

SG89/8

*Original: English***WORLD ORGANISATION FOR ANIMAL HEALTH, VETERINARY SERVICES AND AQUATIC ANIMAL HEALTH SERVICES ENGAGEMENT IN GLOBAL, REGIONAL AND NATIONAL EMERGENCY MANAGEMENT SYSTEMS****Matthew Stone¹, Daniel Donachie², Chadia Wannous², Keith Hamilton²**¹ SPADE Solutions Ltd, Wellington, New Zealand² World Organisation for Animal Health, Paris, France

Executive Summary : *Avian influenza, Ebola, African swine fever and COVID-19 epizootics, epidemics and pandemics in recent years have highlighted infectious diseases emergencies affecting public health and animal health. Emergencies from adverse weather events are expected to increase in frequency and severity driven by climate change.*

A wide variety of other hazards, natural and man-made, have demonstrated their potential to evoke emergencies with impacts that require a coordinated One Health approach. Veterinary Services and Aquatic Animal Health Services have an important role to play in prevention, preparedness, response and recovery for these events, working with One Health partners, the Security Sector and Emergency Services, and this works best when coordinated through a National Emergency Management System. Emergency management uses specific disciplines and is increasingly organised in national, regional and global systems that the World Organisation for Animal Health (OIE) and its Members must become expert in and integrated into.

This paper describes the current global context and systems for emergency management, identifies and characterises threats, describes planning approaches and tools, discusses the range of objectives that must be balanced, and introduces the emergency management disciplines. OIE's expanding programmes and services to Members to develop emergency management capacities are summarised, with conclusions drawn that will shape future directions.

1. Introduction: the global context

In 2020 the OIE published volume 39(2) of the Scientific and Technical Review dedicated to Disaster Prevention and Preparedness (1). The OIE also dedicated a 2020 issue of Panorama to its rapidly developing and expanding work programme on Emergency Management (2). Those actions were prescient given the subsequent global crises that unfolded soon after these works were planned and initiated, with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) crossing over from an animal host creating a pandemic that has claimed over 6 million human lives and tested international and national crisis management systems. The OIE and Member Veterinary Authorities and Veterinary Services have played a key role in these systems.

The COVID-19 pandemic is not the only crisis demanding action from national emergency management systems. Storms, floods, volcanoes, wildfires, oil spills, shipwrecks, nuclear accidents, conflicts, as well as epizootic infectious diseases like avian influenza, African swine fever, Rift Valley fever, to name a few: the list of recent international and national emergencies is lengthy and diverse. For events driven by weather and climate, the International Panel on Climate Change Sixth Assessment Report predicts such emergencies will increase in frequency and intensity (3). Complex emergencies involve the occurrence of several interdependent emergencies at the same time, as often arises with man-made emergencies such as industrial accidents, transport accidents, environmental degradation, pollution, and conflicts.

The OIE Terrestrial and Aquatic Animal Health Codes (OIE Terrestrial Code and OIE Aquatic Code, respectively) do not yet provide a definition for “emergency”. A dictionary definition is “a serious, unexpected, and often dangerous situation requiring immediate action”. With reference to the United Nations Office for Disaster Risk Reduction, the introduction to Sci Tech Rev 39(2) noted that “a disaster is a serious disruption of the functioning of a community or a society, involving widespread human, material, economic or environmental losses and impacts, which exceeds the internally resourced coping ability of the affected community or society”. The OIE Codes do contain some important expectations regarding the role of Veterinary Services in emergencies, in particular with respect to contingency planning – the OIE Aquatic Code even has a chapter dedicated to this topic (4).

Emergency management is now a well-established discipline, demanding engagement from Veterinary Authorities, Veterinary Services, Aquatic Animal Health Services and Wildlife Authorities in the context of animal health, animal welfare and veterinary public health. International and national systems for emergency management need the engagement of the OIE and its Members, but this has tended to focus on infectious disease hazards rather than more broadly on risks to animal health, animal welfare and veterinary public health. This paper intends to provide a summary of emergency management disciplines as they relate to this broader understanding of risk, including the contribution of Veterinary Services and Aquatic Animal Health Services in complex emergencies; to update OIE Members and Partners on OIE’s activities within its own emergency management work programme and Partner activities we are linked to; and to build from the experience of OIE, Members and Partners during the response to the pandemic to ensure Veterinary Services and Aquatic Animal Health Services are proactively contributing to improved preparedness and response to emergencies.

1.1. SARS-CoV-2, pandemics and emerging zoonotic diseases

The combined health, animal, environmental, social and economic impacts from the SARS-CoV-2, or COVID-19, pandemic and national and international attempts to deploy mitigations has been dire and unprecedented in modern history. Even though the full impact is yet to be comprehensively understood and quantified, we can start to evaluate the impacts of SARS-CoV-2 and other emerging diseases that have resulted in epidemics in terms of both human morbidity and mortality, and the benefit:cost relationship between investment in prevention and crisis management approaches (5 & 6). The events since early 2020 were preceded by growing concerns regarding zoonotic disease emergence and the need for international and national crisis management systems to focus on these threats, highlighting the often-repeated error of failing to act on the outputs of risk assessments and early warning systems.

The international response to the SARS-CoV-2 pandemic has consolidated the understanding of and support for the multi-disciplinary One Health approach, cultivated through many years of Tripartite collaboration, and implementation of national Multi-Sectoral One Health Coordination Mechanisms and Platforms (7). Veterinary Services have been integrated into international and national crisis management responses during the global response. This has ranged from the OIE supporting the World Health Organization (WHO) in shaping the research agenda and investigating the origin; OIE and its Members ramping up emerging disease notification systems to provide the comprehensive and definitive source of information on animal infections with SARS-CoV-2; expert advice on risks to health and in trade of animals and animal products; Tripartite collaboration on risk assessments for SARS-CoV-2 and the global fur industry; through to maintaining essential national Veterinary Services in support of food chains, re-purposing of national veterinary laboratory systems to support public health diagnostic testing, and participating in border risk management systems. However, despite this progress in applying the One Health approach to infectious disease threats, we should recognise that at national level there are significant gaps in the integration of Veterinary Services as full partners in cross-governmental disaster management frameworks (8), and some moves that appear to integrate the animal health sector into national or international mechanisms remain superficial and untested.

Emerging zoonotic pandemic and epidemic diseases have also become a preoccupation within the environmental sector. The issue was highlighted within the United Nations Environment Programme (UNEP) Frontiers 2016 report (9) which noted that environmental health initiatives have been less well represented in global zoonoses control programmes, despite the promise of One Health and EcoHealth initiatives. Early in the 2020 SARS-CoV-2 pandemic, a UNEP and International Livestock Research Institute (ILRI) report explored root causes of the emergence and spread of the novel coronavirus and other zoonotic diseases, providing a set of recommendations for policy makers to help prevent and respond to future disease outbreaks by focusing on factors driving disease emergence (10).

1.2. Animal Health and Food Security crises

a) African swine fever in Europe, Asia and the Caribbean

Since the 2007 introduction of African swine fever (ASF) into continental Europe, and with the subsequent spread across Europe, Asia and more recently into the Caribbean, there has been increasing political understanding of the wide-ranging impacts on national food security, economy and trade, as well as the direct effects of the disease and these macro-economic impacts on livelihoods of people working in animal production industries. ASF is not a zoonosis, and its direct impacts on morbidity, mortality and production are confined to suidae. Nonetheless, the disease's broader impacts across economies and societies creates an interesting case study in One Health impacts from non-zoonotic animal disease, including a hypothesis that changes in pork price and availability in China during 2019 led to increases in alternative meat consumption, including from wildlife, which greatly increased opportunity for human-sarbecovirus contacts (11). Despite repeated warnings about the potential risk from ASF, too often countries and industries failed to act on intelligence and risk assessments resulting in action not being taken in a timely manner.

National emergency response mechanisms to ASF have required a range of risk mitigation measures that demand cooperation between Veterinary Authorities, national political leadership, and in some cases law enforcement, military and other civil authorities, to be effective in controlling disease and spread. This has been exacerbated by the absence of approved and efficacious vaccines, or in some cases the intentional subversion of research and regulatory processes for vaccine development and approval (12). Depopulation of infected farms and of managed and wildlife populations in infected zones, as well as associated surveillance and movement control, are difficult and expensive measures, requiring decisive action and strategic collaboration between politicians, government authorities and industry partners. Despite these challenges success has been demonstrated in some countries (13). While it is difficult to clearly understand the relationship between the evolution of outbreaks in relation to national emergency management systems, and there are many factors that can influence ASF outbreaks, it seems fair to conclude that OIE Members with national systems integrating Veterinary Authorities into crisis and emergency management have overall been better positioned to quickly take action to control disease.

b) Avian influenza

Since the emergence of the H5Nx goose/Guangdong virus lineage in 1996, its subsequent and ongoing evolution associated with now seasonally regular epidemic waves involving the H5Nx clade 2.3.4.4b, including the most recent 2021/22 Northern Hemisphere winter, we have observed one of the largest highly pathogenic avian influenza epidemics documented in history affecting many parts of the world (14). OIE Members around the world have been implementing their avian influenza contingency plans and mobilising resources across government and the private sector to respond. The disease is a serious threat to food security, livelihoods, and economies with important implications for public health given its zoonotic nature, making it a priority for the Tripartite. Avian influenza viruses circulate in wild birds and while there is little that can be done to control the disease in its wildlife source, Veterinary Services have been promoting the importance of strict biosecurity to avoid the direct and indirect contact between wild birds and domestic poultry. Infections of avian influenza virus in humans who have had close contact to poultry have been reported. The importance of animal-source influenza viruses with respect to both the risks of seasonal and pandemic human influenza viruses emphasises the need for strong collaboration between Veterinary Services and Public Health Services, with the OIE and FAO Network of Expertise on Animal Influenza (OFFLU) (15) and its collaboration in WHO Vaccine Strain Selection processes exemplifying the One Health approach to preparedness and response to zoonotic infectious diseases.

1.3. Climate Crisis: Projections on impacts for storms, flooding, heatwaves, droughts and infectious diseases

The International Panel on Climate Change (IPCC) Special Report: Global Warming of 1.5°C (widely recognised as an increasingly difficult threshold to remain within) predicts hot extremes in most inhabited regions, heavy precipitation in some regions, and the probability of drought and precipitation deficits in some regions (16). More recently, the IPCC Sixth Assessment Report *Climate Change 2022:*

Impacts, Adaptation and Vulnerability notes that more frequent and intense extreme weather events are causing widespread and, in some cases, irreversible adverse impacts. The report concludes approximately 3.3-3.6 billion people live in contexts that are highly vulnerable to climate change, as are a high proportion of species with human and ecosystem vulnerability interdependent (3). In short, adverse weather events such as storms, flooding, heatwaves and droughts will become more frequent, and probably more intense. While the tragedies of human loss of life, injury and displacements tend to lead headlines during such events, there are many direct and indirect impacts on food systems, animal health and welfare, and biodiversity. As a result, Veterinary Services and Aquatic Animal Health Services should be integrated into national emergency management system planning for adverse weather events.

Bangladesh is one of the countries most vulnerable to climate catastrophes, with intense and frequent flooding, heavy rainfall, tidal surges and resulting water-table salinity impacting crop production. Most coastal cities in Bangladesh are at an average elevation of 1.2-1.5 metres above sea level, and 10% of the country is below 1m above sea level. Climate variability is driven by El Nino and La Nina events every 2-7 years, with additional drivers from the South Asian Monsoon and Indian Ocean Dipole (17). Livestock are both raised for food and used as traction for cropping operations, and death and injury of livestock during adverse weather events compounds recovery challenges after adverse events. Further, COVID-19 hit Bangladesh's agriculture sector hard. Livestock accounts for 1.7% of Bangladesh's GDP but employs 14% of the country's labour force and accounts for one-third of total agricultural employment. Most rural households are engaged in livestock production, with nearly six million people – 40% women – employed directly or indirectly in the poultry sector. As an indication of the importance of this issue, during 2020 the Bangladesh Ministry of Fisheries and Livestock and the World Bank activated a \$96 million emergency response fund to protect livelihoods of the most vulnerable families that operate in the livestock sector. The emergency funds will finance disaster relief and post-disaster emergency recovery expenditures (18).

The pastoralist systems of the Sahel region of Africa are critical to food security and livelihoods of many people. The OIE has partnered with Members in the region and the World Bank through the Sahel Regional Project Supporting Pastoralism (PRAPPS), including through supporting activities in the Peste de Petit Ruminant Global Eradication Programme (PPR GEP) (19). Three consecutive years of prolonged and severe droughts and floods are combining with political and social instability, to which COVID-19 is also contributing, to create a food security crisis in many countries in the region, resulting in massive population displacements (20). These events threaten strategic and operational objectives of PRAPPS and PPR GEP.

The African Risk Capacity Group (ARC) is a specialised agency of the African Union that was created to assist governments to improve their capacities to plan, prepare and respond to extreme weather events and natural disasters. ARC's mission is to use modern finance mechanisms, such as risk pooling and risk transfer, to create pan-African climate response systems that enable African countries to meet the needs of people vulnerable to natural disasters. ARC uses advanced satellite weather surveillance and modelling software to estimate the level of damage from a disaster, triggering the release of funds to African countries to enable response. Since the 2014-16 West African Ebola crisis, ARC developed its Outbreaks and Epidemics programme, which comprises of in-country capacity building work on epidemic preparedness, contingency planning for timely and effective response to outbreaks, outbreak modelling to compute risk analytics from realistically simulated outbreaks events, and a risk transfer parametric product that will cover early response costs of an outbreak. In the case of an outbreak of a specific pre-agreed size, the programme will provide pay-outs to the affected country. The ARC Outbreaks and Epidemics programme currently focuses on four diseases, three of which are zoonotic: Ebola virus disease, Marburg virus disease, and Lassa fever (the fourth focus is meningococcal meningitis) (21).

Climate-induced changes to the epidemiology of vector-borne zoonotic diseases such as Rift Valley fever (RVF), Japanese encephalitis and West Nile fever are recognised by OIE and partners, resulting in these diseases being prioritized for early warning surveillance, monitoring and preparedness (22 & 23). All three are listed by the OIE, triggering obligations by OIE Members to notify outbreaks. Early detection and reporting of RVF in animals is particularly important in informing preventative public health measures. However, many OIE Members only notify their status in six-monthly reports. While this proves useful to illustrate the longer-term trends of expanding distribution or changing frequency

of outbreaks, to a large extent six-monthly reporting nullifies the value of animal-based surveillance as early warning systems for public health, a key attribute that provides a compelling investment case.

1.4. International systems for readiness monitoring, early warning and rapid response

a) UN Sendai Framework for Disaster Risk Reduction and UN emergency coordination mechanisms

In 2015 the United Nations Office for Disaster Risk Reduction (UNDRR) published the Sendai Framework for Disaster Risk Reduction 2015-2030, after its adoption at the Third UN World Conference on Disaster Risk Reduction. The Sendai Framework establishes goals and targets across four priority areas: 1) understanding disaster risk; 2) strengthening disaster risk governance; 3) investing in disaster risk reduction for resilience; and 4) enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction. Each priority is broken down into activities at the national and local level, and at global and regional levels. These activities include specific mention of strengthening protection of productive assets including livestock and working animals, including collaboration and capacity building towards this goal, and development of inclusive policies to maintain food security in the post-disaster phase. More generally, the Sendai Framework establishes important principles and priorities for multi-hazard and multi-sectoral planning, establishing early warning systems, the development and dissemination of instruments such as standards, codes and operational guides, and capacity development through training and exercising. All this can readily be appreciated as inclusive of threats to animal health and welfare requiring the engagement and integration of Veterinary Services into local, national, regional and global systems (24). The UNDRR is the United Nations focal point for disaster risk reduction and oversees implementation of the Sendai Framework.

The United Nations Office for the Coordination of Humanitarian Affairs (OCHA), through the Inter-Agency Standing Committee (IASC), coordinates the UN system response to emergencies, ensuring the engagement of the various UN agencies including technical agencies such as FAO and WHO. The United Nations Disaster Assessment and Coordination (UNDAC), also sitting within OCHA, has a mandate for assessment, coordination and information management in an emergency response mission deployed at the request of the United Nations Humanitarian Coordinator or the affected government. Findings from these missions guide the scale up of services from UN agencies.

The International Journal of Disaster Risk Reduction provides a journal for researchers, policymakers and practitioners across broad disciplines. Although many published articles address emergency management frameworks and the environmental, social and economic implications of emergencies, there are few articles that specifically focus on the role of Veterinary Services. Key word searches using “animal health” revealed seven articles; using “animal welfare” four; “veterinary” 22; and “veterinarian” 3, with many overlaps in these search results. None of the articles focused specifically on the role of Veterinary Services in emergencies, rather peripherally referring to animal health and Veterinary Services in their exploration of more general topics.

b) UN conventions and systems for biological and chemical weapons

The Biological Weapons Convention (BWC) effectively prohibits the development, production, acquisition, transfer, stockpiling and use of biological and toxin weapons and is a key element in the international community’s efforts to address the proliferation of weapons of mass destruction by member states. Importantly, the Convention provides a comprehensive ban on biological agents or toxins that are harmful not only to humans, but also to animals and plants. Since entering into force in 1975, the BWC has evolved from the early 2000s into a practical approach to implementation involving a wide range of stakeholders, including relevant international organisations such as the OIE, and focusing on biosafety and biosecurity, reviews of advances in science and technology, disease surveillance, assistance, preparedness and response in the event of the use of biological weapons, and capacity-building for developing countries (25).

Whilst the BWC covers the threat of the development, stockpiling and use of bioweapons by States Parties, in 2004 the United Nations Security Council Resolution 1540 (UNSCR 1540) decided that all States shall refrain from providing any form of support to non-State actors that attempt to develop, acquire, manufacture, possess, transport, transfer or use nuclear, chemical or biological

weapons and their means of delivery, in particular for terrorist purposes. The Resolution requires all States to adopt and enforce appropriate laws to this effect as well as other effective measures to prevent the proliferation of these weapons and their means of delivery to non-State actors, in particular for terrorist purposes. The OIE is a designated assistance provider to UNSCR 1540 and can be called upon to support capacity building at national level to support implementation of UNSCR 1540.

The UN Secretary-General's Mechanism for Investigation of Alleged Use of Chemical and Biological Weapons (UNSGM) carries out investigations in response to allegations by a UN Member State of the possible use of chemical and bacteriological (biological) and toxin weapons that may constitute a violation of the 1925 Geneva Protocol (26) or other relevant rules of customary international law. The UNSGM is tasked with carrying out an objective science-based investigation which involves deploying a fact-finding team to the site of the alleged incident and to report the results of the investigation to all Member States. Member States nominate expert consultants, qualified experts and analytical laboratories which are then listed in a roster. The OIE has a Memorandum of Understanding with the United Nations Office of Disarmament Affairs (UNODA) which specifies cooperation under the UNSGM (27). This includes the provision of subject matter experts to support an investigation; facilitating access to relevant OIE Reference Centres; participation in exercises; and technical advice on guidelines around the UNSGM. The MOU is functional, with OIE having participated in simulation exercises and review of UNSGM guidelines. WHO experts participated in missions to investigate the alleged use of chemical weapons in Syria (28).

The OIE has been engaged in the development of the International Bio-Emergency Management Framework for Deliberate Events (BEMF), which is part of the UNODA *Strengthening global mechanism to respond to deliberate use of biological agents* project coordinated by the BWC Implementation Unit and funded by the Weapons Threat Reduction Programme of Global Affairs Canada. The BEMF aims to ensure a coordinated international response to the use of biological weapons and was developed in cooperation with several United Nations offices and departments and relevant intergovernmental and international organisations including the OIE. The framework is non-binding and describes the roles and responsibilities of the various organisations in the event of a biological weapon attack (29).

c) Global Pandemic Preparedness Monitoring Board

In 2018 the WHO and the World Bank established and co-convened the Global Preparedness Monitoring Board (GPMB) as an independent monitoring and accountability body to ensure preparedness for global health crises. Specifically, the initiative was framed as an international response to the 2014-2016 West African Ebola outbreak, and the international demands for specific reforms to target gaps in sustainable financing for preparedness, capacities in public health systems to prevent, detect and respond to health crises, and research and development to enhance coordination and capability. The GPMB is tasked with providing an independent and comprehensive appraisal for policy makers and the world about progress towards increased preparedness and response capacity for disease outbreaks and other emergencies with health consequences. It does this through its annual reports. As well as these annual reports, the GPMB prepares and disseminates various background papers providing deeper analysis of issues and recommendations, and hosts roundtable discussions with summaries and submissions made available on its website.

