flu outbreak developments

After August 2010, a few outbreaks of Swine flu were reported in India.

[17] https://www.who.int/csr/disease/swineflu/WHO_case_definition_swine_flu_2009_04_29.pdf
[18] https://www.eurosurveillance.org/images/dynamic/EE/V16N26/art19903.pdf
[19] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5198166/pdf/pathogens-05-00066.pdf
[20] https://onlinelibrary.wiley.com/doi/epdf/10.1002/hec.2862
[21] https://www.rbnz.govt.nz/-/media/ReserveBank/Files/Publications/Research/additional-research/3698971.pdf
[22] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3445335/pdf/nihms284890.pdf
[23] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5819375/pdf/ijhpm-7-154.pdf

3.5.1.4 *Middle East Respiratory Syndrome (MERS)*

The MERS was caused by a new coronavirus (MERS-CoV), first detected in the United Kingdom in 2012 that caused a respiratory illness[24]. The most likely source of infection is through contact with dromedary camels or linked products. The infected patient numbers are not many but the mortality rate is as high as one-third of all infected patients. The detected patients in 27 countries in four continents (Asia, Africa, North America and Europe) were mostly male (68%) with some direct or indirect links (travel history or infected by someone who had travelled) to the Arabian Peninsula[25,26].

Figure 16: Timeline of MERS

Timeline of the pandemic

The first case of MERS was detected in 2012. Two major outbreaks were reported in 2014 and 2015 in the Arabian Peninsula (mainly in Saudi Arabia) and in South Korea, respectively. The WHO came up with an interim case definition for MERS-CoV on the 3rd of July, 2013 which was subsequently revised in 2018. Further, surveillance guidelines were prepared in 2018. The last reported case was in January 2020 with a total number of confirmed cases of MERS at 2519[27].

Surveillance and risk assessment tool

The WHO developed detailed surveillance guidelines for human infection with MERS and how to conduct investigations around confirmed cases[28]. Oman came up with a detailed plan for responding to MERS by focusing on five pillars of action, including public health surveillance and contact management, building laboratory capacity, infection prevention and control, case management, and risk communication[29]. In 2013, post-Hajj pilgrimage, surveillance for MERS-CoV was done using nasopharyngeal swabs for suspected cases. The CDC enhanced its data collection methodology and tools, including Advanced Molecular Detection (AMD) methods for virus detection.

The sectoral impact of SARS

The economic impacts of MERS have been studied from the outbreaks in South Korea and Saudi Arabia. One of major fallouts of the MERS outbreak was on the transportation sector due to a reduction in international travel affecting the aviation industry, local ridership due to national governments putting travel retractions and on local travel in affected areas. The other linked

[24] https://www.who.int/csr/don/archive/disease/coronavirus_infections/en/
[25] https://apps.who.int/iris/bitstream/handle/10665/326126/WHO-MERS-RA-19.1-eng.pdf?ua=1
[26] https://pandemic.internationalsos.com/overview/mers-overview
[27] http://www.emro.who.int/pandemic-epidemic-diseases/mers-cov/mers-situation-update-january-2020.html
[28] https://www.who.int/csr/disease/coronavirus_infections/technical-guidance-surveillance/en/
[29]https://reader.elsevier.com/reader/sd/pii/S1201971214016488?token=838A0F697ADAEFE44CBFA93C75F3825C17D5B6BCD52B357910A3A8DF4B3399D35B20D9F4E13EAF3D24E32ABA2D667F89

sectors, like hospitality, food and beverage and entrainment, were also impacted. In South Korea, the government incurred huge costs for its MERS response, along with the healthcare sector. The retail sector was affected by the MERS outbreak leading to a significant decrease in the offline sale of electronic goods in South Korea[30]. At the same time, online sales increased.

International cooperation and public policy

There were no travel restrictions imposed by the WHO, but a few national governments came up with travel advisories to Middle Eastern countries and South Korea. The CDC used public advisories and risk communication to suggest quarantine, and basic hygiene as methods to reduce transmission. Saudi Arabia, being the most impacted nation, its Ministry of Health (MoH) came up with guidelines for the public and healthcare workers, patients and family members of patients and Hajj pilgrims[31]. For South Korea (Pang, 2015) there was a noted lack of evidence-based public policy.

Post MERS outbreak developments

In 2018, the WHO came up with travel-related recommendations[32]. In addition, the WHO came up with the Environmental Contamination Protocol, Outbreak investigation protocol: Case-control study to evaluate risk factors for infection of healthcare personnel, close contact of confirmed patients and in general high-risk populations.

3.5.1.5 Ebola

The Ebola virus is a deadly virus (90% mortality rate of infected patients) that spreads to people through contact with the skin or bodily fluids of an infected animal and then is passed on from humans[33]. The Ebola virus was discovered in 1976 and has affected many in the African continent. The first reported Ebola outbreak was in 1976 in South Sudan followed by 27 other outbreaks mostly in Africa with some reported cases in Spain and the United States[34]. The most complex of all the outbreaks was in 2014-16 with 28,639 reported cases and 11,316 deaths[35].

Figure 17: Timeline of Ebola

Timeline of the pandemic

From 2014 to 2016, West Africa experienced an Ebola virus outbreak. It started in the republic of Guinea in December of 2013[36] and then it spread to the Republic of Liberia and Sierra Leone. An

[30] https://www.mdpi.com/2071-1050/9/3/411/htm
[31] https://www.longdom.org/open-access/outbreak-control-policies-for-middle-east-respiratory-syndrome-mers-the-present-and-the-future-2329-891X-1000166.pdf
[32] https://www.who.int/ihr/travel/MERS-advice-travel-trade-9-2018/en/
[33] https://www.webmd.com/a-to-z-guides/ebola-fever-virus-infection
[34] https://www.thelancet.com/action/showPdf?pii=S0140-6736%2818%2933132-5
[35] https://www.who.int/csr/resources/publications/presentation.pdf?ua=1
[36] Kaner S. et al. (2016) Understanding Ebola: The 2014 epidemic

official alert was issued on the 24th of January, 2014 at the local level in Guinea. On 13th March, 2014, the Guinea Ministry of Health issued its first alert and WHO took note of it. On the 23rd March 2014, the WHO declared an outbreak. On the 9th July 2014, United Nations Security Council issued raised a concern about the Ebola outbreak and a month later, the WHO declared it an international health emergency. On 29th of March 2016, the WHO declared the end of the Public Health Emergency of International Concern.

Surveillance and risk assessment tool

The WHO developed an Ebola outbreak response plan in July 2014 for West Africa[37]. The WHO shared a surveillance guide in August 2014 for affected countries and extended it for other countries in September 2015[38]. The European Centre for Disease Prevention and Control (ECDC) on 8th April 2014 shared its risk assessment tool for Ebola virus outbreak with proposed scenarios and transmission channels[39]. In November 2015, the WHO came up with a surveillance strategy for phase 3 of the Ebola virus outbreak[40].

Sectoral impact of Ebola Virus

The World Bank reported loss of jobs and a drop in wages and household incomes in Liberia. Further, the agriculture sector was moderately impacted. The tourism and transportation sector faced a significant impact. While the hospitality sector benefited from the international response[41]. In Sierra Leone, impacted sectors were education, healthcare, agriculture, transport, tourism, trade, mining and manufacturing[42].

International cooperation and public policy

The UNSC intervention in July 2014 brought the Ebola outbreak to international notice. WHO and Doctors Without Borders (MSF) reports pointed out that there was a lack of international capacity and cooperation until cases were reported in Spain and the United States. The UN system became a trusted partner in the West African region for Ebola response. International vaccine alliances, like GAVI, stressed the need for vaccine studies and vaccine approval protocols.

Post Ebola virus outbreak developments

Post the 2014-16 Ebola virus outbreak, in 2019 an outbreak was reported in the Democratic Republic of Congo. The WHO engaged the Global Outbreak Alert and Response Network (GOARN), Emerging and Dangerous Pathogens Laboratory Network (EDPLN), Emerging Disease Clinical Assessment and Response Network (EDCARN), and the Emergency Medical Team (EMT) along with regional operational partners and collaboration centres in Africa for preparedness and response[43].

