

**OPERATIONAL FRAMEWORK FOR STRENGTHENING
HUMAN, ANIMAL AND ENVIRONMENTAL
PUBLIC HEALTH SYSTEMS AT THEIR INTERFACE**

Report number: 122980-GLB

Published in January 2018



**OPERATIONAL FRAMEWORK FOR STRENGTHENING HUMAN, ANIMAL AND ENVIRONMENTAL PUBLIC HEALTH SYSTEMS AT THEIR INTERFACE
(P133691)**

Acknowledgments

The team was led by François Le Gall and Caroline Planté and was authored by Franck Berthe, Timothy Bouley, Caroline Plante and Richard Seifman of the World Bank and William B. Karesh and Catherine Machalaba of EcoHealth Alliance. The work builds upon the previous One Health efforts and analysis by Olga Jonas. We thank the following group of international experts for their highly beneficial external review: Stephane de la Rocque, Liz Mumford (WHO), Susan Corning, Tianna Brand, Brian Evans and Bernard Vallat (OIE), Chadia Wannous (UNISDR), Peter Black, Katinka de Balogh, Subhash Morzaria (FAO), Cristina Romanelli (CBD), Casey Barton Behravesh (CDC), Ottorino Cosivi, Manuel Sanchez-Vazquez, Simone Raszl (PAHO), Fanny Demassieux (UNEP), Ricardo Echalar (USAID), Milan Brahmhatt (WRI) and Lonnie King (Ohio State University). Peer review was performed by Enis Baris, John Paul Clark, Stephane Forman, Shafick Hoossein, Juan Jose Miranda Montero, Patrick Osewe, Ernesto Sanchez-Triana (World Bank) and Delia Grace (CGIAR-International Livestock Research Institute). Tekabe Belay, Elizabeth Lule, Julia Mensah, Piers Merrick, and Yvonne Nkrumah (World Bank) also provided key input to inform the development of the document. Additionally, insight provided by the participants and partner organizations of a workshop on the Economics of One Health, held at the World Bank in partnership with the USAID Emerging Pandemic Threats program, EcoHealth Alliance and the EU COST Action Network for Evaluation of One Health, helped inform parts of this Framework. The assistance of Rosalie Trinidad was greatly appreciated throughout the development of this work. Additional support for the development of the contents was provided by the USAID Emerging Pandemic Threats PREDICT-2 project. Much gratitude is owed to Juergen Voegele, Preeti Ahuja, Timothy Grant Evans and Valerie Hickey of the World Bank's Agriculture, Health, Nutrition and Population, and Environment and Natural Resources Global Practices for their leadership and guidance. The final product remains the responsibility of the authors.

CONTENTS

ABBREVIATIONS AND ACRONYMS

EXECUTIVE SUMMARY

GUIDE FOR APPLYING THE OPERATIONAL FRAMEWORK IN PROJECT PHASES

1. STRATEGIC CONTEXT AND RATIONALE

2. VALUE OF INVESTING IN ONE HEALTH

3. POLICY, GOVERNANCE, TECHNICAL AND INSTITUTIONAL ASPECTS: AN INVENTORY OF ONE HEALTH TOOLS

4. ONE HEALTH ENTRY POINTS

5. TECHNICAL GUIDANCE FOR OPERATIONALIZING ONE HEALTH

6. OTHER OPERATIONAL COMPONENTS

ANNEXES

GLOSSARY

REFERENCES

Abbreviations and Acronyms

AGR	Agriculture (refers to World Bank Global Practice)
AMR	Antimicrobial Resistance
CCSA	Cross-Cutting Solutions Area
CBD	Convention on Biological Diversity
CDC	Centers for Disease Control and Prevention
CFE	Contingency Fund for Emergencies
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DALY	Disability-Adjusted Life Year
DPL	Development Policy Loan
EID	emerging infectious diseases
ENR	Environment and Natural Resources (refers to World Bank Global Practice)
ESS	Environment and Social Safeguard
FAO	Food and Agriculture Organization of the United Nations
FETP	Field Epidemiology Training Program
GDP	Gross Domestic Product
GLEWS	Global Early Warning System for Major Animal Diseases
GP	Global Practice (organizational division of the World Bank)
GPAI	Global Program for Avian Influenza and Human Pandemic Preparedness and Response
GPG	global public good
HPAI	highly pathogenic avian influenza
HNP	Health, Nutrition and Population (refers to World Bank Global Practice)
IDA	International Development Association
IFC	International Finance Corporation
IHR	International Health Regulations
IPF	Investment Project Financing
IUCN	International Union for the Conservation of Nature
JEE	Joint External Evaluation (IHR Monitoring and Evaluation Framework)
MIGA	Multilateral Investment Guarantee Agency
MERS-CoV	Middle East Respiratory Syndrome – Coronavirus
NBSAP	National Biodiversity Strategy and Action Plan
NGO	Non-governmental organization
NZD	Neglected Zoonotic Disease
OIE	World Organisation for Animal Health
PAHO	Pan American Health Organization
PEF	Pandemic Emergency Financing Facility
PforR	Program for Results
PVS	Performance of Veterinary Services
REDISSE	Regional Disease Surveillance Systems Enhancement
RVF	Rift Valley Fever
SARS	Severe Acute Respiratory Syndrome
SDG	Sustainable Development Goals
SORT	Systematic Risk-Ranking Tool
TTL	Task Team Leader
UN	United Nations
UNEP	United Nations Environmental Programme
UNISDR	United Nations Office for Disaster Risk Reduction
UNSIC	United Nations System Influenza Coordination
VBPD	Vector-borne and parasitic diseases
WHO	World Health Organization

EXECUTIVE SUMMARY

Public health systems have critical and clear relevance to the World Bank’s twin goals of poverty eradication and boosting shared prosperity. In particular, they are impacted by, and must respond to, significant threats at human-animal-environment interface. Most obvious are the diseases shared between humans and animals (“zoonotic” diseases), which comprise more than 60 percent of known human infectious pathogens; but also aspects of vector-borne disease, food and water safety and security, and antimicrobial resistance.

Zoonotic diseases account for more than one billion cases and a million deaths per year. The high costs of emerging and pandemic diseases are well appreciated, as seen with local and global multi-sectoral economic impacts from SARS, H1N1, and Ebola virus. At the same time, endemic diseases contribute to persistent disease and economic burden through impacts on health and livelihoods, as well as on agricultural production and ecosystems. The occurrence and impact of known and novel disease outbreaks are likely to increase with continued wide-scale changes in land use, transformation of agricultural practices without adequate biosecurity, climate and weather, trade and travel, urbanization and other factors that can facilitate the risk of spillover and spread of diseases. At the same time, many of these pressures are having other wide-ranging impacts on health of humans, animals and environment (from air pollution, nutrition deficiencies, vulnerability to natural and biological hazards, and more). Targeting these drivers may generate shared benefits.

Public health systems must therefore be resilient and prepared to face existing and future disease threats at the human-animal-environment interface. This Operational Framework provides a practical reference toward achieving that aim, with the following key objectives:

- Provide operational guidance to directly address the need for targeted investments that prevent, prepare, detect, respond to and recover from issues like diseases with endemic, emerging and pandemic potential, including antimicrobial resistance;
- Showcase opportunities for targeting disease threats upstream (prevention at the source, or via early detection and effective response) to help reduce the frequency and impact of emergencies the system has to react to;
- Jointly yield long-term gains (and consider trade-offs) in human health, animal production and environmental management, ultimately improving overall health of the planet and the lives, livelihoods and well-being of people;
- Outline activities and interventions with a starting point at the human-animal-environment interface, highlight proposed methods of institutional and technical implementation, and enable mechanisms of coordination and partnership to build more collaborative public health systems.

In its entirety, the Operational Framework provides a strong orientation to One Health to assist users in understanding and implementing it, from rationale to concrete guidance for its application. Six core chapters are included, supported by annexes diving deeper into operational tools and recent World Bank alignment with One Health topics, and a glossary that explains key terms, including interpretations specific to the Operational Framework.

Chapter 1 presents background on the need and scope for One Health, showing how it is inclusive of and can be useful in addressing a broad range of priorities for human and animal health and environment sectors. Chapter 2 reviews the economic argument for One Health for the global and local public good – both through more effective disease prevention and control, as well as operational efficiencies at country and project level. Chapter 3 showcases relevant tools and initiatives for One Health that support capacity for human, animal and or environmental health sectors, bringing them together and articulating possible connections as well as identifying priority areas for further development to aid in successful One Health operations, with additional examples provided in the Annex.

Chapters 4-6 present specific applications of One Health. Examples of entry points for One Health thinking are shown in Chapter 4, including determining relevance of different sectors for involvement based on the specific context. Chapter 5 outlines the building blocks for embedding One Health approaches to prepare for endemic, emerging and pandemic threats, all the way from disease prevention to recovery. Finally, noting the challenge of monitoring progress across sectors, Chapter 6 outlines possible pathways for monitoring and upscaling, showcasing indicators from relevant Bank projects. Ideally, projects will be designed with One Health intent from the onset, allowing Task Team Leaders (TTLs) to align their tools, investments and indicators to yield added value from One Health.

The Operational Framework is intended as a guide for One Health operations, from project and program scoping and identification stages to design and implementation, including monitoring and evaluation, to help optimize investments. Examples are provided in each section to assist sectors in identifying relevant points for participation; each sector will likely identify additional relevance and ideas for operationalizing One Health in reviewing the examples, as well as in the course of developing One Health programs (or in attempting to integrate One Health into existing programs). It opens the door for genuine collaboration and shared gains to address pressing issues central to the World Bank's focus — noting that public health systems will only be stronger by integrating humans, animals and the environment.

There is no one-size-fits-all approach for One Health implementation. Yet this precise fact presents ample opportunities for action based on country context and demand and disease or program-specific objectives to achieve the added value One Health approaches can bring. Use of this Framework is envisioned as iterative, with lessons learned and case studies informing its current and future refinement and collective benefits to multiple sectors. Practitioners — whether from the World Bank, other development and technical agencies, or partners from government authorities in client countries — are encouraged to consider themselves partners in shaping the utility of One Health resources and approaches to optimize collective benefits across sectors and countries to better tackle disease threats at the human-animal-environment interface.

This Operational Framework is designed to provide a comprehensive overview of the One Health concept and operational guidance for One Health application (what, why and how). It is envisioned for use in existing and future projects undertaken by the World Bank and its client countries and technical partners. Certain sections (e.g. chapters 1-2) are more relevant to the preparation of background sections or policy documents, given their emphasis on the human-animal-environment interface, whereas others (e.g. chapters 3-6) provide particular tools, entry points and steps that can be extracted and used in the development and function of projects and programs.

The Operational Framework presents key available instruments, approaches, tools and guidance developed so far by a range of leading technical and/or development agencies and institutions. It helps understand the links between animal, human and environmental health interventions that are typically overlooked when a disease threat is addressed from any one of these perspectives. Based on extensive experience, the Operational Framework also offers guidance on phasing and sequencing interventions so that considered incremental steps can be taken to develop comprehensive and sustainable interconnected, coordinated public health systems.

Practitioners can select the tools and approaches that are most relevant to their situation. Several components can be bundled together and implemented jointly. Alternatively, where capacity and resources are limited, interventions can be undertaken and tools applied separately — where initial activities (e.g. system diagnostics and assessment) lay the foundations for the next phase of work (e.g. investments, policy reform). Zoonotic disease prioritization (see Chapters 3 and 5) is another example of

this approach, as applying One Health approaches to disease-specific contexts may serve as a foundation for upscaling to address other known and unknown hazards (see Chapter 5).

This document is primarily directed to World Bank staff (particularly TTLs), working on health, agriculture and environment sector projects and programs. As a cross-cutting discipline, One Health issues are relevant to projects in many disciplines. However, the document has value beyond this institution as client countries, other development banks, bilateral aid agencies and communities are tackling common issues (and many of these groups have highlighted One Health as a priority). Tools and approaches here can be applied in many of these contexts.

Policy makers and managers likely will find this document useful as it provides strong context for opportunities to strengthen public health systems to inform higher-level dialogue and decision-making. Operational teams should find value in the specific tools and approaches here that can be integrated within development lending programs. The many examples should also provide useful context for all readers and show the breadth of topics where applying One Health may have utility. Building on the World Bank's "People, Pathogens and Our Planet" reports (2010 and 2012) that provide the rationale for One Health, this more robust document aggregates prior work from the World Bank and its partners, including lessons from World Bank programs, providing an inventory of relevant operational tools and steps.

All dollar figures in U.S. dollars, unless otherwise noted.

Guide for Applying the One Health Operational Framework in Project Phases

Project Phase	Steps	Relevant Sections	Outcome
All Phases	Communication	-Chapter 5 (targeted depending on objectives of project phases)	Strengthen stakeholder engagement and multi-sectoral arrangements; Manage risk
	1. Identification	<p>Problem scoping and determination of relevant sectors/ministries</p> <p>Assess financing options (e.g. IPF, PforR, DPL) and identify resource synergies</p>	<p>Risk-based entry points determined; Stakeholders identified</p> <p>Relevant financial instrument(s) identified based on scope and objectives</p>
2. Preparation	Assess basic capacities of institutions, individuals, and technical and physical infrastructures	-Chapter 3: Figure 3.4 (map of relevant tools) and Annex -Chapter 5: Financial and Personnel Resources	Existing capacity, gaps and possible synergies identified across all relevant sectors
	Identify activities to support	-Chapter 5: Key components for prevention, detection response and recovery	Identify risk drivers that contribute to vulnerabilities; Identify entry points for action
	Implementation arrangements	-Chapter 3: Tools for assessing capacity; -Chapter 5: Stakeholder mapping	Stakeholders identified; Multi-sectoral arrangements and capacity strengthened
	Develop Results Framework	-Chapter 6: Core One Health indicators; Annex	Progress tracking
	Economic and financial analysis	-Chapter 2: Costs and benefits -Chapter 5: Financial and Personnel Resources; Governance	Investments optimized; Opportunities to target cost-effective prevention and detection pursued
	SORT and Environmental and Social Safeguards	-Chapter 6: Project Risks and Safeguards (6c and 6d); -Chapter 5: Vulnerable populations -Annex 8: Safeguards	Project risk reduction; Compliance with Safeguards
	3. Implementation	<p>Timelines, actions, monitoring mechanisms that reinforce prevention, detection, response and/or recovery capacity</p> <p>National and external partner arrangements; use of project outputs by stakeholders</p>	<p>-Chapter 5: Table 5.1 (in particular Communication and Technical Infrastructure)</p> <p>-Chapter 3 and Annex 5 -Chapter 6: National arrangements and external partnerships</p>
4. Evaluation	Measure and report progress against indicators and project objectives	-Figure 3.4: Tools for assessing capacity -Chapter 6: Core One Health indicators -Annex 7: Indicator examples	Progress tracking; Further country-level need or foundations for future projects identified
	Measure integration or uptake of One Health strategies into planning and/or practice	-Chapter 5: Communication; Governance	Sustainability of practices; preventive capacity
	Review areas of focus and update plans	-Chapter 5: Risk Analysis and Stakeholder Mapping	New information may warrant updated risk management strategies
	Measure value-added from One Health approach	-Chapter 2: (Table 2.4)	Resource optimization opportunities

1. STRATEGIC CONTEXT AND RATIONALE

The impacts of infectious diseases extend beyond direct morbidity and mortality. The 2014-2016 Ebola outbreak in West Africa was a potent reminder that infectious diseases also affect economic, socio-cultural, educational, health and other development objectives. In essence, these disease events, whether persistent or sporadic, lead to cycles of disruption and limit the ability of communities and countries to pull themselves out of poverty (Bonds et al. 2012). Achieving local and global health security can advance the World Bank's twin goals of poverty eradication and shared prosperity, and associated sectoral gains (e.g. environment, agriculture, disaster risk reduction).

In the context of global environmental change, ecological and human dynamics are amplifying pressures at human-animal-environment interfaces, leading to increasing risks of disease emergence or re-emergence, spread, and persistence compounding already high burdens in affected communities where endemic zoonotic pathogens infect billions of people, and cause upward of two million deaths annually (Grace et al. 2012). In many cases, infectious disease events have close associations with changing ecological and demographic conditions from anthropogenic activity, often with shared drivers of disease and biodiversity loss and ecosystem degradation (WHO-CBD 2015). For example, land use change is one of the leading drivers of emerging infectious diseases from wildlife (associated with factors like expanding urban populations, changing agricultural production to meet increased demand, and natural resource extraction, all which frequently correlate with habitat encroachment and loss) (Loh et al. 2015). The complexity of inter-related animal and human health and ecological and environmental factors, combined with changing demographic, trade and travel trends, makes it difficult for these complex interactions to be easily integrated into development project design and monitoring and evaluations and therefore they often are analyzed and addressed in singularity. The result is existing health programs that, while addressing some aspects of the complexity, are insufficiently equipped to assess risks and outcomes associated with their root causes. Climate change, habitat destruction, encroachment, biodiversity loss, land use change, demographic changes and other dynamics are simultaneously occurring on a profound scale, often threatening human, animal, and environmental health in ways unique in modern history (Richardson et al. 2016).

Addressing these factors as public health challenges requires a systems approach with inputs from many sectors related to human, animal and environmental health and a plan to bring them together. The United Nations Sustainable Development Goals call for integration across sectors and require examining public health systems into a broader context, looking at associations that go beyond the environment and health sector and are linked to city and other land planning; exposure to chemicals at home, at the workplace and in communities (e.g., leading to antimicrobial resistance or endocrine disruption); unsustainable lifestyles and unhealthy diets and more, in addition to climate change and ecosystems disruptions. This Operational Framework presents a multi-sectoral approach to reconcile, connect and develop synergies and efficiencies, strengthen human and animal public health systems and ultimately protect global public goods, while preserving ecosystems and ensuring a more equitable distribution of health gains.

Box 1.1 The Need for Multi-Sectoral Public Health Systems

The division of labor among public institutions makes for a segmented organization of work in which institutions operate independently of one another and from the perspective of their respective discipline or sector. This unavoidably leads to gaps and, sometimes, overlaps. For practitioners working in this Framework, the starting point for action tends to revolve around the question “What am I responsible for?” rather than “What needs to be done?” Changing the organization of work across disciplines to start with this latter question implies a substantial reorientation in which regular communication takes place between practitioners at work in different disciplines and sectors. This does not imply an amalgamation of work but rather the creation of a culture in which practitioners are more likely to understand the significance of a finding or event within their own field for practitioners in other fields, and are more likely to collaborate to optimize outcomes.

1a. What Does this Operational Framework Do?

Efficient and effective preparedness in public health systems is evolving as a major post-Ebola focus. **An Operational Framework to promote health at human-animal-environment interfaces provides operational guidance to directly address the need for targeted investments that prevent, prepare, detect, respond to and recover from issues like diseases with pandemic potential, including antimicrobial resistance.** The term “environment” is used throughout this Framework in recognition of environmental health, inclusive of the term “ecosystems”¹ used by the UN Biodiversity Convention (CBD), Food and Agriculture Organization (FAO), World Organisation for Animal Health (OIE), and World Health Organization (WHO) (here including both abiotic and biotic factors in scope) (see Box 1.3). With a near-term goal of strengthening human and animal public health systems, this Framework can jointly yield long-term gains in animal production and environmental management, ultimately improving overall health of the planet and the lives, livelihoods and well-being of people.

To effectively address shared threats and opportunities, human and animal health sectors should balance ecological or environmental considerations or consider them holistically, especially given the context of local and global environmental change (and further supported in the context of socioeconomic and political change). Tropical and neglected zoonotic diseases, pandemic threats, antimicrobial resistance, and other diseases and challenges at the human-animal-environment health interface pose daily threats to the physical and economic health of poor people in developing countries. Collaboration toward strong public health systems can better serve these vulnerable populations. Moreover, multi-sectoral collaboration itself can contribute to making public health systems more resilient (Box 1.1).

Initial targets provide inputs for implementation in countries to build systems that can better carry out essential public health functions. Zoonotic disease programs have in the past typically been funded in response to emergency situations (e.g. H5N1 highly pathogenic avian influenza, Rift Valley Fever and Ebola outbreaks). Establishing multi-sectoral programs within governments to manage endemic zoonoses can provide solid ground for response to emerging diseases and outbreaks of major importance. Similarly, upfront investments targeted at identifying zoonotic disease at source, or even before emergence, can aid in rapid response, using the One Health values, preventing many outbreaks before they occur and/or greatly reducing their impact through early detection and control. For example, the investigation of Nipah virus in Malaysia in 1998-99 indicated a wildlife-livestock-human transmission chain, with One Health approaches implemented to strengthen farm biosecurity that have helped the country avoid subsequent emergence events of the deadly disease.

¹ Article 2, the Convention on Biological Diversity. <https://www.cbd.int/convention/articles/default.shtml?a=cbd-02>

This Operational Framework **outlines activities and interventions with a starting point at the human-animal-environment interface, highlights proposed methods of institutional and technical implementation, and enables mechanisms of coordination and partnership to build more collaborative public health systems.** Providing guidance on entry points for One Health application, implementation building blocks, and monitoring, it emphasizes the elements that are critical to include in projects (e.g., strengthening governance of human public health, animal public health and environmental management services and multi-sectoral collaborations on strategic areas, addressing global priority issues) and highlights those that might be used to answer specific country requests for national priority issues.

This Framework draws upon work launched by the international community on human health, animal health and environmental health. These partners have endorsed the One Health approach and identified shared priorities, but the tools they have developed primarily correspond to their respective mandates; hence opportunities remain to further integrate and operationalize these tools for local and regional implementation of One Health. This Framework also includes other tools and good practices that can be used to inform, implement and support system strengthening programs — first at country level, but with scope for regional and global advancement in coherence and harmony with international standards and on-going initiatives (e.g., existing surveillance infrastructure and programs), including engagement on regional capacity. Developed by the World Bank in consultation with its partners, including members of the Tripartite group (WHO-FAO-OIE), it is envisioned as a living document accommodating evolution of tools, standards and guidelines, and other practices and experiences gathered from agencies and academia, offering guidance on that basis. In one context, the Framework may also be applied as a foundation for a horizontal series of operations (standard operating procedures) or global program, similar in mechanism to the Global Program for Avian Influenza², with provisions for country-driven variance. The Framework promotes alignment among donors, clients and others interested in this interface.

One Health

There are many definitions of One Health. During the response to avian and pandemic influenzas in 2005-14, the World Bank described One Health as: *a framework for enhanced collaboration in areas of common interests (intersections), with initial concentration on zoonotic diseases, that will reduce risk, improve public health globally and support poverty alleviation and economic growth in developing countries (GPAI³).* This is fully aligned with, but more limited than, the concept proposed in this Operational Framework. Here, we modulate this definition to highlight the discrete disciplinary involvement of human health, animal health and environmental health, and focus on those infectious disease-related issues (including antimicrobial resistance) that undermine overall health and well-being.⁴

² Program summary at <https://openknowledge.worldbank.org/handle/10986/21541>

³ Global Program for Avian Influenza Control and Human Pandemic Preparedness and Response (December 2005)

⁴ While using infectious disease/AMR as a starting point, we recognize this definition and approach is expandable for wider scope (e.g. water and soil pollution that have animal and environment connections).

Box 1.2 Operational Framework definition of One Health

A collaborative approach for strengthening systems to prevent, prepare, detect, respond to and recover from primarily infectious diseases and related issues such as antimicrobial resistance that threaten human health, animal health and environmental health collectively, using tools such as surveillance and reporting with an endpoint of improving global health security and achieving gains in development. While using infectious disease/AMR as a starting point, we recognize this definition and approach is expandable for wider scope (e.g. water and soil pollution which have animal and environment connections).

If a program is focusing on human-animal-environment health interfaces, does this necessarily mean that it is a “One Health” program? Conceptually and theoretically, if work focuses on the linkages between humans, animals and the environment, it falls under the definition of “health [as] a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”.⁵ One Health simply emphasizes this all-embracing definition. Employing a more generic or alternative term, however, may be useful in some settings, particularly in an interdisciplinary institutional capacity where the term may have different meanings to different people. The formal concept and application of One Health that has evolved over the past decade has grown out of an interdisciplinary effort of human health, animal health and environmental professionals as well as other disciplines (e.g. social sciences and risk communicators) via recognition of the need for systems thinking. Amongst these, animal health professionals have been particularly instrumental in the field’s development, due in part to the multi-species nature of veterinary medicine. As a result, there is strong association with and ownership of this term by those in veterinary and animal sciences. Unfortunately, this means using the term can be unintentionally alienating or exclusive because it can signal to those in human medical, public health or environmental communities that this work is the purview of veterinarians and less than optimally relevant to those concerned with human and environmental health. Because of this, the phrasing health risks at the “human-animal-environment” interface has been chosen to highlight the importance and equitability of this work to (i) improving public health in its human, animal and environmental dimensions, (ii) addressing drivers and changes that threaten health, and (iii) optimizing the effectiveness of public health systems in achieving these goals. This clarification is important internally within the World Bank, as it strives to work amongst sectors, and continue building partnerships with other involved organizations like WHO, OIE, FAO, UNEP, CBD, UNISDR and others.