Its 2019 annual report noted seven urgent priorities to accelerate preparedness for health emergencies, targeting this message to leaders at all levels. The report postulated preparedness as a Global Public Good that contributes to efforts to achieve the UN Sustainable Development Goals and noted an important national mechanism for this commitment is the National Action Plan for Health Security (NAPHS). In 2020 the report reviewed the collective failure to take pandemic preparedness seriously as manifested in the poor strategic and operational coordination of the COVID-19 response. The 2021 report again dissected the COVID-19 response and called for a rejection of "indecisive leadership, division, and short-termism", calling for a new social contract to prevent and mitigate health emergencies. The report laid out six solutions for a safer world: 1) Strengthening global governance through an international agreement on health emergency preparedness and response;

2) Strengthening WHO through greater resources, authority and accountability; 3) Creating an agile health emergency system that can deliver equity through better information sharing, and an end-to-end mechanism for research, development and equitable access to common goods; 4) Establishing a collective financing mechanism for preparedness; 5) Empowering communities and engaging civil society and the private sector; and 6) Strengthening independent monitoring and mutual accountability (30). In February 2022, the GPMB noted limited progress towards these solutions and renewed its call for sustained and coordinated commitment (31).

d) **Tripartite and Quadripartite collaboration for One Health early warning, preparedness and response**

The formalisation of the Tripartite One Health Collaboration between FAO, OIE and WHO in 2010 (32), and more specifically the renewed commitment in 2017 (33), provided an enabling framework for numerous initiatives directed towards coordinating public health and animal health early warning systems, including for emerging disease, with risk assessment and prioritisation, and preparedness and response capability development. Some are true shared collaborations, whereas others are led by one agency with the others included as partners. Recent partnering with UNEP to form the Quadripartite ensures a true One Health approach through engagement of the UN agency with accountability for environmental health and membership of national environmental agencies. This partnering was first initiated within the global response to anti-microbial resistance, but its importance has been reinforced through the ongoing exploration of root causes of disease emergence from wildlife.

The creation of the One Health High Level Expert Panel (OHHLEP) (34) in 2021 ensures an expert advisory mechanism for a growing number of initiatives. The initial work plan of the panel included the following four main areas: One Health implementation, including the creation of a renewed definition for One Health (Figure 1); developing an inventory of current knowledge in preventing emerging zoonoses; developing a One Health Framework for surveillance, early detection, and rapid data sharing in the prevention of emerging zoonoses; and identifying Factors contributing to spillover and subsequent spread of diseases and develop risk management framework. OHHLEP has recently released its first annual report.

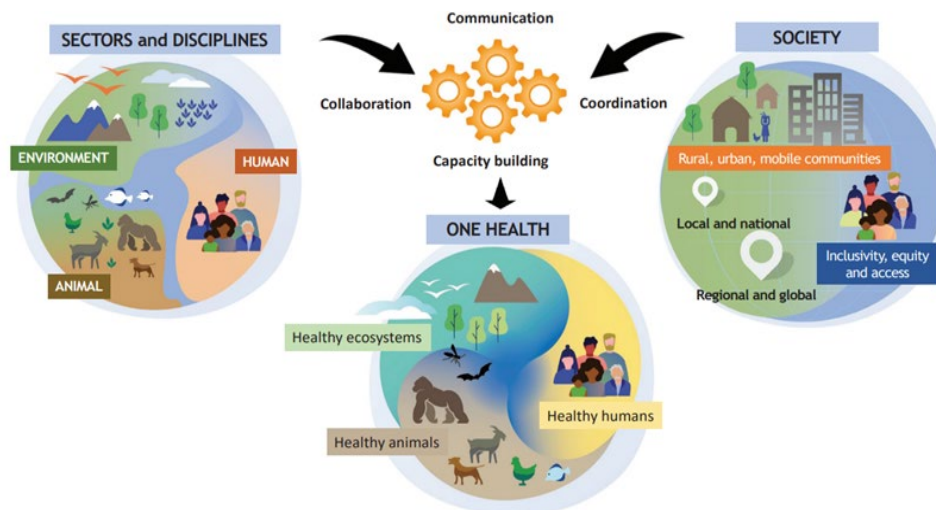


Figure 1. Graphical representation for OHHLEP's definition of One Health: "One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems. It recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent. The approach mobilizes multiple sectors, disciplines and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy and air, safe and nutritious food, taking action on climate change, and contributing to sustainable development". (35)

The Tripartite Global Early Warning System (GLEWS) established a framework for sharing event-based information derived from the respective intelligence and notification systems of FAO, WHO and OIE. In recent years national systems to track and triage internet and social media signals have been incorporated into the intelligence gathering system, and this was accelerated and formalized with the WHO developing its sophisticated Epidemic Intelligence from Open Sources (EIOS) (36) information platform, which is hosted within the WHO Hub for Pandemic and Epidemic Intelligence (37) sponsored by the German government and located in Berlin. The G7-endorsed United Kingdom-sponsored scoping study to explore and design an international One Health Intelligence System (38) sits alongside and builds from these initiatives, while also intending to link in a growing number of national systems and nationally funded international projects.

Systems to evaluate national capacities against WHO and OIE international standards and prepare action and investment plans use the respective institutional tools and processes of the WHO Framework for Monitoring International Health Regulations (IHR) and the OIE PVS Pathway (39). National One Health Bridging Workshops have provided a focused mechanism for national planning of an identified One Health priority. Recent initiatives such as the Tripartite Zoonoses Guide (40), its operational tools, and training mechanisms, and on-line and supported training approaches through the OIE Training Portal (41), the WHO Academy (42), and the FAO and EU-FMD Commission Virtual Learning Centers (43) are rapidly expanding the training and capacity development offering from the Tripartite.

Working with the Quadripartite, the G7 and G20 are strongly engaged in One Health initiatives to support resilience of health services and pandemic prevention, preparedness and response. The G7 Carbis Bay Declaration (44) confirmed G7 support for OHHLEP and the One Health Intelligence System Scoping Study. The G20 Rome Declaration (45) confirmed the commitment to the Global Health Summit to more sustainable financing and better coordinated pandemic prevention, preparedness and response, launching a G20 Joint Finance-Health Task Force aimed at enhancing dialogue and global cooperation.

Two agency-led initiatives provide support to national public health and animal health emergencies. The Global Outbreak Alert and Response Network (46) is a WHO network of technical institutions and member government health authorities that responds to acute public health events with the deployment of staff and resources to affected countries. The FAO Emergency Management Centre for Animal Health (FAO EMC-AH) (47) provides preparedness, response, incident coordination, and collaboration and resource mobilization services to FAO Members: its annual report describes its activities (48). OIE is a partner in both mechanisms. FAO has recently updated and released the third edition of the FAO *Good Emergency Management Practices: the Essentials, a guide to preparing for animal health emergencies* (49). GEMP, as it is known, outlines general principles for animal health emergency management, before working through the emergency management phases and describing activities relevant to each phase. The FAO EMC-AH offers national and regional training workshops based on GEMP and assessment on emergency management capacities through the Progressive Pathway for Emergency Preparedness (50). The FAO EMC-AH also provides advice for national emergency operations centres (48).

WHO has launched two further specific initiatives that are relevant to emergency management systems for infectious disease and other threats: a Framework for Strengthening Health Emergency Preparedness in Cities and Urban Settings; and Building health systems resilience for universal health coverage and health security during the COVID-19 pandemic and beyond (51 & 52).

e) Climate Change Agreement

The Paris Agreement on Climate Change is a legally binding international treaty adopted by 196 Parties at the 21st Conference of the Parties in Paris on 12 December 2015 and entered into force on 4 November 2016. Its goal is to limit global warming to well below 2°C, preferably to 1.5°C, compared to pre-industrial levels. To achieve this long-term temperature goal, countries aim to reach global peaking of greenhouse gas emissions as soon as possible to achieve a climate neutral world by mid-century (3). Adapted and resilient animal health and animal production systems are key to efficiently address the effects of climate change. OIE, Veterinary Services and Aquatic Animal Health Services should have a key role in the design and implementation of appropriate adaptation and mitigation strategies to sustain animal health and welfare and livestock production

in a changing climate and under disaster conditions, such as a higher frequency of extreme weather events and droughts.

f) A new global biodiversity framework

The Secretariat of the UN Convention on Biological Diversity (CBD) has released the first draft of a new global biodiversity framework, to guide actions worldwide through 2030, to preserve and protect nature and its essential services to people. OIE is part of the consortium working under this framework involving UNEP, CBD, the UN Development Programme (UNDP), WHO, the International Union for Conservation of Nature (IUCN) and the EcoHealth Alliance. A fund will be administered by the UNDP Multi-Partner Trust Fund Office to support the Biodiversity for Health and Pandemic Prevention project for an initial 8 years period, with an initial contribution of €50 million from Germany's International Climate Initiative (IKI). The project will help countries achieve more holistic policymaking through application of enhanced One Health approaches creating and using evidence of the links between biodiversity, climate and health, and in so doing will support decision makers and relevant actors to take measures to prevent future pandemics.

g) Civil society coalitions

Livestock Emergency Guidelines and Standards (LEGS) is an independent initiative governed by a Board of Trustees and supported by an Advisory Committee, with FAO and International Committee of Red Cross representation (53). LEGS publishes the LEGS Handbook (54), now in its second edition and with a third edition in preparation. The handbook is produced through a broad consultation process drawing on practice worldwide. LEGS offers training courses based on the handbook. LEGS is a partner to the Sphere movement, started by a group of humanitarian professionals aiming to improve the quality of humanitarian work during disaster response. Sphere is guided by a charter and identifies a set of humanitarian standards for responses (55). Sphere publishes its own handbook with a set of principles and universal minimum standards in humanitarian response (56).

The Towards a Safer World initiative (TASW), started following the zoonotic avian influenza crises of the mid-2000s, convenes a broad range of multi-sector, multi-regional stakeholders involved in whole-of-society preparedness for diverse threats, including non-traditional partners from business and the military. TASW's objective is to improve the capabilities of a network of committed champions of whole-of-society preparedness and their institutions through sharing and applying best practice, and through capacity-building events, simulations, workshops, training and research. TASW's goal is more effective whole-of-society preparedness to lessen the economic, social and humanitarian impact of pandemics and comparable high-impact risks. The TASW website contains a variety of resources such as newsletters, links to relevant news items, reports and publications, and guidance documents (57).

The hypothesised causal factors and widespread impacts of the SARS-CoV-2 pandemic have driven civil society organisations to respond with publications and programmes. Preventing Pandemics at the Source (58) is one notable initiative since it involves a coalition of civil society and private sector organisations with significant resources and capability. The coalition is working through convening expert groups, supporting scientific research, and undertaking awareness raising activities for "nature-based" solutions to stopping spill over and pandemic prevention at source.

h) Discussions and progress towards a "Pandemics Treaty"

During 2020 as the SARS-CoV-2 pandemic spread, WHO Members first raised the prospect of an international mechanism to overcome challenges associated with lack of investment in preparedness, lack of sensitivity and transparency of early warning systems, and lack of strategic coordination of the international response. In March 2021 a commentary (59) signed by 26 Heads of States and published by the WHO called for nations to work together towards a new international treaty for pandemic preparedness and response. The GPMB gave its support for such an agreement in its 2021 annual report. WHO Members agreed (60) to launch a process to develop a global accord on pandemic prevention, preparedness and response at a special session of the World Health Assembly, using Article 19 of the WHO Constitution (as utilised for the WHO Framework

Convention on Tobacco Control), and laying out a timetable of progress reports through to 2024. An intergovernmental negotiating body has been created and tasked with leading the drafting and negotiation process (61). OIE is invited with other key stakeholders to provide input to the ongoing work of the intergovernmental negotiating body as it develops options on form and function of the new instrument (62). OIE is mobilising its Members to take an active role at national and global levels in the negotiation process by reaching out to their counterparts in health, environment and foreign affairs ministries so that animal health considerations and the role of Veterinary Services and Aquatic Animal Health Services will be well reflected in the instrument.

The British Medical Journal in December 2021 published an open access special edition bulletin in flipbook format exploring *Options for a Global Pandemic Treaty* with several opinion pieces, including one from WHO Director General Dr Tedros Adhanom Ghebreyesus, and two analytical papers (63). Thoughtful analysis in this series notes that treaties are gradually translated into national laws creating a binding framework for all relevant sectors, not only the health sector's domain, thereby achieving a better implementation of the One Health approach and stronger political commitment. A treaty would also create a dedicated governing body – a Conference of the Parties – to continuously review and resolve evolving matters, with greater focus through a more specific mandate than the World Health Assembly's oversight of the International Health Regulations. A pandemics treaty could add specificity to how access and benefit-sharing under the Nagoya Protocol operates during pandemics, preventing and resolving conflict since the protocol does not apply to genetic resources covered by specialized international instruments. If the Members wish, a Pandemics Treaty could create stronger mechanisms for national compliance, such as external reviews, independent verifications, site visits and investigations, such as occur in other multilateral treaties. Perhaps at its most basic level, a treaty could deliver greater clarity on triggers and processes for declaring a public health emergency of pandemic potential (64). It is important that animal health, wildlife health and environmental health perspectives from the appropriate representatives continue to be raised and engage in promoting the One Health approach in this important discussion, and that all relevant organisations be included in the negotiation process (65).

The Geneva Graduate Institute's Global Health Centre has established the Governing Pandemics Initiative to compile analysis (often first published elsewhere) on options for the process and content of a global pandemic prevention, preparedness and response mechanism (66). The Governing Pandemics website identifies six key issues that require reform: leadership, monitoring and accountability; International Health Regulations; financing; WHO; countermeasure innovation and access; and national, regional and global preparedness. Each issue is defined and summarised, with the intention of following discussions, and providing access to key resources, including the current instruments and systems, and academic analysis and commentary on the reforms required. Amongst these analyses are calls for “deep prevention”, a focus on the drivers of zoonotic disease emergence such as environmental degradation, wildlife trade, and land use changes, using the new global pandemic treaty to strengthen coherence between international environmental treaties and the WHO International Health Regulations (67).

2. The Hazard Landscape relevant to Veterinary Services

In alignment with the Sendai Framework, OIE advocates for an “all hazards” approach to emergency management preparedness, planning and capacity development. A variety of hazards create national, regional, and international emergencies that require the capabilities of Veterinary Services and Aquatic Animal Health Services. OIE Members are encouraged to undertake a hazard analysis to define those hazards that are most relevant to their national situation (Figure 2).

National planning for emergency management typically assigns lead agency and support agency roles to the various government authorities engaged in an emergency event. The typical role for the Veterinary Authority and the ways Veterinary Services and Aquatic Animal Health Services may be engaged in responding to various hazards are outlined in this section.

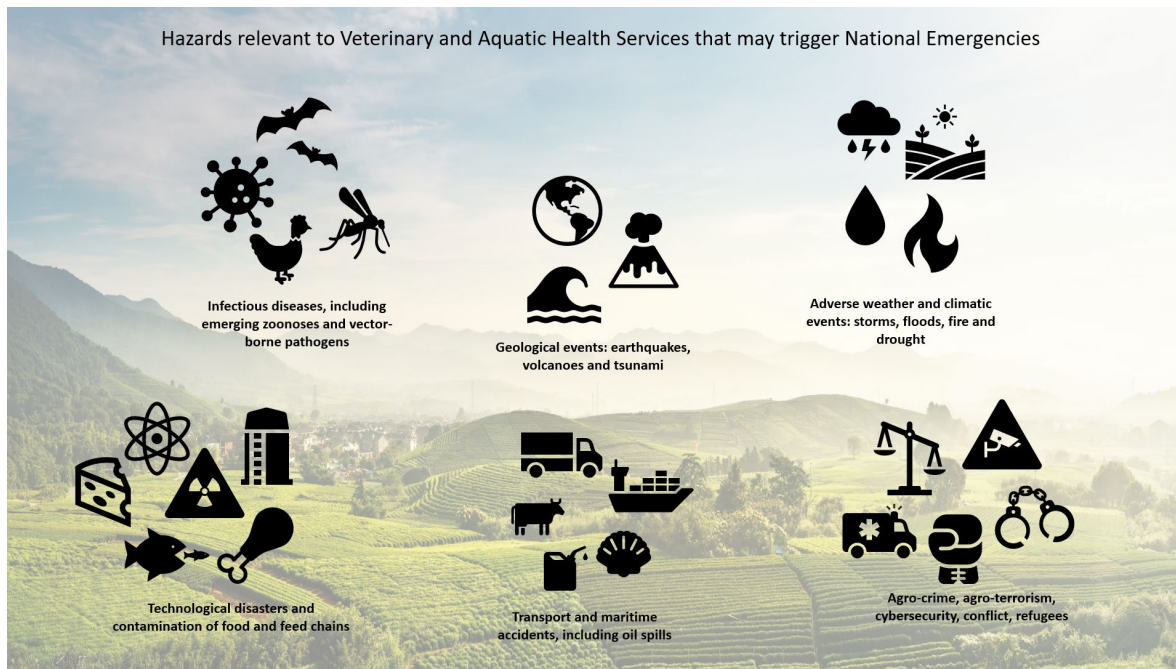


Figure 2. Hazards of relevance to Veterinary and Aquatic Health Services for planning within National Emergency Management framework. Various alternative categorisation approaches can be used to group different hazards, for instance: biological, geophysical, meteorological, climatological, technological, man-made.

The acute versus accumulating and longer-term nature of the impacts from different hazards are an important consideration with respect to contingency planning. Urgent action to respond to acute impacts may be necessary from an animal health and welfare perspective, and similarly important to mitigate longer term impacts. This may create a peak in demand from Veterinary Services and Aquatic Animal Health Services immediately following the event. On the other hand, disease outbreaks may evolve over weeks and months and require sustained response capability, with a peak demand from Veterinary Services and Aquatic Animal Health Services some weeks after event response initiation.

2.1. Transboundary animal diseases

Transboundary animal diseases are the most common scenario for contingency planning and capability development for OIE and its Members. Veterinary Authorities are usually the lead agency from government in managing transboundary animal diseases. Countries determine their priority lists of animal diseases for contingency planning on the basis of national health status, and the projected impact of introductions of disease on animal health and welfare, the economy and livelihoods, and biodiversity (note, in similarity to the criteria of OIE Codes chapter 1.2). The same disease may be considered by different countries as either an endemic hazard to be controlled by routine Veterinary Services and Aquatic Animal Health Services programmes or an exotic hazard that will trigger a national emergency. Early warning systems based on lists of Notifiable Organisms, general surveillance, and targeted surveillance serve both scenarios, but the events triggered by a notification will likely significantly differ in their technical nature, urgency, and engagement of national policy and operational services beyond the Veterinary Services and Aquatic Animal Health Services.

The Global Framework for Transboundary Animal Diseases (GF-TADs) (68) is a joint initiative of FAO and OIE, with the expected participation of WHO for the zoonoses, to achieve the prevention, detection and control of transboundary animal diseases (TADs) and in particular to address their original and global dimensions. GF-TADs is a facilitating mechanism which endeavours to empower regional alliances in the fight against TADs to provide for capacity building and to assist in establishing programmes for the specific control of certain TADs based on regional priorities. The GF-TADs global control and eradication strategies for FMD, PPR and ASF guide countries in the design and implementation of early warning systems, control programmes and contingency plans, providing much needed support for countries that often struggle to resource disease eradication campaigns.

OIE's Aquatic Animal Health Strategy considers disease outbreaks as the greatest threat to aquatic animal production globally, impacting food security, profitability, livelihoods and biodiversity. Disease emergence and the spread of known diseases is driven by risk factors such as industry intensification and expansion, an increase in global trade, and climate change (69).

2.2. Zoonotic diseases and hazards

In 2010 the Tripartite identified three specific zoonotic diseases and hazards as an international focus: zoonotic influenza, rabies and antimicrobial resistance. Comprehensive international programmes, partnering with UNEP in recent years, specifically designed in response to the risks posed by each of these hazards have been initiated based upon the One Health approach, emphasising the importance of Veterinary Authorities, public health and environmental governmental authorities working together to develop and implement surveillance systems, national control programmes and contingency planning.

For events where there is significant mortality or morbidity in the human population, the Public Health Authority will typically lead the government response to an emergency involving zoonotic diseases, with the Veterinary Authority supporting through implementation of risk management in the relevant animal populations. The threat posed by pandemic influenza viruses has resulted in a significant international contingency planning effort in Pandemic Influenza Preparedness Programmes (70), internationally led by WHO and supported by OFFLU. However, for programmes when the major activities are focused in the animal sector (e.g. zoonotic avian influenza), with only rare spillover to humans or with risk management limited to basic personal hygiene and food safety measures, these roles may be reversed.

Over the last two decades there have been numerous other zoonotic disease events that have emerged as national and international crises, including henipaviruses, Ebola virus disease, SARS-CoV, MERS-CoV, and SARS-CoV-2. Other established diseases such as Rift Valley fever occur in epidemic cycles with environmental triggers.

The WHO identifies eight specific pathogens as priority diseases for research and development in emergency contexts (71). All are zoonoses, and the list includes those identified in the preceding paragraph. The WHO Research and Development Blueprint emphasises improving multisectoral coordination as a priority for national preparedness. The Tripartite Zoonoses Guide (72) provides operational tools for countries to develop One Health capacity and preparedness for zoonoses.