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[37] https://www.who.int/csr/disease/ebola/evd-outbreak-response-plan-west-africa-2014.pdf?ua=1

[38] https://www.who.int/csr/resources/publications/ebola/surveillance/en/

[39] https://www.ecdc.europa.eu/sites/default/files/media/en/publications/Publications/Ebola-RRA-West-Africa-8April2014.pdf

[40]https://apps.who.int/iris/bitstream/handle/10665/192997/WHO_EVD_Guidance_Sur_15.1_eng.pdf?sequence=1

[41]https://www.worldbank.org/content/dam/Worldbank/document/Economic%20Impact%20Ebola%20Update%202%20Dec%202014.pdf

42 https://sierraleone.unfpa.org/sites/default/files/pub-pdf/EVD%20report.pdf

[43] https://apps.who.int/iris/bitstream/handle/10665/329377/SITREP_EVD_DRC_20191015-eng.pdf

3.5.1.6 Zika Virus Outbreak

The Zika Virus (ZIKAV) was first discovered in 1947 in Uganda. The Zika virus is a flavivirus that is spread by the bite of an infected Aedes species mosquito, or by blood transfusion or by sexual contact, which can be passed from a pregnant woman to her child leading to certain birth defects[44]. Currently, there is no vaccine for the Zika virus. Between 2015 and 2018, cases of ZIKAV have been reported in 87 countries[45].

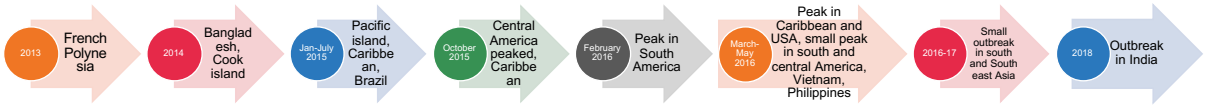

Figure 18: Timeline of Zika

Timeline of the pandemic

Before 2015, Zika virus outbreaks had affected Africa, Southeast Asia, and the Pacific Islands. The first reported outbreak was in French Polynesia in 2013. In 2015 and 2016, large outbreaks of Zika virus occurred in the North and South America. In May 2015, Brazil reported the first case of ZIKAV transmission in South America[46]. In October 2015, Colombia reported ZIKAV transmission, and subsequently Central America, the Caribbean, and parts of North America reported cases. Further in December 2015, Haiti reported cases of ZIKAV. The peak of the ZIKAV cases varied across geographies; while in South America the peak came in February 2016, Central America had its peak in January 2016 and then both central and South America had smaller spikes in mid-2016. In the Caribbean, it peaked in mid-2016. In Africa, an outbreak was declared in October 2015 and in South and South East Asia in 2016 and 2017. The pacific islands reported an outbreak as early as 2014 and subsequently in 2015. The last reported case was in January 2020.

Surveillance and risk assessment tool

In the United States, state health departments are designated to report confirmed cases to the federal CDC through ArboNET, the national surveillance system for arboviral diseases. Further, the CDC started the US Zika Pregnancy Registry to collect information and learn more from pregnant women. The CDC further established the Birth Defects Surveillance and Zika Local Health Department Initiative (LHDI). The European Center for Disease Prevention and Control (ECDC) in its guidance has made a detailed surveillance strategy along with a strengthening of clinical and laboratory testing and reporting[47].

[44] https://www.cdc.gov/zika/about/index.html
[45] https://www.who.int/emergencies/diseases/zika/zika-epidemiology-update-july-2019.pdf?ua=1
[46] Hills S. et al. (2017) Epidemiology of Zika Virus Infection
[47] https://www.ecdc.europa.eu/sites/default/files/media/en/publications/Publications/zika-preparedness-planning-guide-aedes-mosquitoes.pdf

Sectoral impact of Zika Virus

Though the economic impacts of Zika virus are not pronounced equally for all regions, it felt that the developing and least developed countries faced the most hardship. A major fallout of the outbreak has been on the tourism, transportation and hospitality sectors. This is followed by a loss of livelihood, reduction is tax payments, and an increased expense for the government and the health care sector[48].

International cooperation and public policy

The WHO has come up with the ZIKA strategic framework for response comprising of four components for detection, prevention, care and support, and research[49]. The plan[50] is updated quarterly and is aimed at strengthening the capacities of various nations. The CDC's National Center on Birth Defects and Developmental Disabilities is conducting similar tracking and research studies abroad, in collaboration with the governments of Colombia and Brazil.

Post Zika virus outbreak developments

The CDC, along with Instituto Nacional de Salud (INS) and the Ministry of Health in Colombia, is working on the Proyecto Vigilancia de Embarazadas con Zika (VEZ) to monitor the health of pregnant women and infants. The CDC is also working with the government of Brazil on a project called Zika Outcomes and Development in Infants and Children (ZODIAC) to understand the long term impacts of ZIKAV on children. The WHO is constantly monitoring the ZIKAV cases across member states.

3.5.2 Country specific response to COVID-19

COVID-19 has affected 3.19 million people and has caused 270,000deaths in more than 200 countries. The mortality rate has shown variance from one country to the other. In this section, we look at country-specific responses with lower reported mortality rates. The selected cases are Japan, South Korea, Singapore, New Zealand, Germany, and Vietnam.

3.5.2.1 Japan

Japan on 30th April 2020 had 13,964 confirmed cases with 424 reported deaths from two waves. The first case was reported in late January 2020. A few specific prefectures like Tokyo, Chiba, Kanagawa, Saitama, Osaka, Hyogo, Aichi, Hokkaido, among others, reported higher number of cases. The first wave from January to March 2020 consisted of international travellers traced mostly to China. The second wave from March onwards is linked to patients with a history of travel from Europe and the United States.

[48] https://www.ifrc.org/Global/Photos/Secretariat/201702/UNDP-Zika-04-03-2017-English-WEB.pdf
[49] https://www.who.int/emergencies/zika-virus/response/en/
[50] https://apps.who.int/iris/bitstream/handle/10665/246091/WHO-ZIKV-SRF-16.3-eng.pdf?sequence=1

Important developments and decisions taken in Japan

The government response to the COVID-19 situation was in two phases; first phase focused on containment and the second phase on mitigation.

- First ministerial meeting held on the 24th January to discuss counter measures for Coronavirus and by 30th January a coronavirus headquarters was established.
- The quarantine act was enacted in early February and the first expert committee meeting happened on the 16th of February 2020. The government introduced the coronavirus consultation system to coordinate medical testing for the public.
- In early March, schools were requested to close and by 5th March the government of Japan announced a financial aid package and amendments to the counter measures act.
- Due to a sudden spike in cases, Tokyo in early April requested a stop on all non-essential travel.
- On the 8th of April 2020, the Government of Japan declared a State of Emergency for a period of one month.

What worked for containment

An epidemic cluster approach has marked the Japanese government's response, limiting testing and stress on medical infrastructure to ensure access to critical patients[51]. Secondly, evidence-based policy decisions were made supported by an expert committee that was established by the government. Thirdly, border control had a significant impact in controlling the spread of the infections in Japan[52]. Lastly, the public's adherence to the 3C's concept introduced by the Government of Japan which asked citizens to avoid; Closed spaces, Crowded places and Close contacts.

3.5.2.2 South Korea

South Korea on 30th April 2020 had 10,765 confirmed cases, from which 9,059 recoveries and 247 deaths were reported. The first case of COVID-19 was detected on the 20 January 2020. A sudden spike in numbers was reported due to transmission at a mass gathering in a church in Daegu. By April 18, confirmed new cases were reported in single digits.

Important developments and decisions taken in South Korea

- In late December 2019, the government of Korea and the Korea Centers for Disease Control and Prevention (KCDC) strengthened the quarantine process for people entering Korea from the Wuhan region in cooperation with Chinese health authorities and the World Health Organization (WHO).
- On January 8, 2020, the Korean government issued a level Blue alert (the lowest among the four alerts in the national crisis management system) and established a joint response

[51] Djalante et al. (2020) Building resilience against biological hazards and pandemics: COVID-19 and its implications for the Sendai Framework.
[52] Shaw R et al. (2020) Governance, technology and citizen behavior in pandemic: Lessons from COVID-19 in East Asia

system by sharing immigration information among the KCDC, the Ministry of Interior and Safety (MoIS), the Ministry of Justice (MoJ) and other related agencies.