In addition to One Health, the core principles outlined throughout this Framework may also be captured by other terms, such as Ecohealth or Planetary Health, each describing an integrated understanding of health that is not limited by species boundaries and seeks to bring together sectors to better address the health impacts of wide-scale environmental change resulting from human activity (for a more detailed description see Annex 2). Consistent with the way the World Bank has historically used One Health as the paradigm for this type of interdisciplinary health work, we continue to use it in this Framework (though again, recognizing the nuance, distinction, and value of the other approaches).

Steps to Operationalization of One Health Concept

There are many possible entry points for strengthening public systems at the human-animal-interface (see Chapter 4). Step-wise operational guidance for endemic, epidemic and pandemic disease prevention, detection, response and recovery can be found in Chapter 5. Particular tools of greatest utility will depend

⁵ Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19-22 June, 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and entered into force on 7 April 1948.

on the scope and goal of the program. In general, defining the scope, identifying the entry points, and conducting stakeholder mapping are key first steps to know the relevant actors and identify gaps. Each of the respective stakeholder communities (e.g. sectors) have tools and guidance resources that may be commonly used; while these pieces are not new in themselves, applying them together in systematic ways as part of a One Health approach has potential to share information, expertise and resources to generate knowledge that could otherwise not be yielded individually. Progress monitoring and upscaling can also help practitioners and institutions learn from and optimize One Health operations.

Why do we need more collaborative approaches and interventions to strengthen public health systems at the human-animal-environment interface?

- 1. Because animal, human and environmental health are fundamentally linked** (e.g. in food systems), contributing to public health outcomes (e.g. zoonotic diseases, drug resistance, among many others). On average, a new disease in humans has emerged or re-emerged each year since World War II, and 60 percent have come from animals — both wild (72 percent) and domestic (Taylor et al. 2001; King 2004). Spanish flu and HIV alone have taken hundreds of millions of lives over the past century. More than one billion cases of zoonotic disease are recorded every year, though the number of cases and burden of many endemic zoonoses is thought to be vastly underreported (Karesh et al. 2012, Grace et al. 2012).
- 2. Economic losses associated with business-as-usual strategies for zoonotic disease are enormous.** The direct costs of H5N1 highly pathogenic avian influenza (HPAI) outbreaks since its first emergence in Southeast Asia in 2003 have well exceeded \$20 billion. When indirect costs such as losses in other parts of the animal product chain, trade, and tourism are included, these costs multiply. The SARS outbreak in East Asia and Canada led to losses estimated at \$41.5 billion (World Bank 2012). Antimicrobial resistance may reduce world GDP by upwards of 3.5 percent annually by 2050 (World Bank 2016). However, while such economic impacts are severe, investments during peacetime are still very limited, despite high return on investment (see Chapter 2).
- 3. Despite their wide-ranging impacts to public health, the current paradigm for addressing zoonotic disease outbreaks is typically highly reactive,** with detection and control efforts implemented after spillover to humans has already occurred and often spread across human populations. Ideally, risk monitoring will allow us to avoid disease outbreaks through prevention measures at source, or at least enable early detection, control and/or rapid containment. For example, some South American countries conduct Yellow Fever surveillance in sylvatic monkeys and the mosquito vector to inform risk assessment with the goal of preventing pathogen spillover to humans; similarly, where epidemiologically relevant, Ebola virus surveillance in Great Apes may precede human cases, and thus may offer a sentinel monitoring benefit — and also inform biodiversity conservation measures. For some outbreaks, the causal pathogen or its source is not immediately known or is novel, making treatment and control measures challenging (as seen with the emergence of the Middle East Respiratory Syndrome (MERS-CoV) in 2012); in other cases control measures are well established but not readily available to vulnerable populations (in the case of some neglected zoonotic diseases). By employing or promoting early detection at source in animals and, ideally, the detection and prevention of spillover risks before they occur through environmental and epidemiological monitoring and safeguards, public health authorities can help reduce zoonotic disease burden (Fig. 1.1).
- 4. To prevent “downstream” health and financial impacts, fundamental animal-human-environment connections must be recognized, used and addressed “upstream” in our public health systems.** The underlying drivers of disease emergence, re-emergence, increase in prevalence and the factors that facilitate their spread are primarily associated with human-driven forces driving

changes in ecological and social dynamics (e.g. land use changes, population growth, burgeoning demand for livestock products, transformation of livestock systems without sufficient biosecurity improvements, complex intra- and inter-regional value webs, peri-urban farming, rapid urbanizations, etc.). In order for the health sector to get ahead of the possible risks presented by these trends, genuine collaboration with other sectors is needed to understand changing risks in order to prevent, detect, respond to and recover from them.

5. **The World Bank, like many institutions, is structured by sectors. Though necessary for function, this structure can sometimes create artificial boundaries to collaboration** whereby human health, animal health and environmental projects become segregated. This Framework is conceptualized to help bridge these sectors and create **more inclusive, linked programs and solutions**. Enabling this organizational fluidity is a necessity to achieve the multi-sectoral gains necessary to address complex issues of high impact like zoonotic diseases and AMR, and prevent long-term impacts to the environment that compromise ecosystem resilience and disaster risk reduction, food and water provisioning, and other key ecosystem services.
6. In general, **One Health is a sound management approach**, fully aligned with the definition of “health”, and good practice for its predicament on the use of increasingly scarce resources, therefore improving efficiency and efficacy.

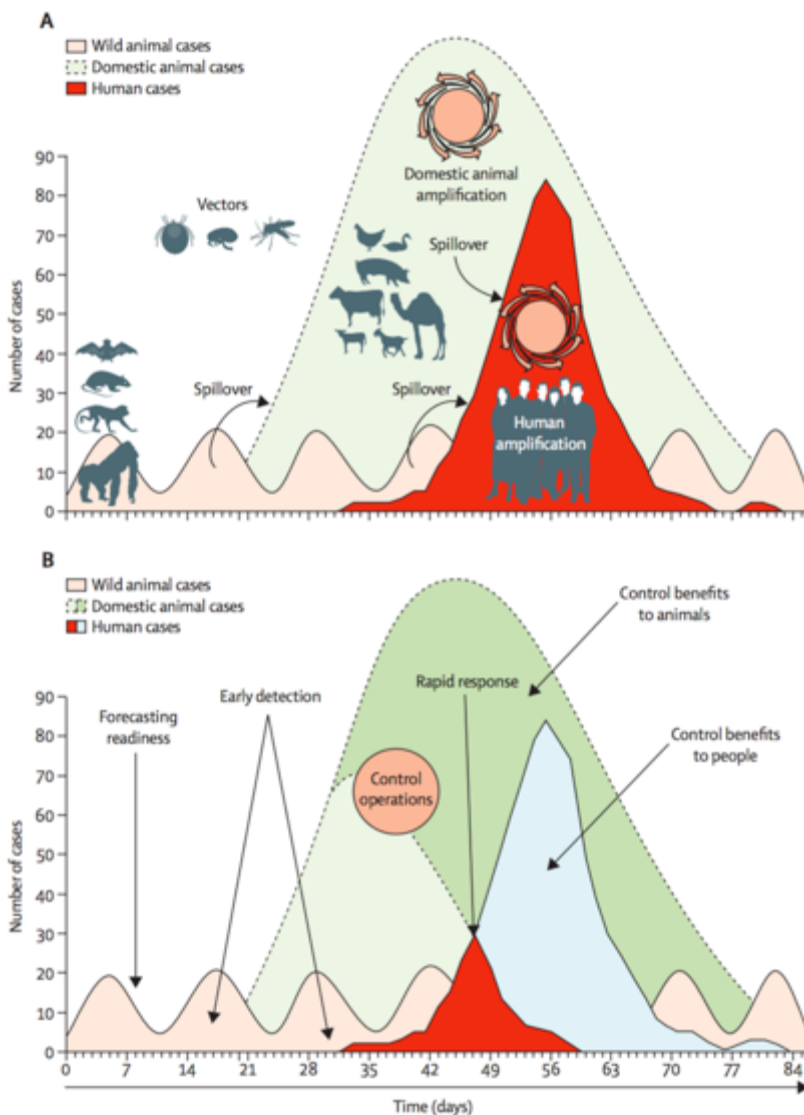


Figure. 1.1 Clinical relevance of disease ecology. (A) Transmission of infection and amplification in people (bright red) occurs after a pathogen from wild animals (pink) moves into livestock to cause an outbreak (light green) that amplifies the capacity for pathogen transmission to people. (B) Early detection and control efforts reduce disease incidence in people (light blue) and animals (dark green). Spillover arrows show cross-species transmission (Karesh et al. 2012).

The depictions above (Fig. 1.1) represent examples of possible scenarios, noting that specific dynamics will depend on the particular context — demonstrating that there may be efficiencies gained from a more complete understanding of the different components and their connections in a given disease system (see Chapter 4).

Box 1.3 Environment and ecology – distinctions in terms of public health

In the context of this Framework, “environment” is intended as a broad term inclusive of ecosystems and ecological dynamics. However, at a finer scale environment and ecological distinctions may become highly relevant when appreciating complexity for a given health threat or conditions at the human-animal-environment interface. These terms can be differentiated by the environment (biotic and abiotic components, e.g. living organisms versus physical forces including wind, sunlight, and soil, as well as man-made infrastructure) and ecology (an aspect of the biotic component that examines how living organisms interact with each other and the environment and includes biological diversity). An ecosystem brings these factors together in a given unit (representing a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit). Environmental (including ecological) expertise can inform on factors shaping disease risk as well as health benefits. For example, in the case of Rift Valley fever virus, transmission involves stages of drought and rainfall, particular vector species, susceptible host specie(s) and their interactions, and soil conditions, among other determinants. Biotic and abiotic conditions may affect potential for persistence and/or dissemination of contaminants (whether pathogen, chemical, etc.)

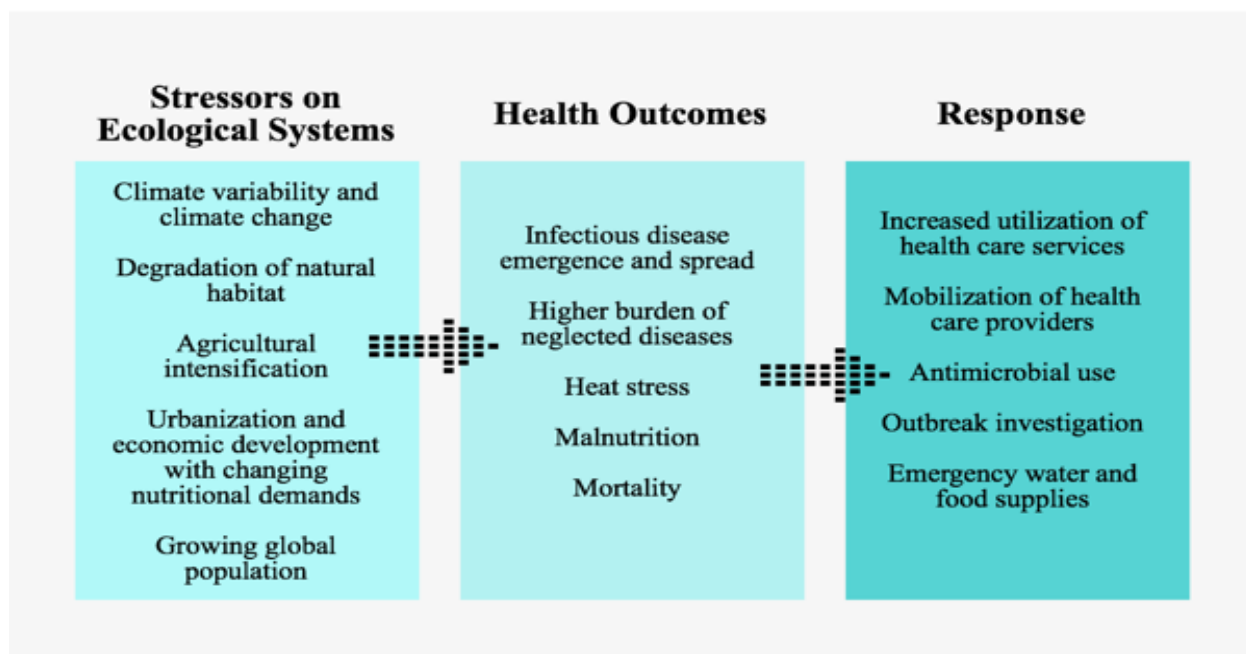


Figure 1.2: Stress to ecological systems from anthropogenic environmental change is resulting in wide-ranging health outcomes. Health systems typically respond with reactive approaches. An alternative approach could address underlying drivers across sectors to prevent or mitigate human, animal and environmental health outcomes proactively, reducing reliance on response.

Audience

Intended primarily as a resource for World Bank Group staff and clients, the audience for this Operational Framework may also extend to including individuals (e.g. researchers and policy makers) and organizations with a shared interest in identifying and implementing One Health solutions. Within the World Bank, this Framework can be used in different ways, depending on needs. TTLs would in particular draw from tools, policy approaches or World Bank projects' specific sections' background information. Those working on analysis could draw from the resources for a variety of reasons ranging from economic assessments to public health interventions. Similarly, management may find the Framework useful for resources that link Global Practices (GP) and Cross-Cutting Solutions Areas (CCSA), and which cultivate a collaborative Bank-wide approach, as well as reducing risk for the success of Multilateral Investment Guarantee Agency (MIGA) investments.

Outside the World Bank, it is envisioned this work would be useful to the broader development and policy making community, particularly those working in health, agriculture, environment and related disciplines, including as a policy tool to contribute to global and national commitments.⁶ Governments can use this as a resource and reference point for working with these organizations on One Health, or when devising programs on their own, particularly for context in relevant resources for knowledge and finance. Civil society organizations and the private sector equally may derive utility from such resources and find it particularly advantageous in the case of public sector and development institution collaboration. While this Framework emphasizes the role of public health systems/sectors toward the provisioning of the global public good of preventing or reducing the impact of disease threats, envisioning public health systems as a broad platform encompassing dimensions of human, animal and environmental health, it also acknowledges that in many cases the private sector will intersect closely and may play a meaningful role in advancing the strengthening of many parts of these systems.

1b. Scope

The nearterm purpose of this Operational Framework is to strengthen public health systems to be better prepared to prevent, detect, respond to and recover from disease pressures at the human-animal-environment interface (i.e. health security). Diseases are increasingly recognized as major disasters that put countries at significant health and economic risk. In addition to pandemic threats, many countries face persistent burden from endemic disease; having a strong foundation to address these directly assist in preparedness for all diseases to reduce threats and their consequences, both at country level and to contribute to universal health security as a global public good. This requires both improving the capacity of individual health systems on their own as well as their ability to connect, arrange and collaborate amongst one another and their integral components (public and private sector) to translate and transmit information and compensate for gaps to improve understanding of transmission pathways and control options. This is essential for facilitating synergies against contemporary threats to human and animal health as well as the environment, especially in light of overall under-resourced efforts to address them.

This document does not directly address all issues that lie at the human-animal-environment health interfaces. To do so would require consideration of virtually every issue that affects human health and well-being: food and nutrition from terrestrial and aquatic resources; the contribution of pollinators to crop productivity and availability; pharmaceuticals from bioprospecting; infectious disease in its many forms derived from or mediated through animal species; the emotional well-being of companion animals,

⁶ Examples of relevant policy commitments include National Biodiversity Strategies and Action Plans, the Sustainable Development Goals, the Sendai Framework for Disaster Risk Reduction, National Action Planning for Health Security, and others.

and many others. Food safety itself is a wide topic requiring complementary interventions of many actors across various sectors along the product value chains. While interventions promoted by this Operational Framework are relevant to addressing some food safety issues at the human-animal-environment interface, more would be needed to cover the entire set of food safety dimensions. In this sense, this Framework, while a component of the broader One Health discipline, examines a subset of its applications.

Infectious disease in animals and humans and antimicrobial resistance are merely two major applications along the plane of the human-animal-environment interface: others are relevant too, including biodiversity loss, pollution, chemical toxicology, climate change, human-animal bond, and more (Fig. 1.3). For infectious zoonotic diseases, even this realm is broad, with over 60 percent of human pathogens being directly traced to non-human animals and approximately three-fourths of recently emerging diseases traced from wildlife, with strong correlations to changing environmental or natural resource and land management practices as a driving factor for their spillover to humans.

At present, there are ongoing projects or programs (World Bank, UN, country-level and others) that address epidemics and pandemics such as Avian Influenza, Ebola, and malaria (and many others that focus on food systems, crops, livestock, and fisheries). Furthermore, there are strong examples of evolution from single disease control efforts (one bug–one drug) to more comprehensive programs (e.g. reducing early childhood diseases or poultry health improvement programs). To date, however, there are very few that address these threats collectively or in such a way that enables the gains earned from one program to be directly translated into the gains for another — a concept which is particularly salient for a set of infectious diseases that are perpetuated by so many of the same system failings. The Regional Disease Surveillance Systems Enhancement (REDISSE) program seeks to aid precisely these collective gains throughout surveillance activities (Box 1.4).

Box 1.4 Regional Disease Surveillance Systems Enhancement Series of Projects (REDISSE)

The REDISSE program, launched by the World Bank in 2016, aims at enhancing disease surveillance strengthening in countries of the Economic Community of West African States (ECOWAS). The program, developed through a series of operations, stems from the World Bank's mobilization of more than \$1.6 billion in financing associated with the West Africa Ebola outbreak, building on the response and recovery efforts to establish core country and regional capacities to help build a resilient, broad-based disease surveillance and response system, based on inter-country collaboration and collective action. Other technical and financial partners, including The Bill & Melinda Gates Foundation, the World Health Organization, the World Organisation for Animal Health, the U.S. Centers for Disease Control and Prevention, among others, support the program. The REDISSE projects' design incorporates a shift from a paradigm grounded in crisis response to one that embraces a health disaster risk reduction approach and better risk management to rapidly detect and respond to biological hazards of national and international concern, reducing the burden of diseases and mitigating the public health and economic risks posed by infectious diseases in humans and animals. Centered on helping improve disease surveillance infrastructure, information-sharing and collaboration across the health, agriculture and environmental sectors in West Africa, a region experiencing rapid population growth, increasing climate instability, changing agricultural production systems, widespread deforestation, natural resource depletion and environmental pollution and degradation, the program is emblematic of action at the human-animal-environment interface.

The Operational Framework adds value by linking up shared challenges and opportunities. Ambitious in scope, it first addresses those components that improve the governance and function of public health systems to better prevent, prepare, respond to and recover from a variety of global and local disease threats (including drug resistance). These efforts stand to have impact for high-profile diseases such as Ebola or Highly Pathogenic Avian Influenza (HPAI), as well as for neglected zoonotic or orphan diseases with environmental determinants (e.g. schistosomiasis, leptospirosis) and for unexpected infectious events, when unprecedented emerging disease scenarios similar to Ebola or MERS-CoV will develop again at the human-animal-environment interface in the future. This approach is not specific to any one disease — or fundamentally, species. Better public health systems for humans, animals and environment must be developed together so that these emerging and persistent disease threats can be addressed more effectively and comprehensively. Over time, these diseases have: (i) caused human suffering and devastating shocks to economies from poorly controlled disease outbreaks; (ii) slowed mid- and long-term economic growth; (iii) caused political instability, and (iv) resulted in debilitating health outcomes for populations in developing countries. The broader portfolio of human-animal diseases, drug resistance issues and environmental degradation that threaten global health security and undermine poverty reduction efforts will be better tackled through this approach as well. The tools and methodologies are similar, so the public health systems that are equipped to deploy them can also successfully tackle these broader challenges.

The Framework builds on the lessons learned and experiences gained from addressing pandemics and epidemics, antimicrobial resistance, and other diseases of global prominence that have direct relevance. While focusing on pathways for infectious disease directly relevant to humans (e.g. zoonotic diseases), we also recognize that other diseases, including non-communicable diseases, and issues are relevant to the human-animal-environment interface and can benefit from the One Health approach (see Chapter 2).

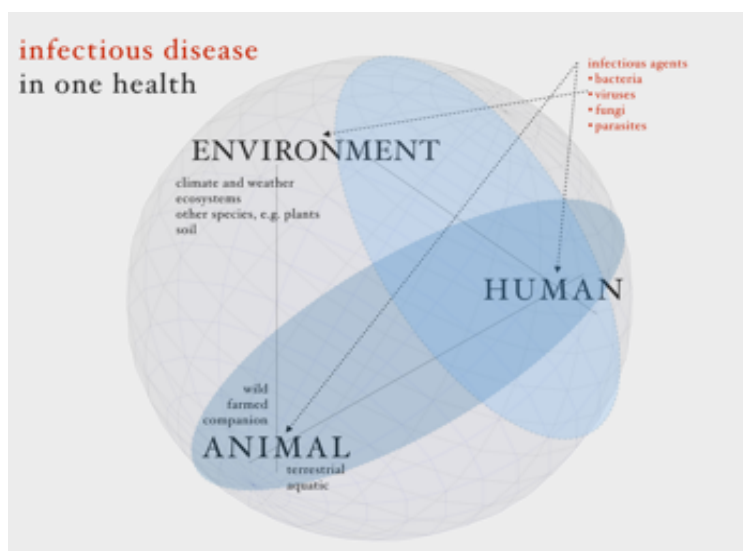


Figure 1.3 How infectious disease acts in One Health and area of focus of the World Bank Operational Framework.

How does this Framework Function?

Areas of focus

This Framework has four areas of focus: (i) human health systems, (ii) animal health systems, (iii) environmental health and management, and in particular, (iv) collaboration and cooperation between any one of these three areas (Fig. 1.3).

While targeted to the context of infectious diseases/AMR, application of this Framework may be adapted to other relevant health issues, e.g. other facets of climate, urbanization, ecosystem disruption and provisioning of ecosystem services, chemical exposure and toxicology, and more. The area of environmental health and management is important because animal and human interactions with the environment are fundamental in the determination of disease course and outcome and can have both short- and long-term effects on economic growth. At the same time, in some cases economic conditions and options may facilitate disease emergence and spread by producing local and global environmental changes and affecting resilience: deforestation, agro-forestry, urbanization, climate change and others have considerable and growing impact on disease emergence and spread and are recognized as drivers of disease within this new Framework. Finally, collaboration and cooperation are essential because they are paramount to linking these independent pillars of One Health to ensure that maximum sustainable health and economic benefits are achieved in the most efficient manner.

Within each area, there are specific tools and approaches that can be applied. The sub-components described for areas (i), (ii), and (iii) could be enacted independently, although to foster a One Health approach, particular attention should be paid to the competencies needed to build bridges and enhance communication, cooperation and synergies between human, animal and environmental health sectors. Fundamentally, the area (iv), collaboration and cooperation, that will necessarily require the inclusion of at least two of the first three areas (but ideally all three so none is systematically excluded), is most critical as it enables the resource and knowledge exchange for truly comprehensive One Health solutions.

Horizontal and Vertical approach

Suboptimal results in improving systems have sometimes come from adopting a purely vertical (disease specific) or horizontal (specific functions of the public health services) approach. While different contexts between countries can justify that an entry point for starting a program or project in a given country or region be one or the other, it is important to try to ensure that both be addressed simultaneously (Fig. 1.4). Adopting only a horizontal approach may lead to a lack of concrete and measurable results that are instrumental to justify recurrent costs financing, upgrading and innovations needed to maintain and improve a system. Conversely, adopting only a vertical disease-specific approach fails to address many other or evolving health issues that a human or animal

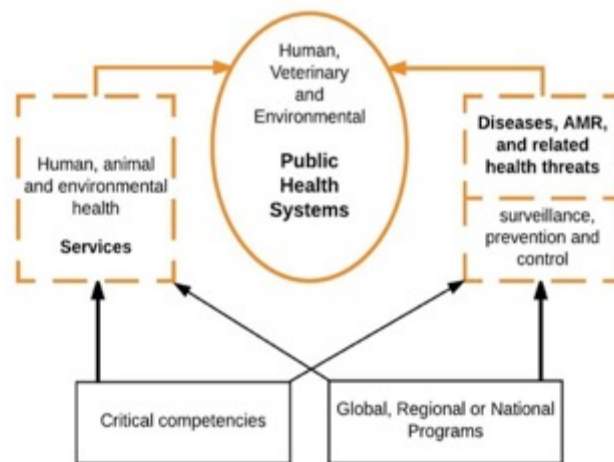


Figure 1.4 Both horizontal and vertical capacities are needed for systems-level improvements.

population or environment/ecosystem may face in a given country or region and that could be prevented or controlled using the same structures, workforce, skills and mechanisms at a limited additional cost, offering significant economies of scale to achieve broader health outcomes. This is why global and regional disease control programs now tend to place a greater emphasis on good governance principles and quality of services that will also serve to address other priority issues. In the animal health sphere, for example, the Global Foot and Mouth disease control strategy and the global Peste des Petits Ruminants control strategy both include components on the strengthening of Veterinary Services and the prevention and control of other major diseases of livestock. This Framework provides various examples of entry points for One Health, be they horizontal or vertical.