Scenarios involving infectious disease hazards encompass biosecurity or biosafety issues with infectious disease laboratories, resulting in accidental or deliberate release of the infectious agent. As noted in the OIE *Guidelines for investigation of suspicious biological events*, there are a range of indicators and triggers that can arouse suspicion that a detected biothreat should be treated as potentially arising from a non-natural source (73).

2.3. Adverse weather and climate-related events

Storms, floods, hurricanes, heatwaves, wildfires and droughts have direct impacts on animal health and welfare, flowing into economic and socio-cultural impacts for farmers and animal owners and at the national and international scale. They also have direct impacts on wildlife management and biodiversity. Veterinary Services and Aquatic Animal Health Services may be involved in animal rescue operations, in treating injuries to animals, in assessing damage to animal production facilities and supporting their recovery, and in a national or international response to maintaining essential services for food supply and food security. Specific support for impacts to wildlife may be required, engaging wildlife health services and veterinarians in animal rescue, treatment, rehabilitation and translocation operations.

National responses to adverse weather and climate-related events are typically led by a central or provincial government authority with a broad civil defence or emergency management mandate. Veterinary Authorities, and other relevant competent authorities (e.g. for Food Safety and Wildlife) or national services will provide support for specific activities relevant to their competence.

2.4. Geological events

Earthquakes, volcanoes and tsunamis share similarities with adverse weather events from the perspective of impacts on animal health and welfare, and with respect to frameworks for emergency management. Like floods, volcanic eruptions can have long-term impacts on animal production through widespread damage to pastures and crops. Acute toxic impacts from ash deposition on pasture may also occur. In urban settings, animal rescue, temporary housing and owner reunification programmes for pets will involve Veterinary Services more broadly, though Veterinary Authorities themselves may not be directly involved in these functions.

2.5. Transport accidents, maritime accidents and oil spills

Transport accidents on roads involving stock trucks or animal transport trailers, by sea involving livestock vessels, or by air when animals are flown internationally, are thankfully rare events. However, the potential for human injury or loss of life, the priority for emergency services to manage these through rescue, triage, treatment and transport to hospitals of people involved, animal health and welfare implications from injuries, and the importance of mitigating ongoing risks from livestock that may be loose on roads, creates an urgent situation where coordination between first responder emergency services (police, fire, ambulance, coastguard) and Veterinary Services and Aquatic Animal Health Services is critical. In such situations, the first response services will typically lead the operational coordination at the accident site, and Veterinary Services and Aquatic Animal Health Services will support animal-based activities. Rare events where transport accidents occur in international settings, such as the high seas or in third countries, will see engagement of foreign ministries in coordination between the relevant agencies in the country responding to the accident and those others affected by it.

Maritime oil spills as a result of accidents or from oil and gas exploration facilities close to coastlines or within harbours create a hazard for spilled oil impacting coastal resources and wildlife. Many countries maintain specific oil spill preparedness and response plans as partnerships between government maritime authorities and the oil and maritime transport industries (e.g. such as that of Maritime New Zealand) (74). Wildlife, aquatic animal and food safety authorities or service providers should be included in such arrangements as support agencies for animal rescue operations and to manage risks to food safety.

2.6. Toxic or radiologic food or feed chain contamination

Local or sometimes more distributed contamination of food and feed chains can occur through oil spills, industrial pollution, or through uncontrolled release of radiological contamination from nuclear facilities, which may itself occur because of a natural disaster. Such technological disasters present a unique set of requirements for Veterinary Services and Aquatic Animal Health Services (75). The interaction between metropolitan systems for sewage and stormwater and natural processes such as wind, rain, rivers, ground water, tides, and ocean currents can result in wider distribution of the local contamination. Failures in risk management of ingredient supply chains can result in contaminated primary produce becoming widely disseminated and affecting many processed products. Such events may be acute (e.g. oil spills, nuclear release) or evolve over longer periods (e.g. industrial pollutants). While it is typically the Environmental Authority that will establish the regulatory frameworks for environmental protection aspects of risk management, the lead agency for emergency events will depend on their nature and the national circumstances. Veterinary Authorities and Food Safety Authorities should be involved in assessing risks to the food and feed chains, and animal health and welfare, and implementing associated risk management, working in coordination with other involved agencies.

Veterinary Services and Aquatic Animal Health Services may require further training and specialised equipment for these specialised emergencies or rely on the expertise of other agencies for some of these events such as for decontamination procedures with hazardous substances (75).

2.7. Agro-crime and agro-terrorism

Some of the hazards and events discussed previously (with the general exception of weather, climate and geological events) may result from deliberate actions involving agro-crime or agro-terrorism¹. Events that are initially characterised as accidents may on deeper investigation of causation reveal breaches of regulatory risk management frameworks, invoking the need for engagement of police or other law enforcement authorities. This possibility should always be considered and requires operational planning and coordination between response and enforcement agencies to ensure responses preserve to the extent possible the integrity of future investigation of causality and potential criminality. This can extend to the way interviews are conducted, evidence is collected, and public statements relating to the event are made. Agency roles between Veterinary Services and Aquatic Animal Health Services, Law Enforcement and any other services involved in response to any such event should be clearly established from the outset, and preferably in planning for generic events while recognizing that specific scenarios encountered are likely to be highly variable. There may be a requirement for the nominated technical and security agency to lead parallel responses dealing with the technical and security elements of an event respectively, with close coordination between the two.

2.8. Cyber-security, bio-cybersecurity and disinformation

A specific aspect of agro-crime and agro-terrorism involves cyber-security. National, international, corporate or individual information assets with relevance to animal and food production, animal health and welfare, and food security may become the target of cyber-security events. This can take diverse forms, such as ransomware attacks of veterinary practices through practice management software, or distributed denial of service (DDoS) attacks of agency services via internet traffic, often with little apparent purpose other than the malicious disruption of service. Specialised government security services may be involved in investigation and response to such events if they are nationally significant.

However, their growing number and the challenges of investigations and enforcement operations means there is a heavy reliance on prevention and protection through a range of information technology and business user behaviour risk management processes.

Bio-cybersecurity is a relatively new concept proposed in 2018 to encompass the intersection of biotechnology, biosecurity and cybersecurity issues as part of an effort to safeguard the bioeconomy. The objective of the merged discipline of bio-cybersecurity is to address the potential for or actual malicious destruction, misuse, or exploitation of valuable information, processes, and material at the interface of the life sciences and digital worlds. Eight vulnerabilities have been described, for instance the hacking of cloud-based patient data (or client data in veterinary practice software management systems), genomic data or epidemiological data to introduce changes for nefarious purposes, creating false alerts or false research and development outcomes (76).

Related is the now widespread problem of misinformation and disinformation that may be deliberately seeded and distributed through the internet for nefarious and disruptive purposes. The WHO has labelled this challenging issue the “Infodemic” in relation to the challenge of maintaining factual information during the SARS-CoV-2 pandemic (77). The impact of such disinformation campaigns can disrupt the response to emergency events or, when deployed in the absence of an emergency, produce effects similar to real events (78).

2.9 War, conflict and refugee crises

Recent refugee crises arising from geopolitical conflict have re-emphasised their action as a hazard with direct and indirect negative influences on other hazards, such as infectious disease. Disruption to national disease control programmes can occur through creating social and security conditions that prevent deployment of vaccination campaigns or non-pharmaceutical interventions such as physical distancing or movement controls. The mass movements of refugees under challenging conditions of a

¹ Agro-crime: A deliberate or accidentally unlawful act or omission involving or impacting agricultural activities and products that violates applicable legislation. When deliberate, such crimes are motivated by financial or personal gain.
Agro-terrorism: The intentional release of biological agents or toxins for the purpose of harming or killing humans, animals, or plants with the intent to intimidate or coerce a government or civilian population to further political or social objectives.

humanitarian crises can result in disease spread to new geographic areas, with limited access to medical services for people under significant stress exacerbating risks (79). The risk of uncontrolled movements of people and the risk goods they may carry across borders can also result in transboundary spread of animal disease. These risks to near neighbours continue while delivery of Veterinary Services and Aquatic Animal Health Services is disrupted and ineffective in the conflict zone, often despite attempts at re-stocking and re-establishment of farming systems. Re-constructing Veterinary Service and Aquatic Animal Health Services following conflicts should be tailored to each country's specific needs (80).

The link between agriculture, food production, and civil unrest and conflict is well recognised, and the interaction operates in both directions. Emergency events that impact food security can trigger civil unrest. Conversely, conflicts unrelated to food security can impact local agriculture and food production. With modern globalised supply chains, local and national impacts potentially create ripple effects for regional and global food security, which then act as the trigger for civil unrest and conflict further afield.

More directly and urgently, safety and security threats to personnel of OIE and Member Veterinary Services, Aquatic Animal Health Services and Public Health Services arise in conflict zones and in countries experiencing political unrest and employing organisations must assume the duty of care over their people under sometimes challenging circumstances.

3. Veterinary Services outcome-based objectives in emergencies

In similarity to any complex programme where a diverse set of activities will compete for priority and resourcing and multiple agencies may be involved, achieving the best all-round outcomes requires clarity of purpose through defining objectives and placing these in a hierarchy. The hierarchy may be as simple as primary and secondary objectives for different agencies. Risk assessment processes will assist in defining the nature of the threat, the importance of different risk management activities, and the degree of risk mitigation achieved. A rapid risk assessment is therefore an important policy tool to assist in defining response objectives.

Policy objectives for the response to the emergency should be used as a referential framework during planning, performance management, and programme monitoring and evaluation. Inevitably competition between objectives will be encountered: an activity targeting one objective may have an adverse consequence for another objective; or resource limitations will force choices on activities targeting different objectives. How deep the analysis can be or how long it can take to resolve such conflicts will depend on the scenario. Urgent scenarios benefit from the clarity achieved through prior planning to define objectives. In the absence of this prior planning, the simplest level of hierarchy can be used. Basic or complex multi-criteria assessment tools can be developed to assist policy or operational planning and implementation.

3.1. Public Health and Safety

Reducing risks and impacts to human health is a common high priority objective in any emergency. This is particularly obvious when the hazard creates a direct and acute threat to mortality or morbidity. Indirect or chronic causal effects to human morbidity and mortality are more challenging but should also be understood, as should the mitigation options and their likely impact.

From an employment perspective, the health and safety of personnel deployed by response agencies is a very high priority. This extends from direct and acute threats to safety from working in emergency settings including infectious disease threats, to longer term issues of prolonged stress leading to burn-out, and the after-effects of emergencies such as post-traumatic stress.

Human health authorities should be involved in risk assessment and objective setting when events pose risks to human mortality and morbidity. Health and safety assessments at each worksite during an emergency event should be incorporated into operational procedures. There should be access to psychological support for emergency service personnel and the victims of emergency events, including farmers affected by animal disease outbreaks, and this should be extended beyond the acute phase of the response.

3.2. Food Safety

The impact on human health through food safety is a specific public health threat that should be understood and assessed when events involve animal production, animal health and welfare, or food services. Sometimes the causal chain is obvious: for instance, zoonotic diseases transmitted through the food chain or where hygiene in food processing is critical, such as Rift Valley fever or zoonotic Highly Pathogenic Avian Influenza. At other times, the causal chain may be less obvious: for instance, volcanic ash contamination of pasture, which may be ingested by animals, creating chronically toxic residues in meat or milk; or loss of electricity in weather or geological events, resulting in food storage challenges, and higher risks of food safety incidents in affected households.

Risk mitigations for food safety risks from animal production through processing may vary based on whether the food is destined for the domestic or export market. While this may sound callous, it reflects that international trade in foods of animal origin is controlled by international standards and national reputation and market access can suffer long-term damages from non-conformances, whereas for domestic supply there is a greater ability to balance competing public health objectives of maintaining food supply and minimizing health impacts. This is an example where public health, food safety, food supply and economic impact mitigation should be carefully considered and balanced to optimize outcomes.

3.3. Animal health and welfare

Reducing the number of farms and animals affected in an event, mitigating the impacts on farms and in animals, and assisting in the recovery of farms and animals to resume normal operations are the core domain of Veterinary Services and Aquatic Animal Health Services. Nonetheless, this can involve difficult choices. Stamping out operations early in a disease outbreak may be the most direct means of stopping spread and minimising the scale, duration and economic impact of the event. However, they may invoke social outrage at the associated wastage, depending on social attitudes to and the understanding of imperatives within farm settings. On a practical level, there will be animal welfare challenges of mass euthanasia in farm settings, and environmental and biosecurity challenges and impacts associated with carcass disposal. The ability to treat, house and rehabilitate injured or affected animals during emergency weather, climatic and geological events, transport accidents or contamination events such as oil-spills will depend on many factors, from the numbers of animals affected, the intrinsic social value of the species and types of animals (e.g. endangered wildlife or animals held in zoological collections; rare breeds of high genetic value) and the availability of animal health services. Veterinary Services and Aquatic Animal Health Services should consider the development of decision-support tools to guide policy development and triage in operational scenarios as part of their contingency planning process.

3.4. Biodiversity and wildlife

Emergencies that impact ecosystems and their fauna and flora, zoological and conservation facilities, or rare breeds of production animals may have long term impacts associated with biodiversity loss. Animal rescue and translocation to preserve biodiversity may be necessary, as might derogation from (e.g. depopulation) or prioritisation of (e.g. vaccination) interventions within animal disease control operations targeting animal resources with special genetic significance. Such situations can create challenges for authorities during emergencies since there may be limited capacity to consider every situation.

3.5. Environmental risks

While a broad assessment of environmental objectives within a multi-hazard emergency framework is beyond the scope of this paper, two specific scenarios illustrate how environmental objectives must be considered to avoid long-term impacts associated with emergency response to animal health events. Stamping out operations during animal disease outbreaks create a significant environmental challenge associated with carcass disposal, and environmental impacts and constraints should be important considerations for carcass disposal options under different scenarios. Cleaning and disinfection operations, either on farms or at roadside checkpoints, create significant potential for chemical contamination of land and waterways. Engaging Environmental Authorities and scientific expertise to assess risks and design risk mitigations is important.

3.6. Assuring food supply and food security

Like food safety, the assurance of food supply and food security is an important sub-component of public health that deserves specific consideration, as distinct from direct impacts on human morbidity and mortality from an emergency event. This is particularly because the risk mitigations and risk management measures will differ, with a potentially varying focus on recovery of existing food supply chains and the rapid establishment of new or temporary chains, in particular imports or humanitarian aid. Recovery of existing food supply chains should be a medium- and long-term priority, because of the importance on livelihoods and employment for all those involved in national food production and processing industries, with flow on impacts for national economies. During humanitarian mobilisation of resources and food aid, best efforts to mitigate risks to human and animal health should be maintained to avoid averting short-term food security crises while incurring medium- and longer-term health risks.

3.7. Export assurance

The impact of an emergency event on an animal or animal product export supply chain and export assurance programme will be specific to the event. National export assurance programmes create market success by building trust and confidence through a combination of in-process controls and end-process testing. Such trust and confidence is built over many years, but may be easily degraded through policy mis-steps in the management of emergency events. For this reason, countries with agricultural exports will often place a high focus on maintaining the integrity and external trust and confidence in export assurance programmes in the context of emergency management.

Emergency events may cause a break in production and processing that immediately halts an export supply chain with negative implications for prospective supply of outstanding orders and therefore future revenue but no retrospective impacts on previously exported products. An event may also create a new hazard that must be factored into surveillance and monitoring within the export assurance programme, such as residues from volcanic ash or radiological contamination. On the other hand, events such as the discovery of pollutants or contaminants with food safety implications may trigger retrospective investigations, with potential longer-term damage to the reputation of national export assurance programmes. In some cases, an emergency event may be sufficient to overturn government or stakeholder support for an industry operating on finely balanced competing policy considerations or fragile social license (e.g. Netherlands exit from the mink fur farming industry following SARS-CoV-2 outbreaks; New Zealand exit from the live breeding cattle export trade following a vessel capsizing in storms with tragic loss of life). De-briefs and lessons learned from responses may also result in additional risk mitigations that reduce the likelihood of recurrence or impacts for exports (e.g. swill-feeding of pigs banned across the European Union following the 2001 outbreak of foot-and-mouth disease in some Members).

3.8. Economic impact mitigation

Emergencies are expensive for national governments through the combined potential for damage to infrastructure, utilities, national productive capacity and livelihoods, and also for the high cost of national responses. There may be indirect and ongoing economic losses, for example to tourism industries from adverse publicity associated with disease outbreaks, other emergencies and the national response. In an ideal situation, the investment in prevention, preparedness, response and recovery will directly offset the economic impacts of the emergency event. There are many scenarios that can arise that evoke complex consideration of competing objectives. A frequent challenge during estimation of economic impacts under different scenarios is the consideration of such indirect impacts, particularly intangible impacts such as damage to reputation and social license. For instance, stamping out infectious disease outbreaks may result in faster return to export trade than taking a vaccination approach to disease control (81). However, stamping out may create negative imagery and perceptions from consumers, the public, and tourists. The trade-offs are even more politically challenging when they pitch public health objectives against economic ones. Moreover, the political tendency during the high-pressure environment of an emergency is to deny the existence of a trade-off by asserting policy not grounded in the realities encountered every day outside of emergency settings (e.g. “protect human life at any cost”).

For political leaders, emergencies can define public views of their leadership capability. Urgency can undermine the rigour of policy and technical decision-making and spending in relation to public and

operational policies during the implementation of response operations (e.g. prudent procurement policies exercising probity may be over-ridden). Emergencies therefore present a time of significant financial risk.

A common policy proposal following emergency responses, where after-action reviews or inquiries inevitably point to delays in decision-making and difficulties in securing financing, is to establish an emergency fund. The prospect of low-quality decision-making creating high spending scenarios usually acts as a significant deterrent to implementation of such a policy proposal. The funding challenge is best addressed through implementation of robust needs, options and cost analysis and decision-making in support of a sustainable programme of preparedness, as well as systems for rigorous analysis of funding decisions during the early stages of an emergency and considering the full range of potential emergency response financing mechanisms (82).

3.9. National security coordination

As noted above, many emergency events may involve an element of non-conformance with regulatory frameworks within the direct causal chain leading to the event, or which is discovered during the investigation of the event and deemed to have a material impact on the likelihood of its occurrence or the magnitude of its impacts. Those parties that feel at risk of implication in the causal chain may seek to subvert evidence.

Even for those types of events where criminal behaviour is unlikely to feature in the causal chain, such as weather, climate or geological emergencies, the post-emergency event environment is often characterized by a change in behavioural incentives and compliance and enforcement capacity which may increase the risk of criminality. This happens during disease outbreaks, when national compensation regimes may be insufficient or overly generous and result in deliberate disease spread or avoidance of detection, or when unscrupulous actors capitalise on the vulnerability of animal owners to offer goods and services that are not fit for purpose, such as falsified vaccines for African swine fever (83).

Close coordination between technical agencies such as Veterinary Authorities and security agencies such as Law Enforcement and the national security service is important during emergencies, so that each achieves its own objectives, understands the others, how activities can work in synergy, and how to avoid undermining each other's objectives through activities analysed from a too-narrow perspective (e.g. New Zealand's response to a criminal blackmail threat to contaminate food) (84). Communication and cooperation during planning, preparedness and response is the key to good collaboration.

4. Emergency Management Systems and Disciplines

Emergency management has become a professional discipline with its own theories, frameworks and tools, and a growing evidence-base supporting continuous learning and development. Veterinary Authorities bring their technical skills and capabilities to the table, but effective collaboration during emergencies requires an understanding of and practice within the emergency management paradigm. Frameworks and tools will vary country-to-country, and so each OIE Member should identify the over-arching lead government agency for emergency preparedness and management in their country, and foster a relationship so that hazards that are specific to the veterinary domain are integrated into national planning, the potential contribution from Veterinary Services and Aquatic Animal Health Services to national emergency management systems is appreciated and integrated, and these services benefit from national planning and capability development for emergency management. This section provides a brief over-view of generic frameworks and tools for emergency management.

4.1. Emergency management cycle as a planning tool (Reduction, Readiness, Response, Recovery)

Emergencies are characterised by high uncertainty, high variability, and high consequence regarding their course and impact. The emergency management cycle is used as a planning tool, by considering emergency planning processes in four phases: reduction (also called mitigation or prevention), readiness (also called preparedness), response and recovery (also called rehabilitation). Graphics representing many variations of this basic cycle can be found on the internet and in OIE guidelines (Figure 3).