- On January 20, 2020, the KCDC confirmed the first imported case of COVID-19. On the same day, the Korean government raised the alert level from Blue (Level 1) to Yellow (Level 2) and set up the Central Discharge Countermeasures Headquarters (CDCHQ).
- By 19th February 2020, after the two mass transmission incidents, the alert level was raised to red (level 4).

What worked for containment

Various factors can be attributed to South Korea's success in keeping infection and mortality rates low.

- South Korea reported one of the highest testing rates per one million population.
- The successful initial management of the COVID-19 situation and the sharing of information. The KCDC shared COVID-19 information with related organizations and established an effective response system[53]. Further, the Ministry of the Interior and Safety (MOIS) established a Community Based Surveillance (CBS) system in collaboration with the Korea Meteorological Administration (KMA), related government agencies and local governments, mobile carrier companies (SKT, KT, LGU+) and cell phone manufacturing companies. The Seoul Metropolitan Government (SMG) published the list of confirmed patients on its webpage.
- As a result of the rapid escalation of COVID-19 cases among members of the "Shincheonji Church of Jesus",, the Korean government raised the alert level to Red (Level 4) and put all available resources to tackle the crisis along with designating special management regions to counter the disease.
- The government's transparent and democratic response, the voluntary participation of citizens, and the efforts of hidden heroes (healthcare professionals, community workers and other frontline workers) prevented the spread of COVID-19 nationwide without the need to enforce extreme draconian measures that restricted the freedom of movement.
- Preventing overseas inflow and strengthening social distancing: The Korean government applied special entry procedures to block the influx of COVID-19 from foreign countries while maintaining its principles of openness, transparency and limited interference to international air traffic, and shifted its social distancing policy from a voluntary recommendation to a strong administrative recommendation that held effectiveness until a significant reduction in the confirmed cases.

3.5.2.3 Singapore

Singapore on 30th April 2020 had 15,641 confirmed cases of which 1,188 recoveries and 14 deaths were reported. The first case of COVID-19 was detected on the 23rd January 2020.

[53]http://www.undp.org/content/seoul_policy_center/en/home/presscenter/articles/2019/Collection_of_Examples_from_the_Republic_of_Korea/covid-public-information-disclosure.html

Important developments and decisions that were taken in Singapore

- Early January 2020, the Ministry of Health (MOH) issued a health advisory and by 20th January it starts temperature monitoring at Changi airport.
- 27th January 2020, the Government of Singapore published travel advisories.
- 31st January 2020, the Ministry of Communications and Information (MCI) imposed measures on social media platforms, search engines and Internet intermediaries to stop fake news and rumors.
- 4th February 2020, it started contact tracing and the use of an online platform for patient movement tracking and hotspot identification.
- 28th February 2020 the Singapore biotech company Veredus launched a COVID-19 test kit for in-vitro diagnosis in 2 hours.
- 3rd to 16th March 2020 it issued a travel ban and imposed quarantines on travellers from various affected countries in ASEAN, Europe and the United States.
- 20th March 2020 – it launched of a contact tracing mobile application.
- 26th March 2020 - it issued new regulations to penalize those violating Stay-Home Notices.
- 14 April 2020, the Ministry for National Development announced that wearing a mask was compulsory
- Three economic stimulus packages were introduced namely; Unity Budget, Resilience Budget and Solidarity Budget in mid-February, late March and early April respectively.

What worked for containment

- The Singapore government put emphasis on the use of risk communication and the use of science and technology to detect, monitor and make evidence-based decisions, supported by public information disclosures, establishment of drive-through virus testing, and e-learning.
- The issuance of an economic stimulus package for the hospitality industry, health care and small businesses.
- The decision to monitor the health of travellers, compulsory self-quarantine monitoring and border control, all had a significant impact on limiting the number of cases.
- Imposing penal legislation for violations of the Stay-Home Notices became a deterrent for citizens thus limiting local transmissions.
- An effective private sector response led to a stabilization of mask supply and distribution. The privet sector was further supported by a simplification of administrative procedures in affected industries.
- Establishing medical and parcel delivery and better waste management measures.

3.5.2.4 New Zealand

New Zealand on 30th April 2020 had 1,129 confirmed cases of which 1,241 recoveries and 19 deaths were reported. The first case of COVID-19 was detected on the 28th of February 2020. On28th April 2020, the Prime Minister of New Zealand free of COVID-19.

Important developments and decisions taken in New Zealand

- Between 18-30 January 2020, the Ministry of Health set up the National Health Coordination Centre (NHCC) in response to the outbreak and an Infectious and Notifiable Diseases Order was issued by enacting the Health Act of 1956.
- On 7 February, the Ministry of Health set up a dedicated a toll-free helpline for COVID-19-related calls.
- On 21 March 2020 the Prime Minister introduced a country-wide alert system in line with the existing fire alert system.
- Between 23-25th March 2020, the alert level was upgraded from level 2 to level 4.

What worked for containment

- Imposing strict quarantine measure for foreign tourists.
- Introduction of the nationwide alert mechanism, which was built on an existing alert system, making it easier for people to follow.
- Increasing investment in emergency spending and introducing legislation to allow local authorities to meet remotely, to allow the repurposing of schools for use as make shift health centers, and to ban no-cause evictions and freeze rents for six months.
- Introduction of financial packages for students and media houses.
- Closure of parks and camping grounds.

3.5.2.5 Germany

Germany on 30th April 2020 had 161,539 confirmed cases of which 113,386 recoveries and 6,467 deaths were reported. The first case of COVID-19 was detected on the 27th of January 2020.

Important developments and decisions taken in Germany

- In late January 2020, the government took measures to keep COVID-19 risks low for Germany.
- 26 February 2020, due to multiple COVID-19 cases in North Rhine-Westphalia, the town of Heinsberg initiated the closure of schools, swimming pools, libraries and the town hall until 2 March.
- 10 March 2020, the Chancellor announced that between 60 and 70 per cent of Germans would be infected and on 11th March 2020 she held a dedicated press conference.
- 17th March 2020, the Robert Koch institute, a German federal government agency and research institute responsible for disease control and prevention, raised the risk level to high and announced the establishment of a hospital for COVID19 patients.
- 22 March- 29 March 2020, a curfew was declared and a financial package was announced.
- Early April 2020, a mobile tracking application was launched, and the wearing of masks was made compulsory for all.

What worked for containment

- The introduction of a mobile tracking application along with the high rate of testing.

- The imposition of a curfew and the compulsory wearing of mask for all citizens.
- Raising the risk alert level to high helped change community perceptions of the risk and also enabled the government to take more stringent measures.

3.5.2.6 Vietnam

Vietnam shares a long border with China and was at higher risk of becoming a hotspot. Vietnam on 30th April 2020 had 270 confirmed cases of which 222 recoveries and 0 deaths were reported. The first case of COVID-19 was detected on the 23rd of January 2020. Three phases have been reported in Vietnam; Phase 1 (23 Jan-25Feb) involving people with a travel history to China, Phase 2 (6-19 March) involving people with a travel history to other countries, and Phase 3, which started on 20 March and is ongoing.

Important developments and decisions taken in Vietnam

- 1 February 2020, Vietnam suspended all flights to and from China. It also decided to keep schools closed after the Lunar New Year break. Two weeks later, a 21-day quarantine was imposed in Vinh Phuc province, north of Hanoi.
- 31 March 2020, the Vietnamese government ordered a nationwide quarantine of 15 days from 1 April to 15 April.

What worked for containment

- The government acted swiftly to suspend flights, shut schools and quarantine new arrivals.
- The introduction of a neighbourhood watch worked as a strong community-based surveillance.
- The imposition of regulations and the support of the military was significant to reducing local transmission and to enforce adherence to regulations.
- Imposition of strict penalties for anyone found sharing 'fake news' and misinformation about coronavirus risks.

3.5.2.7 Bhutan

Bhutan is a landlocked and least developed country (LDC) which reported its first COVID-19 case on the 6th March 2020. As of 4 June, there were 47 confirmed cases with no deaths reported thus far. Bhutan has one of the highest testing rates per million population among LDCs after Djibouti.