Entry points

Though the specific tools and approaches developed within each area might be unique, the disease challenges for application of One Health approaches should be shared by different sectors. For example, the WHO, OIE, FAO Tripartite has identified three priority issues for animal-human health of concern: zoonotic influenza, canine mediated human rabies, and antimicrobial resistance. Each of these particular issues affects or is influenced by animal health, human health, and in some cases, environmental health, and can thus likely be most effectively overcome through collaborative action or information in multiple sectors. Similarly, through risk mapping and prioritization exercises, countries (and regions when possible) should also identify priority diseases or issues to address in conjunction with more horizontal interventions.

It is however important to recognize that for each of these diseases or issues, and depending on the expected outcome of surveillance control or eradication programs envisaged, the three different sectors represented in Fig 1.5 will not be equally represented or involved in the partnership. Chapter 4 illustrates with more details how specific disease interventions may require more efforts from one or two of the sectors, showcasing possible entry points.

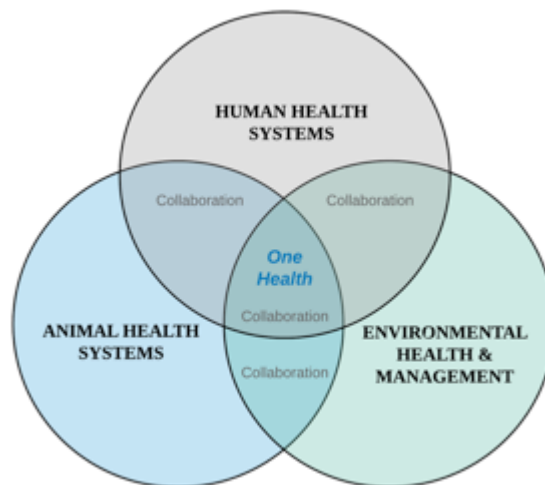


Figure 1.5 Operational Framework
Disciplinary Scope and Areas of Focus

Regardless of how the demand is generated and at what level (national, regional, global), the Framework enables response in a more holistic way. For example, there are already global programs addressing diseases of prominence such as malaria, though they generally lack One Health framing. Any or each of these programs and future ones, such as on pandemic preparedness in the context of IDA18 (WB Corporate commitments), could therefore be entry points, where relevant (Fig1.6).

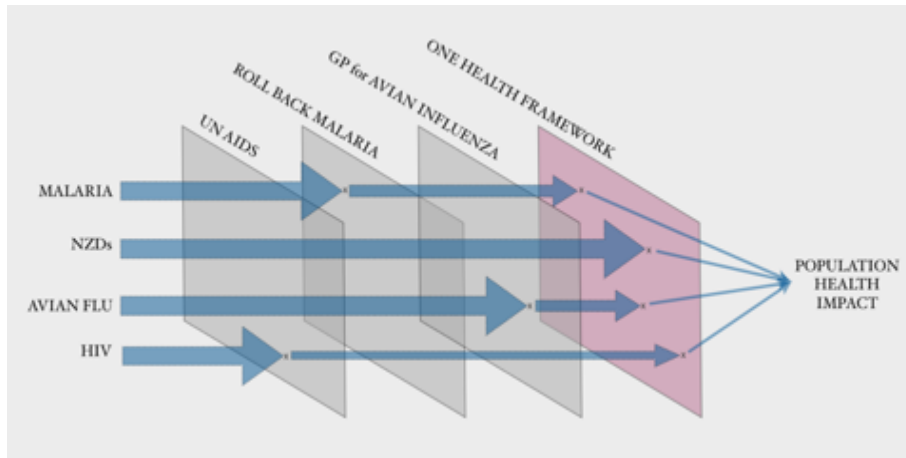


Figure 1.6. Global public health programs and intended impact on burden of disease. Note that the programs represented by grey planes are just examples of pre-existing programs that are targeting specific health threats. The development of a global framework for One Health can reduce the burden of diseases not already covered under a global program (e.g. NZDs) in ways that are not necessarily addressed through disease specific interventions, e.g. animal-human-environment health system collaboration.

Neglected tropical diseases (NTDs), and more specifically, neglected zoonotic diseases (NZDs), however, are good examples of other kinds of diseases not addressed by a global program, yet critically requiring a One Health approach. NZDs are endemic to some of the poorest parts of the world, are major burdens to public health, and are often preventable or treatable with the right interventions (Karesh et al. 2012). Focusing here can clarify approaches and tools to strengthen systems so that they can better manage both these endemic diseases and the more high-profile emerging infectious diseases and pandemic threats. As a result of their local impact, NZDs can also be used in monitoring and evaluation to measure progress (see Box 1.7). Strengthening capacity to respond to these very local disease threats can contribute to the overall ability to address all disease threats, regardless of human, animal or environmental origin. NZDs are in effect, the lowest hanging fruit in a very large tree of health issues that affect animal, human or environmental health and require interdisciplinary, One Health solutions. Given frequently known determinants and control strategies for some diseases (e.g. some endemic zoonoses), quick wins are often feasible and can serve to build momentum for efforts toward substantial long-term gains (i.e., wider global health security).

In another example, emergence and spread of antimicrobial resistance (AMR) pose a significant challenge to global health and animal production with high economic consequence (see Chapter 2). AMR demonstrates the need for an integrated One Health approach. Specifically, the widespread use of antibiotics in human medicine, agriculture and aquaculture can lead to the presence of antibiotics in the environment, where these substances can persist, disperse and interact with living organisms. Animal production-associated antimicrobial resistance — especially given the volume of antimicrobial use — in particular fits under the One Health scope. Without proper waste management, production and use of antimicrobials may also provide a source of introduction of antimicrobial residues and resistant microbes into the environment.

Box 1.5 Human Infectious Diseases – Just a Symptom of Weak Human Health Systems?

Weak public health systems have facilitated the spread of infectious diseases transmissible from human-to-human through inadequate control, as demonstrated in the 2014-2015 Ebola crisis in West Africa. In the case of this Ebola virus outbreak, the origin is thought to be a single spillover event from an animal reservoir that was then entirely human-to-human transmitted. In other cases, some infectious diseases are transmitted from animals to humans on a recurring basis but do not spread further than the index case.

Infectious diseases can be differentiated by their “stages” of transmission to humans (Wolfe et al. 2007) — not passing from animal to human (Stage 1); transmitted from animal to human but from there a dead-end, or only transmitted in exceptional circumstances (Stage 2 and 3); and examples such as the rabies virus, with limited transmission through blood and organ donation, and MERS-CoV, which is thought to stem from multiple contact events with animals but has primarily spread in humans via hospital-acquired infections), and others, including HIV/AIDS, that have become global epidemics sustained through human-to-human transmission (Stage 4). In the case of HIV, as well as the 2003 SARS outbreak, travel networks enabled international spread.

Current human health systems have important roles in preventing transitions between stages, notably through potential vaccination, blood supply screening, sanitation, use of personal protective equipment to reduce exposure potential, and more. Where the animal and environmental health sectors add value for public health through collaboration, therefore, depends on the scope of the problem and intervention point(s). These sectors may not be directly relevant for some critical public health services (such as contact tracing and provision of medical treatment) once an outbreak occurs; however, they may provide critical insight to help prevent further spillover events by helping to elucidate evolutionary and ecological dynamics and in some cases, in breaking the transmission chain (for example, through vaccination of ruminants for Rift Valley fever virus to prevent animal-associated human infections). The Framework will thus have different operationalization and entry points by situation.

Environmental and Social Aspects in the Context of This Framework

The importance of the environment for human well-being and economies is well established (Millennium Ecosystem Assessment). Ecosystems provide critical public health-promoting services, and thus ecosystem degradation may present consequences for human health. Health and social impacts may be especially relevant where socioeconomic factors limit ability to compensate for loss of ecosystem services.

Many zoonotic diseases are strongly connected with ecological dynamics. This is especially apparent for emerging infectious diseases (EIDs). The leading drivers of emerging diseases include land use change (such as deforestation, land conversion for agriculture, and processes associated with extraction of natural resources), human susceptibility to infection, agricultural industry changes, international travel and commerce, and war and famine (Loh et al. 2015). Notably, many of these also overlap with or contribute to the leading drivers of biodiversity loss (e.g. habitat loss is linked to land conversion, carbon emissions from travel leading to climate impacts, commerce of illegal wildlife leading to overexploitation of wild animal populations, etc.) (WHO-CBD 2015) (see Fig. 1.8).

Abiotic and biotic dynamics, as well as their interactions, are often unappreciated in disease outbreaks, but explain why disease risk is not static. Seasonal weather variation and extreme weather events may result in periods of flooding or drought that can lead to human or animal outbreaks. Environmental exposures are a primary determinant associated with several NTDs, including human African trypanosomiasis, leishmaniasis and schistosomiasis (Aagaard-Hansen and Chagnat 2010). Changing climate conditions — for example, suitable host habitat ranges may shift to new areas, and through natural or introduced (e.g. invasive) movement, may potentially bring their pathogens with them to novel

settings. In situations with strong genetic selection pressures — such as with the use of antimicrobials in aquaculture and agriculture — there may be many routes of environmental contamination and exposure. For example, food consumption, direct contact with antimicrobial-treated animals (i.e. farm animal handlers) (Gilchrist 2007, Marshall 2011), waste management and use of manure as fertilizer, run-off, dispersion through waterways, physical forces such as wind and watershed movement, and mobility of animals (i.e. via migration or translocation) have all been implicated in the transfer of antimicrobial resistance (Heuer 2011; Silbergeld 2008; Allen 2010; Davis 2011).

Depending on the context, social aspects may have a major role in environmental exposures (as such, the environmental pathway is sometimes under the heading of the “social determinants of health,” but we present it here as separate broad determinants given its own complexities and dynamics). Certain occupations may present unique risks, as may poverty status or other marginalizing factors (for example, food insecure households may turn to subsistence hunting, reliable water sources may not be available or may be shared with animals, or resource-limited individuals may live in housing not protective of environmental exposures). Human migration, whether for livelihoods or as a result of conflict, may also place humans in new settings that present novel environmental exposures. These situations are expected to increase from conflict over natural resources in the coming decades. At the same time, human behavior and societal preferences may also present new or increased risk — for example, the growing demand for wildlife protein from resource-rich consumers may place more exposure risk on local communities that undertake wildlife hunting activities; similarly, high demand for other food products (e.g. soy-, cattle- or palm-based) is resulting in land conversion, often in tropical forest regions. In some cases, financial benefits of these activities may only minimally extend to local communities, but potential acute and residual health impacts may be significant.

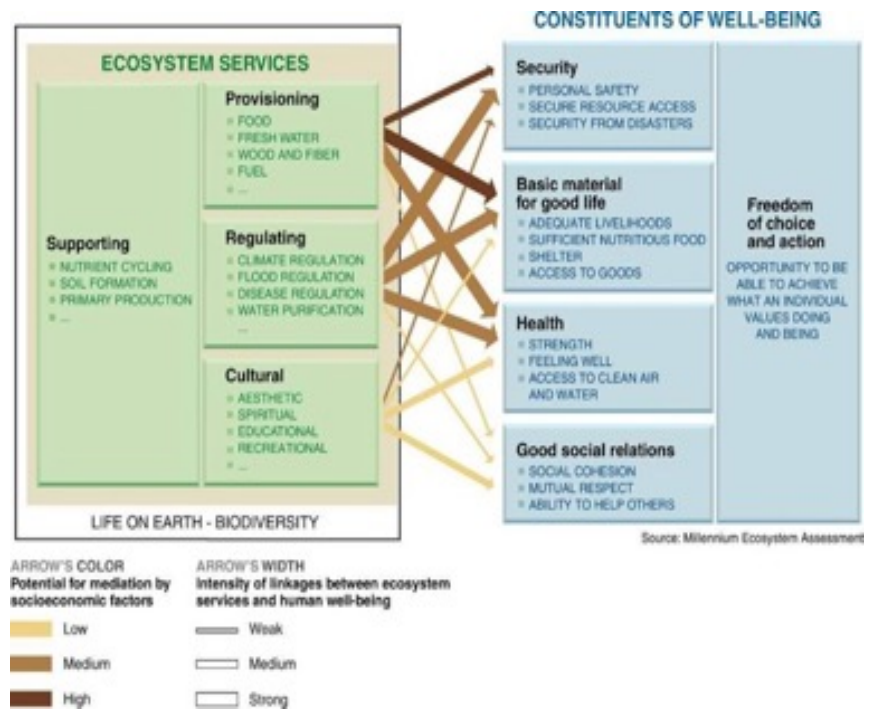


Figure 1.7 Linkages between ecosystem services and human well-being (source: Millennium Ecosystem Assessment)

Table 1.1 Typology of issues at global, regional and national levels (examples)

Typology of issues	Global	Regional	National
Affect or have the potential to affect	Many countries across continents	A group of countries geographically close	An individual country
Examples of Impacts	Economic growth, sustainable development, trade, tourism, poverty reduction, equity	Economic growth, tourism, Sustainable development, trade, poverty reduction	Economic growth, sustainable development, trade, tourism, Poverty reduction, equity
Examples of Diseases	Pandemics, AMR, Zoonotic Influenza, rabies, non zoonotic diseases (Foot and Mouth Disease, Peste des Petits Ruminants)	Ebola, Rift Valley Fever, Brucellosis, Human and Animal Trypanosomiasis	Other Neglected Zoonotic Diseases, Livestock ecto/endo parasitic infections (not necessarily zoonotic), arboviruses (West Nile and other encephalitis, Crimean-Congo haemorrhagic fever)

1bc Global, Regional and Country Issues

While operations will ultimately be rolled-out at country level, regional and global dimensions are important and need to be addressed. Programs should be additive — with work at each level reinforcing the others — so that none is stand-alone, instead working together to diminish overall disease burden. Such efforts should also comply with international references, standards and regulation to promote global consistency and attainment.

Global issues

Infectious disease knows no boundary. In our era of globalization, travel and commerce, infectious disease is readily transmitted across country, continent and sea. These threats are real for everyone and have the potential to undermine security, development, trade, tourism and every other social function predicated on human interaction. One only need look to the extraordinary and effectively incalculable financial and social costs of HPAI, HIV, rabies — or antimicrobial resistance — to glimpse the profound impact of communicable pathogens. More so, we know these disease issues because they are virtually omnipresent across the globe, either through direct presence or indirect impact. None have remained within their country or region of origin, underlining the value of this work to stop diseases at their source for everyone, not merely those who live in the immediate vicinity of initial emergence.

This Operational Framework focuses on improving human, animal and environmental health systems in developing countries, yet the value is truly universal. Stable countries that can address these risks simply contribute more to the global community through safer tourism, trade, exportation of cultural values, and

so on. More effective individual national public health systems means greater global health and food security.⁷ The implementation of this Framework combining development to global health security across a spectrum of disease (and resistance-related) issues means mutual benefits for global development and global health.

Regional issues

The regional dimension of strengthening animal and human public health systems is critical. Common elements, such as ecotypes, agro-ecological zones, human and animal population densities, farming systems, movement and trade patterns, and existing mechanisms for regional cooperation can significantly affect disease emergence and patterns. For example, the regional context in which the H5N1 HPAI occurred in 2003 is very different to that of Ebola — the former a product of dense poultry populations in farms and markets and long and complex intra- and inter-regional poultry value chains, versus the latter’s initial interactions with wildlife (namely via bats, non-human primates and duikers) that then spread widely via human-to-human transmission. However, the spread of both have been exacerbated by weak animal or human health systems and limited environmental management; for example, in West Africa amid the residual effects of civil war, the outbreak was met with limited government capacity and wide distrust in governments (Box 1.5). These factors enabled a so-called microbial “perfect storm”: a combination of factors that may support perpetuation and accelerated spread (Box 1.6) (Institute of Medicine 2003). As another example, Rift Valley Fever (RVF) outbreaks in humans and animals occur only in Africa, the Middle East and the Indian Ocean region. Regular occurrences of RVF in East Africa, for example, pose a heavy burden on countries in the region that derive critical revenues from the trade of ruminants with the Gulf States (see also Chapter 2) — and it represents only one of several vector-borne diseases and co-infections that occur in livestock. The ecological niche for the arthropod vectors is shaped by environmental and anthropogenic determinants, and control is typically highly reliant on environmental management measures. The Middle East Respiratory Syndrome (MERS) demonstrates regional clustering humans (primarily hospital-acquired), though a more disseminated pattern in camels. Even more widely distributed health issues, such as rabies or AMR, have regional penetrance and require geographic specificity in approach depending on context.

**Box 1.6 Combination Factors:
“Microbial Perfect Storm”**

- Microbial adaptation and change*
- Human susceptibility to infection*
- Climate and weather*
- Changing ecosystems*
- Economic development and land use*
- Human demographics and behavior*
- Technology and industry*
- International travel and commerce*
- Breakdown of public health measures*
- Poverty and social inequality*
- War and famine*
- Lack of political will*
- Intent to harm*

Source: Institute of Medicine 2003

Understanding regional context can help focus disease specific interventions that show particular prevalence in a geography. Support to regional coordination mechanisms in “hot spot” areas can help in carrying out risk assessments and analysis at regional level. Additionally, organizations set-up for regional cooperation can help implement these activities in ways that are both necessary and important to stopping disease spread. Perhaps a most salient example can be seen through cooperation (or initial failure of cooperation) amongst West African governments in the recent Ebola outbreak. Travel and trade bans were put in place and outbreak information shared through a convoluted network of international actors

⁷ In addition to the direct threat infectious disease poses to human health, disease in animals and environment fundamentally threaten the food supply and introduce another level of impact.

and government officials. In other areas where there is a stronger mechanism in place for regional alignment and resilient health systems, it is unlikely the disease would have had the broad regional (and global) impact that it did. As the weakest link is poor national health capacity, a regional approach may help reinforce/strengthen national capacity to reduce possible impact of outbreaks, such as expanded access to training, laboratories for rapid diagnoses, cross-border containment, and early warning to implement mitigation measures. This situation led to the regional World Bank financed program REDISSE (Box 1.4).

National issues

With limited resources and a breadth of health challenges to face, including the many endemic diseases affecting animal and human populations, countries usually prioritize investments on those diseases that have most known impacts on food security, incomes and livelihoods, but disease-specific approaches may have limited impact if not enabled by general health system strengthening. Many diseases of animal origin impose a heavy burden on humans through zoonotic infection, sometimes significantly diminishing the productivity of livestock, which is often the most important asset and source of income for poor households. The so-called neglected zoonotic diseases are endemic to many poor countries and tend to be under-diagnosed and under-reported (in both humans and animals). They disproportionately hurt fragile countries and the poor within them. For humans, this means more than 2.2 billion estimated human cases of zoonotic diseases (estimated for 13 zoonoses alone — so likely much higher) annually in developing countries, and about 2.4 million human deaths globally (excluding HIV/AIDS, which is classified as a zoonosis given its origin from an animal reservoir before becoming a global epidemic through human-to-human transmission) (Grace et al. 2012) (see Fig. 1.8). This figure, although reasonably large, is likely an underestimate because it does not include secondary human morbidity and mortality following from loss of livelihood or nutritional resources because of animal disease.

The toll from animal non-zoonotic diseases may also be significant for countries, and deserves attention. High morbidity and mortality due to infectious animal diseases such as Foot and Mouth Disease or Peste des Petits Ruminants and their impacts on livestock trade and value chains, livelihoods and food and nutrition security are well recognized. Others, for example endo- and ecto-parasitic diseases, also seriously impact animal production and productivity, and have a disproportionate effect on poor families and farmers, and may be linked to inadequate environmental management (e.g., poor waste sanitation systems and poor vector control, which themselves may be tied to environmental degradation). Non-zoonotic wildlife diseases also present threats through impacts on ecosystem services (see Chapter 2). Inclusion of these diseases in programs that focus on other diseases could be a low-cost way to address those that have a specific impact on the poor. Piggybacking more locally impactful animal diseases (that are not strictly “One Health” issues) as well as scaling up local and community-based projects onto a broader program targeting other regional and global priorities can provide large co-benefits and provide strong arguments for buy-in from national decision-makers.

Box 1.7 Reducing Burden of Neglected Zoonotic Diseases as a Priority for Systems

Neglected infectious diseases, including zoonotic ones and in particular (NZDs), as well as other endemic zoonotic diseases of significant health or economic burden to animals and humans, such as brucellosis and anthrax, manifest as outcomes and determinants of poverty. Socio-economic factors — ranging from occupation, educational access and attainment, income, access to food and water resources, and housing quality or mobility — may contribute significantly to the exposure, susceptibility and health and productivity burden of societies. These factors often intersect closely with animal and environmental exposures, or may be affected by them. For example, livestock-dependent populations, comprising over one billion people globally, have elevated direct exposure risks to livestock-transmitted zoonoses (Livestock Global Alliance 2016; FAO et al. 2012). However, in addition to direct health burden, they may also suffer from impacts of zoonotic (and non-zoonotic) outbreaks on livelihoods and economic solvency, and in cases of subsistence farming, nutrition security (Molyneux et al. 2011; WHO 2005). Livestock diseases may also reduce production potential and therefore challenge sustainability gains by the agricultural sector, contributing to environmental degradation through unnecessary greenhouse gas emissions, and feed, water and antimicrobial resource use. Efforts to minimize disease risk should thus be built into agricultural transformation initiatives to maximize gains.

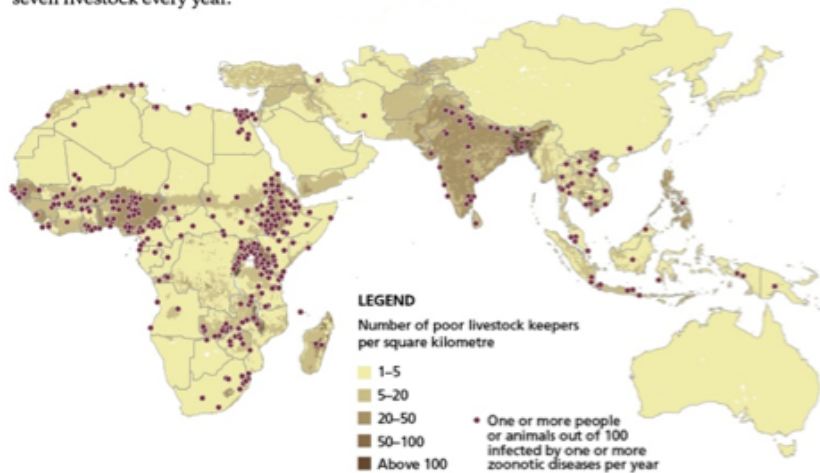
While the global burden of infectious diseases has declined over past decades, the burden of some neglected infectious diseases has increased (Hotez et al. 2014). For example, the Disability Adjusted Life Years (DALY) estimates for Schistosomiasis have risen, in part from ecological changes such as those associated with dam building. Yet less appreciated in DALY estimates are the chronic outcomes they can lead to (for example, cancer linked to Schistosomiasis) and in some cases, their role in susceptibility to other infections and the combined burden of polyinfections (Conteh et al. 2010; Torgerson 2011). In addition to their direct health burden, neglected diseases pose wide ranging non-health impacts, including interruptions in education, decreased worker productivity, decline in tourism, and societal stigma (Hotez et al. 2014). The cost of treatment for an infectious disease may constitute a large portion or be in excess of annual wages for the poor, representing a catastrophic financial event for an individual or household and potentially leading to treatment delays that later inhibit treatment efficacy (Conteh et al. 2010; WHO 2005).

Additionally, there are known correlations between vector-borne parasitic diseases (VBPDs) and income. The work of Bonds et al. (2012) suggests that higher burdens of these types of diseases decrease per capita income and affect overall economic development. The VBPDs are determined by underlying ecological conditions, which are strongly correlated with latitude. There is an additional buffering effect provided by biodiversity — the diminishment of which may result in higher disease burden and further impact on economic status (Bonds et al. 2012).