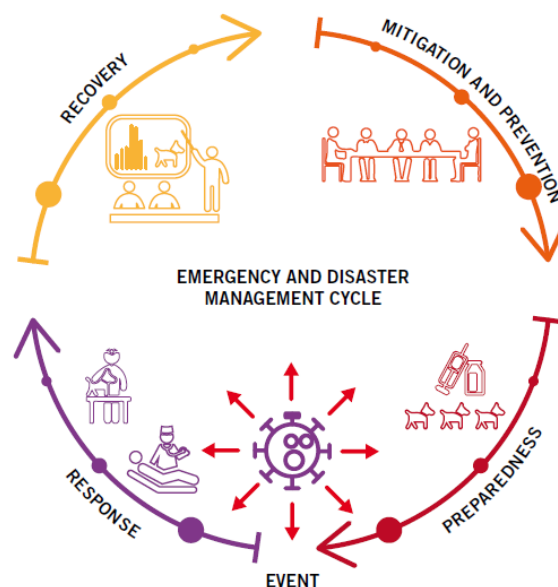


Figure 3. Phases of the emergency and disaster management cycle (from: OIE Guidelines on Disaster Management and Risk Reduction in relation to Animal Health and Welfare and Veterinary Public Health).

These phases allow a clear outcome-based objective to be stated that drives conceptualization, planning and prioritisation of activities within each phase. Within a multi-hazard planning process, it allows a different focus to be placed on different hazards. Importantly, while the cycle is presented with distinct phases, in reality there is blurring of temporal boundaries and more often a gradual transition between phases. This occurs particularly in relation to Reduction and Readiness which operate in parallel prior to the emergency event and can have overlapping and synergistic action. In the same way, after the initiation of the emergency event, the temporal distinction between Response and Recovery activities can be blurred in certain circumstances. For weather, geological and accident events that pose immediate threats to human life and property, response activities that protect human life, health and property are typically given priority over recovery activities. The Response Phase remains active until the threat to human life, health and property is substantially abated; at which time the Recovery Phase can begin.

To assist understanding, the emergency management cycle with examples of activities in relation to animal disease outbreaks is presented, since these are activities that most Veterinary Authorities will already be engaged in or have experience with:

- Reduction: import risk analysis and pathway risk management for imported risk goods; livestock identification and traceability; basic farm biosecurity measures; early warning surveillance systems; pre-emptive vaccination programmes.
- Readiness: contingency plan development; capability development; training and exercise programme; supply and procurement arrangements for critical resources, including human resources; vaccination supply arrangements; laboratory surge capacity planning; critical stores and reagents stocks.
- Response: outbreak surveillance; stamping out measures on infected places; movement controls; cleaning and disinfection on farms and at movement control checkpoints; response vaccination programmes; export certification withdrawal; intra-action reviews.
- Recovery: compensation payments; proof-of-freedom surveillance; self-declaration publication; re-stocking support programmes; farmer welfare support arrangements; market access recovery initiatives, such as export certification re-establishment or re-negotiation; financial and employment stimulus packages following significant shocks to national economy; after-action reviews to identify lessons and appropriate risk mitigation measures.

4.2. National Hazard Analysis supporting Planning and Prioritisation

Hazard analysis in emergency management involves identification, characterisation and prioritisation of various hazards for a particular context, leading to the establishment of capability targets to manage the prioritised scenarios. Hazard analysis in emergency management is a form of risk analysis. It is sometimes referred to as such or using a variety of other terms such as hazard vulnerability analysis, or threat and hazard identification and risk assessment (THIRA) (85).

The perspective taken within a hazard analysis should be explicit. Hazard analysis can be undertaken with a national context (i.e. all hazards likely to trigger a national emergency), a sectoral context (i.e. all hazards likely to trigger an emergency with particular relevance to animal health and welfare), or an agency context (i.e. all hazards likely to trigger an emergency that will impact or involve the Veterinary Authority). All these perspectives have been used to create the list of hazards in Section 3 above (i.e. the list represents those hazards that can trigger national emergencies of relevance to animal health and welfare that are likely to require the engagement of the national Veterinary Authority).

With this list as a hazard identification starting point, hazard analysis moves into further characterisation through outlining the range of scenarios that could realistically be encountered, given the national context (i.e. animal populations and distribution; capacities of Veterinary Services and Aquatic Animal Health Services; production methods, critical processes and supply chain dependencies; importance to the national economy; disease risks; weather and climate risks; geological risks etc). Multi-disciplinary engagement of expertise from non-veterinary domains is important in this process to ensure that scenarios are realistic and comprehensive, such as economists, meteorologists, geologists, environmental scientists and wildlife experts.

National emergency management specialists with a broad overview of emergency events that might not immediately be appreciated as having high impact on animal health and welfare should also be included in this characterisation process. Their understanding of impacts to national utility services such as electricity, fuel, water, sewerage, roading and communications infrastructure can reveal important impacts for animal health and welfare, since most farming operations rely on these utility services and their acute or prolonged absence can create a multitude of risks to animal health and welfare, and to animal production, processing and marketing. As a simple illustration, cuts to electricity will have immediate impacts on animal housing, heating and ventilation systems, automated feeding systems, and milking machines. Re-establishing electricity supply will typically prioritise areas with high human density, meaning rural areas may need to be ready to cope with prolonged absences. If reverting to manual processes is not feasible, emergency or portable electricity generation may become a high priority driven by animal welfare and economic considerations.

The further characterisation of various scenarios associated with identified hazards can reveal a wide range of diverse risks that emergency planning could address. A mechanism to prioritise is usually important. A simple framework involves placing identified hazards (or specific scenarios associated with identified hazards) into a matrix with likelihood and impact on x and y axis respectively (or vice versa). Hazards or scenarios in the upper right quadrant should be prioritised in national planning (i.e. high likelihood, high impact).

4.3. Whole of Government capability

Events that trigger large scale impacts may be considered national emergencies. National legislation or emergency management policies and plans will typically establish criteria, process and authority for the designation of a national emergency. Once designated, national emergencies typically engage a broad array of government agencies, invoking the so-called Whole-of-Government approach to emergency management (even though any particular national emergency will involve a defined set of government agencies depending on its nature and impacts).

The Whole-of-Government approach to emergency management is usually supported by defined arrangements for:

- **Lead Agency:** the designated government agency accountable for preparedness and controlling the government response to particular hazards or scenarios.

- **Support Agencies:** the government agencies that are coordinated through the emergency control mechanism, responsible for providing specific services in support of the national response, while still commanding the internal direction of personnel and resources within their agency.

Animal disease outbreaks would usually see the Veterinary Authority as the lead agency. Veterinary Authorities are therefore accountable for ensuring all aspects of the emergency management planning cycle are addressed, even if a Support Agency is responsible for a specific activity, or a defined scenario with massive impacts invokes lead agency status passing to another central government agency under the direct control of the executive arm of government. Therefore, contingency planning for animal disease outbreaks should be integrated within a national emergency management planning process, and the resulting plans understood in this way by the Veterinary Authority and the agency responsible for the National Emergency Management system (Figure 4).

Whole of Government emergency management mechanisms typically establish clear decision authorities and direct interaction processes between the executive arm of government and the management of the government authorities engaged in the response, flipping from peace-time processes that may be better suited to deep and slow analysis with broad consultation, to rapid and responsive command over a wide-ranging and fast-moving scenario. Since such decision-making authorities are usually defined in legislation, this new arrangement is also usually described in the national emergency management legislation or policies. Such authorities may be considered less democratic than routine peace-time functioning, and therefore the national legislation or policy should impose limits to the duration of such a mandate, requiring it to be periodically renewed if the emergency conditions prevail, or through other checks and balances to the exercise of power, such as liability arrangements and powers of inquiry.

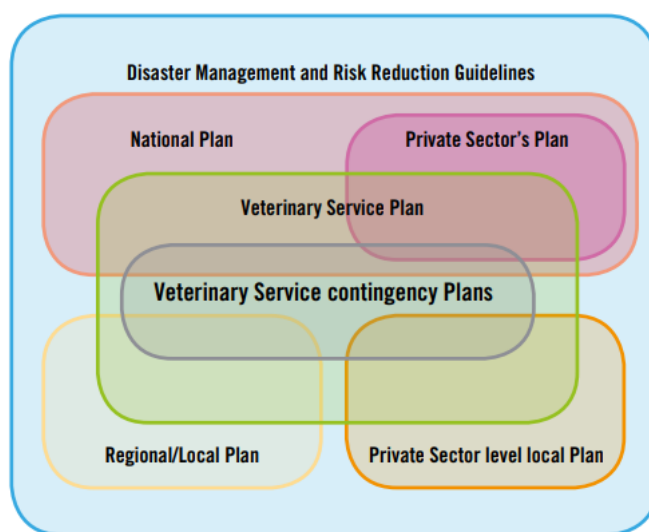


Figure 4. Veterinary Service contingency plans, for animal disease outbreaks or any other hazards, acknowledged within the overarching national framework for emergency management (from: OIE Guidelines on Disaster Management and Risk Reduction in relation to Animal Health and Welfare and Veterinary Public Health.

4.4. Command and Control using Incident Management Systems

Incident Management Systems are mechanisms to exert coordinated command and control across multiple agencies engaged in a crisis management process. They are typically be-spoke to a national or institutional context, and while there is flexibility in their design, they should have common structures, processes and terminology for all the parties that are expected to collaborate and coordinate during management of emergencies. National Incident Management Systems guide all levels of government, nongovernmental organizations and the private sector to work together to prevent, protect against, mitigate, respond to and recover from incidents (86). Models and principles of Incident Management Systems in the context of animal disease emergencies have been recently reviewed (87).

Control means the overall direction of response activities in an emergency, operating horizontally across agencies. Command means the internal direction of personnel and resources of an agency,

operating vertically within that agency. The key benefits of command and control through Incident Management Systems are that they clarify and simplify the flow of directions and information, while providing scalability and inter-operability between different groups and agencies.

The command and control approach is a feature of rapid response by emergency services, and arguably one of its strengths. However, the approach certainly comes with risks, in particular that interventions become technocratic and ignore social and environmental impacts and human rights concerns (88). There is therefore an inevitable tension between command and control in emergencies within national political systems defined by democratic principles.

Incident Management Systems will typically comprise:

- An organisational structure with an Incident Control function, and generic functional groupings with names such as Planning, Operations, Intelligence, Logistics, Liaison and Public Information. These generic functional groups support agency interoperability by allowing quick identification of counterparts for coordination (Figure 5)
- A daily rhythm of meetings and deadlines in support of situational awareness, coordination and issues management, and reporting deadlines
- A set of templates for strategic and operational planning and reporting (Situation Reports), allowing assimilation of inputs from different participants in the system. Common terminology is also agreed between agencies to harmonise communication
- A data management process and repository providing “one source of the truth” for key metrics on field operations and tasking, technical, economic or social impacts, and response performance
- An approach to facilities to house the emergency response organisational structures and support operations. This will typically involve an Emergency Operations Centre housing Control functions at a pre-designated location with the facilities required to host staff and provide IT and communications linkages, as well as any Staging Posts and Command Posts close to an emergency location that are required to coordinate operations.

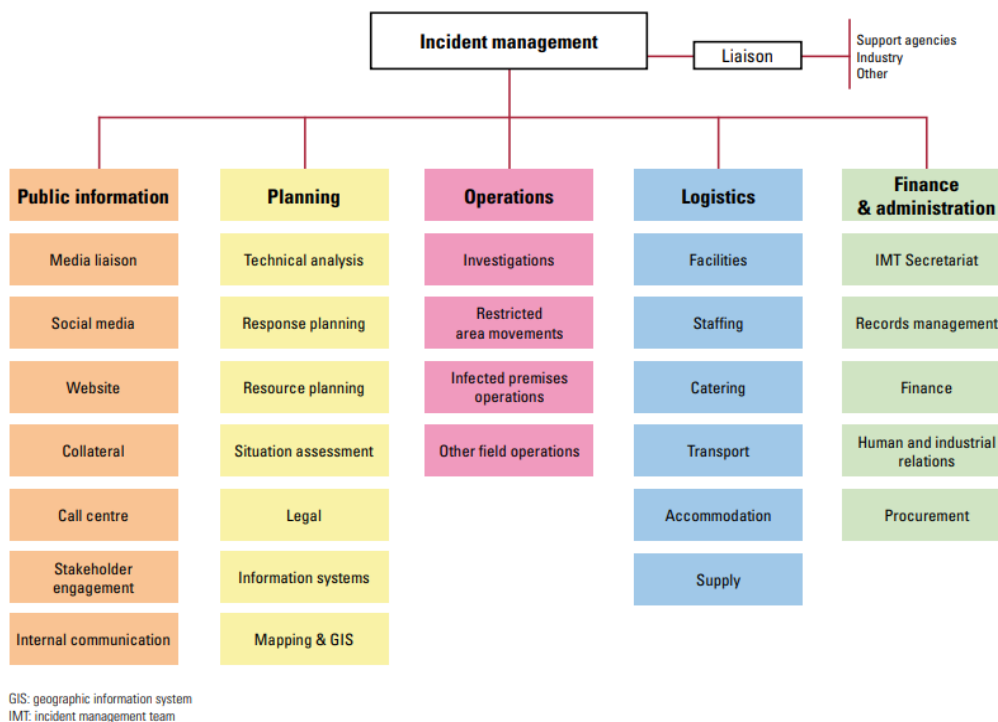


Figure 5. Incident management teams – sections and units. An illustration of the functions that may be performed by each section within an emergency operations centre. (From: Callan, 2020, OIE Sci Tech Rev 39(2) pp 309-405).

Since Incident Management Systems represent a deliberate and time-bound departure from routine organisational management structures and processes, practice prior to implementation through training and simulation exercises is normally important for efficient and orderly transition into and out of them.

4.5. Roles and Responsibilities and people capability focus

Rapid deployment, operationalization and scale-up within Emergency Operations Centres to achieve the organisational structures defined by the Incident Management System is achieved through clearly defined roles and responsibilities for each group within the structure, and the personnel leading and working within those groups. A quality system approach for the documentation supporting this is achieved through Job Cards which describe group functions and person roles (e.g. New Zealand National Emergency Management Agency, Coordinated Incident Management System Role Cards) (89). These will often have specific skills and competencies defined for role holders as a Person Specification. Professional Profiles can also help understanding the capabilities and behaviours required by illustrating potential backgrounds and experience. These tools for Emergency Management often sit alongside the core organisational Human Resources systems and specifications, so that people working within organisations with emergency management functions are recognised as having dual roles: their “peace time” role during prevention and preparedness phases, and their Emergency Management role when an emergency event is occurring and their organisation has moved into an emergency response phase. As much as possible there should be an alignment between these, thereby ensuring the emergency management capability is reinforced by normal business processes. Specific training and exercising programmes to ensure people understand their roles and develop the required skills are part of the overall organisational approach to people capability.

4.6. Monitoring, Evaluation, Learning, Capability Assessment, Training and Exercising approaches – After-Action Reviews, Simulation Exercises and Gaming

As emergency management disciplines have continued to evolve and adopt continuous learning philosophies a range of performance management tools and approaches have been developed. These are typically integrated into the Emergency Management cycle, so that learning and review following responses feeds into preparedness activities (Figure 6). After-Action Reviews are an important learning mechanism and can take the form of “hot wash” debriefs amongst teams in the immediate aftermath of an emergency event, or a deeper process of workshops to identify lessons learned and mitigation measures. Capability Assessment Tools and Reports have been developed that allow agencies to assess their state of readiness with respect to documented systems and processes as well as people capability. Capability Assessments should be undertaken with a defined scope and purpose, and recommendations integrated into preparedness work programmes.

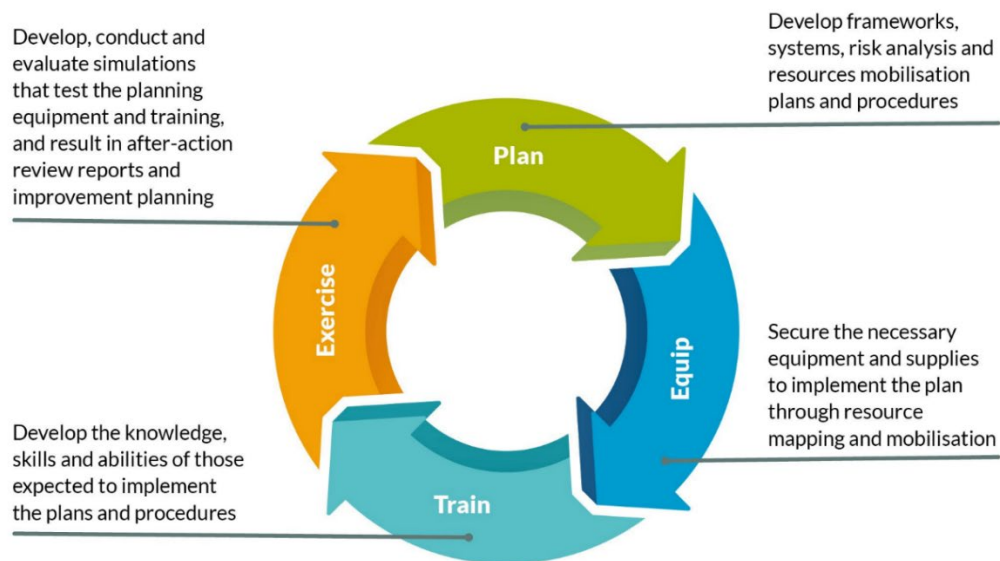


Figure 6. Integrating exercises into the preparedness cycle. (Source: OIE Guidelines for Simulation Exercises, (2020))

Emergency Management systems have adopted and evolved training approaches from military paradigms involving simulation exercises and gaming. The OIE has summarised these approaches as they apply to Veterinary Services and Aquatic Animal Health Services in a recent guideline that lays out the benefits of exercising, the different forms exercises take (tabletop, drills, functional and full-scale exercises), and how to plan a national programme and specific exercise (90). Veterinary Services and Aquatic Health Services intentions to hold a simulation exercise should be notified to the OIE, allowing dissemination of the notification and avoiding any misapprehension that the exercise pertains to a real world event (91).

Information technology is being increasingly integrated into training to provide realistic emergency scenarios for planning exercises such as through the use of mathematical and geo-based simulation models (e.g. European Foot-and-Mouth Disease Spread Model, EuFMDiS) (92) to create time-lapsed injects for relatively low-cost desktop exercises, or to provide a fully-simulated gaming environment as an exercise tool. In 2019-2020 the OIE launched the Rinderpest Vigilance game as part of the programme of activities to maintain a degree of readiness for a rinderpest resurgence following global eradication (93).

4.7. Emergency Management software and data management

Aside from the use of information technologies in modelling and exercises, emergency management software is an important aspect to readiness and response. Emergencies generate a large amount of data relating to incoming information regarding the status of different locations and teams, the tasking and directing of activities in response, and monitoring performance. Prior to 2000 such information systems were typically developed as specific information technology projects within different agencies. This was particularly the case for specialised technical services, such as Veterinary Services and Aquatic Animal Health Services, preparing for events that were not always recognised as sitting within a national emergency management framework, such as animal disease outbreaks. As the high risk of this approach became more widely appreciated, including high initial expenditure, high maintenance costs, data and agency interoperability challenges, and rapid obsolescence, in the last two decades there has been rapid growth in “off the shelf” emergency management software products. The products and services often include support to agencies for further customisation to address any specificities with their hazard set and institutional or national approach. Various industry websites provide summaries of the plethora of business software products specific to emergency management that are available (e.g. SourceForge summarises almost 50 products on its website) (94). The large number of products available, their significant initial and ongoing licensing costs, and the specific technical elements and requirements associated with Veterinary Services and Aquatic Animal Health Services as emergency responders means Veterinary Authorities considering investing in information technology for emergency management should carefully consider their needs and options, and preferably do this in consultation with the national government authority that is the lead coordination agency for emergency management. A national solution to the challenge might involve a generic emergency management event registration and task tracking software tool operating alongside animal health specific software for national demography of farms, animal populations and traceability, for surveillance activities in the field, the Laboratory Information Management System, and specialized tools for epidemiological analysis, predictive modelling, and resource estimation such as personnel required for surveillance and depopulation. A national data strategy that defines data standards in support of interoperability becomes important within any such design.

4.8. Public Information Management, Risk and Crisis Communications

Chapters 3.5 and 3.3 of the OIE Terrestrial and Aquatic Codes, respectively, provide the high-level principles, definitions and systems requirements for communications, including crisis communications, which are further developed within the framework of the OIE Communications Handbook (95) as training support for OIE Member Communications Focal Points.

The understanding of risk communication and approaches to crisis communications is a rapidly evolving field, with new communication technologies and channels through social media, and the rise of misinformation and disinformation, adding to complexity and challenges. Much has been exposed during and learned from the international and national responses to the SARS-CoV-2 pandemic, which deepened and consolidated the understanding of risk and crisis communications from the climate crisis. There have been many excellent recent reviews undertaken by academics, institutions and management

professionals culminating in a large body of recommendations that will need to be further considered and integrated into national and institutional communications tools (96, 97, 98 & 99).