Important developments and decisions taken in Bhutan

- The government closed its international borders upon confirmation of the second COVID-19 case in late March 2020 and repatriated Bhutanese nationals from India.
- Government banned the import of vegetables, fruits and meat.
- Extension of quarantine period from 14 days to 21 days based on reported cases and the launch of a door-to-door awareness raising campaigns.
- Suspension of all airlines except the national carrier (Druk air).
- Distribution of printed reading materials in addition to online classes.

What worked for containment

- The door-to-door awareness raising program and the establishment of quarantine centers.
- Sealing of international borders and the banning of imports, which lead to less transboundary human spread from hotspots.
- Support for local agriculture production to make up for the import shortfall.

3.5.2.8 The Maldives

The Maldives is a Small Island Developing State (SIDS) in the Indian Ocean and had its first reported case on the 7th of March 2020. As of 4 June, the island has reported 1,850confirmed cases and 7 deaths.

Important developments and decisions taken in Maldives

- The Maldives declared COVID-19 a public health emergency on 12 March 2020.
- The Government of the Maldives placed a temporary travel restriction to and from countries with a high number of cases
- The Maldivian government turned the resort island of Villivaru in the Kaafu Atoll into a quarantine facility that provides free medical care with a capacity of 2,288 beds.

What worked for containment

- The Maldives increased its COVID-19 bed capacity and put travel bans to control the number of cases.
- Free medical care for COVID-19 confirmed cases eased the burden on individual as the country entered a possible economic downturn.

Box 5: Case study of a local response to the Nipah Virus

Nipah Virus, Kerala, India: Local government response

Kerala, a state in India, had faced a Nipah virus outbreak in 2018. The Government of Kerala used its Nipah virus response framework to detect the threat of a possible public health emergency due to COVID-19. The government was able to establish a three tier detection system with surveillance down to the village level. Secondly, past experience in hospital management and training of doctors, nurses and other health care workers to respond to the Nipah virus helped them quickly respond to COVID-19 cases. In addition, the state was able to utilize the outbreak monitoring units which were set up in all the medical colleges for the Nipah virus to monitor COVID-19. Lastly, community-level awareness raising campaigns played a significant role in promoting social distancing norms in the State.

Box 6: Summary of review of past cases and country specific cases

By analysing past cases of pandemics and country specific cases, the following lessons can be drawn.

1. Governments with prior experience of handling a national outbreak are better prepared to respond to a pandemic as has been seen in the case of Europe's handling of swine flu after SARSs or the Indian State of Kerala's handling COVID-19 after responding to the Nipah virus outbreak in 2018.
2. Non pharmaceutical measures like lockdowns, quarantines and travel restrictions have both short term and long-term social, economic and psychological impacts. Mostly the long-term impacts are indirect and wider, thus are not captured in post pandemic scenarios when designing recovery plans.
3. There is a need for strong evidence-based decision making to inform long term public policy for managing pandemics.
4. The cases of Singapore, New Zealand, and Vietnam point towards a need to have strong penal laws for pandemic legislation for effective enforcement. Such measures might be needed when voluntary adherence to government-issued guidelines is limited and the spread of the infection is on the rise.
5. The role of the national government, especially in creating a reporting and monitoring mechanism, is important for an early detection and warning of an outbreak.
6. International Health Regulations (IHR) and linked real-time monitoring tools provide an environment for early detection of an outbreak.
7. The risk assessment tools for each new outbreaks have to be contextualized based on local conditions. Further, risk assessment tools need to be updated and customized to reduce the re-emergence of subsequent waves of infection.
8. Use of modern technology and innovation is important for early detection, and risk communication.
9. From past pandemics and outbreaks, the sectors have a higher chance of being impacted are tourism, education, health, transportation, hospitality and manufacturing and retail. Sectors that face an indirect impact include the agriculture sector and livelihoods in linked industries especially among micro, small and medium enterprises (MSMEs). This includes the informal sector, where many workers lack access to social protection.
10. Small Island Developing States (SIDS) and Least Developed Countries (LDCs) face challenges around food security in long term and delayed economic recovery in comparison to other countries due to the loss of tourism.

4. Key steps and learning

A successful integration of biological hazards into disaster risk reduction and response planning can be achieved if the following two goals are reached.

- GOAL 1: Flattening the curve and enhancing the capacities of the health care system to have a better initial response
- GOAL 2: Preventing and minimizing negative impacts in terms of human (lives and livelihoods), socio-economic sectors and development goals

To achieve these goals, the key steps and learning in Figure 19 can be followed. These steps and learning might seem primarily focused around achieving Goal 1, but they can also contribute to achieving Goal 2.

Specific aspects of risk assessments and impact assessments are included in Section 7 of main document, which relate to the integration of biological hazards into DRR strategies. The risk reduction and pre-disaster preparedness parts are included in the main document. This section draws lessons from the biological hazard responses:

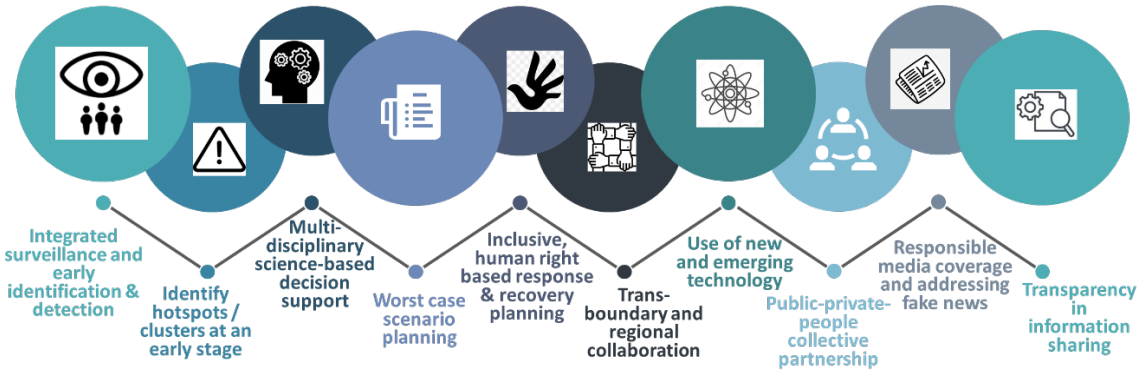

Figure 19: Basic steps and learning for biological hazard integration into DRR

1. Integrated surveillance and early identification and detection: Early identification and detection of a disease before the outbreak stage is extremely important. When a disease is already in the stage of outbreak or epidemic, it is important to have proper surveillance and introduce a rapid and mass testing system. In case of an epidemic or pandemic that impacts a wide area, restricted travel and controlled entry to the affected area may be required.

2. Identify hotspots / clusters at an early stage: Adopting the cluster approach to identify clusters that are spreading the disease early and quickly taking actions to stop the spread can be effective at an early stage of the epidemic / pandemic.

3. Multi-disciplinary science-based decision support: It is important to have a science-based decision support team, comprised of experts from health and medical sectors, data scientists, response specialists, DRR specialists, contingency managers, and human right specialists, to name a few. The multi-disciplinary nature of the team will not only help in the initial response phase, but can also help in short, medium- and longer-term recovery planning.

4. Worst case scenario planning: While closely monitoring the daily situation, it is important to develop a worst-case scenario. It is important to seek the help of data scientists, along with virologists and epidemiologists. The worst-case scenario can help the government set different targets, like number of lockdown days / weeks/ months, percentage of human density reduction, etc.

5. Inclusive (leave no one behind), human rights-based response and recovery planning: Recovery planning for longer term resilience is a critical part of responding to biological hazards, which often last longer than other hazards. Early planning is important in this regard. Also, to reduce the impact on different sectors, an inclusive approach to social security and recovery planning are required, keeping in mind the diversity of the society, economic levels, livelihoods, age groups and gender. Adopting a human rights-based approach can help avoid discrimination, stigma and strengthen respect for political, civil and socio-economic rights especially for some vulnerable populations such as refugees, migrants, LGBTQI, etc.