Preventive strategies and effective treatment are available for many NZDs, yet are not routinely employed or accessible in some communities, especially the rural poor. Control of zoonotic diseases in animals can be highly successful in preventing human cases, as suggested by control in cattle and insects to reduce human infections of sleeping sickness associated with the tsetse fly. The “prevention at the source” approach can also yield cost-effectiveness gains, as shown for rabies virus through control by vaccination in its domestic canid reservoir (WHO 2005).

Greatest Burden of Zoonoses Falls on One Billion Poor Livestock Keepers

An ILRI study shows that zoonotic diseases are major obstacles in pathways out of poverty for one billion poor livestock keepers. The diseases mapped cause 2.3 billion human illnesses and 1.7 million human deaths a year. In poor countries, the diseases also infect more than one in seven livestock every year.



Map by ILRI, from original published in an ILRI report to DFID: *Mapping of Poverty and Likely Zoonoses Hotspots*, 2012.

Figure 1.8. Burden of Zoonoses (Source ILRI) - Zoonotic diseases are major obstacles in pathways out of poverty

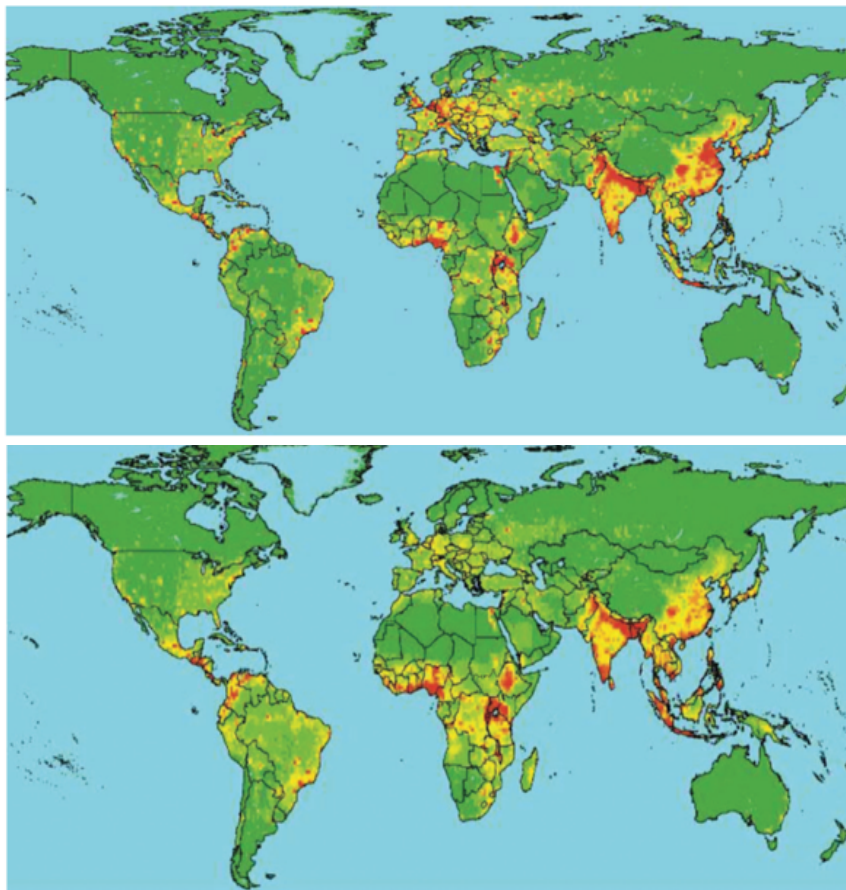


Figure 1.9. These maps highlight regions disproportionately affected by emerging zoonotic disease risk based on emerging infectious disease event data from 1940-2004 (green = lower relative risk and red = higher relative risk) (Source Jones et al. (2008)).

Upper panel: Zoonotic diseases from wildlife;
Lower panel: Zoonotic diseases from non-wildlife.

1d. Rationale for Collaborative Involvement

The World Bank has for many years and from multiple sectors been building to address One Health-related systems strengthening. A number of global studies over the last decade have explored International Financial Institutions (IFI) and Intergovernmental Organizations (IGO) entry-points for this work: *People, Pathogens and Our Planet, V.I & V.II, Connecting Sectors and Systems for Health Results, Reducing Climate-Sensitive Disease Risks*, and *Drug-Resistant Infections: A Threat to Our Economic Future*; as well as a number of white papers, speeches and notes that have addressed the issue with more regional and country-level focus. The World Bank also provided financial support for the development of a bridging framework for the OIE and WHO national capacity assessment tools (through a grant entitled “National Human and Animal Health Systems Assessment Tools and Bridges project” (P133572)) (see WHO-OIE 2014). The World Bank has also supported developing countries to implement the first global public health program for avian influenza control and human pandemic preparedness and response (in short “Global Program for Avian Influenza” – GPAI), which, while not framed as a One Health program, unequivocally contains One Health components, as does the REDISSE program in West Africa.

World Bank support for analytical work on reducing zoonotic and pandemic risks diminished after 2010 as other issues became prioritized for investment, such as partnerships, non-communicable diseases, and universal health coverage. In 2014-15, however, the Ebola crisis renewed interest in addressing epidemics and pandemics, which a World Bank survey identified as now widely viewed to be among the top global threats (World Bank, 2015). Ebola has reminded policy makers of the extreme risks posed by infectious disease of animal origin, and reminded them of the high (health, social and economic) costs of inadequate capacity for prevention, preparedness and response.

Why the World Bank Must Be Involved

- The World Bank has both a global reach and engages in all the sectors concerned (public health, animal health, environment, disaster risk management, global risk communications). Few development institutions combine such a country-level track-record of engagement through lending and economic work in all these sectors — and, moreover, a capacity for global scope in delivery.
- The World Bank has valuable operational expertise supporting multi-sectoral programs, from design to appraisal to implementation of substantial investments and related policies, working to improve coherence and coordination across sectors.
- The World Bank can finance and mobilize additional resources for these programs; the projected incremental annual costs of animal-human-environment public health systems are well above the capacity of UN agencies to manage.
- The World Bank has a mandate to work on provision of global public goods (GPG) (prevention of infectious diseases is a grossly undersupplied GPG and the only health issue that meets the World Bank Development Committee’s narrow definition of GPGs). The World Bank was a critical donor in mobilizing funds for Ebola and HPAI response, and thus has a strong incentive to invest in cost-effective multi-disease prevention and preparedness capacity to avoid high ad-hoc emergency response costs.
- Tackling threats such as zoonoses and antimicrobial resistance is a pressing and increasingly severe development challenge, with significant impacts on health, poverty, food security, nutrition, trade, environmental outcomes, ecosystem dynamics, and food safety in poor countries;

addressing these present and future health risks is fully in line with the World Bank's mandate and IDA agreements.

- The World Bank has extensive experience with emergency responses and with operations in fragile states. This experience offers lessons for the task of strengthening systems for disease prevention and preparedness for control actions that can be valuable for partner institutions.
- The World Bank played a leading role in the response to avian influenza and Ebola, and thus has a stock of experience and established relationships within countries and among other stakeholders, as well as credibility.
- The Framework builds on various operational experiences including on the lessons learned from the GPAI and Ebola responses to present a menu of activities with relevant references and case studies to help countries in the design and implementation of projects that build sustainable and efficient country systems and their collaboration (see also part 1e on lessons learned).
- The World Bank is committed to increase cross-pollination of interests and collaboration amongst teams. The recent World Bank Public Health policy document, "Connecting Sectors and Systems for Health Results," sets out a multi-pillared approach to achieving health goals and emphasizes galvanization of actors outside the traditional public health sphere.
- The World Bank has developed privileged relationships with key international actors such as WHO, OIE, FAO, CBD, UNEP and UNISDR that can support global partnerships and enable implementation synergies in client countries.

Box 1.8 World Bank President's speech in support of One Health

In 2014, Dr. Jim Yong Kim, the World Bank President, delivered a speech articulating the relevance of One Health to addressing AMR concerns in particular:

"As a physician, the issue of antimicrobial resistance -- or AMR -- is very familiar to me. It has plagued health communities for decades, contributing to some of the greatest challenges in modern medicine, including pneumonia, tuberculosis, and other diseases that disproportionately affect the sickest and most vulnerable among us.

AMR costs tens of billions of dollars in treatment, and millions of lives in both rich countries and poor ones, where expensive therapies are beyond the reach of many.

The problem goes beyond hospitals. Antimicrobial resistance crosses boundaries of nations, sectors, and even species -- affecting livestock, crops, and wildlife. Any living thing susceptible to microbes is susceptible to microbial resistance.

We're growing our knowledge of the complicated relationships between systems, species, and disease -- and the implications these have for economies and human well-being.

The World Bank is coordinating efforts across agricultural, environmental and health sectors under the umbrella of One Health -- an approach designed to overcome these shared risks, and to better achieve our twin goals of ending extreme poverty and boosting shared prosperity.

We're working to develop cross-sectoral solutions with partners like the World Health Organization, the World Organisation for Animal Health, and the UN Food and Agriculture Organization.

We're also analyzing the 'cost of inaction' on AMR, which we hope will spur effective mitigation -- and a coordinated global response strategy.

And we're learning from recent experience. In 2006, the international response to the H5N1 Highly Pathogenic Avian Influenza was effective because of deliberate collaboration across sectors, and among international agencies and donors. The World Bank contributed not only its financing, but also policy analyses, implementation expertise and vital coordination -- both globally and in countries. A global crisis was averted, largely thanks to commitments from developing countries, the cooperation of poor farmers who controlled the virus at its animal source, and rapid support from the international community.

If we work together and draw upon our mutual strengths, we can preserve the health of our economies, our crops, our animals, and our people."

Role of Other Development and Technical Actors

The World Bank, however, is just one of many actors working in this space. The international community has also sharpened its focus on One Health. For example, since 2011 four International One Health Congresses have been held (in Australia twice, Thailand and The Netherlands); the Global Risk Forum held One Health Summits in Davos, Switzerland; the World Medical Association and World Veterinary Association co-signed a memorandum to collaborate on One Health (WMA 2012); and the World Veterinary Association released a position paper (WVA 2014). In line with activities carried out under the Joint Work Programme on Biodiversity and Human Health of the Convention on Biological Diversity (CBD) and WHO, in 2014 and 2016 the CBD Conference of the Parties adopted decisions recognizing the value of One Health to address the cross-cutting issue of biodiversity and health, as an integrated approach also consistent with the ecosystem approach. In addition, the World Organisation for Animal Health (OIE), Food and Agriculture Organization (FAO), and the World Health Organization (WHO) have been working together in a tripartite partnership to address infectious diseases at the animal–human–ecosystems interface (WHO 2008; FAO/OIE/WHO 2010) (Barrett, 2014), and the WHO has established a One Health office in its Health Emergencies program. The Pan American Health Organization, which serves as the Regional Office for the Americas of WHO and through it the Pan American Foot and Mouth Disease Center, has long been providing technical cooperation to countries on zoonotic and foodborne diseases, food safety and Foot and Mouth Disease, working closely with Ministries of Health, Ministries of Agriculture, academia, nonprofit and international organizations and the private sector. An example of such an integrated approach is the technical cooperation for the regional elimination of human rabies transmitted by dogs. PAHO technical cooperation is guided by the Meetings of Directors of National Programs for Rabies Control in Latin America (REDIPRA), including animal health and welfare and public health partners and sectors. In addition, the Meeting at the Ministerial Level, on Health and Agriculture (RIMSA) provides the political framework for such technical cooperation. The effectiveness of such an approach, when compared with the results achieved by other developing regions, cannot be overemphasized.

Individual countries, also, are taking up the fight against zoonotic and non-zoonotic diseases because they recognize their impact on public health, animal production and regional and international markets access, and environmental quality and provisioning of ecosystem services. Most countries acknowledge their insufficient capacity to address these issues and require support: on the animal health side, as of April 2017, more than 130 countries had asked the OIE to help them evaluate their systems through the Performance of Veterinary Services framework in order to further strengthen them, and 109 of them have requested a PVS Gap Analysis (PVS Costing Tool) to help them quantify the financial needs of their national veterinary services over a five-year period. The OIE also offers twinning programs (for laboratories and on veterinary education) to facilitate better alignment of beneficiary countries with OIE intergovernmental standards, recommendations and guidelines while aiming at an enhanced capacity in developing countries. Under the IHR (2005), WHO has established a Monitoring and Evaluation framework to provide robust support to countries wishing to evaluate their core capacities to detect, assess, report and respond in a timely manner to public health emergencies of international concern at the national level, thus contributing to health security globally. This Framework, and the IHR generally, emphasize taking multi-sectoral approaches in addressing such disease threats. As an example of collaboration on environmental health, in 2015 the OIE and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) signed a Memorandum of Understanding with the aim of promoting biodiversity through collaboration on animal health surveillance and welfare issues, and the Convention on Biological Diversity (CBD) and WHO have established a Joint Work Programme to work on biodiversity and human health interlinkages. Enhanced capacity within and across these underlying human, animal and environmental public health systems are thus critical in strengthening

capacity at their interface. The demand from countries for more coordinated human-animal-environmental health interventions has also been evinced, particularly in Africa, Europe, Asia and the Americas. Within the World Bank, for example, this has been seen in requests for One Health-related studies and investments in Turkey, China, Mongolia, Kyrgyzstan and Nepal, and regionally in Central Asia and South Asia. PAHO has coordinated an Inter-American Meeting in Health and Agriculture at Ministerial Level (RIMSA) every two to three years since 2001 to facilitate technical cooperation on veterinary public health topics; the CBD and WHO hosted regional workshops for Africa and the Americas on the interlinkages between biodiversity and human health in 2012-13, and in October-November 2016 WHO together with FAO and UNEP coordinated a series of inter-ministerial meetings (e.g., meetings in Manila and Dakar).

The high degree of international involvement indicates a strong appetite for adoption of One Health approaches, with global, regional and/or national level focus. Select examples of existing regional and national One Health operations are highlighted (see Annex 6), demonstrating the variety of topics and types of information and networks that have been developed. They provide a foundation for further progress; working together, the messages and actions in this Framework can be incorporated into policy toward achieving actionable One Health outcomes.

Box 1.9 Preparedness and Risk Reduction

Reducing the risks and enormous impacts from endemic, emerging and re-emerging zoonotic diseases will require, as a prerequisite, improving the installed physical and human resource capacity to predict, prevent and to control them. Such risk reduction is an important public good. While OECD countries are able to assess their respective needs and develop the necessary physical and institutional capabilities to meet the challenge, the situation may be challenging for low-income developing countries. Since the integrity of a global disease prevention and control capacity is dependent on a minimum capability of each member of the community and “the chain is only as strong as its weakest link,” assistance to low-income countries to make the necessary investments to install the requisite capability — physical and human — supports the global public good for health security. As the contributions of the international specialized agencies are indispensable to a global effort to predict, prevent and control highly infectious diseases, including zoonoses, adequate funding for them must also be provided, including to catalyze and sustain mechanisms for them to work across disciplines and data-sharing platforms. Preparing for pandemics includes preparing for neglected diseases, engaging communities in reporting as part of surveillance efforts and supporting them with technical collaboration from national and local authorities (see Chapters 2 and 5).

1e. Higher-Level Objectives to Which the Program Contributes

Though the near-term goal of this Operational Framework is to strengthen public health systems in response to recent disease crises (e.g., Ebola and Zika viruses), this work can be leveraged to yield long-term gains for animal health and environmental management, and ultimately improve overall health and resilience of the planet. Through the creation of better health, we are closer to achieving the World Bank mission of alleviating poverty and creating shared prosperity, and contributing to the broader international efforts described by the 17 global Sustainable Development Goals (SDGs) of the UN 2030 Agenda (Figure 1.9), as well as multiple related initiatives (e.g. the Sendai Framework for Disaster Risk Reduction).

This Framework has direct relevance for SDGs 1, 2, 3, 8, 10, 13, 14, 15 and 17 — and is indirectly relevant for each of the others — which underlines how important health is for development, and not just

human health but also the health of animals and the environment. Similarly, development has a significant role in health in relation to SDG Goal 16 in terms of environmental justice; building in risk assessment and mitigation can address possible health or disease externalities of development decisions (e.g. those leading to land degradation), especially to local communities. Individually and collectively, improving health within and across these spheres for integrated understanding and action will help us achieve a more sustainable future.

Each of these SDGs is higher level than what we are proposing in this Framework. Infectious disease is merely one challenge that threatens health. By addressing it at its source and preventing spillover and spread, we disable it before it has a chance to have an impact on species and systems, enabling better overall health outcomes that will contribute to the achievement of multiple goals. Reducing infections linked to reproductive and development disorders — such as brucellosis and Zika virus — has benefits for maternal and child health. Healthy farm animals mean more food and income for farmers and safer value chains, with myriad potential socioeconomic benefits; for example, improved animal vaccination rates for East Coast Fever have been linked to improved school attendance by girls (Marsh et al. 2016). Healthier ecosystems and wild animals means diminished chance of transmission to humans and livestock, as well as biodiversity protection. And less infectious disease in humans of course equates with better health, a better chance at overcoming poverty, shared prosperity and more energy to direct toward environmental stewardship.



Figure 1.10 The 2015-2030 Sustainable Development Goals, adopted by the United Nations in 2015.

This Framework also strongly reinforces opportunities for hazard management to reduce the frequency and impact of health emergencies under the Sendai Framework for Disaster Risk Reduction 2015-2030, which includes a focus on biological hazards. Promoting whole of society approaches to disaster risk management, cross-sectoral collaboration is emphasized in risk reduction for and readiness in responding to health emergencies. In particular, the action at the human-animal-interface provides opportunities for risk reduction for known and novel diseases, and also can help inform preparedness for health emergencies linked to other disasters (e.g. earthquakes), reinforcing all-hazards capacity to promote public health system resilience. Operationalizing One Health approaches may directly assist with the national implementation of the Bangkok Principles for the International Conference on the Implementation of the Health Aspects of the Sendai Framework for Disaster Risk Reduction, agreed in

2016. For example, systematic integration of health into disaster risk policies, coherence in national policies and strategies, and cross-sectoral and transboundary information sharing can promote more coordinated risk assessment to account for human, animal and environmental impacts and trade-offs of decisions.

While of clear benefit to the human and animal health communities, this Framework also supports progress on initiatives directly from the environment sector. Examples include the Paris Agreement and associated National Adaptation Plans (both under the United Nation Framework Convention on Climate Change), particularly in understanding the role of climate change on zoonotic and vector-borne diseases (including changes in species ranges, climate-sensitive diseases, food and water security, and more) for emerging risk anticipation and adaptation. Similarly, action on the drivers of emerging infectious diseases can also address the major causes of biodiversity loss, assisting in achievement of the Aichi Biodiversity Targets, particularly on halting species decline and mainstreaming biodiversity and ecosystem services that contribute to health.

1f. Lessons Learned

This Operational Framework reflects the lessons of experience in the responses to major infectious disease outbreaks, including the ongoing AIDS pandemic, SARS in 2003, the H5N1 HPAI panzootic in 2003-14, the 2009 H1N1 HPAI pandemic, MERS since 2012, and the Ebola epidemic in West Africa in 2013-15. The most salient experiences are noted below, keeping in mind that the main characteristics of this program are its focus on understanding of infectious disease risk analysis across sectors and bringing it to a scale that is commensurate with the gravity of two formidable challenges. First, the ongoing burden that poor populations in developing countries bear every day is severe. Second, the economic, health, and societal impacts from antimicrobial resistance and pandemics would affect all countries and may be catastrophic (see Box 2.4).

The Global Program for Avian Influenza Control and Human Pandemic Preparedness and Response (GPAI). Given its global scope, influence, multi-sectoral interventions, and duration, GPAI offers strong lessons that can be applied to this Framework. For the same reasons, the Independent Evaluation Group produced a report in 2014, *Responding to Global Public Bads – Learning from evaluation of the World Bank experience with Avian Influenza 2006-2013*, which highlights a number of interesting lessons that are incorporated in this Operational Framework. The international response to the avian flu epidemic was the single largest multi-sectoral global public health emergency program in history. The GPAI, a horizontal adaptable program loan (APL) of emergency operations, engaged 62 countries through 83 operations with an estimated commitment value of \$1.3 billion (including \$0.13 billion from trust funds). It had political support from both developed and developing countries for actions in developing countries and by international organizations, under a framework that the World Bank designed to avoid the creation of a vertical fund while generating timely information required for coordination of an evolving multi-country, multi-sector emergency program. Several features of the GPAI became a model for the World Bank's response to the 2008 food price crisis.

GPAI notably focused on prevention (control of the virus at the source), and, to a lesser extent, on pandemic preparedness and response. Most countries and partners prepared and implemented their responses on an emergency basis. There was adequate resourcing for external coordination among the World Bank, the UN (coordinated by UNSIC), and the US- and EC-led "core group" of partners (large OECD countries), which increased UN effectiveness (according to independent evaluations). Implementation was rapid overall, although the operations were inevitably complex, often involved contracting by countries (with close technical support to countries from FAO, OIE and WHO individually as well as collectively through the Tripartite), and had to devote resources and attention to an

unpredictably evolving disease situation, as well as engage in systematic coordination among sectors (human health, animal health, disaster risk management, communication) and with numerous partners.

The World Bank organized a series of 24 global-learning events and VC-based seminars on pandemic avian influenza. It also supported knowledge-sharing among countries (including South-South) and produced influential economic and policy documents, notably on economic costs of a pandemic and on compensation for culled poultry. Environmental safeguard planning employed for laboratory waste management and culled poultry also helped promote biosecurity measures.

Under GPAI, the Vietnam Avian and Human Influenza and Human Pandemic Preparedness (2007-2014) project was rated “highly satisfactory” by the IEG.⁸ The Implementation Completion and Results (ICR) report notes key factors that affected implementation and outcomes. A few highlights from this ICR as well as the IEG 2014 report are mentioned below.

- Among notable success obtained, the agreement on a common framework guiding the preparation and design of projects having a similar objective across regions was considered vital to make a complex endeavor succeed, especially in an emergency and where there are multiple partners, professions, stakeholders, and contexts.
- External political and financial support, and a well-coordinated engagement of all partners are important factors of success, yet a robust country-led program with strong government commitment remains essential.
- Adequate provisions for integration and coordination, and emphasis on communication, allow for close collaboration to be maintained between sectors even with shifting funding levels during project implementation.
- Building on countries’ own experience of management of previous outbreaks helps develop more effective interventions (e.g. Vietnam had disastrous avian influenza outbreaks in 2003).
- Coordination on multidimensional solutions is not spontaneous. It costs money, takes time, and requires high-level attention, but it makes the difference between success and failure. The World Bank was (and continues to be) well-placed to play the requisite integrating role by financing and supporting coordination and implementation of multi-sectoral programs, which, to be effective, have to involve actors from a range of disciplines, including human health, agriculture, economics, finance, and planning.
- There is a need to provide for a balance between short- and long-term actions. Immediate action is needed in case of outbreaks. In the longer term, the need to build capacity that performs core public health functions to the international standards established by OIE and WHO is paramount, and capacity for environmental health must be more fully established and integrated in public health systems along the prevent, detect, respond and recover spectrum to truly operationalize One Health in the context of infectious disease but also more widely (e.g. protection of natural resources and systems). Monitoring of performance of these systems will be key. Such indicators should be included in comprehensive evaluation systems that are capable of providing timely guidance on what actions are and are not effective.
- While World Bank performance in developing and managing the GPAI was successful overall, the failure to sustain its support to infectious disease prevention and control left countries

⁸ See ICR00003330 for additional information:

<http://documents.worldbank.org/curated/en/913201468311659515/pdf/ICR33300P1016000disclosed0120300140.pdf>

insufficiently prepared to face recurrent or new threats. Moving away from emergency response, and working toward long-term capacity building to support health systems using multi-sectoral interventions, was identified as the proper approach. Long-term investment in catastrophic risk prevention is generally under-funded and under-prioritized, and incentives are needed to encourage country participation for attainment of a global public good (Brahmbhatt and Jonas 2015).

The Regional Disease Surveillance Systems Enhancement project (REDISSE). Beyond avian influenza, limited preparedness for other disease events and limited attainment of the IHR core public capacities indicated the need for an all-hazards approach that incorporates or works alongside disease-specific objectives. Indeed, the REDISSE program was founded to address overall national and regional systems, advancing 1) surveillance capacity; 2) laboratory capacity; 3) preparedness and emergency response, including multi-sectoral coordination mechanisms, and 4) workforce development. Although the REDISSE program is still at an early stage of implementation, the following are evidence of the One Health perspective in program planning:

- In Guinea, a REDISSE Technical Working Group (a “One Health platform”) was established, and a high-level meeting on human health, animal husbandry and production, and water and forest availability met under the auspices of this platform on April 21, 2017.
- In Benin, a new project implementation unit for the REDISSE program, situated in the president’s office, will bring together key people from the ministries of health, agriculture and environment to enable comprehensive planning to build surveillance capacity.