A particularly modern challenge has been characterised as the “infodemic”, meaning too much information including false or misleading information in digital and physical environments during a disease outbreak. The United Nations General Assembly and the World Health Assembly have issued resolutions referencing the infodemic and launched initiatives ranging from international conferences (100), social media monitoring services, a public health research agenda, specific training courses, and highlighting fact-checking services (77).

4.9. Emergency Management Financing, Cost-Sharing and Insurance

International organisations, national governments, the financial sector and the animal-based industries have a common interest in facilitating preparedness and rapid response to emergencies while maintaining fiscal probity based on sound epidemiological and economic judgement. The G20 has recognised the importance of strengthening global health security, identifying a lack of sustainable financing as one of the important reasons for a series of identified weaknesses, including gaps in national preparedness and financing of national action plans for health security. Recognising that investing in preparedness is more cost effective than investing in response, G20 recommended that its members should consider providing a source of sustainable, flexible, and predictable funding for country preparedness and response, and aid other countries in addressing these and other preparedness gaps, including capacities to rapidly deploy resources to enable the global community to scale responses more quickly to future health security threats (101).

Readiness therefore includes developing the investment case and securing financing through: economic impact assessments to understand the scale of risks; costing of response plans and options through benefit:cost analysis; and the establishment of emergency management finances, which may involve cost-sharing policies and funds. The macro-economic perspective to benefit:cost analysis can support the attribution of costs and benefits between public and private entities, supporting policies regarding cost-sharing.

Governments can fund emergency responses directly from the national budget, using specific appropriations achieved through the normal and often time-consuming process, or by establishing a national emergency management funding mechanism with processes supporting urgency while maintaining rigour. Public-private cost-sharing agreements for priority disease outbreaks between governments and animal-based industries are increasingly in place in certain OIE Members and defined in agreements with legal status. The government contribution follows either normal or emergency processes, whereas the private sector’s contribution may be initially under-written by government and re-paid through the producer or processor levies or insurance arrangements.

The financial sector is increasingly providing insurance direct to farmers, or mutualized through industry associations, for specific hazards including disease outbreaks. Certainty and transparency associated with government policies for disease control and compensation are important in the financial sector and industry associations developing the supporting financial instruments to manage sector risks. These issues were explored and reported on during the OIE workshop on animal health emergencies (102). The Organization for Economic Cooperation and Development (OECD) has also produced analysis and case studies exploring economic and social risks and options for livestock disease management (103), and associated compensation schemes (104).

5. OIE Emergency Management strategies, standards, programmes and services

The OIE has long recognised through its international standards and capacity building programmes the important role of Veterinary Services and Aquatic Animal Health Services in managing emergencies that affect animal health, animal welfare, and veterinary public health. In recent years the OIE with Members and Partners, specifically the FAO and INTERPOL through the “Building resilience against Agro-Terrorism and Agro-Crime” project supported by the Weapons Threat Reduction Programme of Global Affairs Canada, has established and consolidated its programme of work to research and promote innovative approaches to improving sustainable management of animal health emergencies (102). OIE’s partnering with INTERPOL has created opportunities to reach audiences with operational capacity committed to our common objectives, be they investigation and response to disease outbreaks or countering criminal behaviour that undermines animal health objectives (105).

OIE has continued its partnership with WHO to ensure Joint External Evaluations to assess country capacities to prevent, detect and rapidly respond to public health risks whether occurring naturally or due to deliberate or accidental events, have a One Health focus, referencing not only the national implementation of WHO International Health Regulations but also OIE International Standards as evaluated through the OIE Performance of Veterinary Services Pathway (106). This ensures that National Action Plans for Health Security (NAPHS) are well informed by the current state across public health, animal health and veterinary public health.

The Quadripartite One Health Joint Plan of Action will build on and strengthen the existing cooperation among WHO, FAO, OIE and UNEP by establishing a common strategy and joint work plan on One Health to improve prevention, monitoring, detection, control and containment of zoonotic disease outbreaks. The plan includes supporting members to strengthen One Health capacities, reduce risks from emerging zoonotic epidemics, control and eliminate endemic zoonotic diseases, address food safety risks and AMR, and integrate the environment into their programmes (107).

5.1. OIE Strategies: Biothreat Reduction, Aquatic Animals

The OIE's Biological Threat Reduction Strategy (108) was developed in 2015 during the 5th Strategic Plan as part of the ongoing drive to strengthen global biological security against deliberate or accidental release of infectious agents. Implementation of the strategy has seen a wide range of initiatives to strengthen systems for intelligence, surveillance, early detection and rapid response, and biosafety and biosecurity.

The OIE's Aquatic Animal Health Strategy (109) was launched in 2021 during the 7th Strategic Plan in recognition of the importance of the contribution of aquatic animal health and welfare to sustainable economic growth, poverty alleviation and food security, and the achievement of the Sustainable Development Goals. Objective 3 of the strategy deals directly with resilience to emerging aquatic animal health issues through developing coordinated approaches to disease emergencies, supporting responses at the national level, and collaboration during emergency responses.

5.2. OIE Position on Climate Change

The OIE has been working internally to achieve clarity on its institutional role in the climate crisis. Improving animal health worldwide, the core mission of the OIE, helps mitigate climate impacts and drive towards environmental sustainability by improving livestock sector efficiency (i.e. improving the ratio of productive outputs to inputs) (110). OIE is also engaged in adaptation to climate change through early warning systems for emerging disease (including climate-sensitive diseases such as vector-borne diseases, and emerging zoonoses with causal webs involving environmental factors), and developing international and national One Health resilience through emergency management systems, which can be applied to endemic, epizootic and emerging disease events, adverse weather events, or the full range of hazards and emergencies discussed in this paper.

5.3. International standards and guidelines relating to Emergency Management

OIE Terrestrial and Aquatic Code Section 1 on listed diseases and surveillance, as well as their implementation through the international notification systems of the OIE-WAHIS, provide early warning systems that are critical for international and national intelligence on animal disease emergencies. The requirement to report emerging diseases specified in Articles 1.1.3 of both Codes, the associated glossary definition of emerging disease, and the recently developed Standard Operating Procedure for emerging diseases (111) add further important detail to the international early warning system. Emergency management is referenced in Terrestrial Code Chapters 3.2 Quality of Veterinary Services, 4.19 Official Control Programmes for Listed and Emerging Diseases, Chapter 3.3 Legislation, and Aquatic Code Chapters 3.2 Quality of Aquatic Animal Health Services and 4.6 Contingency Planning.

FAO produces and publishes the *Good Emergency Management Practice: The essentials - A guide to preparing for animal health emergencies* (GEMP) (49). GEMP is comprehensive in scope, addressing all types of animal health events, all animals (terrestrial, aquatic, domestic and wild), and providing a detailed overview of processes to follow in the different phases of animal health emergencies.

In 2015 the OIE published *Guidelines on disaster management for National Veterinary Services* (112). OIE published *Guidelines for Investigation of Suspicious Biological Events* in 2018 (73). In 2020 OIE published *Guidelines for Simulation Exercises* (90).

The OIE South-East Asia and China Foot and Mouth Disease Commission has produced a training manual on FMD Emergency Preparedness and Response Planning (113).

5.4. OIE Programmes supporting Veterinary Services and Emergency Management

Within the OIE PVS Pathway numerous critical competencies have relevance to the generic capabilities of the Veterinary Services and Aquatic Animal Health Services to respond to emergencies. Specifically, critical competencies I-9 Emergency Funding and II-5 Emergency Preparedness and Response provide a definition and five levels of attainment for these functions, framed in accordance with the international standards (Figures 7 and 8). OIE PVS Pathway Evaluation Reports of Members therefore provide information that is interesting and relevant to emergency management capabilities and systems (Figures 9 and 10).

II-5. EMERGENCY PREPAREDNESS AND RESPONSE	
DEFINITION	LEVELS OF ADVANCEMENT
The authority and capability of the VS to be prepared and respond rapidly to a sanitary emergency threat (such as a significant disease outbreak or food safety emergency).	1. The VS have no field network or established procedure to determine whether a sanitary emergency threat exists or the authority to declare such an emergency and respond appropriately.
	2. The VS have a field network and an established procedure to determine whether a sanitary emergency threat exists, but lack the legal and financial support to respond effectively. The VS may have basic emergency management planning, but this usually targets one or a few diseases and may not reflect national capacity to respond.
	3. The VS have the legal framework and financial support to respond rapidly to sanitary emergency threats, but the response is not well coordinated through an effective chain of command. They have national emergency management plans for some exotic diseases, but they are not updated/tested.
	4. The VS have the legal framework and financial support to respond rapidly to sanitary emergencies through an effective chain of command (e.g. establishment of a <i>containment zone</i>). The VS have national emergency management plans for major exotic diseases, linked to broader national disaster management arrangements, and these are regularly updated/tested such as through simulation exercises.
	5. The VS have national emergency management plans for all diseases of concern (and possible emerging infectious diseases), incorporating coordination with national disaster agencies, relevant <i>Competent Authorities</i> , producers and other non-government stakeholders. Emergency management planning and response capacity is regularly tested, audited and updated, such as through simulation exercises that test response at all levels. Following emergency events, the VS have a formal 'After Action Review' process as part of continuous improvement.

Figure 7. Criteria for Critical Competency II-5 in the World Organisation for Animal Health (OIE) Performance of Veterinary Services Tool

I-9. EMERGENCY FUNDING	
DEFINITION	LEVELS OF ADVANCEMENT
The capability of the VS to access extraordinary financial resources in order to respond to emergency situations or newly emerging issues, as measured by the ease with which contingency and related funding (i.e. arrangements for compensation of producers in emergency situations) can be made rapidly available when required.	1. No emergency funding arrangements exist.
	2. Emergency funding arrangements with limited resources have been established, but these are inadequate for likely emergency situations (including newly emerging issues).
	3. Emergency funding arrangements with limited resources have been established; additional resources may be approved but approval is through a political process.
	4. Emergency funding arrangements with adequate resources have been established; their provision must be agreed through a non-political process on a case-by-case basis.
	5. Emergency funding arrangements with adequate resources have been established and their rules of operation documented and agreed with interested parties.

Figure 8. Criteria for Critical Competency I-9 in the World Organisation for Animal Health Performance of Veterinary Services Tool

OIE's Emergency Preparedness and Resilience Programme (114) supports OIE Members in planning and responding to animal health emergencies. This includes developing guidelines and informing the development of standards based on the latest scientific evidence shared from the OIE's network of Reference Centres and Partners, overseeing initiatives to build capacities in Members for preparedness and resilience, and promoting the One Health approach. The OIE provides access to the National Contingency Plans of OIE Members when Delegates have granted permission to publish their plans on the OIE website.

Within this broader programme, the joint OIE-FAO-INTERPOL project on agro-crime, agro-terrorism and emergency management project has been supporting emergency management capability development in OIE Members through workshops, guidelines development, and a nascent twinning programme. Through the relationship built from this project, the OIE and INTERPOL have agreed and signed a memorandum of understanding to formalise their cooperation to better support their respective Memberships with regards to threats posed by acts of agro-crime, agro-terrorism and incidents involving animal and zoonotic pathogens, or biological toxins affecting animals. Through consultations with respective Members the two organisations will work to develop a plan to operationalise the agreement and to encourage Veterinary Services and Aquatic Animal Health Services in OIE Members to actively collaborate with their counterparts in Law Enforcement. New funding support from Global Affairs Canada, the donor for this project, will further extend the OIE's Emergency Management and Resilience work (see 5.8 below).

More generally, the Global Burden of Animal Diseases (GBADs) programme (115) is intended to help monitor impact and costs of animal diseases over time, while the OIE Observatory (116) will monitor implementation of international standards, combining to create a monitoring framework that will help prioritise diseases, and measure capability and programme performance.

5.5. OIE Collaborating Centre Network on Veterinary Emergencies (“EmVetNet”)

As part of its core mission, the OIE aims to share the latest scientific evidence to inform animal health and welfare policy. OIE Collaborating Centres are present in all regions and are designated to provide services to the OIE within a Focus Area and Speciality (117). As part of their terms of reference, Centres should establish and maintain networks with other Centres in similar fields. In 2018 the OIE Collaborating Centre Network on Veterinary Emergencies (EmVetNet) was founded and includes:

- The Centro Nacional de Sanidad Agropecuaria (CENSBA) in Cuba focused on the reduction of the risk of disasters in animal health.
- The Institute for Infectious Animal Diseases (IIAD), Texas A&M University in the United States focused on biological threat reduction.
- The Istituto Zooprofilattico Sperimentale dell’Abruzzo e del Molise “G. Caporale” (IZSAM) in Italy comprising four Centres working on a) veterinary training and capacity building, b) epidemiology, modelling and surveillance, c) animal production and food safety, and d) animal welfare.

EmVetNet facilitates evidence-based approaches to the OIE's Emergency Preparedness and Resilience Programme and aims to foster a scientific network of experts working in this field. The objectives of the Network are:

- To provide technical advice and support for training, exercising, and evaluation across the emergency management cycle for all hazards, and to facilitate multidisciplinary approaches
- To exchange and share knowledge on best practices (including models and case studies e.g., model legislation, contingency/emergency plans, communication)
- To make recommendations on research needs to support veterinary emergency management.
- To identify, cooperate and coordinate with stakeholders (Member Countries, NGOs, public health, private sector) and seek to extend and diversify the network.

- To support operational activities e.g. OIE, Quadripartite, GOARN, or FAO EMC-AH response missions.

This will eventually lead to Competency Package 6 Emergency Management development as part of the OIE Training Platform (118). As the OIE continues to build its emergency preparedness and resilience programme, the expertise from EmVetNet will be essential to ensure it is fit-for-purpose and accounts for the latest developments in the field.

5.6. Rinderpest Post-Eradication – contingency planning approach for resurgence

In 2011 Rinderpest was declared globally eradicated after a joint programme between OIE and FAO. Since the last case was recorded in 2001, efforts have focused on confirming eradication through surveillance, identifying virus stocks held in laboratories and ensuring they are held under appropriate biosafety conditions, and contingency planning for a resurgence. This post-eradication phase of the Rinderpest campaign is a world first in animal health, sitting alongside the public health programme following smallpox eradication, and therefore much has been learned and progressively implemented. The “Never turn back” campaign is coordinated through GF-TADs and supported by a Joint Advisory Committee and Secretariat. It has involved the development of the Global Rinderpest Action Plan (119) laying out activities in each phase of the emergency management cycle, as well as roles and responsibilities; the designation of facilities as Rinderpest Holding Facilities and Rinderpest Vaccine Holding Facilities for holding virus containing materials and vaccine respectively, with a monitoring and reporting mechanism; update of the Rinderpest Chapter of the Terrestrial Code to provide the regulatory framework for these prior activities; and publication of a range of advocacy, training and capability development products, such as the serious game Rinderpest Vigilance, and various publications and infographics (120).

5.7. OIE Wildlife Health Framework and EBO-SURSY Project

The outbreaks of Ebola virus in West Africa 2013 -2016 were some of the most significant public health emergencies in recent times. To build capacity to avoid a repeat and to prevent future largescale outbreaks of viral haemorrhagic fevers, the OIE, supported by the European Union, and in partnership with CIRAD, Institute Pasteur, and IRD launched the seven year EBO-SURSY project in 2017 (121). The project aims to strengthen early detection systems for wildlife in West and Central Africa to prevent outbreaks of Ebola Virus Disease (EVD), four other viral haemorrhagic fevers (Marburg virus, Rift Valley fever, Crimean-Congo haemorrhagic fever, and Lassa fever) and coronavirus. The project embraces a One Health and multiscale approach, looking at pathogens' transmission pathways at the human-animal-environment interface from the molecular scale to the ecosystem level, while engaging young professionals and students in multibackground teams led by implementing partners with expertise ranging from animal health, human health, ecology, virology, epidemiology to the latest innovative laboratory diagnostics. Several years of capacity building, especially at the laboratory level, allowed some countries to be able to switch from Ebola virus to SARS-Cov-2 virus diagnostic capacity, increasing the rapidity of diagnostic response in the COVID-19 pandemic. In addition, a multi-sectoral investigation team was able to be mobilised in a timely manner to investigate a potential source of Ebola Marburg source in wildlife shortly after a Marburg outbreak was declared in Guinea in 2021 for the first time.

Wildlife are inextricably involved in the epidemiology of several important animal diseases (avian influenza, PPR, FMD) and zoonoses (rabies, Lassa fever, yellow fever, EBOV, Marburg), sometimes as reservoirs or as victims of disease themselves. Wildlife populations in Africa have still not recovered from the rinderpest outbreaks which swept through the southern part of the continent in the latter part of the 19th century. As a result of this association, wildlife are often viewed as a threat for disease emergence, which is misleading. Wildlife are a vital resource, providing essential ecosystems services and a source of biodiversity. Wildlife are at the heart of resilient ecosystems and also at risk from disease emergence. Managing the risk of disease emergence and protecting wildlife health should be complementary. Wildlife are particularly vulnerable to natural (wild fires, extreme weather events, floods) and unnatural (land use change, deforestation, pollution, chemical and toxin spills) disasters. The direct impact of such disasters on wildlife populations can be catastrophic. Such hazards may also disrupt the natural ecosystem, creating conditions for a disease emergence or spill over. It is important that wildlife health is incorporated into emergency management frameworks.

With the adoption of the OIE Wildlife Health Framework by its Membership in 2021 (122), wildlife has become recognised as an integral component of OIE's core work programme. The framework reflects a strategy with the mission of 'protecting wildlife health to achieve One Health' and two overarching objectives: managing the risk of disease emergence at the human-animal-ecosystems interface, and protecting wildlife health. The first phase of implementation has focussed on identifying opportunities to strengthen wildlife health in existing frameworks (international standards, PVS Pathway, OIE Training Platform) and strengthening cooperation with key partners at international and national level. Wildlife health is not the responsibility of one agency at national level or one organisation at international level and therefore it is essential to work through cooperative partnerships. Work has also been initiated on guidance aimed at reducing the risks of disease spill over through wildlife trade and along the wildlife supply chain, an important component of prevention.

5.8. OIE Incident Management System

The SARS-CoV-2 pandemic thrust the WHO into a high-pressure environment, as lead technical agency for the UN system during the global response. Mirroring national multi-agency emergency response systems, the OIE adopted for itself a support agency role to the global One Health response by ensuring WHO had access to animal health expertise from the network of OIE Members, Partners and References Centres, and that national Veterinary Services were informed, connected and supported as pandemic impacts and response operations spread. For the first time, and without prior training, OIE established an Incident Management System approach, with a bespoke internal structure of groups with designated roles coordinated through a weekly rhythm to achieve situational awareness, coordinated work planning and issues management (123). SARS-CoV-2 in animals was designated as an emerging disease, evoking notification obligations from Members and resulting in the ability to compile and publish comprehensive and up-to-date intelligence on animal-based events. Expert groups were formed to advise on specific topics using the institutional processes of *ad hoc* Groups, ensuring animal health expertise was available to WHO for the development of the science and research agenda and investigation of origins, and producing a range of guidelines supporting national Veterinary Services and their engagement in national emergency management systems. The OIE webpages on COVID-19 became a trusted source of information and advice, with a wide range of media resources to support public understanding of SARS-CoV-2 as a zoonosis, the role of the OIE, and national Veterinary Services (124).

Recognising this experience would be formative for the organization, in late 2020 the OIE instigated a formal After-Action Review process in two stages, with an interim report in early 2021 and a follow-up later the same year. Findings and recommendations were structured in four components: the technical component of mobilizing the OIE networks; the events management component relating to the re-design of delivery mechanisms for essential business during 2020 when the General Session was cancelled and in 2021 when it was held as a virtual event for the first time; a component relating to institutional internal and external communications; and a component covering human resources and logistics.

In 2021 the OIE Incident Management System was initiated for the second time to ensure strong internal coordination when ASF was first reported in the Americas, in Dominican Republic in July 2021. These experiences are consolidating the OIE experience in emergency management in support of OIE Members and Partners, in particular the partnership with FAO through GF-TADs and the FAO EMC-AH.

Building on these experiences, the OIE recently signed a grant with the Weapons Threat Reduction Programme of Global Affairs Canada for a three-year Project titled *Fortifying Institutional Resilience Against Biological Threats*. The project will improve OIE's ability to anticipate, respond and recover from emergencies (including bio-crime and bio-terrorism events) and ensure business continuity, in the face of international emergencies, thereby ensuring continuity of support for its Members. The project will contribute more broadly to the OIE Emergency Management and Resilience work programme by:

- strengthening OIE Member Countries' abilities to respond to emergencies (including bio-crime and bio-terrorism events), particularly in Africa
- improving capacity of Veterinary Services and Aquatic Animal Health Services globally to respond to biological emergencies in a timely and efficient manner

- strengthening OIE as a partner for other security organisations thereby strengthening the health-security function.