6. Trans-boundary and regional collaboration: In the case of a pandemic, proper data and information sharing across the borders is crucial. Where there are lockdowns or travel restrictions , trans-boundary information sharing, collaboration and cooperation becomes essential for a smooth flow of the resources as well as stranded people. The same is equally important at a regional level.

7. Use of new and emerging technology: Breaking the digital divide would be the key to the future responses. As Utilization of new technologies such as drones, robotics, artificial intelligence, etc., should become wider as the gradual development of 5G system in several countries makes technologies more accessible and affordable to more communities.

8. Public-private-people collective partnerships: The private sector plays an important role in the response as well as recovery process, as a result, public-private-people partnerships become crucial to mounting a successful response. The private sector plays a crucial role in supply chain management during an epidemic or pandemic, while MSMEs need special attention in the recovery planning, since they are the often the hardest hit with least resilience.

9. Responsible media coverage and addressing fake news: In the age of social media, pandemics can become "*infodemics*" due to misinformation. Responsible media reporting can be very important in shaping the response phase and how people behave. Proper measures need to be taken to avoid the spread of fake news and enhance better risk communication.

10. Transparency in information sharing: While it is important to maintain the privacy of the affected people, countries need to transparently disclose the government's response plans, to gain the public's trust and drive voluntary participation. This also can enhance accountability in decision making. There also needs to be transparency and oversight in how governments can access and use personal information through big data analysis or CCTV footage, etc. and properly share information / results / decisions with the public in a timely manner.

5. Key sectors

A socio-economically connected society is vulnerable to the impacts of infectious-disease outbreaks. Factors like mortality and the total number of infected people are mostly a concern during the outbreak, but what lingers after an outbreak are the socio-economic hardships.

Advancements in science and technology have at one hand enabled the early detection of an outbreak and effective sharing of information to various parts of the world, but at the same time has amplified the spread risk of an outbreak from one region to the other.

Taking a cue from the past outbreaks, this section elaborates on which sectors can help in the mitigation a biological hazard, which sectors can increase transmission, and which sectors are commonly impacted. Based on these three factors, implications for development planning are suggested.

5.1 Sectors that help in mitigation

This section lists the various sectors which directly contribute in mitigating a health emergency.

5.1.1 Healthcare

A robust healthcare system is important to monitor, provide early warning, and share critical information on the pandemic. Ideally, the healthcare sector consists of both public and private organisations providing medical services, manufacturing of medical equipment or drugs, and providing health insurance and access to services for all people. Increasing the production of PPEs, research and development in vaccines and treating patients all contribute towards mitigating and containing a health emergency. The management of the dead bodies by involving the death care industry with the health sector can help cut down the risk of further spread of the infection. Of note, in many countries, due to constraints in the health care systems, health care during an emergency or crisis context is provided by informal sectors. Therefore, effective mobilization of care providers in the informal sector for response purposes can be a challenge[54].

5.1.2 Non-Governmental Organisations (NGOs)[55]

Non-profit organisations provide an essential backup to the healthcare sector and also supports governments by engaging in needs assessments, training, staffing, community outreach, and relief distribution. Further, NGOs become a bridge between communities and governments thus building trust and relationships and amplifying community voices. During the Ebola outbreak, NGOs were leveraged in the roll-out of response programs in the United States of America[56]. Similarly, during the Nipah virus outbreak in Kerala State of India, NGOs and community Based Organisations (CBOs) played an important role in community outreach and awareness raising.

[54] Chan, EYY, Gobat N et al. Health-Emergency and Disaster Management (Health-EDRM) Technical Brief Series: A review on implications of home care on biological hazard. The case of SARS-CoV-2/COVID 19. CCOUC Health-EDRM Technical Review Series No 7. May 2020.

[55] Non-governmental sector

[56] https://www.aub.edu.lb/k2p/Documents/K2P%20COVID_19%20Rapid%20Response%20Series_Strengthening%20the%20Role%20of%20Local%20and%20International%20NOGs%20in%20Pandemic%20Responses.pdf

5.1.3 Education

Higher education institutions (HEIs) can be especially resourceful in conducting research on various aspects linked to an outbreak and in increasing risk awareness. During the COVID-19 outbreak, the important role HEIs can provide in response to a health emergency. This has been highlighted by examples such as the role of Johns Hopkins University in developing an online dashboard documenting the spread of the infection or the role of students at the Indian Institute of Roorkee in developing low cost ventilators.

5.1.4 Information and telecommunication (IT)

The information and telecommunication sector is essential for maintaining effective communication locally and globally for people to stay informed and businesses connected. This sector has major ability to reach people on a wide-scale and at an individualized basis. This is critical to ensuring that accurate information reaches the public. Furthermore, as lockdowns have been used as an important non-pharmaceutical step in almost all past health emergencies, the IT sector is essential for supporting the surge in remote learning modalities, tele-medicine and medical advices, continuation of businesses from remote locations, and the powering of the e-commerce .

5.1.5 Banking and financial

The banking and financial sector is important for mitigating the economic impact of a pandemic due their ability to offer financial restructuring, provide loans, and maintain liquidity in markets. In an era of online and contactless transactions, this sector is of the utmost importance for the continuation of commerce and global economic stability[57].

5.1.6 Media and entertainment

The role of media (print, electronic and social) is important in risk communication and community outreach. Media coverage during the H1N1 epidemic in 2009 was found to have a mitigating effect on transmission by promoting social distancing and self-isolation[58]. The media is also an important vehicle for governments to communicate with the public and can also serve as a voice of the people to provide feedback to the government. Further, the media plays an important role in connecting communities to global events and learning from them.

5.1.7 Public utility and other essential services

Public and essential services are the backbone of modern life, for their role in providing critical services (health, water and sanitation, industry etc.). During a health emergency, the maintenance of power and water supplies, along with waste management and disposal services, become important parts of the emergency response. Further, guidelines on health and hygiene are important to stem the spread of vector borne diseases. Moreover, maintaining law and order through policing and other public services can have a direct role in mitigating a health emergency

[57] https://www.nap.edu/read/21855/chapter/10
[58] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3958770/pdf/CMMM2014-680743.pdf

by enforcing containment measures. In addition, a functioning judiciary helps in safeguarding human rights.

5.1.8 Transportation

The transportation sector is crucial for connecting people to the healthcare sector, supply necessary medicine and goods, and to keep other sectors operational by maintaining supply chains. Further, as seen in many countries during the COVID-19 pandemic, train compartments and ships can double as mobile hospitals and buses can be made into mobile testing centers. In certain countries the informal transportation sector is a community lifeline for essential commuting[59].

5.2 Sectors that exacerbate transmission of infectious diseases

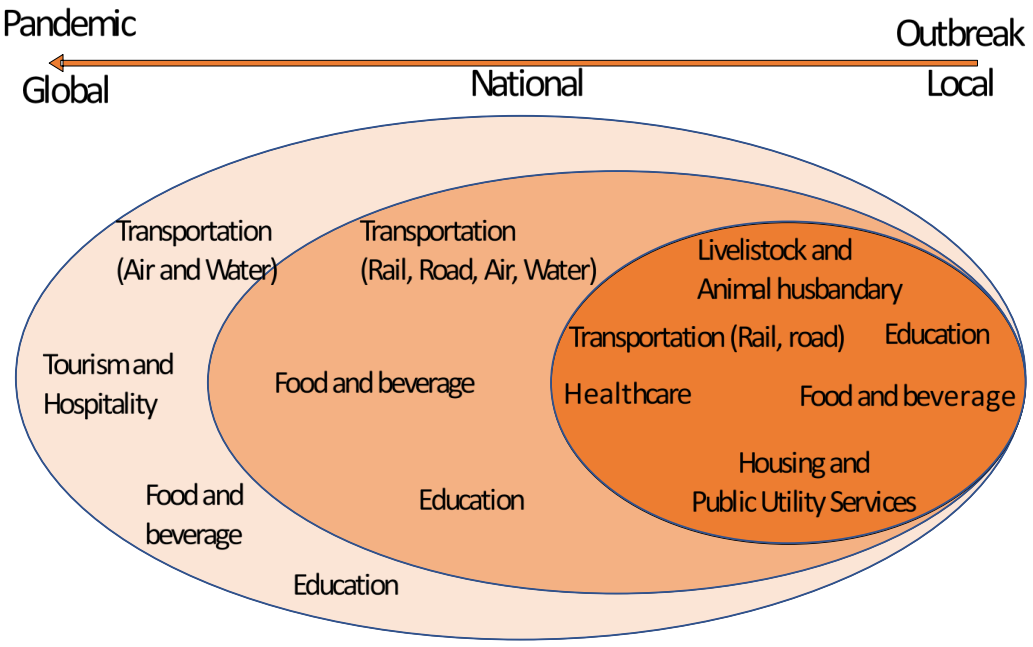

Figure 20: The sphere of transmission of infectious diseases based on sectors

This section points at sectors which can contribute to the possible transmission of an infectious disease or a biological hazard beyond its initial impact zone. The transmission can be categorized broadly as local within a country or international as a result of international travel. A sectoral transmission may happen among workers in a sector due to the nature of their work (Figure 20).