Because these One Health platforms carry implementation and/or financing responsibilities, assessing their value in meeting REDISSE program objectives will provide valuable lessons for future programs with a One Health approach.

Other World Bank financed projects. Even if not specifically defined as bringing a One Health approach, various projects provide strong cases of multi-sectoral implementation on key priorities. In particular, the World Bank is supporting numerous country clients to target neglected tropical diseases and infectious diseases, as well as related public health threats to human health, animal health, and environmental health. For example, the Brazil-Piauí Productive and Social Inclusion DPL⁹ expands public health services to control and address neglected diseases. Recognizing the close links between environment and health, it targets health and natural resource management (as well as education, gender, and other dimensions), noting that strengthening the institutional capacity of the health sector will contribute to tackling environmental health risks.

While playing a key role in advancing practices that can be supportive of One Health, e.g. through the expanded biodiversity conservation safeguards in the 2016 update of the World Bank Environment and Social Safeguards Framework, important lessons from other programs can be drawn.

- Individual countries are central to a coordinated global program; neither donors, nor international agencies, can lead such a program on their own. In particular, while the threat of AMR and pandemics is global, programs that will be taken on to reduce these increasingly recognized threats must be initiated and led by countries.
- Programs need to be based on assessments of opportunities to meet country goals through the reduction of infectious disease burdens, both those that are already endemic and those

⁹ Report No. 100559-BR: <http://documents.worldbank.org/curated/en/375151468179954645/pdf/100559-PGD-P146981-R2015-0226-1-Box393260B-OUO-9.pdf>

that are potential, addressing drivers of disease emergence such as environmental degradation, etc.

- Country commitment to integrated programs is critical, as is coordinated donor support for such programs. Whereas the international community can provide critical advice and support, implementation and sustaining of the programs will remain countries' responsibility.

Development funders outside of the World Bank. Some have also invested in One Health programs. For example, the USAID Emerging Pandemic Threats PREDICT project has mobilized funding of more than \$150 million over its two phases (2009-2019) for pathogen surveillance in more than 30 countries aimed at monitoring known and novel viruses with pandemic potential and the behaviors, practices and conditions associated with viral evolution, spillover, amplification and spread. Engaging human and animal health and environment sectors, the project has facilitated data-sharing across ministries with the goal of making coordinated interpretation routine. As a result, many countries have formalized policies on data sharing and/or have developed multi-ministry platforms to address a wider range of topics.

2. VALUE OF INVESTING IN ONE HEALTH

Given the high cost of emerging diseases as well as the persistent burden of endemic diseases (e.g. on human health and agricultural production) (see Figure and Table 2.1), One Health should be seriously considered to assist client countries in strengthening their ability to address known and potential disease threats at the human-animal-environment interface. For a One Health approach to be warranted, it must provide added value. Fundamentally, strong sectoral health systems (e.g. human health, animal health, environmental health) must be in place — or existing systems strengthened — to support effective coordination and collaboration. Relevant metrics for value generation depend on the goal of an investment or client country, but in general, One Health offers synergies among these sectoral systems, providing expanded capacity and effectiveness in prevention of damages and/or control of disease, efficiency, and ultimately financial savings.

In many cases, the technical value of the One Health approach is already clear; for example, human rabies eradication efforts won't succeed if not addressed in animal populations. However, taking stock of the economic case for One Health to generate added value is important for funder and political buy-in. Noting that overall One Health operations have been limited, this chapter examines its value addition, first reviewing impacts of previous disease events where a One Health approach was not applied but would be relevant, and then presenting existing evidence from theoretical or actual application of One Health approaches to date at different scales (global, regional and national, and project). The chapter then expands on two key dimensions where One Health offers great if not underutilized potential: addressing multi-sectoral and environmental impacts. Overall data gaps are presented at the end of the chapter, with key recommendations for further evaluation to help optimize One Health implementation.

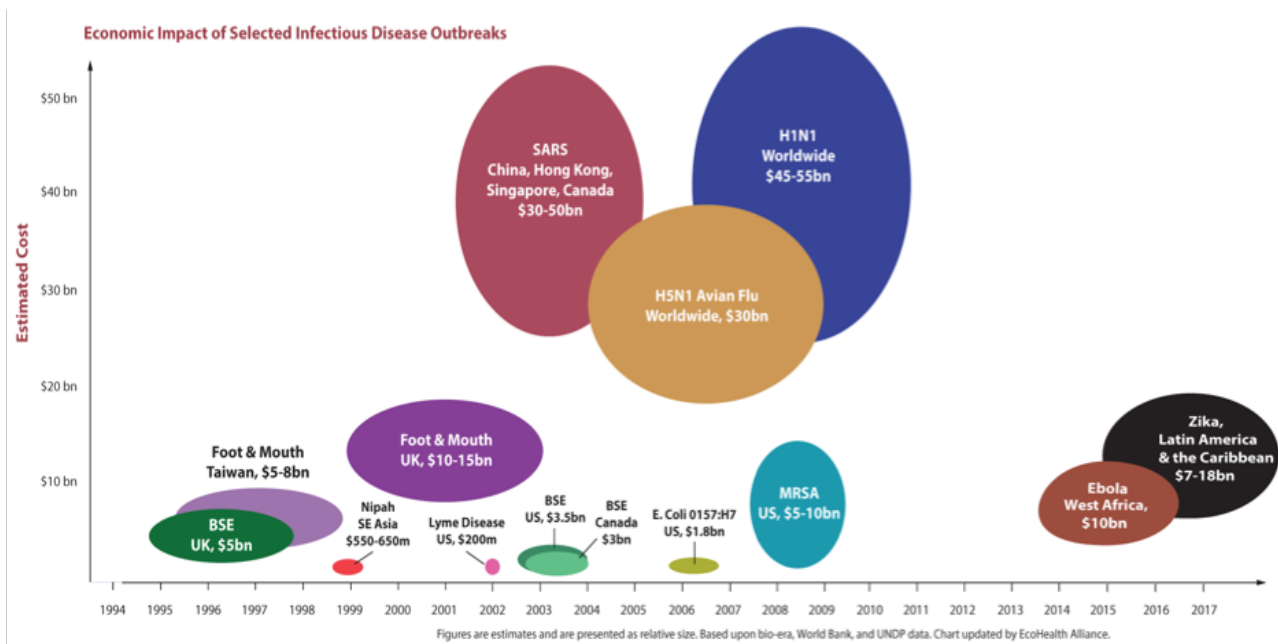


Figure 2.1: Examples of economic impacts of disease outbreaks (see also Table 2.1)

2a. Disease Impacts and Rationale for One Health's Value

According to Harvard economist and former US Treasury Secretary Lawrence Summers, the high pandemic risk makes investments in veterinary and human public health systems “possibly the most productive investments on behalf of mankind.”

The economic costs of disease at the human-animal-environment interface are significant, despite frequent data gaps that limit their full accounting (World Bank, 2012). Diseases vary in their nature and thus may have different impacts at global or local level; resultant costs of outbreaks can also vary by country context and other factors — including preparedness capacity in place. Certain transmission pathways (e.g. airborne) or symptoms (respiratory) may have greater spread potential, as seen with SARS and H1N1 influenza, and may affect consumer or trade behavior in different ways. Examples in Figure 2.1 provide an indication of the extent of select disease outbreaks over the past two decades, noting that methods used to assess losses may not be uniform, and damages may only be partially assessed (e.g. analysis limited to certain regions as with Zika virus or certain cost items). Even if a disease has an apparently lower global economic impact, regional or national impacts may be disproportionately severe.

Less prominent outbreaks cause additional losses that could be highly damaging locally, especially in poorer regions, but these costs remain uncounted both in the affected countries and as a global aggregate. The main factors that promote outbreaks and disease spread include weak and deteriorating public health systems in fragile states, growing mobility through travel and trade, fast-growing demand for animal protein in low-and middle-income countries, and encroachment of humans and livestock on wildlife habitats. Trends in these “drivers” suggest that the expected annual costs — or the economic risk — of disease outbreaks will keep rising.

The global importance of pandemics for economic development was highlighted in the World Bank's 2014 World Development Report (WDR), *Risks to Development*. The report singled out for attention three major global risks: pandemics, climate change and financial crises. The WDR analyzed investments in prevention and other risk-management measures in these three areas because inaction would result in very high costs for this and future generations. Notwithstanding the substantial attention to pandemic risk in the WDR, international organizations and many governments have devoted significantly fewer resources to mitigating pandemic risk than to mitigating climate change, financial crises and other global risks. The view that the world deals with pandemics through neglect followed by panic is accurate. Explanation of the costs associated with neglect can contribute to risk awareness, both in countries and their international organizations.

We know that the resource requirements of building robust public health systems are modest relative to potential public health and economic benefits. The cost of pandemics and epidemics (Figure 2.1) can become extremely high when contagion grows exponentially while detection and control measures are delayed because of weak public health systems, suggesting high expected benefits from prevention or effective control of disease. We can employ and build on this knowledge to promote investments in the capacities needed for all people in all countries to enjoy the global public good of prevented infectious disease. The global public good confers both public health benefits and security from the very costly economic and social disruptions that accompany contagion. This Framework is equally suited to providing regional and national public goods, however. While the approach has roots in tackling disease outbreaks (notably those with epidemic or even pandemic potential), it is first and foremost a capacity-building approach to strengthening the pillars of health systems as a whole. Thus, the aim is to ensure that all governments deliver the core public-health functions that are required for realization of the economic

and social prospects of the population, especially the poor. Control of contagion is an example of the quintessential public good in communities, countries and globally.

Table 2.1 Example of impacts of diseases at the human-animal-environment interface

Disease	Situation	Financial Cost	Health Burden	Human-Animal-Environment Interface	Source
Highly-Pathogenic Avian Influenza	January 2004-January 2009, Asia; public and animal health service costs, compensation, production and revenue losses to the livestock sector; some primarily affecting smallholder producers in East Asia and imposing social impacts (livelihoods, trade opportunities, food and nutrition security and safety)	\$20 billion	486 human cases with 282 deaths	Wild birds mixing with backyard poultry; agricultural intensification without sufficient biosecurity; food security challenges	WHO, 2016; FAO, 2005
Antimicrobial Resistance	Cumulative impacts by 2050	\$100 trillion (up to \$6.1 trillion / year in high-impact scenario)	10 million human deaths annually	Agriculture/aquaculture contribute to direct transmission of resistant strains and antimicrobial dispersion; reduced efficacy threatens both health and food production	O'Neil 2014; World Bank, 2017
Severe Acute Respiratory Disease	November 2002–July 2003; trade and travel disrupted in China; Spread to 29 countries	\$41.5 billion	8,500 cases, 813 deaths	Bat-human contact facilitated disease emergence; Live markets may have had an amplification role	World Bank, 2012
East Coast Fever	Annually for Tanzania, Zambia, Malawi and Kenya, from endemic disease; death or reduced growth and productivity	Less than \$200 million		Tick-borne agricultural disease (cattle, sheep and goats); threat to livelihood, food and nutrition security	Minjauw and McLeod 2003
Schistosomiasis (zoonotic)	Based on estimated 14 percent total Schistosomiasis (zoonotic and non-zoonotic) burden; heavily impacting parts of Southeast Asia, some Africa		10 million DALYs annually	Ecological changes from anthropogenic activity (damming and irrigation) create favorable habitat for vector; non-zoonotic forms can also reduce livestock productivity	Torgerson et al. 2011
Top 13 neglected zoonotic diseases of importance to poor livestock keepers	Zoonotic gastrointestinal disease; leptospirosis; cysticercosis; zoonotic tuberculosis; rabies; leishmaniasis; brucellosis; echinococcosis; toxoplasmosis; Q fever; zoonotic trypanosomosis, hepatitis E; and anthrax		2.4 billion cases and 2.2 million deaths annually	Various environmental determinants and agricultural exposures	Grace et al. 2012

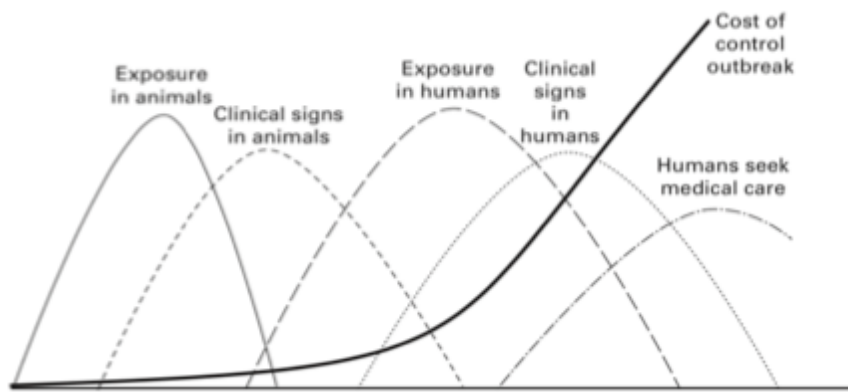


Figure 2.2 Early control of Zoonotic Disease is Both Cost-Effective and Prevents Human Disease (source: World Bank 2012/adapted from IOM (2009). The curves represent a hypothetical scenario; patterns may vary based on specific disease (see chapter 4).

Investment and action at the human-animal-environment interface are most clearly aligned with prevention, detection and early response to counter disease threats. However, a One Health approach to pandemic preparedness may also add value to recovery efforts (See Chapter 5). For example, trace-back and examination of the source of the outbreak during the outbreak, after-action review and/or follow-up investigation that use One Health approaches will be more likely to successfully identify the reservoir and risk factor(s) for a disease, and thus help shape more effective future prevention strategies. Building strong laboratory capacity and coordination between laboratories from different sectors (e.g. animal and human health) is necessary to equip countries to rapidly detect pathogens of high concern, provide surge support, and may also increase the likelihood that diagnostics for other diseases continue during an outbreak. Rapid diagnosis and containment of disease (known and novel) means fewer and less lengthy societal disruptions in the numerous sectors that can be affected during an epidemic (e.g. education systems, vaccination campaigns, tourism, supply chains, agricultural trade, etc.). Co-benefits in terms of reduction of other risks through effective recovery is substantial. For instance, national emergency-response capacity, particularly from well-trained personnel, may also promote resilience to other types of disasters (such as extreme weather events); personnel may be able to conduct some level of routine operations from external sites or may be able to apply skills to assist with other emergencies. National capacity can also assist other countries in health disasters (e.g. via deployment of surveillance, medical treatment, temporary laboratories) to minimize regional impacts. The economic value of a swift and effective recovery is not easily assessed, but may be substantial.

Table 2.2: Examples of direct and indirect costs that may result from human or agricultural disease (adapted from “People, Pathogens and Our Planet: the Economics of One Health”). Depending on the disease and/or country context, the particular sectors directly and indirectly affected and the extent of impact may vary widely. For example, in the case of non-zoonotic disease in wildlife, direct costs could be on ecosystem services and environmental management.

Cost Category	Examples of Cost Items
Direct Costs	<i>Costs of medical treatment; culling and disposal of animals; control costs e.g. contact tracing, vaccination); consequential farm losses (i.e., fall in breeding stock, restricted movements, loss of value of animals etc.)</i>
Indirect Costs	<i>Domestic market and export losses; reduced tax revenue; spillover to tourism and wider society (i.e., food availability, environmental impact and/or loss of ecosystem services, economic losses from higher human mortality); ripple effects on upstream and downstream industries (i.e., feed supply, processors, retailers, consumers)</i>

2b. Examples of Added Value from One Health

Because the economic risk of disease at the human-animal-environment interface is already substantial, the expected rate of return on investments in prevention through strengthening of veterinary and human public health capacity is very high. Similarly, the consequences of poor coordination among sectors have been documented for various disease emergencies.¹⁰ The limited application of One Health in practice, however, limits data available to analyze its benefits (Hasler et al. 2014; Baum et al. 2017). As with any public health program, One Health investments should be analyzed against their objectives, but also begin to create an evidence base for One Health-specific indicators that can help optimize its application (see Chapter 6 for further discussion). This will also help to identify entry points for where One Health is beneficial compared to targeted uni-sectoral approaches that can also achieve prevention or control.

Broadly, One Health may generate the following broad effectiveness and efficiency outcomes, which in turn can generate financial savings at global, national and regional, and project levels (see examples in Table 2.4 of observed and projected value):

- Improve effectiveness of core public health systems, which is their ability to achieve their objectives of prevention, early detection, correct diagnosis, and control of the outbreak. *Effectiveness* of the systems increases thanks to more timely, more complete and more accurate information. As a result, the public health authorities are able to “connect the dots” earlier, more correctly, and with more confidence than if information did not readily cross the boundaries between departments responsible for animal, human and environmental health. The outcomes of more effective responses are lower morbidity, lower mortality and lower economic costs of the outbreak. Producers and their communities can sustain livelihoods thanks to market access. Effective responses promote poverty reduction — especially given that many zoonotic diseases are, quite appropriately, called the “diseases of the poor.” Effective responses also improve food security, reduce loss of biodiversity, decrease demand for complex and costly pandemic emergency response services, and increase income from tourism.
- Achieve results *more efficiently*, at lower cost to the government. Veterinary and human public health services can avoid duplication of tasks, prioritize interventions, and select most cost-effective options to address cross-sectoral issues. Additionally, they may share some of their equipment, supplies and personnel, which reduces investment and operating costs.

Some of the benefits of One Health may be more easily quantified than others. For example, One Health approaches that assist in reduced incidence of an endemic disease may be easier to document compared to prevention of unknown disease emergence where there is poor baseline risk data at country level. Improved effectiveness of public health systems through One Health may also help countries better meet their capacity and reporting requirements (typically collected as intermediate indicators of programs but highly meaningful in terms of public health system preparedness for all hazards).

Global

Public expenditure data on animal and human disease prevention and control systems are seldom in the public domain, however, and to date they have not been covered by the World Bank’s expenditure reviews. An initial global estimate was presented in *Contributing One World, One Health: A Strategic*

¹⁰ See, for example, Table 8.2 of *People, Pathogens and Our Planet: Economics of One Health* (World Bank 2012).

Framework for Reducing Risks of Infectious Diseases at the Animal–Human–Ecosystem Interface, prepared by a group of international agencies that includes FAO, OIE, WHO, UNSIC, UNICEF and the World Bank. This paper estimated the 12-year (2008-2020) cost of a global surveillance system for the prevention of emerging and re-emerging zoonotic diseases and the control of HPAI to be \$852 million per year for 43 low-income countries (requiring infrastructure and capacity advancements) and \$1.343 billion for 139 non-OECD countries. Using the basic costs data from this report and its stated assumptions, implementation of the One Health approach can achieve significant cost savings. The results were published in *People, Pathogens, and Our Planet, Volume 2: The Economics of One Health* (World Bank, 2012). In the 139 countries (classified as low- and middle-income countries as of 2008), the savings due to adoption of One Health approaches were \$184 million per year in the low disease-prevalence scenario, or 10 percent of the total costs. These savings were about equally divided between low- and middle-income countries. In the high disease-prevalence scenario, the savings could amount to \$506 million per year, or 15 percent of the total cost. It should be noted, however, that these figures do not include potential savings in the areas of planning and communication, education, natural resource benefits, nor the extra costs of training or research. Training and research are each budgeted at 5 percent of the total costs (i.e., about \$95 million per year) (adapted from World Bank 2012).

The expenditure required in all developing countries to build and operate One Health systems for timely and effective disease control would be up to \$1.9-\$3.4 billion per year, depending on disease risk. These estimates do not, however, include spending — nor possible benefits — from coordination and system strengthening for environmental management authorities. One Health investments would have co-benefits because the public veterinary, human health services and environmental managers would be better equipped to work together in tackling non-zoonotic disease threats. The expected benefit of One Health systems to the global community was estimated in 2012 to be at least \$37 billion per year. The estimated need for expenditure on prevention (\$3.4 billion annually) is a fraction — less than 10 percent — of the expected benefits. This means that making resources available for this expenditure is thus highly justified. The total global cost is also modest: if all financing were sourced in OECD countries, it amounts to just \$3.40 per capita. The expected rate of economic return is in excess of 100 percent per annum, making One Health investments an extraordinarily attractive opportunity for the international community.

- The economic case for early and effective control of zoonotic diseases is compelling. The economic losses from six major outbreaks of highly fatal zoonoses between 1997 and 2009 amounted to at least \$80 billion. If these outbreaks had been prevented, the avoided losses would have averaged \$7 billion per year (World Bank 2012).
- A second part of the benefits will accrue to the whole world because some outbreaks, if not promptly controlled, will become epidemics, which will spread worldwide as pandemics. This prospect has a low probability, but when it occurs, it will result in highly damaging, possibly catastrophic impacts on health, economies, and society. The World Bank (2008) has modeled the global economic impact of pandemic influenza, finding that outcomes could include a reduction in global GDP of 2 percent in a moderate scenario and 4.8 percent in a scenario of a severe flu pandemic (with deaths of about 1 percent of populations). Based on 2015 global GDP ¹¹, the economic impact of a severe flu pandemic would thus be \$6 trillion, corresponding to a major global recession. Avoidance of such enormous economic losses is a substantial benefit for all countries. An early and effective control of outbreaks is required to produce this benefit.

¹¹ World GDP in current US dollars (purchasing power parity terms) is estimated to be \$115.3 trillion in 2015. Source: World Bank, World Development Indicators. The \$6 trillion economic impact estimate corresponds to a \$60 billion annual risk if the probability of pandemic onset is just 1 percent in any year.

- A third set of benefits accrues to populations of developing countries, both to livestock keepers and to communities where endemic zoonoses are common. The total cost of such endemic zoonotic diseases has been put at some \$90 billion per year. Reducing these infectious diseases would bring benefits of \$90 billion per year, far above the estimated annual cost of \$21 billion for disease control, which would be required in addition to the \$3.4 billion cost for the core veterinary and human public-health capacities (Grace 2014). The bulk of these benefits would accrue to the poorest communities in low-income countries.

The frequency of onset of outbreaks with pandemics potential is low and uncertain, although the probability in any year is not zero. **The expected annual economic benefit from prevention of pandemics is very large, even considering the low probability of onset in any one year.** If a pandemic of severe flu or similar disease occurs just once in 100 years, preventing it by early and effective control of outbreaks generates an annual expected benefit of \$60 billion from avoided losses, year after year. Notably, this amount is a substantial global public good, which benefits all countries. Conversely, **if this global public good is not provided, all countries are at risk.** The global public good cannot be provided as long as weak links exist in the public health system capacities anywhere in the world. Because these weak links will make early and effective control of disease outbreaks difficult or even impossible, pandemics will not be prevented.

Considering just the benefit of reduced pandemic risk, the economic rates of return on spending on early and effective control of outbreaks are very high. Assuming that annual expenditures of \$3.4 billion in 139 developing countries are made to bring all countries' public health systems to the international standard in the key functions of early detection, correct diagnosis, and prompt, effective disease outbreak control, the *Economics of One Health* (World Bank 2012) report showed that the expected rate of return is 86 percent annually if all pandemics are thus prevented; even if only a portion are prevented, return on investment remains high (Table 2.3). As noted above, the investments in veterinary and human public health systems also serve to prevent major zoonotic disease outbreaks and, especially, to reduce the burden of endemic zoonoses and diseases affecting agricultural production. Including these co-benefits in the calculation would clearly result in still-higher expected rates of return. There are also strongly positive impacts on health, poverty, shared prosperity, nutrition, food safety, trade in livestock, and food security.

Box 2.1 Subjective valuation of health

Estimates of pandemic risk — whether \$37 billion (World Bank 2012) or \$60 billion (NAM 2016) — are the expected economic impact of a pandemic in any given year. In these estimates, disease impacts on human health are treated as follows: Increased mortality and morbidity (illness) during a pandemic are valued at the market cost of labor. For instance, a premature death that shortens a working life by 10 years has an economic cost, which is equivalent to the foregone wages during 10 years. This is a standard analytical method, which has yielded estimates of costs of a severe pandemic of 4-5 percent of GDP across a number of simulations. However, alternate valuations of human health have been proposed. Summers, Fan, and Jamison (2016) use a subjective valuation of life. Their simulations suggest that “even a moderately severe pandemic could lead to 2 million or more excess deaths.” They draw on research on the high intrinsic cost of mortality (intuitively, people would pay many times more than their foregone annual wages to avoid death and live a year longer). Their estimates of pandemic cost are thus inclusive: they include income loss and the cost of elevated mortality. One of their scenarios has 700,000 deaths due to the pandemic, with an expected mortality cost of a staggering \$490 billion in a given year. Adding an expected income loss estimate of \$80 billion over a year, the all-inclusive expected cost of a pandemic is \$570 billion in a given year — a result equivalent to 0.7 percent of global income.