5.9. OIE and the Quadripartite incident coordination processes

The OIE, WHO and FAO coordinate themselves in response to emergencies at the human-animal interface, with UNEP now to be integrated into this process. The nature of cooperation varies depending on the context, including the characteristics of the emergency and the specific needs of the sector. This requires an ‘agile system’ for cooperation which can be responsive to different situations.

Building from the experience gained since the early 2000s managing the international crises involving zoonotic transmission of highly pathogenic avian influenza (HPAI) H5N1 Asian lineage from farmed poultry, the OIE and FAO established the OFFLU, which has continued to coordinate international surveillance, including specific advice and support to WHO regarding preparation of human vaccines. OFFLU’s objectives include supporting risk assessment and capacity building. The uncontrolled spread of HPAI H5N1 across the world highlighted the deficiencies of veterinary services to respond to emergencies. Significant investments were made to bolster the capacity of Veterinary Services in low-income countries, but much of this investment was short lived and not sustainable once the threat of a pandemic had receded. HPAI was not only the stimulus for OFFLU, but also the stimulus for GF-TADS (to better coordinate FAO and OIE activities), the Tripartite agreement, the OIE-FAO Crisis Management Centre (as it was originally established, later becoming the FAO EMC-AH), and the OIE laboratory twinning programme. The United Nations community responded in 2007 by establishing the United Nations System Influenza Coordination mechanism, of which OIE was a member.

Subsequent areas of significant crisis coordination between OIE, FAO and WHO included MERS-CoV, zoonotic H7N9 influenza and SARS-CoV-2. On each occasion the OIE was included in joint investigations into the origin and as the animal health sector representative in technical advisory groups.

Engagement of the environment sector in the Quadripartite preparedness and response coordination mechanisms, through UNEP, has been more recent as a result of increasing evidence that environmental factors, both local and global, play a significant role in disease emergence and epidemiology. Greater engagement of the environment sector should create opportunities for better predicting, preparing for and responding to outbreaks.

5.10 OIE Scientific Publications on Emergency Management

The 2004 publication of OIE Scientific and Technical Review volume 23/2 on *Emerging zoonoses and pathogens of public health concern* (125) reviewed the then recent emergence of SARS-CoV and the role of animal hosts in coronavirus emergence; the zoonotic avian influenza H5N1 epizootic; arbovirus epidemiology, evolution and emergence; animal production systems and their role in controlling zoonotic risks on-farm; and the role of wildlife in emerging zoonosis. The 2006 OIE Sci Tech Rev volume 25/1 on *Biological Disasters of animal origin: the role and preparedness of veterinary and public health services* (126) examined case studies on deliberate and accidental animal disease events; crisis management tools and incident management systems; the investment case for preparedness; traceability, modelling and microbial forensics and the need for international and national collaboration to build systems for emergency management and One Health resilience. The 2008 OIE Sci Tech Rev volume 27/1 (127) focused on aquatic animal health emergencies, looking at the principles of governance during emergencies; contingency planning; farm-level biosecurity plans; biotechnological tools, modelling and compartmentalisation in aquatic systems.

The 2017 OIE Sci Tech Rev volume 36(2) dedicated to *Biological Threat Reduction* reviewed the use of animal pathogens and zoonotic agents as bioweapons, and the potential impacts of animal pathogens, including zoonotic agents, on economies, social unrest, food security, and public health (128). Even more recently, the 2019 OIE Sci Tech Rev volume 38/1 (129) provided many case studies of One Health services responding to Middle East Respiratory Syndrome coronavirus (MERS-CoV); the great Japanese earthquake of 2011; Ebola virus during West African outbreaks in 2013-2016; and the overall importance of One Health approaches to Global Health Security.

When Veterinary Services were surveyed for the 2019 Technical Item on *Veterinary Services in a changing world: climate change and other external factors*, as published and expanded upon in the

2021 OIE Sci Tech Rev volume 40/2 sharing the same title (130), they reported emerging disease, adverse events and crisis management systems as some of their leading preoccupations.

In 2020 the OIE Sci Tech Rev volume 39(2) was dedicated to *Disaster Prevention and Preparedness* (1), providing the most comprehensive and up-to-date series yet. The review articles and experiences of OIE Members in this volume provide both broad and deep coverage of the science, technologies and disciplines for emergency management that are relevant to Veterinary Services and Aquatic Animal Health Services. They address integration of Veterinary Services and Aquatic Animal Health Services into national emergency planning frameworks, case studies and reviews of different hazard types, planning and coordination addressing specific issues and challenges such as information management, human resource management, new technologies, conflict areas and animal welfare, and the interface with security services and military forces.

6. Emergency Readiness and Response in OIE Members

6.1. PVS Pathway summary review

In 2018 through to 2019, as the OIE was launching a new programme of activities with partners FAO and INTERPOL focused on emergency management, agro-crime and agro-terrorism, a review of the emergency management capacities and national contingency plans (NCP) in OIE Members was undertaken (131). That project included compilation and synthesis of information from 125 OIE PVS Pathway reports in relation to the two specific critical competencies relating to Emergency Management, CC I-9 on Emergency Funding and CC II-5 on Emergency Preparedness. The OIE reviewed 125 PVS evaluation reports from OIE Members and found for emergency response only 53 Members were at level 3 or above, and for emergency funding 55 Members were at level 3 or above (Figures 9 and 10).

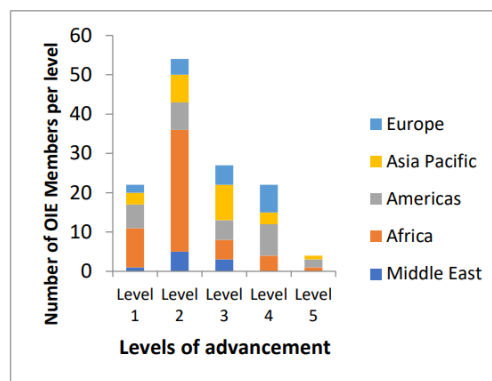


Figure 9. Summary of OIE PVS Pathway results by region (n=125) showing levels of advancement for emergency response (CC II-5)

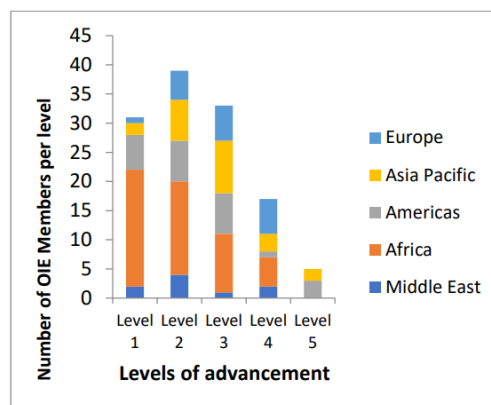


Figure 10. Summary of OIE PVS Pathway results by region (n=125) showing levels of advancement for emergency funding (CC I-9)

6.2. National contingency planning and plans

The same project reported on the status of National Contingency Planning in OIE Members following a survey which inquired on the existence of generic or disease specific plans. It was found that most OIE Members had a national contingency plan (nearly 90%) for at least one disease. However, this does not necessarily mean the Veterinary Services and Aquatic Animal Health Services have the capacity to implement the plan as shown by the evidence from the review of PVS Evaluation reports. Some of the OIE Members consulted in this review have allowed the OIE to publish their contingency plans on the OIE website as part of a database of National Contingency Plans to support emergency planning by sharing good practices (114).

6.3. Regional collaboration and shared resourcing

The OIE's Regional and Sub-Regional Commissions, either directly within Commission work programmes and conferences, within the GF-TADs collaboration with FAO, or in specific programmes such as SEACFMD, provides an environment where sharing of good practices and collaboration in planning, programmes and capacity building is supported.

6.4. European Union Foot-and-Mouth Disease Commission “Get Prepared” Programme

“Get prepared” is an emergency preparedness programme and toolbox developed by EuFMD. The components of emergency preparedness are graphically represented as a wall, with each brick in the wall envisaged as eventually providing access to response tools, and resources for assessing gaps and developing capacity. The on-line publication of the tools is being progressively implemented (132, 133)

6.5. The Animal Health Quadrilateral Alliance, UK and Ireland International Animal Health Emergency Reserve

The International Animal Health Emergency Reserve (IAHER) was conceived in 2004 and has been progressively formalised between the Veterinary Authorities of Australia, Canada, Ireland, New Zealand, United Kingdom and United States of America as a technical resource sharing arrangement during emergencies. An operations manual sets out agreed policies, procedures and templates ensuring rapid activation and deployment of personnel in emergencies, on the request of the hosting country. Policies define how technical competency requirements are specified, and address employment conditions for all deployed personnel, including insurance and professional indemnity coverage (134 & 102).

6.6. Nordic-Baltic Veterinary Contingency Group

The Nordic-Baltic Veterinary Contingency Group (NBVCG) is a Nordic-wide Working Group for Microbiology & Animal Health and Welfare that has been active since 2006. The primary objective is to improve cooperation, communication, and exchange of information and experiences between the Veterinary Authorities within the Nordic-Baltic region, in the context of contingency planning and during animal disease emergencies. This pooling of resources for a regional exercise can allow smaller countries to have their voices heard and to play an active role in emergency preparedness activities. The Group has run multiple exercises, and publishes reports and plans on its website (135 & 102).

6.7. Public-private partnership approaches to incentivise preparedness and share decision-making and costs during responses

The OIE Public Private Partnership (PPP) programme (136) has developed a typology of PPP initiatives in three clusters (Transactional, Collaborative and Transformative PPPs), identified over 100 success stories after surveying OIE Members (recently launched as a searchable database), and published a guideline for setting up different types of PPPs. Relevant initiatives that demonstrate shared design, decision-making and funding for emergency preparedness and response include:

- Animal Health Australia, a partnership between multiple levels of government, livestock industry and other stakeholders set up as a not-for-profit public company to develop response strategies and plans, deliver training to members, and perform specific services relating to biosecurity, traceability, surveillance and animal welfare standards (137.)
- Foundation of Animal Health Services (FUNDASSA) collaboration between the Veterinary Authority of Paraguay (SENACSA) and cattle producers to support operations within the national programmes for eradication of FMD, and control, prevention and eradication of brucellosis (138).
- Namibia's collaboration between the Directorate of Veterinary Services and the Meat Board of Namibia to develop FMD contingency plans, which includes mobilisation of resources (Emergency animal health fund for FMD) and operational and communications campaigns to rapidly contain outbreaks, successfully implemented in 2015 and 2021 (102).
- The United States Department of Agriculture Business Continuity and Security Food Supply Plans that define good biosecurity practices through risk analysis processes for different food producer and processor sectors, in order to implement continuity of business plans during disease outbreaks, incentivising compliance through a variety of proactive mechanisms in advance of outbreaks, and reactive ones during responses (139).

7. Conclusions

7.1. National Emergency Management Programmes are adopting All-Hazards and Whole-of-Government approaches that encompass the veterinary domain and inter-disciplinary systems-based One Health approaches

Zoonotic emergence and pandemic spread of novel infectious agents like SARS-CoV-2 has emphasized infectious disease hazards as international and national crises, triggering international and national emergency management mechanisms that require collaboration between international organisations, executive arms of governments and political leaders, Competent Authorities for public health and animal health, national security services, and a broad range of other government agencies and civil society organisations, including those focused on maintaining essential services and providing humanitarian support. Despite years of effort in preparedness for zoonotic hazards not dissimilar to the SARS-CoV-2 scenario, national response plans quickly veered into uncharted territory, with the implementation of measures such as lockdowns and border closures not foreseen in Pandemic Influenza Preparedness Programmes, illustrating weaknesses in strategic and technical coordination during preparedness planning.

In parallel, the world is experiencing more frequent adverse events due to weather and climate, with significant impacts on public health, animal health, animal welfare, food security, and livelihoods.

The threat of civil unrest and conflict also constitutes a risk for Veterinary Services and Aquatic Animal Health Services, either through disruption of infrastructure and governance, by amplifying infectious disease risks, by creating food insecurity, threatening workforce safety, or a combination of all of these.

Emergency management has rapidly evolved and expanded as a political and technical professional discipline. National emergency planning now involves legislation, policies and plans that embed the all-hazards and whole-of-government approach to planning and preparedness. A standard toolkit within national Incident Management Systems is being adopted by the agencies designated lead and support roles for responses to different hazards and scenarios.

Veterinary Authorities, Veterinary Services and Aquatic Animal Health Services are most often engaged leading emergency responses to animal health and food safety events. Veterinary Authorities, Veterinary Services and Aquatic Animal Health Services should also be ready to support animal health, animal welfare and food safety objectives within a diverse range of other emergency scenarios from other hazards. Interdisciplinary One Health whole-of-government scenario planning will ensure a comprehensive approach to establishing objectives and considering impacts.

Veterinary Authorities familiarity with risk analysis approaches, design and implementation of animal health policies and programmes, contingency planning and capability development provide the core skills for this engagement.

There are specific knowledge, skills and competencies associated with National Emergency Management systems that Veterinary Authorities, Veterinary Services and Aquatic Animal Health Services can acquire to ensure they successfully navigate and operate within these systems. National Emergency Management Systems typically welcome Veterinary Authorities, Veterinary Services and Aquatic Animal Health Services engagement, as a result of the specific capabilities they bring, and the increasing identification of animal health, animal welfare, zoonosis and veterinary public health as encompassing important hazards within national planning. Engagement within national COVID-19 responses over the last two years provides an important platform to build a long-standing relationship if this did not already exist.

7.2. Engagement in National Emergency Management enhances the investment case for Veterinary Services and Aquatic Animal Health Services.

Veterinary Authorities tend to narrowly define their mandate based on “peace-time” pre-occupations, in particular control programmes for animal disease. However, an emergency event such as those discussed in this paper, invoking a national crisis, precipitates a significant change in national priorities. Political and organisational leaders rapidly reorient priorities towards the crises. They will look across their services for the agencies with capabilities to assist in crisis management. Emergencies provide technical agencies with significant opportunities for direct interaction with highly engaged political leaders.

During national emergencies, Veterinary Authorities will be expected to provide the gateway to the animal-based skills amongst a wide grouping of Veterinary Services and Aquatic Animal Health Services stakeholders, whenever this access is required. The broad implications of many of the hazards within national emergency management plans create important impacts for production animals and wildlife sectors, and Veterinary Authorities should engage in broad systems thinking to identify these impacts and how they can contribute.

Veterinary Authorities will have leadership, management, administration and communications skills that may be co-opted by the national crisis management team. Being prepared for this rapid re-orientation will ensure that Veterinary Authorities, Veterinary Services and Aquatic Animal Health Services contribute to national and international objectives. Being unprepared or inflexible during such times of emergency management could result in long-lasting damage to the reputation of Veterinary Authorities. Emergency preparedness is an opportunity to demonstrate broad utility of Veterinary Authorities, Veterinary Services and Aquatic Animal Health Services, enhancing the investment case.

7.3. The current state of Veterinary Services and Aquatic Animal Health Services engagement in emergency management reflects highly variable experience, capability and engagement.

Do the Veterinary Authorities, Veterinary Services and Aquatic Animal Health Services in OIE Members understand and are they ready to play the role expected of them in National Emergency Management systems? The experience and state of readiness is highly variable, and the factors affecting variability are not well understood. Levels of resourcing clearly play a role; however, it would be wrong to automatically leap to the conclusion they are the major factor.

The maturity of the National Emergency Management framework that Veterinary Authorities, Veterinary Services and Aquatic Animal Health Services participate in is surely another factor, since clear systems, processes and priorities at the national level providing clear expectations of different agencies will facilitate engagement. Regional mechanisms can play an important role in supporting national planning.

Veterinary Authority leadership is possibly the most important factor. Recognising the opportunities from a broader systems-based engagement in national emergency management preparedness and response systems should encourage Veterinary Authorities to orientate their services towards supporting national objectives. Veterinary Authority leaders should use strategic foresight to recognise and understand risks and opportunities for their organisations associated with the full array of current and future hazards that evoke national emergencies, using programme planning and management to establish incremental benefits for emergency preparedness building from everyday priorities and programmes, so that services are ready to rapidly pivot towards emergencies when inevitably called upon to do so.

Highly variable national contexts in relation to hazards, scenarios, objectives, resources and approaches requires emergency preparedness to be nationally bespoke: importing plans from another country doesn't work. As is often the case, the planning process is probably more important than the plan itself because the actual emergency scenario encountered will likely differ from those defined in plans. Moreover, preparedness involves both the plan and the capability necessary to execute. Capability covers designated roles and responsibilities, human resources with technical and logistical skills and competencies, and equipment. A training and exercise programme is important.

Resource constraints in Veterinary Authorities, Veterinary Services and Aquatic Animal Health Services in all countries will require that "peace-time" priorities are used to create a solid base for emergency capability, in so far as they can. Defining the mechanisms to rapidly scale up from this base with adoption of emergency management structures, systems and processes is the primary objective of preparedness programmes.

7.4. OIE has enhanced its emergency management service offering to Members but there are further opportunities to develop support mechanisms to improve uptake and implementation.

The OIE has recognised in its international standards that emergency management is a core service and requirement of Veterinary Authorities, Veterinary Services and Aquatic Animal Health Services. The OIE Emergency and Resilience Programme has been established to provide a focus for services to OIE Members.

Good emergency management practices across OIE Members are being identified through the Emergency and Resilience Programme, within the PVS Pathway, and in the Public Private Partnership programme. Our collaborations with Partners such as the Quadripartite, EuFMD, and INTERPOL opens access to a wide range of additional resources and serves as a model for the inter-disciplinary cooperation that we expect from national Veterinary Authorities within all-hazards whole-of-government emergency management services.

The OIE has established the OIE Collaborating Centre Network for Veterinary Emergencies as a mechanism to exchange knowledge, encourage best practices and support capacity building. The OIE Training Portal identifies Competency Package 6 for Emergency Management, though has not yet developed and published training modules within this package.

The degree of involvement of Veterinary Services in wildlife health varies between countries, and the national lead on wildlife topics may be shared between different agencies e.g., Veterinary Services, law enforcement, Wildlife Health Authorities, environment agencies, NGOs. With the greater recognition of the importance of ensuring wildlife health to achieve One Health, the OIE will also be looking to better integrate wildlife health within its emergency management frameworks

Through these mechanisms the OIE has created the structures that can be developed into a comprehensive service offering to Members to assist the development of emergency management capability. As always, the support of OIE Members and Partners in bringing this vision to fruition will be crucial.

7.5. OIE should continue to work within and contribute to the development of systems operating between institutions and agencies that form the international crisis management system, including the negotiation of a new international instrument on pandemic prevention and preparedness, so that OIE expertise and networks contribute to cohesive strategic and operational systems for prevention, readiness, response and recovery from international emergencies, including pandemics, grounded in the One Health approach.

As well as the existing mechanisms reviewed in this paper, OIE is closely engaged, with the Quadripartite, and through initiatives supported by G7 and G20, in several important initiatives that are further developing international One Health prevention, preparedness and response capability. The OHHLEP is providing technical support and advice for this work as new international systems are designed and implemented. The high-level design of a global intelligence and early warning framework within the G7-endorsed and UK-government supported One Health Intelligence Scoping Study makes clear that an effective risk management response to any intelligence triaged through risk assessment

processes is critical, though beyond the scope of that particular project. Some risk management response capability already exists within Quadripartite systems, but there are limitations that constrain these systems so that they are neither comprehensive across the One Health spectrum nor particularly well-coordinated with other national processes or international processes driven from the UN system or civil society.

The launch of the International Negotiating Body and the exploration of options for an international instrument in support of pandemic prevention, preparedness and response, considering options such as a framework agreement, a stand-alone treaty, or a WHO instrument, is crucial to consolidate international will and provide strategic direction. Any instrument should adopt the OHHLEP definition of One Health as an overarching principle, and it is essential that all relevant organisations be included in the negotiation process. The OIE and its Members should continue to strongly promote the importance of animal health, animal welfare, and veterinary public health, and therefore the matters under the mandate of the OIE and its Members, as key components of this One Health approach. The OIE's mandate, its standards, the data that we collect and its contribution to the international early warning and risk assessment system, and our role in supporting capacity development in our Members are critical elements of pandemic prevention, readiness and response under this One Health approach. The OIE must be engaged in the design and negotiation process, and eventual implementation, of any new international instrument for pandemic prevention, and that process and instrument should recognise the OIE mandate, standards and strategies.