5.2.1 Transportation

Air, water and land transport play an important role as a local and global connector of people and goods. Advances in the transportation sector have enabled pathogens and vectors to travel

[59] https://nextcity.org/daily/entry/even-during-a-lockdown-public-transport-can-be-a-lifeline

faster to distant locations thus putting higher proportions of the population at risk[60]. While local transmission can be attributed to domestic travel and transportation, international transmission can be attributed to mostly to the shipping and aviation industries. In some cases, also to road and rail transport if it crosses borders. Cities which serve as travel hubs can become centers for the distribution of the disease Airport malaria is a classic example of how a disease can spread without the carrier being exposed to the natural habitat of the vector[61].

5.2.2 Tourism and hospitality

The tourism and hospitality sectors can also become sources of transmission because of the volume of travel they support. For example, during the SARS outbreak, a health professional from Guangdong spent a night in a hotel in Hong Kong, which was enough to transmit the SARS infection to 16 other guests who in turn spread it to Toronto, Singapore and Vietnam (ibid). Similarly, in the COVID-19 pandemic, the initial cases that were reported in Japan and other Asian countries were as a result of tourists travelling from Wuhan, the epicenter of the outbreak. Organizing large sports and cultural events, that attract domestic and international tourists, during a pandemic may also help spread an infection.

5.2.3 Education

The education sector can become transmitter of a disease due the large number of students. Locally, schools and universities are possible hotspots of an outbreak, according to past outbreaks due to the higher rate of infections among young people, especially for influenza outbreaks. The higher education institutes are especially vulnerable to outbreaks due to the large number of international students and faculties. Also, as universities conduct research on biological hazards, specimens can caused new infections, as was the case with Swine flu, where a number of cases were reported to have been transmitted from laboratory specimens and samples.

5.2.4 Livestock and animal husbandry

Animals sometimes carry harmful viruses, bacterial, parasites, and fungi that can spread to people and cause illness (zoonotic diseases or zoonoses). The SARS, Avian flu, MERS and COVID-19 outbreaks are all zoonotic in nature. People who are engaged with various animal breeding, livestock rearing, or people who are involved in selling pets or sell meat are all at high risk of transmitting a disease locally. On the other hand, processed food can become a source of spreading an infection both locally and globally.

5.2.5 Healthcare

The people who are engaged in the healthcare sector have high exposure to the pathogen and, hence, are potent local transmitters themselves. In the case of the COVID-19 pandemic, many healthcare professionals became infected due to direct exposure to patients. Further, the risk of

[60]https://reader.elsevier.com/reader/sd/pii/S0065308X0562009X?token=127A4D542E8119534C096C21FADBCAB2EC43A3336808C4F5C1E201EAD47855D97C4E7F1CAB19704FCEC3C77486B6622B

[61] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2491318/pdf/bullwho00064-0132.pdf

transmission is high among their family members and co-workers. The contamination of hospitals and equipment can also lead to higher transmission in the healthcare sector. In many countries there is high reliance on informal/traditional healthcare, and local practitioners. Such a dependency without proper training and monitoring has the potential of unintentionally promoting harmful practices that increase the spread of an infection. Women who serve as informal healthcare providers within community and family units may also become exposed at higher rates. It is essential to provide informal care providers with training, knowledge, information and resources (e.g. face masks) to protect them and disrupt infection transmission.

5.2.6 Housing and public utility services

The housing sector and public utility services, like water and solid waste management, can help mitigate but may also become an important source of transmission. The SARS outbreak in Hong Kong pointed at building maintenance, inadequate plumbing and sewage systems as causes of the spread of the infection to residential areas[62]. Further, water borne diseases like cholera, arsenic contamination and other forms of bioterrorism can be transmitted easily to large populations by contaminating public utility services. Informal settlements also pose a serious challenge for containing a health emergency due to the high population density, lack of essential services, and other socio-economic factors[63].

5.3 Sectors impacted

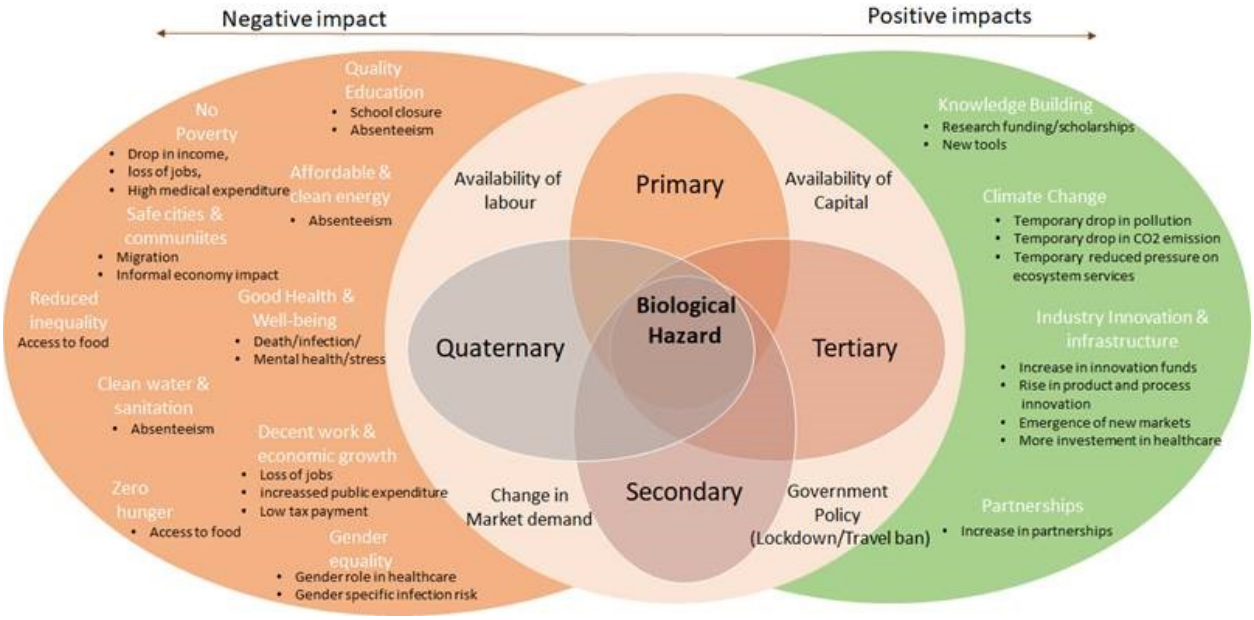

Figure 21. Sectoral impact of a biological hazard

[62] https://www.who.int/mediacentre/news/releases/2003/pr70/en/
[63] https://unhabitat.org/sites/default/files/2020/04/final_un-habitat_covid-19_response_plan.pdf