Table 2.3 Global Benefits of Pandemic Risk Reduction Greatly Exceed the Costs of the Requisite Veterinary and Human Public Health Systems. Rate of return is shown for prevention; outcomes may differ at other stages of risk reduction (e.g. early warning, response).

Success in preventing pandemics	Expected annual rate of return*
20 percent (only one in five pandemics prevented)	25 percent
50 percent (only half of pandemics prevented)	57 percent
100 percent (all pandemics prevented)	86 percent

* Severe pandemic case assumptions: (a) impact is 4.8 percent of GDP (\$3.7 trillion based on 2010 GDP at market prices used in the report; using 2015 GDP at purchasing power parity, the expected impact is \$6 trillion (see footnote 9 above); (b) probability of onset in any year is 1 percent. Thus, the expected benefit of prevention is \$37 billion/year. Estimated costs of preventive effort (veterinary and human public health systems that meet WHO-OIE standards) is \$3.4 billion/year. Estimated benefits are only from pandemic risk reduction; they do not include additional substantial national co-benefits from prevention of major outbreaks, control of endemic zoonoses, and reduction of other risks.

Source: World Bank (2012). *People, Pathogens and Our Planet, Vol. 2: The Economics of One Health.*

Regional, National and Local

All countries will benefit from the global public good of reducing pandemic disease risks. Many countries will obtain, in addition, local and regional benefits from avoided high costs of emerging and endemic zoonotic and non-zoonotic diseases. These benefits can be large. While epidemics and pandemics gain media and public attention for their international spread, impacts of outbreaks and limited epidemics on local and country economies tend to be unreported though they may be severe. For example, in addition to \$7 billion funding mobilized from donors, Guinea, Liberia and Sierra Leone suffered more than a 12 percent combined GDP loss from the Ebola virus epidemic in West Africa, which was an economic catastrophe by any standard. During the epidemic, these countries saw interrupted schooling (>30 weeks), reduced childhood vaccination (by 33 percent), reduced treatment for other illnesses (accounting for over 10,000 deaths), and reduced healthcare worker capacity (World Bank 2016; CDC 2016). These local and national impacts in countries with outbreaks remain generally under-appreciated since they are reported less frequently than information on mortality, donor funding, and treatment of any patients evacuated to developed countries. Public health system strengthening through One Health may thus yield tangible outcomes at country and regional level, such as reduced disease burden and more reliable protection of a country's agricultural trade status and tourism industry.

Entry points vary based on country or regional program objectives; some disease control efforts may not require or necessarily benefit from One Health collaboration (e.g. human-to-human transmission of HIV/AIDS), while still yielding benefits for other sectors (such as public health gains from rabies control via vaccination of domestic dogs; see additional examples in Chapters 3 and 4). At a country or regional level, One Health coordination mechanism(s) may have an upfront or ongoing cost, such as a dedicated national One Health secretariat to conduct coordinated risk assessments and risk management, development of preparedness plans and processes to allow for rapid mobilization of multi-sectoral investigation teams, or data sharing systems. Their potential value may be spread across multiple hazards to support broad public health system strengthening (though this may be most readily apparent in specific disease management).

Project Level

Project-specific investments should consider possible benefits of taking a One Health approach versus uni-sectoral approaches. For example, there may be resource efficiencies in project implementation (e.g. transport sharing if human, animal and/or environmental project team members would be conducting sampling at the same sites anyway, sample collection to enable surveillance for multiple priority diseases, etc.) Similarly, through expanded information access and coordinated implementation (e.g. sampling methodologies, time of data collection), multi-sectoral projects may also generate value through earlier or more complete and accurate understanding of disease ecology and epidemiology that leads to more efficient and effective risk management — with possible time savings in disease investigations and/or avoided costs or damages. Entry points may be disease-specific depending on context or broader public health systems strengthening (see Chapter 4); processes such as multi-sectoral action planning for health security or disaster risk reduction plans may provide a platform for coordination of resources to promote efficiency in project spending across donors.

Table 2.4: Examples of value added from One Health approaches (projected and observed)¹²

Category	Description	Metric	Outcome	Assumptions	Source
<i>Global</i>					
Country capacity	\$1.9-\$3.4 billion annual investment in veterinary and human health system capacities to attain standards in 139 LMICs	Financial savings	\$30 billion per year in avoided damages (projected)	Assumes a once-a-century pandemic is prevented	World Bank, 2012
AMR Containment	Investing a cumulative \$0.1 trillion in AMR containment at a steady pace between now and 2030	Financial savings	Lower health care expenditures in that single year by as much as \$0.22 trillion if the low-AMR case is avoided, and by as much as \$0.7 trillion if the high-AMR case is avoided (projected)	Prudent antimicrobial usage results in decrease in AMR infections	World Bank 2017
Resource sharing	Joint transport and communication systems, as has been demonstrated in HPAI and other campaigns	Resource efficiency	10-30 percent savings (projected)	Implementation of the One Health Concept in 139 World Bank Client Countries (60 low- and 79 middle-income countries) in Peacetime and Emergency Operations	World Bank, 2012

¹² See additional qualitative and quantitative case studies in “People, Pathogens and Our Planet: Economics of One Health” (World Bank 2012) and “One Health in Action” (PREDICT Consortium, 2016)

<i>National and Regional</i>					
Ministry agreements	Cameroon's One Health Strategy and Zoonotic Program was applied to an investigation of Monkeypox in sick chimpanzees. The strategy includes One Health focal persons appointed to four ministries and allows for a single travel authorization for inter-ministerial teams in outbreak investigations.	Time efficiency; Resource efficiency; Public health protection	Ten days faster and reduction in cost compared to previous outbreak responses. Of 72 chimpanzees in the sanctuary, the outbreak was limited to six cases of infection, with only one fatality and no spillover to human contacts (observed)	Cross-sectoral planning and response: literature reviews, on-site risk investigation, observations, sampling and laboratory diagnostics, and reporting to international agencies allowed for better knowledge sharing, faster response time, and decreased cost.	PREDICT Consortium, 2016
Sentinel surveillance	Coordination among partners utilized early warning information on Yellow Fever risk initiated by reports of deceased howler monkeys; preventative vaccination, mosquito control and public outreach quickly mobilized	Time efficiency; Public health protection	Response mobilized rapidly: detection to resolution within eight days; No human cases detected (observed)	Rapid information sharing among ministries and non-governmental partners	PREDICT Consortium, 2016
Resource sharing	Canadian Science Centre for Human and Animal Health in Winnipeg	Resource efficiency	\$5 million, or 26 percent, per year through sharing of common services (e.g. for library, safety, media); the joint facility has also facilitated collaboration in human and animal surveillance activities (observed)	Single facility designed and built for multiple uses	World Bank, 2012
Surveillance capacity	REDISSE program investments	Cost-benefit	Over a five-year period, a ratio of 17.25, i.e., for every dollar invested in this major regional project, the expected benefit will be \$17.25. When the same analysis was applied to a time horizon of 50 years, for every dollar invested, the expected benefit will be \$237.37 (projected)	Calculated from the present-value terms of the costs and benefits	World Bank, 2016. Project Appraisal Document for the Regional Disease Surveillance Systems Enhancement Program (REDISSE). Report No: PAD1752, June 6, 2016.

<i>Project</i>					
Resource sharing	Human, animal and environment team transportation sharing in Understanding Rift Valley Fever in South Africa	Resource efficiency	31 percent fewer number of total trips made for the research study Savings of \$6,432 (observed); coordinated sampling may also yield study power gains with greater potential for detection of relevant associations (projected)		Rostal et al. 2018
Disease control in animal population	Vaccination of owned, unowned or community dogs; euthanasia of (suspect) rabid dogs; sterilization of roaming dogs; education of children and adults in bite prevention and rabies awareness; dog managed zones; provision of health care and post-exposure prophylaxis (versus control: vaccination of owned dogs, culling of roaming dogs, and provision of health care and post-exposure prophylaxis) in Colombo City, Sri Lanka		738 DALYs averted; Increased acceptance of dogs roaming in society		Haesler et al. 2014
Disease control in animal population	Mass vaccination of livestock for brucellosis control (planned 10-year campaign - ruminants and cattle) in Mongolia	Financial savings and reduced human morbidity	\$26.6 million and 49,027 human DALYs averted (projected)	Scenario of 52 percent reduction of brucellosis transmission between animals (\$8.3 million cost)	Roth et al. 2003

2c. Multi-sectoral incentives and opportunities

While human epidemics and pandemics may have high health burden and conventionally are primarily managed by the health sector using its resources, in many cases the costs of disease may be similarly or disproportionately high for other sectors outside of health care or public health (Fig. 2.3). For example, the private sector has experienced high losses from reaction to “contagion fear” behaviors by the public, such as avoided travel, tourism and public event attendance; direct loss of livestock and/or agricultural trade potential, closure of economic generation sites (e.g. mines), and overall disruption to business continuity. SARS in 2003 is a reminder of this, with cost estimated at upwards of \$50 billion for under 800 deaths; impacts were particularly high to the airline industry (Asia-Pacific airlines experienced losses

estimated at 8 percent of annual passenger traffic) (IATA 2006). For the public sector, governments may mobilize resources for outbreak response and control measures, typically through the health and/or agricultural sectors; losses may also apply to other budget lines, such as tax revenues affected by reduced domestic trade or trade bans. The public itself may experience myriad other societal and productivity disruptions (e.g. evacuation of homes, school shutdowns, reduced nutrition and food security, and persistent illness that reduces success in the workforce).

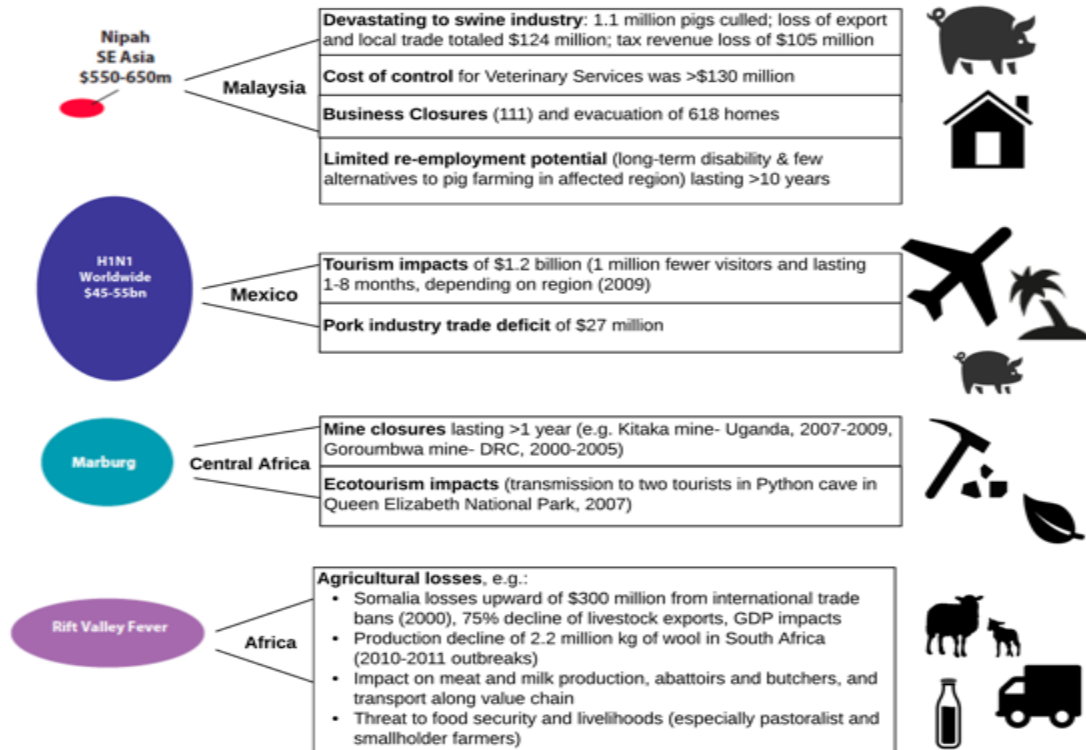


Figure 2.3: Examples of zoonotic disease outbreaks and the range of relevant sectors and business lines at risk of financial losses (theoretical or observed) Impact data compiled from FAO 2002, Ng et al. 2009, BioERA/Newcomb et al. 2011, World Bank 2012, Rassy et al. 2013, Peyre et al. 2015, and National Wool Growers Association of South Africa 2017 (see reference section for full citations).

The wide-range impacts of disease to multiple sectors enables possible opportunities for investment in risk management (Fig. 2.4), potentially reducing the costs for investments for the public sector and ideally avoiding damages (see Chapter 5, particularly on prevention, early detection and containment opportunities). There may be opportunities for more integrated resource allocations and leverage of existing private sector resources (e.g. networks of livestock holders that may assist in disease detection). This reinforces the importance of multi-sectoral involvement in action planning for health security and/or health disaster risk reduction (e.g., under processes supporting the IHR and the Sendai Framework for Disaster Risk Reduction).

Box 2.2 Investing in Addressing Antimicrobial Resistance (AMR)

“We now know that — unless addressed swiftly and seriously and on a sustained basis — the growing global problem of antibiotic resistance will be disastrous for human and animal health, food production and global economies. The fact that, left unchecked, it would penalize the poor more than anyone, makes clear why this needs to be addressed as a critical issue for development.” — Margaret Chan, Director-General of the World Health Organization (WHO), September 2016

AMR presents a major challenge for global health security, as well as economic growth. An estimated annual investment of \$9 billion globally is needed for containment measures, including strengthening of core animal and human health capacities. This investment falls vastly short of the potential impacts of non-containment, including 3.8 percent reduction of world GDP from base (2017) levels by 2050 under a “high-AMR” scenario. Low-income countries will be disproportionately affected by AMR (with their populations comprising the majority of the estimated 8-28 million additional people that will be forced into extreme poverty) (see Table 2.2 for additional health and economic impacts) (World Bank 2017). In light of the threats posed by AMR, the UN General Assembly developed a political declaration at the 71st session of the UN General Assembly, calling upon “the World Health Organization, in collaboration with the Food and Agriculture Organization of the United Nations, the World Organisation for Animal Health, regional and multilateral development banks, including the World Bank, relevant United Nations agencies and other intergovernmental organizations, as well as civil society and relevant multi-sectoral stakeholders, as appropriate, to support the development and implementation of national action plans and antimicrobial resistance activities at the national, regional and global levels” (United Nations, 2016).

AMR containment is a global public good, which will prolong the availability of effectiveness of antimicrobials for all countries. Loss of effectiveness compromises treatment of both humans and animals, affecting health as well as livelihoods, animal productivity, food security and food safety. When drug-resistant pathogens infect people and animals, the pathogens and their AMR genes can continue to spread by many pathways, such as human-to-human, animal-to-human, and animal-to-animal, by the means of vectors like mosquitoes and rats, and in the environment, including in water from aquaculture farms, sewage, and animal and other wastes from farms and slaughterhouses. Thus, the human-animal-environment interface is extremely pertinent when looking at key contributors to AMR as well as opportunities to slow the rate at which AMR emerges and spreads.

As noted in Chapter 4, the context of the issue may affect where to intervene and which sectors are most directly involved. In the case of AMR, over- or mis-use in both humans and animals, with limited traceability, as well as environmental dissemination pathways and potential impact to humans, animals and the environment, warrants inclusion of AMR in efforts for public health strengthening at their interface. Treatment of infections is a global public good that improves human and animal population health in directly affected communities and globally. Improved animal health also contributes to food production, livelihoods and economies, and animal welfare. These benefits and the large externalities across borders and sectors constitute a strong rationale for development of capacity to reduce the threat of AMR in all countries; investment in this global public good suggests high return on investment (Table 2.4).

Source: World Bank. 2017. “Drug-Resistant Infections: A Threat to Our Economic Future.” Washington, DC: World Bank.

2d. Assessing Environmental Impacts

Disease burden and/or associated costs of disease (including control measures) in the human health and agricultural sectors are frequently calculated, though often only consider the costs in one of the sectors. Greater integration is needed to determine where there may be efficiencies in developing foundational capacities and to correctly assess the costs and benefits of risk management options. Evaluation of the costs and benefits of disease or disease control measures on the environment sector also remains limited.

Biotic and abiotic environmental conditions may affect contaminant persistence and/or dissemination (whether pathogen, chemical, etc.). Changes to the environment may yield a reduction or enhancement of the benefits people derive from it (“ecosystem services”), which include “provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth” (Millennium Ecosystem Assessment 2003). Increasing attention is being paid to assessing ecosystems for their risk of “collapse” in which they no longer functionally provide services, including through The Economics of Ecosystems & Biodiversity (TEEB), a global initiative that seeks to mainstream the values of biodiversity and ecosystems into decision-making at all levels using a structured approach to valuation. While a growing body of literature is assessing the value of ecosystem services (see Box 2.3), the contribution toward health is not routinely considered (Machalaba et al. 2017).

Prevention or control options	Key Partners
Animal vaccination (e.g. Rabies, Brucellosis)	Agriculture
Biosecurity improvements (e.g. Avian Influenza, Nipah)	Agriculture, Environment
Sentinel monitoring (e.g. die-offs of Great Apes from Ebola virus in Central Africa, sheep and goat herd monitoring for RVF)	Agriculture, Environment, Ecotourism
Exposure reduction – personal protective equipment, avoiding high-risk areas and/or species (e.g. caves with Marburg risk)	Extractives, Agriculture, Ecotourism
Human vaccination, therapeutics	Medical/Pharma
Other options, including wait-and-see, quarantine, etc.	Medical

Figure 2.4: opportunities to explore shared multi-sectoral value and investment for disease risk management (examples)

Given the many dynamic interactions in a given ecosystem, which may be disrupted or permanently altered (for example, from establishment of invasive alien species that out-compete native species, modify food chains, change species abundance levels, etc.), full restoration of ecosystems and renewed yield of ecosystem services may not always be automatic or feasible. **The value of One Health is to bring together sectors at the human-animal-environment interface to allow a more complete and more robust consideration of benefits and costs of different disease management options (some which may be long-lasting, particularly with environmental degradation).** This promotes stronger safeguards and risk mitigation (see Chapters 3, 5 and 6). As environmental integration in One Health (especially beyond wildlife) has been limited to date, the full extent of value is not presently known; but even if precise economic estimates are not available for environmental impact or protection, at least

assessing the probable direction and magnitude of the consequence of a policy or investment decision can provide a starting point.

Wildlife services, typically managed through environment/forest departments, are one critical component of a country's natural resource assets, promoting wildlife population monitoring and protection and facilitating ecotourism. They may potentially serve an important role in public health systems, particularly as less than 70 percent of recently emerging zoonotic infectious diseases have wildlife origins, and changes to ecosystems may increase risk of new diseases spilling over between wildlife to humans and/or agricultural animals (there are a multitude of yet-to-be-discovered pathogens, stemming from upwards of hundreds of thousands of unknown mammalian viruses (Jones et al. 2008, Anthony et al. 2013). Park rangers may be the first to observe wildlife morbidity or mortality events, or liaise with community stakeholders dependent on wildlife subsistence hunting who may be the first exposed to a disease circulating in wildlife (as seen with index cases of Ebola virus in Central Africa). Overall government investment in wildlife services is typically minimal, and investment in monitoring wildlife health even more deficient. A survey of expenditures indicated that the proportion of wildlife services budgets allocated to wildlife health services was extremely low in most countries included in the survey — approximately only 5 percent (World Bank 2012). Zero or low funding of wildlife health services may lead to low capacity to address potential zoonotic disease threats to humans (and risks to ecotourism revenues, food supply and other activities). There may be high-yielding opportunities for synergies between wildlife health services and public health, including via sentinel surveillance and in identifying and managing risk factors related to environmental determinants of disease. Importantly, some management strategies may be inappropriate, ineffective or counter-productive for wildlife disease control and undermine protections afforded to endangered species. Environmental expertise should be sought when designing disease control strategies involving wildlife.

Box 2.3 Value of Environmental Health

Some diseases have clear environmental determinants — for example leptospirosis risk from flooding events. For other environmental health issues (e.g. non-zoonotic diseases), public health connections may be less direct but still critically important- with **significant economic implications**. For example:

- The fungal pathogen *Pseudogymnoascus destructans*, responsible for White Nose Syndrome, has caused bat colony die-offs in North America, raising concerns over declining bat populations, including loss of their pest control and pollination services; these ecosystem services have an estimated value of \$3.7 billion to as high as \$53 billion annually in the continent (Boyles et al. 2009). Similarly, chytrid fungus, which has been linked to global amphibian declines and even species extinction, affects provisioning of natural vector control, and has been largely spread via wildlife trade (which itself also poses threats to biodiversity from overexploitation).
- In addition to infectious diseases, chemical toxicity presents a serious threat to biodiversity and other natural resources. Disease control itself may drive loss of ecosystem services. For example, non-target exposure to the anti-parasitic ivermectin via livestock manure is associated with declines of coprophagous insects (e.g. dung beetle) populations, which contribute to soil fertility (Nichols et al. 2008; Verdu et al. 2015). Veterinary use of the non-steroidal inflammatory drug Diclofenac has been linked to severe vulture die-offs (up to 95 percent of *Gyps* populations in parts of South Asia) when incidentally poisoned via feeding on carcasses of Diclofenac-treated livestock. Declines of this keystone species reduce the critical ecosystem service vultures provide (enabled by a specialized digestion that allows them to scavenge on carrion), meaning that carcasses may pollute water and other environmental settings, and may attract pests that could be vectors for disease — all with possible economic consequences. Weak environmental assessment processes for veterinary pharmaceutical licensing hinders proactive solutions to anticipate and address such ecological threats (Margalida et al. 2015).
- The processes associated with many causes of environmental degradation may also present a dual or multiple burden for health. Resource extraction for energy or production may increase forest encroachment that facilitates pathogen disease spillover; downstream, the burning of fossil fuels contributes to effects of global climate change, including possible changing geography of infectious disease vector distribution, and also to air pollution and respiratory disease locally. Pollution not only threatens health through direct toxicity, as seen with heavy metals, but may also serve as a mediator for susceptibility to infectious disease.
- Changing ecological dynamics, including introduction and establishment of invasive alien species, may affect pest control and thereby vector-borne disease, and reduction of agro-biodiversity affects nutrition provisioning as well as soil health.
- Plant diseases may reduce food security, and climate change may exacerbate negative impacts including threats to food safety in certain regions (e.g. via increasing aflatoxin poisoning risk). The FAO's Office for Asia and the Pacific has expanded its One Health scope beyond infectious diseases to include plants and animals at large, including pesticide residues in the food chain.

Health consequences of environmental degradation may manifest as “externalities” of development decisions not routinely factored into economic decision making. **Applying a One Health lens may help assess and address the economic costs and benefits of environmental management options.**

2e. Data Needs and Directions Forward

Innovative financing mechanisms have been recently proposed to promote pandemic preparedness and animal and public health system capacity; the need for One Health is reinforced by key recommendations generated by an International Working Group convened by the World Bank and WHO (Box 2.4). As countries consider investing in health security and other targets (e.g., agricultural production and food security, healthy ecosystems, etc.), One Health can be a particularly relevant concept for country budget allocation among the ministries responsible for security as well as human, animal and environmental health (e.g., in decisions by the finance minister, parliamentary body or Prime Minister). It also helps render analyses of spending optimization by World Bank country economists relevant and impactful, since it brings focus to the public expenditures that have what are likely the highest expected returns among all areas of public expenditure (see example from the regional project to improve disease surveillance in West Africa, Table 2.4).

As stewards of public resources, ministries of finance will favor more productive projects over less productive ones. In addition to informing decision-making, country-level analyses reflect local contexts, including socio-cultural priorities and economic considerations that may affect viability and success of different prevention or control measures.

A “One Health” approach to budget allocations for a particular multi-ministry (or multi-sector) program will be useful in budget decisions on:

- Investments in public health systems: in general budgeting, as well as in costing country capacity needs and action plans, the contributions (existing or potential) of strengthened human, veterinary and environmental health services to public health systems should be considered, and capacity and infrastructure needs (capital and recurrent) determined. There may be possible opportunities for resource sharing (e.g. in establishing laboratory infrastructure) that also automatically enable improved coordination between ministries (see Chapter 5 for examples of where cost items may be shared). Alternately, coordination mechanisms may require funding (e.g. for data-sharing systems), but may yield benefits such as early detection and potential for rapid control. The role of veterinary/agricultural and environmental services in public health should be reinforced in budgets given their essential roles in risk management for zoonoses as well as non-zoonotic diseases that affect nutritional and other resources (Box 2.3);
- Investments in control measures for specific diseases: for a given disease or set of diseases prioritized by a country, there may be several different options for risk management (see Chapters 3 and 5 for more on disease prioritization, and Chapter 4 on entry points). The foremost criteria should always be the effectiveness of potential interventions; then cost-benefit assessment to determine the anticipated net benefit, and a judgment on whether the benefit meets a designated threshold.