References:

1. World Organisation for Animal Health (OIE) (2022). Disaster prevention and preparedness. Science and Technical Review 39(2) Editor: Vroeginewey, G.A. Available at: https://doc.oie.int/dyn/portal/digidoc.xhtml?statelessToken=1aOi3qxm6eufRPJ7yi1-p8-MVycGRtcZ3WnPSx_PfW8=&actionMethod=dyn%2Fportal%2Fdigidoc.xhtml%3AdownloadAttachment.openStateless (accessed on 6 April 2022).
2. World Organisation for Animal Health (OIE) (2020). Strengthening preparedness and resilience to emergencies. Panorama Bulletin 2020-2. OIE, Paris, France. Available at: <https://OIEbulletin.fr/wp-content/uploads/2020/Panorama2020-2/panorama-2020-2-en.pdf> (accessed on 6 April 2022).
3. Intergovernmental Panel on Climate Change (IPCC), (2022): Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report [H. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegria, M. Craig, S. Langsdorf, S. Lösschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. Available at: <https://www.ipcc.ch/report/ar6/wg2/> (accessed on 6 April 2022).
4. World Organisation for Animal Health (OIE) (2021). Aquatic Animal Health Code, 4.6 Contingency Planning. OIE, Paris, France. Available at: https://www.oie.int/en/what-we-do/standards/codes-and-manuals/aquatic-code-online-access/?id=169&L=1&htmlfile=chapitre_contingency_planning.htm (accessed on 6 April 2022).
5. Sarkodie, S.A., Owusu, P.A. (2021) Global assessment of environment, health and economic impact of the novel coronavirus (COVID-19). *Environ Dev Sustain* **23**, 5005–5015. Available at: <https://doi.org/10.1007/s10668-020-00801-2> (accessed on 6 April 2022).
6. Bernstein, A.S., Ando, A.W., Loch-Temzelides, T., Vale, M.M., Li, B.V., Li, H., Busch, J., Chapman, C.A., Kinnaird, M. Nowak, K., Castro, M.C., Zambrana-Torrel, C., Ahumada, J.A., Xiao, L., Roehrdanz, P., Kaufman, L., Hannah, L., Daszak, P., Pimm, S.L., Dobson, A.P. (2022) The costs and benefits of primary prevention of zoonotic pandemics. *Science Advances* Vol.8, No. 5. Available at: <https://www.science.org/doi/epdf/10.1126/sciadv.abl4183> (accessed on 6 April 2022)
7. Food and Agricultural Organisation of the United Nations (FAO), World Organisation for Animal Health (OIE) and World Health Organisation (WHO), (2019). Taking a Multisectoral, One Health Approach: A Tripartite Guide to Addressing Zoonotic Diseases in Countries. Available at: <https://www.oie.int/app/uploads/2021/03/en-tripartitezoonosesguide-webversion.pdf> (accessed on 6 April 2022).
8. Nasim, A., Attal-Juncqua, A., Eia, C., Phelan, A. and Katz R. (2020) Inclusion of Veterinary Services in national emergency management plans *Scientific and Technical Review*, 2020, 39 (2), 359-371. Available at: https://doc.oie.int/dyn/portal/digidoc.xhtml?statelessToken=nU5dM_O5zgdglSpcq9d1_EVxo2Bf4sc-PNMKcoCBqc=&actionMethod=dyn%2Fportal%2Fdigidoc.xhtml%3AdownloadAttachment.openStateless (accessed on 6 April 2022).
9. United Nations Environment Programme (UNEP) (2016) *Frontiers 2016 Report: Emerging Issues of Environmental Concern*. United Nations Environment Programme, Nairobi. Available at:

- https://www.unep.org/resources/frontiers-2016-emerging-issues-environmental-concern?_ga=2.199938727.821360607.1644352687-1052337560.1644352687 (accessed on 6 April 2022).
10. United Nations Environment Programme (UNEP) and International Livestock Research Institute (ILRI) (2020). Preventing the Next Pandemic: Zoonotic diseases and how to break the chain of transmission. Nairobi, Kenya. Available at: <https://www.unep.org/resources/report/preventing-future-zoonotic-disease-outbreaks-protecting-environment-animals-and> (accessed 6 April 2022).
 11. Xia, W., Hughes, J., Robertson, D. and Jiang, X. (2021) How One Pandemic Led to Another: Asfv, the Disruption Contributing to Sars-Cov-2 Emergence in Wuhan. Available at: <https://www.scienceopen.com/document?vid=c0524475-8a3f-4926-934f-9459fb8d760e> (accessed on 26 April 2022).
 12. World Organisation for Animal Health (OIE) (2021) Disease Alerts. Alert message: Unlicensed ASF Vaccines. OIE, Asia and the Pacific. Available at: <https://rr-asia.oie.int/en/news/alert-message-unlicensed-asf-vaccines/> (accessed on 6 April 2022).
 13. World Organisation for Animal Health (OIE). Self-declaration of the recovery of freedom from African swine fever in all suids by the Czech Republic. Self-declaration submitted to the OIE on 01 April 2019. Available at: https://www.oie.int/fileadmin/Home/eng/Animal_Health_in_the_World/docs/pdf/Self-declarations/2019_05_CzechRep_ASF_ANG.pdf (accessed on 6 April 2022)
 14. World Organisation for Animal Health (OIE) (2022) High Pathogenicity Avian Influenza (HPAI) Situation Report. Available at: <https://www.OIE.int/app/uploads/2022/03/hpai-situation-report-20220224.pdf> (accessed on 6 April 2022).
 15. Food and Agricultural Organization of the United Nations (FAO) and World Organisation for Animal Health (OIE). Joint OIE-FAO Scientific Network on Avian Influenza (OFFFLU). Available at: <https://www.offlu.org> (accessed on 6 April 2022).
 16. Intergovernmental Panel on Climate Change (IPCC) (2018) Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press. Available at: <https://www.ipcc.ch/sr15/> (accessed on 6 April 2022).
 17. Red Cross Red Crescent Climate Centre (2021) Bangladesh Climate Fact sheet. Relief Web OCHA Services. Available at: <https://reliefweb.int/report/bangladesh/climate-factsheet-bangladesh> (accessed on 6 April 2022)
 18. Berger, C. and Janssen, W. (2020) Emergency relief for Bangladesh's pandemic-hit livestock sector. World Bank Blogs. Available at: <https://blogs.worldbank.org/endpovertyinsouthasia/emergency-relief-bangladeshs-pandemic-hit-livestock-sector#:~:text=The%20Bangladesh%20Ministry%20of%20Fisheries%20and%20Livestock%20and,finance%20disaster%20relief%20and%20post-disaster%20emergency%20recovery%20expenditures.> (accessed on 6 April 2022).
 19. World Organisation for Animal Health (OIE), Regional Representation for Africa, Bamako, Mali. Sahel Regional Project supporting Pastoralism (PRAPS). OIE, Africa. Available at: https://rr-africa.oie.int/en/projects/praps_en/#:~:text=PRAPS%20is%20co-funded%20by%20governments%20and%20the%20World,%28Permanent%20Interstates%20Committee%20for%20Drought%20Control%20in%20Sahel%29. (accessed on 6 April 2022).
 20. United Nations Office for the Coordination of Humanitarian Affairs (OCHA) (2022) Suffering in silence: it's time to step up action for the Sahel. Available at: <https://www.unocha.org/story/suffering-silence-it-s-time-step-action-sahel> (accessed on 11 April 2022).
 21. The African Risk Capacity Group (ARC) (2022) ARC's Outbreaks & Epidemics Programme. An African Union Initiative for Public Health Emergencies Preparedness and Early Response Financing. Available at: <https://www.arc.int/outbreaks-and-epidemics> (accessed on 6 April 2022).
 22. Food and Agriculture Organization of the United Nations (FAO) (2021) Driving preparedness and anticipatory actions through innovation: A web-based Rift Valley fever Early Warning Decision Support Tool. Available at: <https://www.fao.org/resilience/resources/resources-detail/en/c/1417879> (accessed on 11 April 2022).
 23. Dungu, B. and Anyamba, A. (2020) Rift Valley fever and the challenges of remaining fully prepared for this periodic emergency. Available at: https://OIEbulletin.com/?panorama=03-2-2020-2_rvf (accessed on 11 April 2022).
 24. United Nations Office for Disaster Risk Reduction (UNDRR) (2015) Sendai Framework for Disaster Risk Reduction 2015-2030. Available at: https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf (accessed on 6 April 2022).

25. Feakes, D. (2018) The Biological Weapons Convention and its practical application. Panorama Bulletin Perspectives 2018, OIE, Paris, France. Available at: <https://OIEbulletin.fr/?panorama=03-the-biological-weapons-convention-and-its-practical-application-2> (accessed on 6 April 2022).
26. United Nations Office for Disarmament Affairs (UNODA) (1925) Geneva Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare. Available at: <https://www.un.org/disarmament/wmd/bio/1925-geneva-protocol/> (accessed on 11 April 2022).
27. World Organisation for Animal Health (OIE) and United Nations Office for Disarmament Affairs (UNODA) (2012). Memorandum of Understanding between The World Organisation for Animal Health and the United Nations Concerning OIE's cooperation with the United Nations Secretary-General's mechanism for investigation of the alleged use of chemical biological or toxin weapons. Available at: <https://www.oie.int/app/uploads/2021/03/unoda-ang.pdf> (accessed on 11 April 2022).
28. United Nations Office for Disarmament Affairs (UNODA) (2015) The Secretary-General's mechanism for investigation of alleged use of chemical bacteriological (biological) or toxin weapons. A lessons-learned exercise for the United Nations Mission in the Syrian Arab Republic. Available at: <https://unoda-web.s3-accelerate.amazonaws.com/wp-content/uploads/assets/publications/more/syrian-ii-report/syrian-ii-report-2015.pdf> (accessed on 11 April 2022).
29. Global Partnership Against the Spread of Weapons and Materials of Mass Destruction (GPWMD) (2020) Strengthening global mechanisms to respond to the deliberate use of biological agents. Available at: <https://www.gpwmd.com/strengthening-global-mechanisms-bwc> (accessed on 11 April 2022).
30. Global Preparedness Monitoring Board (GPMB) (2021). From worlds apart to a world prepared: 2021 Annual Report. Co-convened by the World Health Organization (WHO) and the World Bank. Available at: https://www.gpmb.org/#tab=tab_1 (accessed on 11 April 2022).
31. Global Preparedness Monitoring Board (GPMB) (2022). GPMB calls for a renewed global commitment to 'six solutions for a safer world' in 2022. Co-convened by the World Health Organization (WHO) and the World Bank. Available at: <https://www.gpmb.org/news/news/item/14-02-2022-gpmb-calls-for-a-renewed-global-commitment-to-six-solutions-for-a-safer-world-in-2022> (accessed on 11 April 2022).
32. Food and Agricultural Organization of the United Nations (FAO), World Organisation for Animal Health (OIE) and World Health Organization (WHO) (2010). The FAO-OIE-WHO Collaboration: Sharing responsibilities and coordinating global activities to address health risks at the animal-human-ecosystems interfaces. Available at: <https://www.oie.int/app/uploads/2021/03/final-concept-note-hanoi.pdf> (accessed on 11 April 2022)
33. Food and Agricultural Organization of the United Nations (FAO), World Organisation for Animal Health (OIE formerly OIE) and World Health Organization (WHO) (2017). The Tripartite's Commitment: Providing multi-sectoral, collaborative leadership in addressing health challenges. Available at: <https://www.oie.int/app/uploads/2018/05/tripartite-2017.pdf> (accessed on 11 April 2022).
34. One Health High Level Expert Panel (OHHLEP) (2021). 26 International Experts to kickstart the joint FAO/OIE/UNEP/WHO One Health High Level Expert Panel (OHHLEP). Available at: <https://www.oie.int/en/what-we-do/global-initiatives/one-health/#ui-id-5> (accessed on 11 April 2022).
35. Food and Agricultural Organization of the United Nations (FAO), World Organisation for Animal Health (OIE), World Health Organization (WHO) and United Nations Environment Programme (UNEP) (2021). Tripartite and UNEP support OHHLEP's definition of "One Health". Available at: <https://www.oie.int/en/tripartite-and-unep-support-ohhleps-definition-of-one-health/> (accessed on 11 April 2022).
36. World Health Organization (WHO) (2019) Epidemic Intelligence from Open Sources (EIOS). Available at: <https://www.who.int/initiatives/eios> (accessed on 1 April 2022).
37. World Health Organization (WHO) (2021) WHO Hub for Pandemic and Epidemic Intelligence. A new understanding of pandemic and epidemic risks. Available at: <https://www.who.int/initiatives/who-hub-for-pandemic-and-epidemic-intelligence> (accessed on 11 April 2022).
38. Food and Agricultural Organization of the United Nations (FAO) (2022) Strengthened early warning systems are urgently needed to reduce the risk of global health crises. Available at: <https://www.fao.org/emergencies/fao-in-action/stories/stories-detail/en/c/1469770/> (accessed on 11 April 2022).

39. World Organisation for Animal Health (OIE) and World Health Organization (WHO) (2014) WHO-OIE Operational Framework for good governance at the human-animal interface: Bridging WHO and OIE tools for the assessment of national capacities. Available at: <https://www.oie.int/app/uploads/2021/03/who-oie-operational-framework-final2.pdf> (accessed on 11 April 2022).
40. Food and Agricultural Organization of the United Nations (FAO), World Organisation for Animal Health (OIE) and World Health Organization (WHO) (2019) Taking a Multisectoral, One Health Approach: A Tripartite Guide to Addressing Zoonotic Diseases in Countries. Available at: <https://www.oie.int/app/uploads/2021/03/en-tripartitezoonosesguide-webversion.pdf> (accessed on 11 April 2022).
41. World Health Organization for Animal Health (OIE) Training Portal for the reinforcement of Veterinary Services worldwide. Available at: <https://training.oie.int> (accessed on 11 April 2022).
42. World Health Organization (WHO). WHO Academy: Transforming lifelong learning for health impact. Available at: <https://www.who.int/about/who-academy> (accessed on 11 April 2022).
43. Food and Agricultural Organization of the United Nations (FAO). FAO Virtual Learning Centers. Available at: <https://virtual-learning-center.fao.org/> (accessed on 11 April 2022).
44. G7 Cornwall UK (2021) G7 Carbis Bay Health Declaration. Available at: <https://www.gov.uk/government/publications/g7-carbis-bay-health-declaration> (accessed on 11 April 2022).
45. G20 Italia (2021) G20 Rome Leaders Declaration. Available at: <https://www.governo.it/sites/governo.it/files/G20ROMELEADERSDECLARATION.pdf> (accessed on 11 April 2022).
46. World Health Organization (WHO) Global Outbreak Alert and Response Network (GOARN). Available at: <https://extranet.who.int/goarn/about-us> (accessed on 11 April 2022)
47. Food and Agricultural Organization of the United Nations. Emergency Management Centre for Animal Health (FAO-EMC-AH). Available at: https://www.fao.org/emergencies/how-we-work/prepare-and-respond/emc-ah/en/?page=6&ipp=10&tx_dynalist_pi1%5bpar%5d=YToxOntzOjE6IkwiO3M6MToiMCI7fQ== (accessed on 11 April 2022).
48. Food and Agricultural Organization of the United Nations (2021) Emergency Management Centre for Animal Health (FAO-EMC-AH), Annual Report November 2020 – October 2021. Available at: <https://www.fao.org/3/cb8070en/cb8070en.pdf> (accessed on 11 April 2022).
49. Gary, F., Clauss, M., Bonbon, E. and Myers, L. (2021) Food and Agriculture Organization of the United Nations Rome. Good emergency management practice: The essentials. A guide to preparing for animal health emergencies. Available at: <https://www.fao.org/3/cb3833en/cb3833en.pdf> (accessed on 11 April 2022).
50. Food and Agricultural Organization of the United Nations (FAO)(2021) Progressive pathway for emergency preparedness. Available at: <https://www.fao.org/3/cb7324en/cb7324en.pdf> (accessed on 11 April 2022).
51. World Health Organization (WHO) (2021) Framework for strengthening health emergency preparedness in cities and urban settings. Available at: <https://apps.who.int/iris/bitstream/handle/10665/348351/9789240037830-eng.pdf?sequence=1&isAllowed=y> (accessed on 11 April 2022).
52. World Health Organization (WHO) (2021) Building health systems resilience for universal health coverage and health security during the COVID-19 pandemic and beyond: WHO position paper. Available at: <https://www.who.int/publications/i/item/WHO-UHL-PHC-SP-2021.01> (accessed on 11 April 2022).
53. Livestock Emergency Guidelines and Standards (LEGS) (2022) Independent Board of Trustees with FAO and Red Cross representation. Available at: <https://www.livestock-emergency.net> (accessed on 12 April 2022).
54. Livestock Emergency Guidelines and Standards (LEGS)(2014) LEGS Handbook, second edition. Available at: <https://www.livestock-emergency.net/wp-content/uploads/2021/09/LEGS-Handbook-2nd-edition-web-version-1.pdf> (accessed on 12 April 2022).
55. Sphere (2022) Charter and humanitarian standards for responses. Available at: <https://spherestandards.org/about/> (accessed on 12 April 2022).
56. Sphere (2018) The Sphere Handbook. Available at: <https://spherestandards.org/handbook-2018/> (accessed on 12 April 2022).
57. Towards a Safer World initiative (TASW) (2022). Practical approaches to advance disaster preparedness. Available at: <http://towardsasaferworld.org> (accessed on 12 April 2022).
58. Preventing Pandemics at the Source (2020) We can prevent the next Covid-19. Available at: <https://www.preventingfuturepandemics.org> (accessed on 12 April 2022).

59. World Health Organization (WHO) (2021) COVID-19 shows why united action is needed for more robust international health architecture. Available at: <https://www.who.int/news-room/commentaries/detail/op-ed--covid-19-shows-why-united-action-is-needed-for-more-robust-international-health-architecture> (accessed on 12 April 2022).
60. World Health Organization (WHO) (2021) World Health Assembly agrees to launch process to develop historic global accord on pandemic prevention, preparedness and response. Available at: <https://www.who.int/news/item/01-12-2021-world-health-assembly-agrees-to-launch-process-to-develop-historic-global-accord-on-pandemic-prevention-preparedness-and-response> (accessed on 12 April 2022).
61. World Health Organization (WHO) (2021) The World Together: Establishment of an intergovernmental negotiating body to strengthen pandemic prevention, preparedness and response. Available at: https://apps.who.int/gb/ebwha/pdf_files/WHASSA2/SSA2_CONF1Rev1-en.pdf (accessed on 12 April 2022).
62. World Health Organization (WHO)(2022) Intergovernmental Negotiating Body to draft and negotiate a WHO convention, agreement or other international instrument on pandemic prevention, preparedness and response. Available at: <https://apps.who.int/gb/inb/> (accessed on 12 April 2022).
63. British Medical Journal (2021) Special edition bulletin: Options for a Global Pandemic Treaty. Available at: <https://www.bmj.com/global-pandemic-treaty> (accessed on 12 April 2022).
64. Nikogosian, H. and Kickbusch, I. (2021) Confronting future pandemics: What could a new treaty resolve beyond the IHR. British Medical Journal (2021) special edition bulletin. Available at: <https://cloud.3dissuue.net/25996/26306/26532/65478/index.html> (accessed on 12 April 2022).
65. Woolaston, K. and Lewis, B. (2022) Options for a Preventative Pandemic Treaty based on One Health, SSRN. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4058944 (accessed on 12 April 2022).
66. The Geneva Graduate Institute's Global Health Centre (2021) Governing Pandemics Initiatives website. Available at: <https://www.governingpandemics.org/about> (accessed on 13 April 2022).
67. Burci, G.L., Moon, S., Viñuales, J. and Le Moli, G. (2021) A Global Pandemic Treaty should aim for deep prevention. Geneva Graduate Institute. Available at: <https://www.graduateinstitute.ch/communications/news/global-pandemic-treaty-should-aim-deep-prevention> (accessed on 13 April 2022).
68. Food and Agricultural Organization of the United Nations (FAO) and World Organisation for Animal Health (OIE) (2004) The Global Framework for the Progressive control of Transboundary Animal Diseases (GF-TADS). Available at: <http://www.gf-tads.org> (accessed on 13 April 2022).
69. World Organisation for Animal Health (OIE) (2021) Aquatic Animal Health Strategy 2021–2025. Paris, France. Available at: <https://www.oie.int/app/uploads/2021/05/en-oie-aahs.pdf> (accessed on 13 April 2022).
70. World Health Organization (WHO) (2011). Pandemic Influenza Preparedness (PIP) Framework. Available at: <https://www.who.int/initiatives/pandemic-influenza-preparedness-framework> (accessed on 13 April 2022).
71. World Health Organization (WHO) (2020) Prioritizing diseases for research and development in emergency contexts. Available at: <https://www.who.int/activities/prioritizing-diseases-for-research-and-development-in-emergency-contexts> (accessed on 13 April 2022).
72. Food and Agricultural Organization of the United Nations (FAO), World Organisation for Animal Health (OIE) and World Health Organization (WHO) (2019). Tripartite Zoonoses Guide, Operational tools and approaches for zoonotic diseases. Available at: <https://www.who.int/initiatives/tripartite-zoonosis-guide#:~:text=The%20Tripartite%20Zoonoses%20Guide%20%28TZG%29%20has%20been%20jointly,sustainable%20and%20functional%20collaboration%20at%20the%20human-animal-environment%20> (accessed on 13 April 2022).
73. World Organisation for Animal Health (OIE) (2018). OIE, Paris, France. Guidelines for investigation of suspicious biological events (Guidelines for National Veterinary Services). Available at: <https://www.oie.int/app/uploads/2021/03/guidelines-investigation-suspicious-biological-events.pdf> (accessed on 13 April 2022).
74. Maritime New Zealand (2022) Oil spill response strategy; New Zealand Marine Oil Spill Readiness and Response Strategy 2018-2022. Available at: <https://www.maritimenz.govt.nz/public/environment/responding-to-spills/response-strategy.asp> (accessed on 13 April 2022).
75. Vroegindewey, G.A. and Evans, K. (2020) Technological disasters and Veterinary Services. Science and Technical Review 39(2), 445-450. Available at: <https://doc.oie.int/dyn/portal/digidoc.xhtml?statelessToken=EuIDlqcXHItV2UItJE1nLLpX4LxCuC-BHRriT5jWBw=&actionMethod=dyn%2Fportal%2Fdigidoc.xhtml%3AdownloadAttachment.openStateles> (accessed on 13 April 2022).
76. Richardson, L.C., Connell, N.D., Lewis, S.M., Pauwels, E. and Murch, R.S. (2019) Cyberbiosecurity: A Call for Cooperation in a New Threat Landscape. Frontiers in Bioengineering and Biotechnology. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6562220/> (accessed on 13 April 2022).