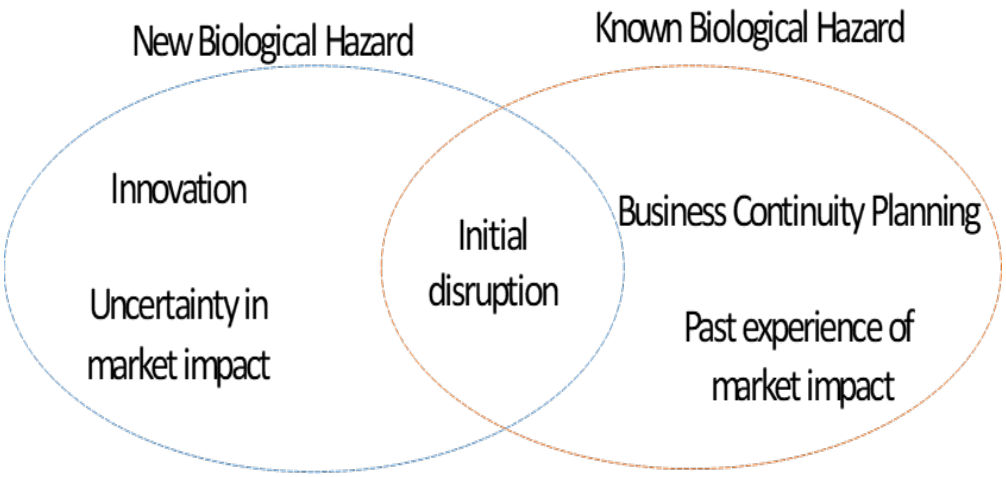

Figure 22. Sectoral approaches for new and known biological hazard

A biological hazard can impact various sectors differently, as shown in Figure 21. Further the impact and response by the sector would also vary based on the characteristics of the biological hazard. The immediate impacts of a biological hazard on the Primary, Secondary, Tertiary and Quaternary sectors of the economy, as defined by the 'three-sector model' in economics, and its long-term positive and negative impact on the SDGs is shown in Figure 22.

5.3.1 Impact on the primary sector

The impact on the primary sectors, like ***agriculture, livestock and mining,*** will depend on the geographic location, seasonality and on the nature of the outbreak. for example, the Ebola outbreak in Africa resulted in a moderate impact on the agriculture and mining industries. The agriculture labour force is mostly seasonal and in many countries the onset of planting and harvest seasons can lead to reverse migration from the urban to rural areas. Restricted travel and lockdowns imposed by governments become an impediment for such daily waged laborers who are engaged in the agriculture industry. In addition, the supply chain connecting agriculture products to markets or other dependent industries can also be hampered. It is also important to understand other dynamic risks agriculture industry may face during an outbreak. For example, a pest attack or an extreme weather event may compound the impact on the agriculture industry thus putting the food security of millions at risk.

Zoonotic virus borne outbreaks are more likely to impact the livestock industry. For example, the swine flu outbreak led to a fall in pork consumption in Mexico and the culling of pigs in Egypt. Similar events were noticed during avian flu which lead to the culling of poultry in various parts of the world.

The Mining Contribution Index (MCI) of 2018 shows that low to middle-income economies are largely dependent on the mineral sector. Hence an outbreak impacting such economies are more likely to impact the mining sector due to absenteeism as a result of governmental imposed lockdowns or due to self-quarantine by the workforce, restriction in transportation, halting of equipment production, and the shutting down of domestic and international markets.

5.3.2 Impact on the secondary sector

Secondary sectors, similar to the primary sectors, would be impacted based on the geographic location, seasonality and on the nature of the outbreak. The manufacturing sector may be hit by absenteeism, lack of transportation, raw material and equipment shortages or service disruptions. The COVID19 pandemic caused the garment industry in Bangladesh, Cambodia, India, Vietnam and other Asian countries to face labour shortages, resource limitations, lack of demand and compulsory closures[64].

The secondary sector has a high dependency on critical infrastructure for their operations. In a likely scenario of a multi-hazard event, the disruption in critical infrastructure may severely cripple the manufacturing sector. Further, the very nature of the industry and its scale would be important parameters for the impact and continuation of the individual businesses in the aftermath of an outbreak. In Sierra Leone, the Ebola outbreak impacted various manufacturing units *(*soap making, bakery, carpentry, manufacturing of food product among others) as well as the energy industry. Further, electricity, gas, air conditioning, and the supply of alternate energy sources like hydro, sun and wind, thermal plants, were all affected[65] . Government restrictions and risk aversion behaviour by the public can also lead to lower demand for locally produced goods. But on the other hand, pharmaceutical companies and companies involved in the production of PPEs and other essential goods stand a high chance of gaining business from the sudden rise in demand for their products.

5.3.3 Impact on the tertiary/ service sector

Cases of past outbreaks point towards a significant impact on the service sector. In all outbreaks, the healthcare industry has borne the maximum hardship. The ***healthcare sector*** in developed, developing and least developed countries face a serious challenge in making sufficient investments in increasing their workforce, equipment, and other resources, to ensure operational readiness. During a pandemic, hospitals often see a decrease in visits by normal patients thus straining their regular cash flow. At the same time, as medical resources are diverted for management of the pandemic, the provision of medical care and services for other patients tends to get compromised too.

A major fallout of outbreak or a pandemic are the travel advisories which impact the transportation, tourism and hospitality industries. This was experienced in case of MERS, as national governments announced individual travel advisories. These advisories have a profound cascading effect on the ***aviation industry*** and linked industries including the entertainment industry and taxi services. Further, imposing lockdown can lead to local restaurants and entrainment venues losing business. Many of these small businesses are family run and employ large numbers of people, hence their closure leads to stress on household incomes.

[64] https://www.ilo.org/wcmsp5/groups/public/---asia/---ro bangkok/documents/briefingnote/wcms_741642.pdf
[65] https://sierraleone.unfpa.org/sites/default/files/pub-pdf/EVD%20report.pdf

The ***media*** is another important service industry which is critical for risk communication in case of an outbreak. The impact on media, culture and entrainment houses can be direct due to a halt in movie production and the closure of theatres, and indirect due to imposition of restrictions on media reporting. Singapore is a case in point for curbing the media reporting to stop 'fake news' while New Zealand came up a relief package to bail out electronic media. In African countries where the media's reach and internet access are limited, engaging in community awareness programs maybe a more workable solution[66].

Another critical aspect that the current pandemic has highlighted is the need to support the continuation of businesses involved in the manufacturing and supply of essential products and services. Many of these businesses engage contractual workers and daily wagers who have no alternate income sources, thus exposing them to issues of food insecurity of food and poverty. Similarly, lockdowns and closures disrupt cash flow for micro and small businesses (include street vendors) who may become unable to run their businesses and households.

With an increased dependence on online and virtual platforms for operating businesses, delivery of essential services, financial transactions, etc., cases of online scams also rise. Various governments like that of the Republic of Korea have worked to enhance scam alert systems in cooperation with major telecommunications service providers. This underscores the need for enhanced considerations for cyber security in policies and contingency plans that call for enhanced virtual operations.

5.3.4 Impact on the quaternary sector

The ***education sector*** has been found to be one the most frequently impacted service sectors. The main reason being the closure of schools and absenteeism of teachers. The propensity of children to become infected with particular virus infections has led to the closure of schools in the past. This disturbs the academic calendar and adds stress to parents and students alike. The education sector has embraced online tools, redefining how learning takes place by opening up the traditional classroom. The effectiveness of online education in student learning and its impact on care providers' regular responsibilities (e.g. work duties and care responsibilities) should not be neglected. Issues of undernutrition in low income groups in developing countries and obesity globally, not only put the children at high risk of infection but also may expose them to long-term developmental, psychological, physical, and emotional complications[67]. A pandemic may expose children to higher risks of abuse, neglect, and other issues around child protection[68]. On the other hand, a biological hazard may often be an opportunity for higher education institutes, research organization to engage in developing new tools, further research and innovation and find new funding opportunities.

[66] https://www.itu.int/en/mediacentre/Pages/2019-PR19.aspx
[67] https://www.nejm.org/doi/full/10.1056/NEJMp2005638
[68]https://www.unicef.org/media/65991/file/Technical%20note:%20Protection%20of%20children%20during%20the%20coronavirus%20disease%202019%20(COVID-19)%20pandemic.pdf

A biological hazard may also disrupt the functioning of public utility services due to the loss of workforces due to migration or absenteeism. This in turn can impact the functioning of the other sectors that are dependent on essential services like electricity, water and gas.