Box 2.4 International Working Group on Financing Preparedness (IWG)

In 2016, the World Bank convened an international working group to propose ways that countries and development partners can ensure adequate and sustainable financing for pandemic preparedness and achieving capacity to meet IHR and OIE standards. Their report, released at the occasion of the 70th World Health Assembly, outlines 12 recommendations for achieving health security. These feature innovative financing mechanisms and capacity development for preparedness planning to prevent, identify and contain outbreaks, including getting all national governments to commit to conducting assessment of preparedness and animal health capacities by the end of 2019; ensuring the results of these assessments are translated into costed action plans, supported by financing proposals and investment cases; reinforcing tax resources, including earmarked taxes, to finance preparedness; ensuring that donors fulfill their commitments, focusing development assistance on large one-off capital expenses that countries cannot afford, on regional initiatives and on fragile states; and ensuring the economic risks of infectious diseases are factored into macroeconomic assessments and investment decision-making, like other systemic risks. The report affirms the need for One Health initiatives to reduce the frequency and impact of zoonoses, including via drivers of emergence and spread; this Framework seeks to provide support for efforts on this front toward achievement of universal health security.

World Bank. 2017 From Panic and neglect to investing in health security: financing pandemic preparedness at a national level.

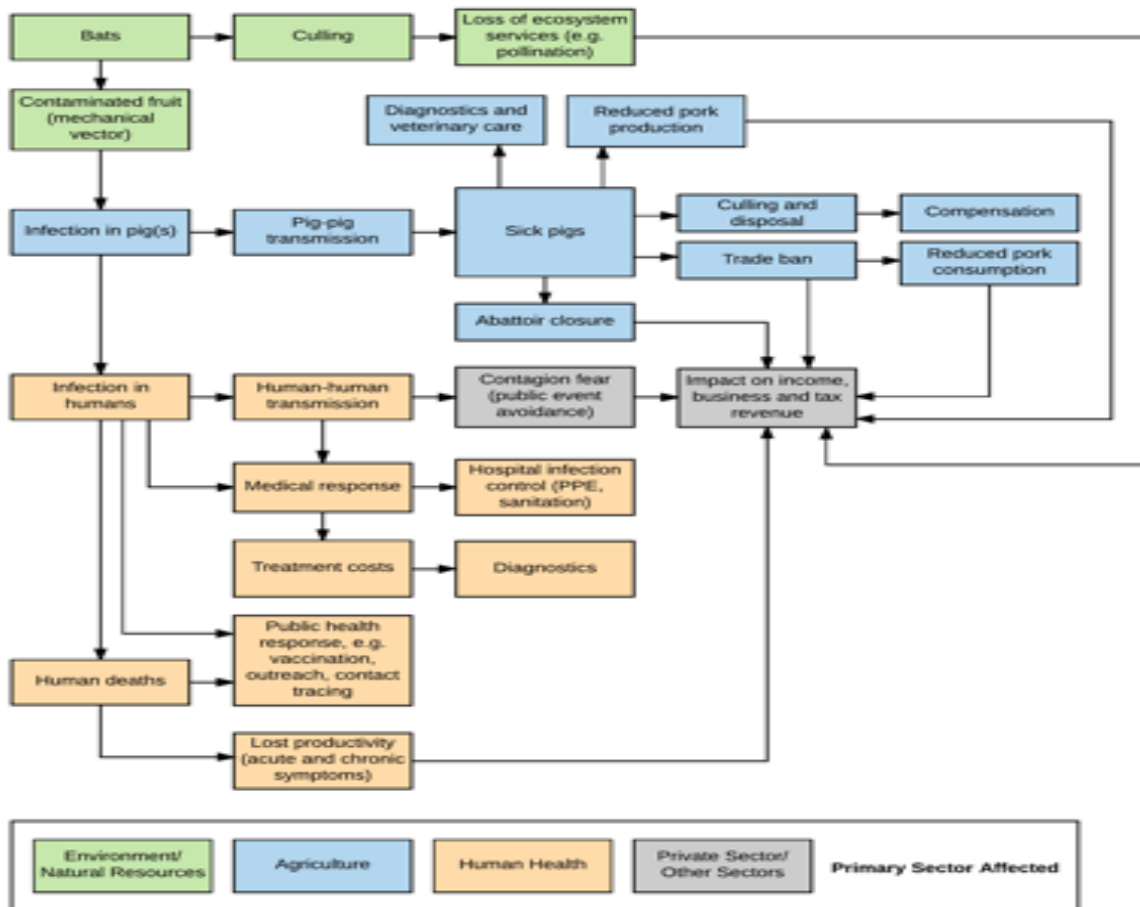


Figure 2.5: Illustrative example of an impact costing flow diagram; relevant sectors and impacts may vary by a given disease and context (e.g. primary transmission route and transmissibility, extent and severity of infection, control measures, etc.)

The overall need for additional data on One Health implementation to allow for robust analysis of its potential benefits is well established. One Health data needs, methodologies and metrics for evaluation and decision-making at country level were the focus of an expert workshop held at the World Bank in February 2017. Key recommendations (Box 2.5) promote more equitable and inclusive consideration of costs and benefits in addressing diseases as well as their drivers.

The following process was informed by the workshop discussions, and can serve as general guidance for countries when considering evaluation of One Health;¹³ these general steps could be performed within a risk analysis framework, taking into account particular country or population-specific factors that may affect feasibility or acceptability of proposed approaches (see Chapter 5 for relevant discussion on stakeholders, risk analysis, and governance applications). Depending on program objectives, evaluation may most readily focus on disease-specific management or coordination mechanisms that may be applied. While the focus of the workshop was economic assessment, other outcomes may be measurable and relevant (e.g. sector-specific indicators, public health outcomes, time or resource efficiency). These and other relevant approaches will benefit from testing and refinement based on factors such as user needs and priorities, fit within decision making processes, and data availability:

(i) Problem or issue framing (the specific disease, risk interface, etc. in question); (ii) Impact costing to identify the extent of impacts, and to which sector(s): system mapping with input from other sectors may be helpful to determine the full sectors involved and affected (which may not be readily apparent from the onset), and help inform options; then impacts can be collected (or estimated) for each of the sectors (see Figure 2.5); (iii) Option assessment (i.e., business as usual, specific interventions, etc.) and possible multi-sectoral costs and benefits assessment: this step can also identify where other sectors can gain, and may be advocates in securing funding and/or directly contributing to risk management; (iv) Measuring effectiveness: interventions may or may not work optimally and may need to be refined; similarly, disease risks or management options may be dynamic (or more information may become available that modifies understanding of transmission), potentially warranting updates in risk management approaches to enhance effectiveness.

For example, a Minister of Finance seeking to reduce agricultural losses from brucellosis in his or her country could consider the direct impacts to the agricultural sector (e.g. reduced production yield or impact on international trade status). With input from the human health ministry, he or she may learn of human cases of brucellosis in the country over recent years, with high treatment costs and impacts to work ability. Vaccination is known to be a highly effective strategy in preventing brucellosis in livestock, breaking the transmission chain to humans. Assessing the whole-of-society costs could thus yield a higher benefit of disease control from vaccination than would be gained from merely accounting for agricultural costs (or alternately, just human disease or workforce reduction costs from infection with brucellosis) (see Roth et al. 2003 for a detailed example from Mongolia). Similarly, input from the environment ministry may help to factor in the ecological processes that modulate disease outcomes and inform adaptive management options, such as long-term prevalence trends in wild animals, risk management actions (e.g., harvest, culling), and prevailing ecological conditions (e.g. winter-kill, predation) on these trends; based on this information, there may be trade-offs that need to be evaluated in the management of protected areas that include both livestock and wildlife to address transmission cycles.

Ultimately, One Health must demonstrate added value to warrant its implementation. A strong evidence base on potential or observed approaches (e.g. business as usual vs. One Health options) can

¹³ Developed from the “Prevent, Prepare and Respond: Economics of One Health to Confront Disease Threats” workshop held at the World Bank February 2017; see workshop report for further details and examples: https://www.ecohealthalliance.org/wp-content/uploads/2017/10/Prevent-Prepare-and-Respond-Economics-of-One-Health-to-Confront-Disease-Threats_Workshop-Report.pdf

help countries and donors optimize their resource allocation. In particular, **expanding evaluation to multiple sectors — including better integration of environmental factors and impacts — offers possible benefits for more inclusive analyses as well as possible solutions.** Several tools and planning processes featured in the following chapters along the prevent-detect-respond-recover spectrum provide entry points for possible use of this information.

Box 2.5: Recommendations from “Economics of One Health to Confront Disease Threats”:

Promote cross-sectoral understanding through clear terminology: Given the unique expertise that each sector brings, there is potential for misunderstanding or disagreement around the different meaning of terms among human health, animal health and environment sectors (as well as other potential participants such as economists, behaviorists, etc.). Wherever possible, developing working definitions understandable and acceptable to participants may assist in collaboration. Developing a platform for ongoing dialogue on terminology (e.g., via a Wiki) may help in compiling and refining a set of terms.

Work within country context: The importance of context (e.g., socially and culturally acceptable parameters, values, and practices) was emphasized to ensure approaches considered in the One Health Economic Evaluation process are pragmatic and could have successful uptake. Furthermore, using follow-up to ensure approaches are followed and sustainable allows for identification of failed mitigation strategies and opportunity for substitution with more effective measures. Thus, while international experts may have an interest and role in supporting development of this field, it is essential to involve in-country researchers and partners in the refinement of methods and integration into country planning that works for them. World Bank country economists may be an excellent resource for collaboration and information sharing.

Work toward multiple gains, but recognize that specific disease priorities may provide a platform for initial engagement: Experts noted the importance of working toward multiple gains to optimize efficiency, rather than considering options for addressing single diseases alone. While striving for this, opportunities and interest in One Health application may vary, and may be initiated and tested via dialogue on specific single-disease issues (e.g. rabies control).

Recognize that participants may have different priorities and levels of buy-in: Sectors may have varying degrees of initial interest, and varying goals for their participation in the assessment process. Certain metrics may have high relevance and priority to some sectors and not to others (e.g., Disability-Adjusted Life Years are highly relevant to the human health sector). Therefore, it may be useful to showcase a range of evaluation metrics (e.g. economic and epidemiological data). Goals should be transparent and discussed throughout the process to ensure all participants are motivated to collaborate where needed.

Increase representation of environment sector: While environment is one of three main sectors in the concept of One Health, in practice it is systematically underrepresented. The chronic lack of economic, and even ecological data available on impacts to the environment sector was a recurring discussion point. Participants suggested that in the absence of concrete data, initial qualitative assessments that demonstrate the known or expected direction (and where available, magnitude) of an impact be used. This approach may also help identify priority data gaps (which then could potentially be addressed by relevant initiatives such as ecosystem service assessments undertaken by TEEB or the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, or IPBES). Furthermore, understanding that the breadth of economic costs related to environmental impacts often affect human and animal health and other sectors (e.g., contamination of natural water sources can lead to public health problems with drinking water, livestock disease spread, and required clean-up or alternative planning interventions by government, sectors using irrigation, tourism industries, etc.), beyond the inherent value of the ecosystem itself, warrants greater efforts toward costing environmental impacts.

Promote integrated risk and impact assessment: Assessing risks and impacts to human, animal, environmental and other (e.g., social) sectors provides a more complete understanding of their potential links. This broadens understanding of potential outcomes of disease control options, or could be applied to other contexts (e.g., potentially facilitating future iterations of safeguard frameworks to help promote the health of people and the environment associated with nationally funded, development, or private investment projects). A common set of indicators may help provide a starting point for integration.

Reinforce the value of prevention: As understanding of the drivers and mechanisms for pathogen spillover increases, more can be done to mitigate risk and work toward prevention (e.g., via integrated risk assessment to anticipate possible externalities that could affect public health, whether positive or negative). In some cases, individual behavior change may drive prevention, but may be aided by a public-sector investment (e.g., via education campaigns); in other cases, broader-scale public and private sector policies may be needed (e.g., redirecting land conversion sites to avoid high risk of disease emergence).

3. POLICY, GOVERNANCE, TECHNICAL AND INSTITUTIONAL ASPECTS: AN INVENTORY OF ONE HEALTH TOOLS

The Framework provides activities, tools and interventions that can be used to strengthen public health systems at the human-animal-environment interface. As mentioned previously, it is intended to be updated periodically, bringing together and linking documents and initiatives for added value. The suites of curated packages that are being reviewed and endorsed by the World Bank and its partners may only represent a portion of existing or future resources. An initial inventory is provided on pages (see Fig. 3.4), following this background on overall relevance to recent initiatives of the World Bank and global institution partners. Additional applications and adaptations of these tools and One Health approaches are provided in Chapters 4-6 and Annex 5. While emphasizing and ultimately aiming at public systems, there are also important parallel or intersecting contributions and opportunities from the private sector to generate public benefits.

3a. Horizontal Management and Multisectorality

Good Practice for Development

This Framework is oriented to maximize effectiveness of World Bank operations on development objectives. To that end, it seeks to optimize externally financed activities especially in the context of health, environment and natural resources, and agriculture programs. This is especially poignant given the high economic and overall societal disruption cost imposed on countries and on poor communities within those countries affected by outbreaks at the human-animal-environment interface (as expanded on in Chapter 2), resources required for response by development agencies, and the increasing anthropogenic practices that are likely to continue environmental degradation trends as well as increase frequency of disease spillover events.

Strengthening public health systems at the human-animal-environment interface means strengthening them in ways that they can carry out the core functions of preventing, detecting and controlling disease efficiently and effectively in populations in communities, countries, regions and the world. Though the methods for effective and efficient disease control are often well-known, this is too rarely done. Core functions like disease surveillance are seldom delivered due to lack of leadership and capacity. Moreover, the systems are still highly siloed and reactive, which makes them ineffective. They can face neither the growing epidemic threats, nor the existing, endemic diseases with high persistent health and poverty burdens. Yet we have the technology to solve many of these disease challenges.

The utility of strengthening public health systems at the human-animal-environment interface should thus be reflected in country engagement, consistent with the World Bank Group's twin goals of ending extreme poverty and increasing shared prosperity in a sustainable manner through evidence-based, systematic approaches. As an example, assessing public health threats and their economic implications adequately will require consideration of relevant dimensions of the human-animal-environment interface. **Surfacing and quantifying these risks should be a standard part of the World Bank's Systematic Country Diagnostic, to help prioritize areas of shared need for strengthening, coordinate investments to avoid gaps and unnecessary duplication, and develop synergies to help identify and avoid possible negative impact for a sector.** Global commitment to effective use of public resources was reiterated in the Paris Declaration on Aid Effectiveness, based on the pillars of ownership, alignment, harmonization, managing for results, and mutual accountability. Operationalizing One Health approaches fully aligns with these pillars and delivers high expected economic, developmental and public health

benefits to developing countries, especially to the poor. As such, it is unambiguously good practice in development aid.

Technical Institutions' Vision

Over the past decade, several technical institutions have made notable efforts toward operationalizing One Health approaches. In 2008, in the context of the global avian influenza crisis, the FAO, OIE and WHO, in collaboration with UNICEF, UNSIC and the World Bank, developed a joint strategic framework “*Contributing to One World, One Health*” to address risks associated with emerging and re-emerging diseases. This document set out six specific interlinked objectives for countries to consider in their approach to infectious disease control at the human-animal-environment interface:

- Develop international, regional and national capacity in **surveillance**, making use of international standards, tools and monitoring processes;
- Ensure adequate international, regional and national capacity in public and animal health — including communication strategies — to **prevent, detect and respond** to disease outbreaks;
- Ensure **functioning national emergency response capacity**, as well as a global rapid response support capacity;
- Promote **inter-agency and cross-sectoral collaboration** and partnership;
- **Control** HPAI and other existing and potentially re-emerging **infectious diseases**;
- Conduct strategic **research**.

In order to advance this agenda, an expert consultation was conducted in 2009 in Canada and recommended the development of supranational, multidisciplinary and transboundary approaches. These, and other related One Health events, led to the Stone Mountain Meeting in May 2010 that was organized by diverse global institutions with the intent of providing a forum for national and international specialists to focus on policies and implementation of a One Health approach to improving human and animal health (CDC 2011). Their vision for One Health translated into four areas and seven groups of activities.

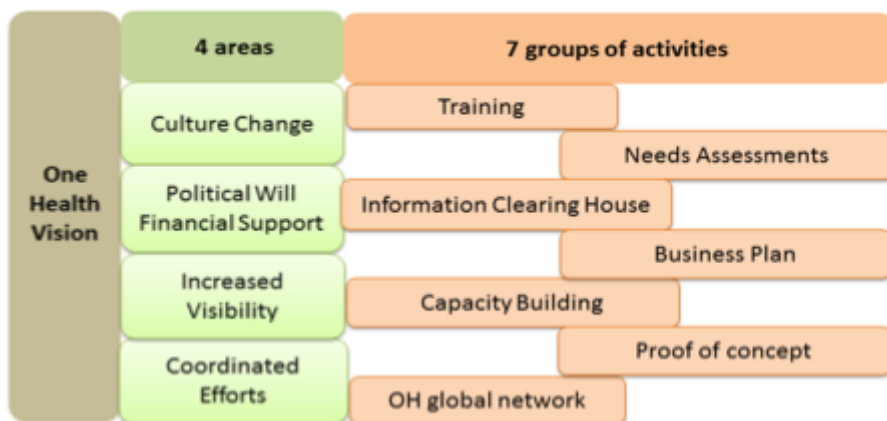


Figure 3.1: Stone Mountain vision for One Health

The group emphasized the need to foster horizontal coordination and synergies across the systems depicted in Figure 3.1.¹⁴ While Stone Mountain as a group no longer exists in name, the key premise of One Health operationalizing and the systems to be engaged/strengthened in coordination have been reinforced by numerous other groups, initiatives and programs.

A large amount of effort has been devoted to the Needs Assessment component. The Stone Mountain Group, for example, decided to focus on core capacities for cross-sectoral collaboration needed to meet One Health goals, looking at (i) leadership and human resources, (ii) governance and infrastructure, and (iii) stakeholder engagement needed to forge and maintain collaboration.



Figure 3.2 Sectoral pillars identified by the Stone Mountain Working Group, summarizing the need for collaboration among disciplines and organizations to achieve a shared goal to be well-founded on shared governance.

Per the Stone Mountain Group’s assessment, the agriculture and environment pillars had not been equipped with practical tools covering governance aspects that can “talk with” the other human and animal health tools in order to facilitate inter-agency collaboration and synergies (Figure 3.2). Instead, the WHO and OIE, the leading international organizations setting standards on human and animal health respectively, have developed and regularly update a set of assessment and costing tools to help their member countries identify strengths and weaknesses in their human¹⁵ and animal¹⁶ health systems. The underlying standards, objectives and specificities of these tools, and as importantly, the synergies and complementarities that exist at national level to facilitate the development of joint strategies to address more efficiently priority zoonotic diseases and issues such as antimicrobial resistance, are detailed in the document “*WHO-OIE Operational Framework for Good Governance at the Human-Animal Interface.*” This document provides an excellent overview of the foundations for good governance at the human-animal interface, including for early warning systems and notification, and for capacity development; of existing OIE and WHO/IHR assessment and costing tools for resource planning, their mechanism and use, as well as the main similarities and differences between these tools (See Table 3.1).

¹⁴ From the OH “Framework for Identifying Institutional Strengths and Needs for One Health Programs” prepared by the Stone Mountain Group (May 2013)

¹⁵ The WHO developed an IHR self-assessment tool that is based on a questionnaire that countries fill and send to WHO on a yearly basis ahead of the WHO General Assembly. The WHO has also developed a costing tool to help countries estimate realistic start-up and operating costs for core actions needed to develop, strengthen and maintain IHR core capacities. This tool was piloted in a few countries in different regions in full cooperation with WHO regional offices and could be used with the support of WHO staff in countries.

¹⁶ OIE developed Performance of Veterinary Services related tools, OIE PVS Evaluation and PVS Gap Analysis, that can be used under the OIE auspices and provide qualitative and quantitative analysis, respectively. They facilitate the development of a five-year strategic plan to respond to current and future needs in line with national overarching goals (quantitative analysis). As at April 2017, more than 130 countries had received a PVS evaluation mission, and more than 90 had received a PVS Gap Analysis mission.

The WHO and OIE reaffirmed the need to build more robust public and animal health systems that are based on good governance and are compliant with the IHR (2005) and OIE intergovernmental standards; this approach shifts away from externally driven, short-term, emergency response type ‘vertical’ approaches, and contributes to a more sustainable “horizontal approach” and long-term strengthening of systems.

Table 3.1: Main similarities and differences between the International Health Regulations (IHR) Monitoring Framework and the PVS Pathway (WHO-OIE, 2014)

	IHR Monitoring Framework and tools	PVS Pathway and tools
Objective	Assesses the capacities of States Parties to promptly and effectively respond to public health risks and emergencies according to international regulations	Continuous process to help Member Countries to sustainably improve compliance of Veterinary Services with OIE intergovernmental standards (OIE Codes)
Use of manual and tools	Mainly via self-evaluation	Mainly via third party (OIE-certified PVS experts)
Obligation	Mandatory annual report to the World Health Assembly (States Parties can choose their preferred monitoring process, including use of the IHR Monitoring Framework)	Voluntary process initiated solely further to a request from the country to the OIE (country-driven)
Time frame	Specific deadlines outlined in the IHR (2005)	Step-based and continuous process
Scope	Countries' capability to address international public health emergency of international concern	Improve compliance and performance of Veterinary Services
Outcome	Sustainable foundations for the integrated protection of human health and animal health at national, regional and international levels	
Confidentiality	The outputs are the property of the country and are kept confidential by the World Health Organization and the OIE ^a	

The two organizations have worked together to advocate for their member countries to take advantage of existing frameworks and benefit from coordinated actions to prevent the spread of animal diseases of high impact for public health. They identified areas in which the core capacities under the IHR Monitoring Framework match, overlapped or synergized with the critical competencies under the PVS Pathway, and developed a matrix offering human and animal health services an opportunity to see and discuss around points of convergence (cf. Table XIII of the WHO-OIE Operational Framework). More specifically, a 2017 WHO-OIE document, the “*Handbook for Assessment of Capacities at the Human-Animal Interface*”,¹⁷ assists in assessing veterinary services capacity in terms of supporting IHR implementation, identifying areas of relevant parallel capacity. Through the assessment criteria it promotes use of the findings of the OIE Performance of Veterinary Services Pathway assessment reports in annual country IHR compliance reporting. In its second edition, it reinforces synergies with the WHO-led Joint External Evaluation process (JEE) and tool (JEET) launched in 2016 to facilitate assessment of national capacities to prevent, detect and rapidly respond to public health threats under the IHR and integrating some sources of information from the OIE PVS.¹⁸ The PVS Pathway report can inform JEE efforts both in the self-review phase by countries as well as in external team evaluations; the handbook provides guidance on specific use of data from the PVS Evaluation to assist in implementing the JEE, including the relationship between indicators in the PVS Pathway and JEE. An IHR-PVS Pathway National Bridging Workshop

¹⁷ Second edition (2017), related to the Joint External Evaluation Tool International Health Regulations (2005) <http://www.who.int/ihr/publications/9789241511889/en/>

¹⁸ <http://www.who.int/ihr/publications/WHO-HSE-GCR-2016-18/en/>

(NBW) program has also been launched by WHO and OIE to gather national professionals from the human health, animal health and other sectors involved in the management of zoonotic outbreaks and professionals. Through case studies with fictitious scenarios, interactive sessions and other type of facilitating approaches, the NBWs guide the participants to revise the assessments conducted in both the human and animal health sectors (e.g. PVS for animal health and JEE for public health), explore options for improved collaboration and coordination, and inform operational strategies to be used by policy makers for concerted correctives measures and strategic investments in national roadmaps.

Integration with other sectors and scales can be further expanded to more fully address challenges at the human-animal-environment interfaces. There is no formal parallel to the IHR Monitoring and Evaluation Framework and the OIE PVS for environmental health capacities, and integration of wildlife and wildlife disease capacities under the tools remain limited. Beyond IHR and OIE standards, countries may have to face local endemic situations for which there are no international standards. Lastly, international standards do not extend to action on the root causes (drivers) of disease, especially in the context of anthropogenic changes to our environment (see Figure 3.3). Whereas previous tools have primarily been developed in disciplinary silos, reflecting firmly established (and expert) people, institutions, systems and cultural practices, this Framework brings them together to be considered in synergy, and expands integration of environmental assessments into planning processes from the onset. This strategic shift aims at bridging the horizontal pillars in 3.2, cross-linking them and identifying where gaps need to be filled (shifting to “*What needs to be done?*” rather than “*What am I responsible for?*”).