77. World Health Organization (WHO) (2022) Infodemic. Available at: https://www.who.int/health-topics/infodemic#tab=tab_1 (accessed on 13 April 2022).
78. Bernard, R., Bowsher, G., Sullivan, R. and Gibson-Fall, F. (2021) Disinformation and Epidemics: Anticipating the Next Phase of Biowarfare. Health Security Vol.19, No. 1, Special feature: Infodemics and Health Security. Available at: https://www.liebertpub.com/doi/10.1089/hs.2020.0038?url_ver=Z39.88-2003&rft_id=ori%3Arid%3Aacrossref.org&rft_dat=cr_pub++0pubmed (accessed on 13 April 2022).
79. Park, A. (2022) Why Ukraine's COVID-19 Problem Is Everyone's Problem. Time Magazine. Available at: <https://time.com/6153254/ukraine-russia-war-covid-19/> (accessed on 13 April 2022).
80. Cornwell, M.S. and Dodd, C.C. (2020) The role of Veterinary Services in areas of conflict. Science and Technical Review 39(2), 451-460. Available at: <https://doc.oie.int/dyn/portal/digidoc.xhtml?statelessToken=7lIKsEKro3703kaXcHkvGaerSCI6UH6p01LtgOrAORo=&actionMethod=dyn%2Fportal%2Fdigidoc.xhtml%3AdownloadAttachment.openStateless> (accessed on 13 April 2022).
81. World Organisation for Animal Health (OIE) (2018) Paris, France. Terrestrial Animal Health Code, Chapter 8.8 Infection with Foot and Mouth Disease Virus. Available at: https://www.oie.int/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmlfile=chaptre_fmd.htm (accessed on 13 April 2022).
82. World Bank Group (WBG) (2017) From panic and neglect to investing in health security: financing pandemic preparedness at a national level. Washington, D.C.: World Bank Group. Available at: <http://documents.worldbank.org/curated/en/979591495652724770/From-panic-and-neglect-to-investing-in-health-security-financing-pandemic-preparedness-at-a-national-level> (accessed on 21 April 2022).
83. The Straits Times, Singapore (2021) China to crack down harder on fake vaccines for African swine fever. Available at: <https://www.straitstimes.com/asia/east-asia/china-to-crack-down-harder-on-fake-vaccines-for-african-swine-fever> (accessed on 22 April 2022).
84. Ministry for Primary Industries, Biosecurity New Zealand (2020) 1080 blackmail threat. Available at: <https://www.mpi.govt.nz/biosecurity/about-biosecurity-in-new-zealand/1080-blackmail-threat/> (accessed on 22 April 2022).
85. Department of Homelands Security, United States of America (2018). Threat and Hazard Identification and Risk Assessment (THIRA) and Stakeholder Preparedness Review (SPR) Guide. Comprehensive Preparedness Guide CPG201, 3rd edition. Available at: <https://www.fema.gov/sites/default/files/2020-04/CPG201Final20180525.pdf> (accessed on 22 April 2022).
86. The Federal Emergency Management Agency (FEMA), (2017) Department of Homelands Security, United States of America. National Incident Management System, Third edition October, 2017. Available at: <https://www.fema.gov/emergency-managers/nims#:~:text=The%20National%20Incident%20Management%20System,to%20and%20recover%20from%20incidents.&text=NIMS%20defines%20operational%20systems%20that%20guide%20how%20personnel%20work%20together%20during%20incidents>. (accessed on 22 April 2022).
87. Callan, T. Emergency operations centres: models and core principles (2020) Science and Technical Review 39(2), 399-405. Available at: <https://doc.oie.int/dyn/portal/digidoc.xhtml?statelessToken=jl1tXY-uSiajN8T-bvXgOc-jMtQX4utF3gcDtcHEK3KU=&actionMethod=dyn%2Fportal%2Fdigidoc.xhtml%3AdownloadAttachment.openStateless> (accessed on 22 April 2022).
88. Imperial, A.J. and Vanclay, F. (2019) Command-and-control, emergency powers, and the failure to observe United Nations disaster management principles following the 2009 L'Aquila earthquake. International Journal of Disaster Risk Reduction, Volume 36, May 2019, 101099. Available at: <https://www.sciencedirect.com/science/article/pii/S2212420918312548> (accessed on 22 April 2022).
89. New Zealand National Emergency Management Agency (2021) Coordinated Incident Management System (CIMS) 3rd Edition. Available at: <https://www.civildefence.govt.nz/resources/coordinated-incident-management-system-cims-third-edition/> (accessed on 22 April 2022).
90. World Organisation for Animal Health (OIE) (2020) Paris, France. Guidelines for Simulation Exercises; A consistent set of good practices for preparing, delivering, and learning from animal health and welfare and veterinary public health simulation exercises for Veterinary Services. Available at: https://www.oie.int/fileadmin/Home/MM/DD_OIE_Guidelines_for_Simulation_Exercises.pdf (accessed on 22 April 2022).
91. World Organisation for Animal Health (OIE) (2020) Paris, France. Simulation Exercises. Available at: <https://www.oie.int/en/what-we-do/animal-health-and-welfare/disease-data-collection/simulation-exercises/> (accessed on 22 April 2022).
92. Food and Agricultural Organization of the United Nations (FAO) (2018) The European Commission for the Control of Foot-and-Mouth Disease (EuFMD). Available at: <https://www.fao.org/eufmd/global-situation/eufmdis/en/> (accessed on 22 April 2022).

93. World Organisation for Animal Health (OIE) (2020) Paris, France. The Rinderpest Vigilance game. Available at: <https://rinderpestvigilance.com/en/play-the-game/> (accessed on 22 April 2022).
94. SourceForge website (2022). Emergency Management Software. Available at: <https://sourceforge.net/software/emergency-management/?page=1> (accessed on 22 April 2022).
95. World Organisation for Animal Health (OIE formerly OIE) (2015) Paris, France. Communication Handbook; Veterinary Services. Available at: https://www.oie.int/fileadmin/Home/eng/Media_Center/docs/pdf/EN_Guide_de_Communication_FINAL.pdf (accessed on 22 April 2022).
96. Hyland-Wood, B., Gardner, J., Leask, J. and Ecker, U.K.H. Toward effective government communication strategies in the era of COVID-19. *Humanit Soc Sci Commun* **8**, 30 (2021). <https://doi.org/10.1057/s41599-020-00701-w> (accessed on 22 April 2022).
97. Overton, D., S. A. Ramkeesoon, K. Kirkpatrick, A. Byron, and E.S. Pak (Eds.). 2021. Lessons from the COVID-19 Crisis on Executing Communications and Engagement at the Community Level During a Health Crisis. Washington, DC: National Academies of Sciences, Engineering, and Medicine. Available at: <https://doi.org/10.17226/26340> (accessed on 22 April 2022).
98. International Federation of Red Cross and Red Crescent Societies (IFRC), United Nations Children's Fund (UNICEF) and World Health Organization (WHO) (2020). COVID-19 Global Risk Communication and Community Engagement Strategy; An RCCE strategy from UNICEF, WHO and IFRC. Available at: <https://www.unicef.org/documents/covid-19-global-risk-communication-and-community-engagement-strategy> (accessed on 22 April 2022).
99. Mendy, A., Stewart, M.L., and Van Akin, K., McKinsey and Company (2020). A leader's guide: Communicating with teams, stakeholders and communities during COVID-19. Available at: <https://www.mckinsey.com/business-functions/people-and-organizational-performance/our-insights/a-leaders-guide-communicating-with-teams-stakeholders-and-communities-during-covid-19> (accessed on 22 April 2022).
100. World Health Organization (WHO) (2020) 1st WHO Infodemiology Conference. Available at: <https://www.who.int/teams/risk-communication/infodemic-management/1st-who-infodemiology-conference> (accessed on 22 April 2022).
101. G20 Italia (2021) G20 Health, Position Paper on Healthy and Sustainable Recovery. Available at: https://www.salute.gov.it/imgs/C_17_pagineAree_5459_9_file.pdf?msckid=18627bd5b62911ecbe15e867a1351d8b (accessed on 25 April 2022).
102. World Organisation for Animal Health (OIE) (2019) Paris, France. Exploring innovative approaches to improving sustainable management of animal health emergencies. Available at: <https://www.oie.int/app/uploads/2021/03/dd-exploring-innovative-approaches-to-improving-sustainable-management-of-animal-health-emergencies.pdf> (accessed on 25 April 2022).
103. Organisation for Economic Co-operation and Development (OECD) (2017) Producer Incentives in Livestock Disease Management. Available at: <https://www.oecd.org/publications/producer-incentives-in-livestock-disease-management-9789264279483-en.htm> (accessed on 25 April 2022).
104. Organisation for Economic Co-operation and Development (OECD) (2012). Livestock Diseases; Prevention, Control and Compensation Schemes. Available at: https://read.oecd-ilibrary.org/agriculture-and-food/livestock-diseases_9789264178762-en#page1 (accessed on 25 April 2022).
105. International Criminal Police Organization (INTERPOL) (2022) Bioterrorism: Operational response & investigative support. Available at: <https://www.interpol.int/Crimes/Terrorism/Bioterrorism/Bioterrorism-Operational-response-investigative-support> (accessed on 25 April 2022).
106. World Organisation for Animal Health (OIE) Paris, France. PVS Pathway. Available at: <https://www.oie.int/en/what-we-offer/improving-veterinary-services/pvs-pathway/> (accessed on 25 April 2022).
107. World Health Organization (WHO) (2022) Online consultation - Call for Member States comments on the draft One Health Joint Plan of Action. Available at: <https://www.who.int/news-room/articles-detail/online-consultation-call-for-member-states-comments-on-the-draft-one-health-joint-plan-of-action#:~:text=The%20draft%20One%20Health%20Joint%20Plan%20of%20Action,was%20developed%20through%20a%20participatory%20and%20inclusive%20process.?msckid=ede7e1eab62c11ecb81808d2e4d24f35> (accessed on 25 April 2022).
108. World Organisation for Animal Health (OIE)(2015) Paris, France. OIE Biological Threat Reduction Strategy, strengthening global biological security. Available at: <https://www.oie.int/app/uploads/2021/03/en-final-biothreat-reduction-strategy-oct2015.pdf> (accessed on 25 April 2022).

109. World Organisation for Animal Health (OIE) (2021) Paris, France. OIE Aquatic Animal Health Strategy 2021–2025. Available at: <https://www.oie.int/en/document/oie-aquatic-animal-health-strategy-2021-2025/> (accessed on 25 April 2022).
110. Rushton, J. (2008) The economics of animal health and production. Available at: <https://www.cabi.org/cabebooks/ebook/20093020677> (accessed on 25 April 2022).
111. World Organisation for Animal Health (OIE formerly OIE) (2021) OIE Standard Operating Procedure for determining if a disease should be considered as an emerging disease. Available at: <https://www.oie.int/en/document/oie-standard-operating-procedure-for-determining-if-a-disease-should-be-considered-as-an-emerging-disease/#:~:text=%5B1%5D%20Emerging%20disease%20means%20a,unrecognised%20pathogenic%20agent%20or%20disease> (accessed on 22 April 2022).
112. World Organisation for Animal Health (OIE) (2015) Paris, France. Guidelines on disaster management for National Veterinary Services. Available at: <https://www.oie.int/app/uploads/2021/03/disastermanagement-ang.pdf> (accessed on 25 April 2022).
113. World Organisation for Animal Health (OIE) (2018). Sub-Regional Representation for Southeast Asia, Bangkok, Thailand. Manual 9: Emergency preparedness and response planning. Available at: <https://rr-asia.oie.int/wp-content/uploads/2019/09/seacfmd-manual-9.pdf> (accessed on 22 April 2022).
114. World Organisation for Animal Health (OIE) (2022) Paris, France. Emergency and Resilience Overview. Available at: <https://www.oie.int/en/what-we-offer/emergency-and-resilience/> (accessed on 25 April 2022).
115. Global Burden of Animal Diseases (GBADs). Available at: <https://animalhealthmetrics.org> (accessed on 25 April 2022).
116. World Organisation for Animal Health (OIE) Paris, France. OIE Observatory: For a better understanding of the implementation of OIE International Standards. Available at: <https://www.oie.int/en/what-we-offer/safe-trade-and-movement-of-animals/observatory/> (accessed on 25 April 2022).
117. World Organisation for Animal Health (OIE) (2021) Paris, France. List of main focus areas and specialties for OIE Collaborating Centres. Available at: <https://www.oie.int/app/uploads/2021/03/a-list-of-focus-areas-and-specialties-for-OIE-collaborating-centers.pdf> (accessed on 25 April 2022).
118. World Organisation for Animal Health (OIE) (2022) Paris, France. OIE Training Portal for the reinforcement of Veterinary Services Worldwide. Available at: <https://training.oie.int> (accessed on 25 April 2022).
119. Food and Agricultural Organization of the United Nations (FAO) and World Organisation for Animal Health (OIE) (2018) Global Rinderpest Action Plan: Post-Eradication. Available at: <https://www.oie.int/app/uploads/2021/03/global-rinderpest-action-plan-2018.pdf> (accessed on 25 April 2022).
120. World Organisation for Animal Health (OIE) (2021) Paris, France. Rinderpest. Available at: <https://www.oie.int/en/disease/rinderpest/> (accessed on 25 April 2022).
121. World Organisation for Animal Health (OIE), Regional Representation for Africa, Bamako, Mali. The EBO-SURSY Project. Available at: <https://rr-africa.oie.int/en/projects/ebo-sursy-en/> (accessed on 26 April 2022).
122. World Organisation for Animal Health (OIE) (2021) OIE Wildlife Health Framework; Protecting wildlife health to achieve one health. Available at: https://www.oie.int/fileadmin/Home/eng/International_Standard_Setting/docs/pdf/WGWildlife/A_Wildlife_health_conceptnote.pdf (accessed on 26 April 2022).
123. World Organisation for Animal Health (OIE) (2020) Paris, France. OIE's activities during the COVID-19 pandemic crisis and opportunities for OIE work programmes. Available at: https://www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/COVID-19/Stone_oie_and_COVID-19_DelegatesPartners_07July2020.pdf (accessed at 25 April 2022).
124. World Organisation for Animal Health (OIE) (2021) Paris, France. COVID-19: A coordinated and scalable response mechanism. Available at: <https://www.oie.int/en/what-we-offer/emergency-and-resilience/covid-19/#ui-id-1> (accessed on 25 April 2022).
125. World Organisation for Animal Health (OIE) (2004) Paris, France. Emerging zoonoses and pathogens of public health concern. Scientific and Technical Review Vol. 23(2). Available at: https://doc.oie.int/dyn/portal/digidoc.xhtml?statelessToken=NwmRNhWKBs_XuOP8iRrFrPDMA9YrNX13CSRczG65UaMk=&actionMethod=dyn%2Fportal%2Fdigidoc.xhtml%3AdownloadAttachment.openStateless (accessed on 25 April 2022).
126. World Organisation for Animal Health (OIE) (2006) Paris, France. Biological disasters of animal origin; The role and preparedness of veterinary and public health services. Scientific and Technical Review Vol. 25(1). Available at: <https://doc.oie.int/dyn/portal/digidoc.xhtml?statelessToken=xAhEao6EjbuV13hWk5o-4HyPPLJLgTDfDfJYQupdyAs=&actionMethod=dyn%2Fportal%2Fdigidoc.xhtml%3AdownloadAttachment.openStateless> (accessed on 25 April 2022).
127. World Organisation for Animal Health (OIE) (2008) Paris, France. Changing trends in managing aquatic animal disease emergencies. Scientific and Technical Review Vol. 27(1). Available at:

- <https://doc.oie.int/dyn/portal/digidoc.xhtml?statelessToken=UMIF-q6vERNXroxhVwlpFUy4K3MXJMyTu98YpiG0IU0=&actionMethod=dyn%2Fportal%2Fdigidoc.xhtml%3AdownloadAttachment.openStateless> (accessed on 25 April 2022).
128. World Organisation for Animal Health (OIE formerly OIE) (2017) Paris, France. Biological threat reduction. Scientific and Technical Review Vol. 36(2). Available at: <https://doc.oie.int/dyn/portal/index.xhtml?page=alo&aloId=34818> (accessed on 25 April 2022).
129. World Organisation for Animal Health (OIE formerly OIE) (2019) Paris, France. Successes and remaining challenges within the One Health approach. Scientific and Technical Review Vol. 38(1). Available at: <https://doc.oie.int/dyn/portal/digidoc.xhtml?statelessToken=-kIYQ1xgLyZqpY2FoM1sN5hRI7zLaSTnCwsbLExfUAE=&actionMethod=dyn%2Fportal%2Fdigidoc.xhtml%3AdownloadAttachment.openStateless> (accessed on 25 April 2022).
130. World Organisation for Animal Health (OIE formerly OIE) (2019) Paris, France. Veterinary Services in a changing world: climate change and other external factors. Scientific and Technical Review Vol. 40 (2), 371-373. Available at: https://doc.oie.int/dyn/portal/digidoc.xhtml?statelessToken=REAZ6_abSMRrx6eGxM-qHQ3xkrbdiT4HGIL5wkkatno=&actionMethod=dyn%2Fportal%2Fdigidoc.xhtml%3AdownloadAttachment.openStateless (accessed on 25 April 2022).
131. McDougal, J., Sabirovic, M., Pietropaoli, S., and Hamilton, K. (2020) The gulf between emergency plans and the resources needed: a global review. Scientific and Technical Review Vol. 39 (2), 373-384. Available at: https://doc.oie.int/dyn/portal/digidoc.xhtml?statelessToken=WO6OzSDPzMAKvRDE2_cacp3mwMLfm5VvCg-fEUKVnv0=&actionMethod=dyn%2Fportal%2Fdigidoc.xhtml%3AdownloadAttachment.openStateless (accessed on 26 April 2022).
132. European Commission for the control of Foot and Mouth disease (EuFMD)(2022) Get Prepared Toolbox. Emergency Preparedness. Available at: <https://www.eufmd.info/getprepared> (accessed on 26 April 2022).
133. Food and Agricultural Organisation of the United Nations (FAO)(2022) The European Commission for the Control of Foot-and-Mouth Disease (EuFMD). Available at: <https://www.fao.org/eufmd/global-situation/getprepared/en/> (accessed on 26 April 2022).
134. Readford, P. (2016) Sharing resources in an emergency animal disease response. Animal Health Surveillance Quarterly Report, Vol.21(2), pp 4-5. Available at: <http://www.sciquest.org.nz/node/123907> (accessed on 26 April 2022).
135. Nordic Co-operation (2022) About the Nordic-Baltic Veterinary Contingency Group (N-B VCG). Available at: <https://www.norden.org/en/information/about-nordic-baltic-veterinary-contingency-group-n-b-vcg> (accessed on 26 April 2022).
136. World Organisation for Animal Health (OIE) (2019) Paris, France. Public-Private Partnerships in the veterinary domain. Available at: <https://www.oie.int/en/what-we-offer/improving-veterinary-services/pvs-pathway/targeted-support/public-private-partnerships-in-veterinary-services/> (accessed on 26 April 2022).
137. Animal Health Australia (AHA) (2022) Available at: <https://animalhealthaustralia.com.au> (accessed on 26 April 2022).
138. Foundation of Animal Health Services (FUNDASSA) (2022) Available at: <https://www.fundassa.org/#> (accessed on 26 April 2022).
139. The United States Department of Agriculture Business Continuity and Security Food Supply Plan (2022). Available at: https://www.aphis.usda.gov/animal_health/emergency_management/downloads/fad_prep_rrg_sfs_cob.pdf (accessed on 26 April 2022).