Table 5: Sectoral impacts on different sector based on past health emergencies

	Economy type and corresponding impacts		
Sectors	**Developed Country**	**Developing Country**	**LDCs**
Manufacturing	Low	Moderate	High
Retail	High	High	Low
Mining	Low	Moderate	High
Public utility services	High	High	Moderate
Education (Resarch and development)	Low	Low	Low
Education (school education)	High	High	High
Transportation	High	High	High
Tourism	High	High	High
Livestock	Low	Moderate	High
Livelihood	High	High	High
Health care	Moderate	High	High
Hospitality	High	High	High
Food and Bevarage	High	High	High
Energy and CI	Moderate	Moderate	High
Primary (Overall)	Low	Moderate	High
Secondary (Overall)	Moderate	Moderate	High
Tertiary (overall)	High	High	High
Quarternary Sector (Overall)	Low	Moderate	Moderate

6. Cross cutting issues

6.1 Human rights violation, domestic violence

Adherence to human rights is key for effective response to a health emergency while protecting lives and livelihoods. A major fallout of the extensive lockdowns to flatten the pandemic curve has been their impact on other human rights like education, access to healthcare, security, and livelihood, among others[69]. The COVID-19 pandemic has been accompanied by an increase in cases of domestic violence and abuse due to restricted mobility and confinement. Violence against women can result in injuries, physical, mental, sexual and reproductive health problems. Further, chances of sexually transmitted infections like HIV may increase[70] leading to the risk of a cascading health emergency. A biological hazard may become an excuse to deny or curtail humanitarian access to education, healthcare and other basic needs for vulnerable and marginalized populations (Internally Displaced Population (IDPs), prisoners, prisoners of war (POWs), and refugees living in transit camps, among others[71].

6.2 Age, gender and disability

Pandemics and outbreaks are not age and gender neutral and are important factors to understand the impact of a health emergency. The Spanish flu and swine flu epidemics had a 'W shaped' age curve with high infection rates among infants, youth and senior citizens while the SARS had the highest infection rate among the age group of 20-49 years. Both had a higher impact

[69] https://www.un.org/victimsofterrorism/sites/www.un.org.victimsofterrorism/files/un_-_human_rights_and_covid_april_2020.pdf
[70] https://apps.who.int/iris/bitstream/handle/10665/331699/WHO-SRH-20.04-eng.pdf
[71] https://reliefweb.int/sites/reliefweb.int/files/resources/icrc_ihl_rules_on_humanitarian_access_and_covid-19_april_2020.pdf

on working age adults, thus leading to economic risks. While the Zika virus outbreak is a glaring example of a hazard that had higher risks for pregnant women. In contrast, the MERS outbreak has affected mainly males. Further, the socio-cultural roles based on gender play an important role in an outbreak. The Ebola outbreak in West Africa put women at higher risk of exposure due to their societal role as care givers[72]. A health emergency may lead to an increase in gender-based violence and abuse of children (sexual exploitation of children, online abuse/harassment and forced early marriage)[10]. Further, gender an important factor in effective communication, and existing power and societal inequalities can widen in such circumstances. Persons with disabilities face higher risks due to limited access to health information an the lack of proper guidelines and protocols that address their needs[73].

6.3 Disruption in public events and impact in socio-cultural identity

Suspension of public events and restricted access to religious institutions and other socio-cultural events which mark the identity and belief systems of people may significantly contribute to the spreading or the mitigation of an outbreak. In many countries, social and religious congregations have been identified as possible hotspots of transmission leading to curbs. Further, due to the high contagious nature of outbreaks, funeral ceremonies for victims of the outbreak have been mostly devoid of immediate family members, which would compound the psychological stress of a health emergency. Further, the cancellation of sporting events could have severe economic and cultural impacts.

6.4 Impact on disaster response, preparedness and recovery

A public health emergency may have serious cascading effects for disaster management. An outbreak could burden the disaster management system with the additional tasks of incorporating and managing emergency evacuations, providing shelter, relief distribution, and distribution of medical aid, which could hamper their ability to effectively respond to a natural hazards event at the local, national or regional level. Further, a health emergency would hamper training and capacity building exercises, which impacts preparedness. In addition, disaster recovery programs may last for an extended time period which could result in possible funding shortfalls.

6.5 Supply chain

A resilient supply chain is an important component for keeping economic sectors operational during an outbreak. The continuation of supply chains is linked to various factors like the availability of raw materials, transportation, government policies and human resources. At the community level, external supply chains can be responsible for providing basic provisions and services like food, water and electricity. For both upstream and downstream supply chains, understanding the direct and indirect links of various supply chains to the global economy is of

[72] https://unidir.org/commentary/pandemics-are-not-gender-neutral-gender-analysis-can-improve-response-disease-outbreaks

[73] https://www.ohchr.org/Documents/Issues/Disability/COVID-19_and_The_Rights_of_Persons_with_Disabilities.pdf

the utmost importance to build their resilience. The response to 2009 swine flu outbreak highlighted a gap in the projected supply and demand for N95 respirators and facemasks due to uncertainty of the pandemic and the complexity of the supply chain system[74]. In the backdrop of an outbreak, the market's production ability and aggregated surge capacity data are often not readily available to governments, which becomes an impediment for accurate estimates.

6.6 Human resources and mental health

The availability of human resources is important to continue various essential functions in society. For example, the functioning of the primary and secondary sectors depends on the physical presence of the workforce. In past health emergencies, the high rates of worker absenteeism, either self-imposed or imposed by the government, have had a negative impact on the economy. In the health care industry, a health emergency suddenly increases the need for extra staff. Such a surge without mobility restrictions can be met by pulling in human resources from other locations, but in case of pandemics where a majority of countries are impacted, the staffing surge has to come from the local population. The Nipah virus response in Kerala aided the COVID-19 response due to availability of trained human resources is a point in case. In case of severe contagion with high mortality rates, the replaceability of frontline workers becomes a challenge. Further, losses of income, uncertainty of livelihoods, increases in cost of living, social distancing, and fear of exposure, may also impact the mental health of frontline staff.

6.7 Migration

Human networks and disease transmission are directly linked[75]. However, migration during an outbreak may be stopped through the implementation of stringent laws. In the aftermath of an outbreak, migration from the affected areas to more favourable economic areas is a common adaptation strategy by the affected community. Such movements can be a short distance or may be overseas, which risks spreading the disease to new geographic locations[76]. The 'immigrant health paradox'[77,78] is a counter argument that lists the benefits such a migration would bring to the host population. Notwithstanding, migration may become a serious challenge for local authorities which need to provide housing, essential services and maintain food security, especially in the urban centers. The rural to urban migration also undermines the shift of the workforce from primary to secondary or tertiary sectors, thus straining agriculture production, mining and the supply of raw materials.

[74] https://www.liebertpub.com/doi/10.1089/hs.2016.0129

[75] Fan C. et al. (2020) The Relationship between the Migrant Population's Migration Network and the Risk of COVID-19 Transmission in China—Empirical Analysis and Prediction in Prefecture-Level Cities

[76] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6247124/

[77] 'Immigrant health paradox' is an established theory for immigrant receiving countries. It is theorized that post adjusting with the socioeconomic status, the immigrants generally have lower mortality than the native born, however this initial advantage disappears with increasing time in the receiving country and across generations. This finding is paradoxical because, over time and across generations, the economic conditions of immigrants generally improve and acculturation stress reduces; hence this will lead to a positive trend in health with lower mortality risk over time (Luthra, 2018).

[78] https://www.migrationpolicy.org/article/when-outbreaks-go-global-migration-and-public-health-time-zika

6.8 Livelihood and Social Security

Biological emergencies and outbreaks need to be seen as a mix of health, social security and developmental challenges. Similar to a war, an outbreak can have a long-term impact on food security (access, availability), mental and physical wellbeing, and on livelihoods. Hence, the a whole-of-society approach needs to be imbibed when responding to and planning for recovery from a health emergency. Specifically, the livelihoods of both formal and informal workers maybe affected to different levels. In the formal sector, pay cuts and layoffs become common following an outbreak, while in the informal sector, access to work can become uncertain and hence also impact food security and wellbeing, pushing marginalized populations into poverty. The rise in public debt, inability to settle loans, reduction in tax payments, slow growth, low inflation and a reduced access to capital for investment can become common issues across all the sectors (IMF, 2020).

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