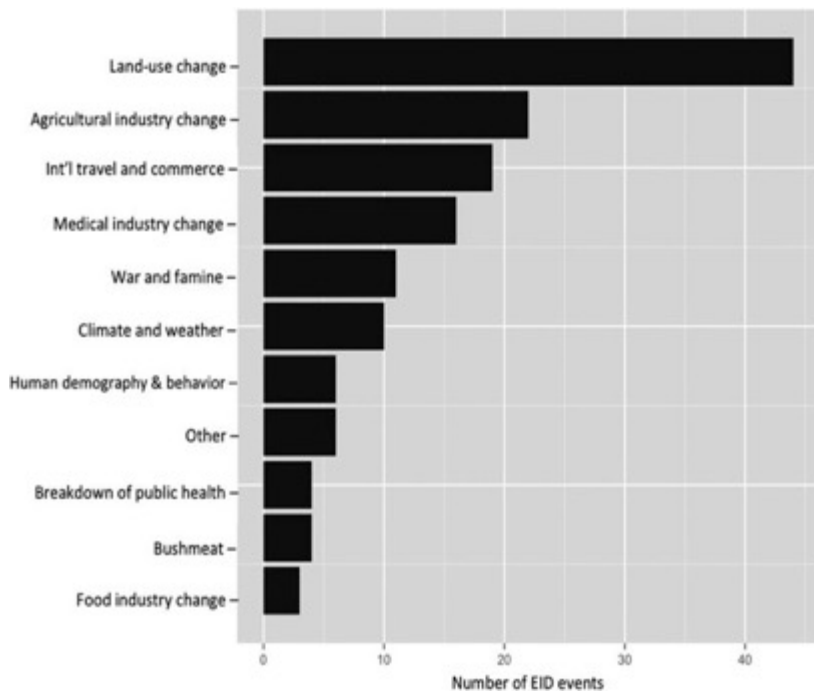


Figure 3.3: Infectious disease emergence events seen in recent decades are linked to practices that fundamentally change ecological dynamics and place people in increased or novel contact with animals and the environment. These practices typically also pose a wide range of other impacts to ecosystems that are associated with effects on human health. (Loh et al. 2015)

Incentives

To date, incentives encouraging collaboration across disciplines have been lacking. Similarly, funds for addressing pandemic threats are typically made available for reactionary responses in epidemic situations, rather than long-term capacity building in countries. This sporadic resource mobilization pattern limits sustainability and ensures focus stays on response and preparedness, rather than a paradigm shift to prevention. However, there is extremely high return on investment to be yielded from pandemic prevention (see Chapter 2 and e.g. World Bank 2012; Pike et al. 2014) — the premise for the USAID Emerging Pandemic Threat initiatives and the World Bank-financed REDISSE program. Funding structures such as the Regional IDA programs, which finance two-thirds of projects out of supplemental, rather than country IDA budget allocations, have been effective in incentivizing country participation in regional projects.

Addressing the limited integration of the environment sector in One Health to date

While the environment sector is recognized as one of the three pillars of One Health, in practice its integration in the analysis and implementation of projects has been limited. Some persistent challenges can be acknowledged. Taken as a whole, the environment has wide scope, with expertise areas that may be distributed across multiple ministries; hence there may not always be one designated authority to consult. At the same time, ministries of environment could themselves be better integrated into planning and programs with health implications to yield critical contributions.

Additionally, the environment sector is typically under-resourced, which may by default limit capacity to initiate resource sharing. For example, while they may be key sources of information on the underlying ecological processes and dynamics that may contribute to disease emergence or prevalence, they may not have the infrastructure or resources (nor mandate) to conduct a disease investigation themselves. Functionally, the environment sector may be at a disadvantage given disparity in infrastructure for human and livestock surveillance, ranging from lack of diagnostic tests validated for wildlife to practical considerations of safe capture, handling and sampling for certain wild species. Whereas human and animal health services are well defined, the lack of a concrete assessment tool to define and measure relevant capacities for environmental health services impedes systematic integration in public health delivery.

These limiting factors are not the fault of any particular sector(s); finding opportunities for shared multi-sectoral value may help overcome these consistent challenges to sufficiently bring the environment sector to the table and generate the full scope of potential added value of One Health. Despite many challenges, the entry points and relevance of each sector situation may vary (see Chapter 4), providing opportunity for targeted involvement to optimize information and action. In some cases, a gap may not be apparent without bringing in expertise from the environment sector (for example, we may lack critical information about the disease transmission cycle if the reservoir host for a pathogen has not been determined).

Fortunately, many functions can be potentially integrated into the existing workflow of environmental management and health professionals. For example, park rangers may observe animal morbidity or mortality events that could potentially signal a disease event of relevance to agricultural, ecosystem or public health services. Establishing reporting channels with actionable follow-up (such as specimen collection and diagnostic services) may help to harness the value of this information. Identifying the ecological dynamics of virus spillover and circulation can provide critical insights for risk management. Other routinely collected data — such as climate and weather forecasting, biodiversity assessments and species range, and food webs — may also be highly valuable to animal and human health services. In

many cases, enhancing awareness of how to access and interpret this information may help, and may drive feedback loops to better identify information gaps that could be collected in the future. Moreover, public health education campaigns that integrate ecological dimensions may help embed a more integrated way of approaching public health systems at the human-animal-environment interface. Environmental sector input is also valuable in the evaluation of potential co-benefits, including long-term benefits in the context of global environmental changes as well as in assessment and formulation of trade-offs.

Participation by the environment sector on single-disease investigations, risk assessment and management will open the door for expanded participation on other relevant topics. This is particularly important given that there may be consequences of disease control strategies for the environment as well as impacts resulting from environmental management that may impact on health outcomes, providing a clear mutual incentive for their engagement. Many tools, such as strategic environmental and environmental impact analyses, as well as established multilateral environmental agreements, provide overarching guidance, guidelines and tools for countries, as well as relevant inputs for more comprehensive health impact assessment and strategic environmental assessment, particularly useful to inform on development decisions. The value of healthy environments on human health and agriculture (as directly as the provisioning of feed, food and water, pollination services, pollution remediation, among myriad other benefits) “mainstreams” the value and relevance of the environmental sector’s work with other sectors.¹⁹ Despite compelling economic arguments from protecting ecosystem services, and concrete assessments of the financial benefits derived from ecosystem services, such as those used for The Economics of Ecosystems and Biodiversity (TEEB), the cost of losing such services in specific relation to human health are generally lacking in decision-making processes. Even qualitative estimation may be valuable for determining acceptability of different risk management options; adaptive management may help address uncertainties and non-linear ecosystem processes with relevance to health (see Text box).

Finally, as the IHR and OIE Terrestrial Animal Health Code and Aquatic Animal Health Codes set out defined standards that can be monitored for capacity attainment in human and animal health systems (e.g. via the JEE and PVS), standards for environmental health systems may help advance more prominent service delivery. Given that these standards are not defined, the starting point may be baseline capacity assessment to develop a benchmark for countries and identify the key elements needed for environmental health systems. The World Bank’s Country Environment Analysis tool provides detailed analysis of the adequacy and performance of policy, legal and institutional frameworks for environmental management. Its use can be complemented by the Country Assessment of Environmental Health Services, a tool being developed to promote links with human and animal health services for action at their interface, identifying capacities and gaps where resources can be established and cross-linked to optimize information collection and sharing for risk assessment and management (see Box 3.3).

¹⁹ For example, the Strategic Plan for Biodiversity 2011-2020 adopted by the UN General assembly at its 65th session has health directly embedded in its vision and mission, and Aichi Biodiversity Target 14 explicitly recognizes the value of ecosystems for health, livelihoods and wellbeing while several other Aichi Targets also directly or indirectly influence human health outcomes.

Box 3.1 The ecosystem approach and adaptive management

The ecosystem approach, derived from a management perspective, recognizes the interconnectedness of biotic and abiotic elements of the environment and their complex interactions. It requires adaptive management to deal with the complex and dynamic nature of ecosystems, in which processes are often non-linear and resulting time lags may lead to surprise and uncertainty. Simply stated, it recognizes that management for human health cannot be separate from the pursuit of ecosystem health.

The ecosystem approach recognizes that management must be adaptive in order to effectively respond to uncertainties. It contains elements of “learning by doing” or research feedback. Measures may need to be taken even when some cause-and-effect relationships are not yet fully established scientifically. The ecosystem approach does not preclude other management and conservation approaches, such as biosphere reserves, protected areas and single-species conservation programs, as well as other approaches carried out under existing national policy and legislative frameworks, but could, rather, integrate all these approaches and other methodologies to deal with complex situations. There is no single way to implement the ecosystem approach, as it depends on local, provincial, national, regional or global conditions. Indeed, there are many ways in which ecosystem approaches may be used as the framework for delivering the objectives of the Convention in practice.

Adapted from: CBD COP5 Decision V/6: The ecosystem approach

3b. Technical Considerations

Core functions, Core capacities and Critical Competencies

Activities to promote operationalizing will seek to enhance capacities, modernizing and rationalizing infrastructure, organization and management of animal, human and environment health services and their collaboration with other relevant agencies and stakeholders, as described in the international standards and guidelines. While using a different order or approach, the WHO/IHR and OIE PVS Pathway tools, which are similar in their objectives, respectively, list “core capacities” or “critical competencies” for these systems to function adequately (cf Tables 3.2-3.4 below).

- Human health: the IHR monitoring and evaluation framework includes several tools, in which i) the tool for annual reporting to the WHA establishes eight core capacities and four specific hazards, plus specific requirements at Points of Entry (ports, airports, ground-crossing). A set of 28 global indicators²⁰ (with 256 indicator attributes) (Table 3.2) are used by countries to assess their level of compliance with the core capacities that reflect the required capability to detect, assess, notify and report events and to respond to public health risks and emergencies of national and international concern, as stipulated in Articles 5 and 13 and Annex 1 of IHR (2005); ii) the JEE tool builds on four core elements (prevent, detect, response, other IHR-related hazards and point of entry),¹⁹ Technical Areas and 48 associated indicators (Table 3.3).
- Animal health: the OIE PVS evaluation tool establishes four fundamental components and 47 critical competencies against which the Veterinary Services are evaluated (Table 3.4). Providing the foundation for the PVS Pathway is the dedicated section on the quality of Veterinary Services in the *Terrestrial Code* (OIE 2016).²¹

Table 3.2: Capacities and Indicators used in the IHR Monitoring and Evaluation Framework for annual reporting.

Human Health Services (IHR)	
Eight Core Capacities + Capacities at point of Entry + Four Specific Hazards	28 indicators
1. National legislation, policy and financing	- Legislation, laws, regulations, administrative requirements, policies or other government instruments in place are sufficient for implementation of the International Health Regulations (IHR). - Funding is available and accessible for implementing IHR NFP functions and IHR core capacity strengthening

²⁰ From these 28 indicators, a subset of 20 is used for annual reporting to the World Health Assembly, but countries are encouraged to report on all 28 indicators.

²¹ *Terrestrial Code* Section 3, Chapter 3.1, ‘Veterinary Services’, and Chapter 3.2, ‘Evaluation of Veterinary Services’)

2. Coordination and National Focal Point communications	<ul style="list-style-type: none"> - A functional mechanism is established for the coordination of relevant sectors in the implementation of the IHR. - IHR National Focal Point (NFP) functions and operations, as defined by the IHR (2005), are in place.
3. Surveillance	<ul style="list-style-type: none"> - Indicator-based surveillance includes an early warning function for the early detection of a public health event. - Event-based surveillance is established and functioning. - Influenza surveillance is established.
4. Preparedness	<ul style="list-style-type: none"> - A Multi-Hazard National Public Health Emergency Preparedness and Response Plan is developed and implemented. - Priority public health risks and resources are mapped and utilized.
5. Response	<ul style="list-style-type: none"> - Public health emergency response mechanisms are established and functioning. - Case management procedures are implemented for IHR relevant hazards. - Infection prevention and control is established and functioning at national and hospital levels. - A program for disinfection, decontamination and vector control is established and functioning.
6. Risk communications	<ul style="list-style-type: none"> - Mechanisms for effective risk communication during a public health emergency are established and functioning.
7. Human resource capacity	<ul style="list-style-type: none"> - Human resources are available to implement IHR core capacity requirements.
8. Laboratory	<ul style="list-style-type: none"> - Laboratory services are available to test for priority health threats. - Laboratory biosafety and laboratory biosecurity (biorisk management) practices are in place and implemented. - Laboratory data management and reporting are established. - A coordinating mechanism for laboratory services is established. - A system for collection, packaging and transport of clinical specimens is established.
9. Points of entry (PoE)	<ul style="list-style-type: none"> - General obligations at point of entry (PoE) are fulfilled (including for coordination and communication). - Routine capacities and effective surveillance are established at PoE. - Effective response at PoE is established. - Coordination in the prevention, detection and response to public health emergencies at PoE is established.
10. Hazards _ 10.1. Zoonotic	<ul style="list-style-type: none"> - Mechanisms for detecting and responding to zoonoses and potential zoonoses are established and functional.
_ 10.2. Food safety	<ul style="list-style-type: none"> - Mechanisms are established and functioning for detecting and responding to foodborne disease and food contamination.
_ 10.3. Chemical emergencies	<ul style="list-style-type: none"> - Mechanisms are established and functioning for the detection, alert and response to chemical emergencies that may constitute a public health event of international concern.

_ 10.4. Radiation emergencies	- Mechanisms are established and functioning for detecting and responding to radiological and nuclear emergencies that may constitute a public health event of international concern.
-------------------------------	---

Table 3.3 JEE core elements, capacities and indicators (WHO 2016).

Four Core Elements	19 Capacities	48 Indicators
PREVENT	National Legislation, Policy and Financing	P.1.1 Legislation, laws, regulations, administrative requirements, policies or other government instruments in place are sufficient for implementation of IHR. P.1.2 The state can demonstrate that it has adjusted and aligned its domestic legislation, policies and administrative arrangements to enable compliance with the IHR (2005)
	IHR Coordination, Communication and Advocacy	P.2.1 A functional mechanism is established for the coordination and integration of relevant sectors in the implementation of IHR.
	Antimicrobial Resistance (AMR)	P.3.1 Antimicrobial resistance (AMR) detection P.3.2 Surveillance of infections caused by AMR pathogens P.3.3 Healthcare associated infection (HCAI) prevention and control programs P.3.4 Antimicrobial stewardship activities
	Zoonotic Disease	P.4.1 Surveillance systems in place for priority zoonotic diseases/pathogens P.4.2 Veterinary or Animal Health Workforce P.4.3 Mechanisms for responding to infectious zoonoses and potential zoonoses are established and functional
	Food Safety	P.5.1 Mechanisms are established and functioning for detecting and responding to foodborne disease and food contamination. P.6.2 Biosafety and biosecurity training and practices
	Biosafety and Biosecurity	P.6.1 Whole-of-government biosafety and biosecurity system is in place for human, animal, and agriculture facilities P.6.2 Biosafety and biosecurity training and practices
	Immunization	P.7.1 Vaccine coverage (measles) as part of national program P.7.2 National vaccine access and delivery
DETECT	National Laboratory System	D.1.1 Laboratory testing for detection of priority diseases D.1.2 Specimen referral and transport system D.1.3 Effective modern point -of-care and laboratory based diagnostics D.1.4 Laboratory Quality System

	Real Time Surveillance	D.2.1 Indicator and event based surveillance systems D.2.2 Interoperable, interconnected, electronic real-time reporting system D.2.3 Analysis of surveillance data D.2.4 Syndromic surveillance systems
	Reporting	D.3.1 System for efficient reporting to WHO, FAO and OIE D.3.2 Reporting network and protocols in country
	Workforce Development	D.4.1 Human resources are available to implement IHR core capacity requirements D.4.2 Applied epidemiology training program in place such as FETP D.4.3 Workforce strategy
RESPOND	Preparedness	R.1.1 Multi-hazard national public health emergency preparedness and response plan is developed and implemented R.1.2 Priority public health risks and resources are mapped and utilized.
	Emergency Response Operations	R.2.1 Capacity to Activate Emergency Operations R.2.2 Emergency Operations Centre Operating Procedures and Plans R.2.3 Emergency Operations Program R.2.4 Case management procedures are implemented for IHR relevant hazards.
	Linking Public Health and Security Authorities	R.3.1 Public Health and Security Authorities, (e.g. Law Enforcement, Border Control, Customs) are linked during a suspect or confirmed biological event
	Medical Countermeasures and Personnel Deployment	R.4.1 System is in place for sending and receiving medical countermeasures during a public health emergency R.4.2 System is in place for sending and receiving health personnel during a public health emergency
	Communication	R.5.1 Risk Communication Systems (plans, mechanisms, etc.) R.5.2 Internal and Partner Communication and Coordination R.5.3 Public Communication R.5.4 Communication Engagement with Affected Communities R.5.5 Dynamic Listening and Rumour Management
Other IHR-related hazards and Points of Entry (PoE)	Points of Entry	PoE.1 Routine capacities are established at Points of Entry PoE.2 Effective Public Health Response at Points of Entry
	Chemical Events	CE.1 Mechanisms are established and functioning for detecting and responding to chemical events or emergencies. CE.2 Enabling environment is in place for management of chemical Events
	Radiation Emergencies	RE.1 Mechanisms are established and functioning for detecting and responding to radiological and nuclear emergencies. RE.2 Enabling environment is in place for management of Radiation Emergencies

Beyond IHR core functions, which are to detect, assess, report and respond to all public health emergencies of international concern (PHEICs) at central, intermediate and community levels, a national human Public Health system is expected to provide other important functions. Various lists have been established to date by diverse groups and organizations and provide interesting elements to consider when strengthening human health systems. For example, the WHO Region for the Eastern Mediterranean launched in 2013 an initiative to assess public health capacity and performance in countries of the Eastern Mediterranean Region, and developed a specific framework to this aim listing the following essential public health functions.

1. Surveillance and monitoring of health determinants, risks, morbidity and mortality.
2. Preparedness and public health response to disease outbreaks, natural disasters and other emergencies.
3. Health protection, including management of environmental, food, toxicological and occupational safety.
4. Health promotion and disease prevention through population and personalized interventions, including action to address social determinants and health inequity.
5. Assuring effective health governance, public health legislation, financing and institutional structures (stewardship function).
6. Assuring a sufficient and competent workforce for effective public health delivery.
7. Communication and social mobilization for health.
8. Advancing public health research to inform and influence policy and practice.

Other examples of frameworks include those of the Centers for Disease Control and Prevention and the Pan American Health Organization essential public health functions; US essential public health services; WHO essential public health function categories; and EURO Essential Public Health Operations.²²

Other initiatives have created their own set of activities to promote to reach slightly different objectives. The Global Health Security Agenda (GHS), for example, was launched in February 2014 to accelerate progress in countries' capacities to prevent, detect and respond to public health emergencies. Some of the capacities explored by the GHS are aligned with those of the JEE.

²² <http://www.emro.who.int/about-who/public-health-functions/index.html>

Table 3.4: Fundamental Components and Critical Competencies identified by the OIE PVS.

Veterinary Services
4 Fundamental components; 47 Critical Competencies
<p><u>I. Human, physical and financial resources</u></p> <p>I-1.A. Professional and technical staffing of the Veterinary Services. Veterinarians and other professionals</p> <p>I-1.B. Professional and technical staffing of the Veterinary Services. Veterinary paraprofessionals and other technical professionals</p> <p>I-2.A. Professional competencies of veterinarians including the OIE Day 1 competencies</p> <p>I-2.B. Competencies of veterinary para-professionals</p> <p>I-3. Continuing education</p> <p>I-4. Technical independence</p> <p>I-5. Stability of structures and sustainability of policies</p> <p>I-6.A. Coordination capability of the Veterinary Services. Internal coordination (chain of command)</p> <p>I-6.B. Coordination capability of the Veterinary Services. External coordination</p> <p>I-7. Physical resources</p> <p>I-8. Operational funding</p> <p>I-9. Emergency funding</p> <p>I-10. Capital investment</p> <p>I-11. Management of resources and operations</p>
<p><u>II. Technical authority and capability</u></p> <p>II-1.A. Veterinary laboratory diagnosis. Access to veterinary laboratory diagnosis</p> <p>II-1.B. Veterinary laboratory diagnosis. Suitability of national laboratory infrastructures</p> <p>II-2. Laboratory quality assurance</p> <p>II-3. Risk analysis</p> <p>II-4. Quarantine and border security</p> <p>II-5.A. Epidemiological surveillance and early detection. Passive epidemiological surveillance</p> <p>II-5.B. Epidemiological surveillance and early detection. Active epidemiological surveillance</p> <p>II-6. Emergency response</p> <p>II-7. Disease prevention, control and eradication</p> <p>II-8.A. Food safety. Regulation, authorization and inspection of establishments for production, processing and distribution of food of animal origin</p> <p>II-8.B. Food safety. Ante and post mortem inspection at abattoirs and associated premises</p> <p>II-8.C. Food safety. Inspection of collection, processing and distribution of products of animal origin</p> <p>II-9. Veterinary medicines and biologicals</p> <p>II-10. Residue testing</p> <p>II-11. Animal feed safety</p> <p>II-12. A. Identification and traceability. Animal identification and movement control</p> <p>II-12.B. Identification and traceability. Identification and traceability of animal products</p> <p>II-13. Animal welfare</p>

III. Interaction with interested parties

III-1. Communication

III-2. Consultation with interested parties

III-3. Official representation

III-4. Accreditation/authorization/delegation

III-5.A. Veterinary Statutory Body (VSB). VSB Authority

III-5.B. Veterinary Statutory Body (VSB). VSB Capacity

III-6. Participation of producers and other interested parties in joint programs

IV. Access to markets

IV-1. Preparation of legislation and regulations

IV-2. Implementation of legislation and regulations and compliance thereof

IV-3. International harmonization

IV-4. International certification

IV-5. Equivalence and other types of sanitary agreements

IV-6. Transparency

IV-7. Zoning

IV-8. Compartmentalization

Box 3.2 The WHO Approach to Neglected Zoonotic Diseases

Control of neglected zoonotic diseases calls for integrated interventions among human and animal health, and other relevant sectors. WHO approaches to reducing their impact on people's health and livelihoods include:

- Assessing local, regional and global societal burdens and the cost-benefit and cost-effectiveness of intervention strategies;*
- Improving collaboration and raising awareness among governments, organizations and the wider stakeholder community engaged at the human–animal–ecosystems interface;*
- Compiling evidence for the validation of tools and developing guidance for surveillance, prevention, control and treatment of specific diseases;*
- Assisting countries in building and strengthening their capacity to apply and contextualize tools and implement integrated cost-effective strategies for prevention, control and treatment;*
- Establishing or strengthening mechanisms for the exchange of information across relevant sectors and programs in countries, in particular to bridge the gap between agriculture and health;*
- Using evidence-based advocacy to leverage commitment and increase investments in prevention and control activities, capacity strengthening and applied research.*

Source: http://www.who.int/neglected_diseases/zoonoses/infections_more/en/

For practitioners using this Framework, emphasizing a needs-based approach (rather than solely individual responsibilities), can help institutions overcome the segmented divisions of labor that inevitably lead to gaps, and may also help identify opportunities for value-added information and other resource sharing. The WHO's approach to neglected zoonotic diseases provide an example of how to bring services work together around a common public health issue (cf Box 3.2).

When designing programs or projects using One Health approaches, it is important to consider both the sectoral systems and the connections between them. **Strong uni-sectoral health systems (e.g. human health, animal health, environmental health) systems must be in place — or existing systems strengthened — and then mechanisms for coordination and collaboration established.**

Classical and Innovative One Health-related Activities

Cost effectiveness of measures aiming at preventing zoonotic disease at the animal source have been well documented, e.g. with rabies control through vaccination in reservoir species and parasitic diseases management (e.g. echinococcosis, cysticercosis) leading to improved human health and reduced health care costs, greater animal productivity and benefits to livelihoods (see Chapter 2). These are the most classic examples of zoonotic diseases for which nationwide and long-term control programs or risk management measures (e.g. at slaughterhouse level) have been put in place in developed economies to control or eradicate previously endemic diseases. Though not all zoonotic disease can be controlled at the animal source for cost-effectiveness and feasibility reasons, these aspects should be properly reviewed when designing zoonotic disease-control strategies. Categorization and prioritization of diseases should be carried out and updated regularly, using a sound methodology based on solid data; a series of approaches/tools have been developed and applied for agricultural and zoonotic diseases.²³ These include disease ranking processes (e.g. Rist et al. 2014) as well as stakeholder and network mapping to identify institutional capacity strengths and gaps and promote coordination (e.g., Sorrell et al. 2015; Myhree et al. 2017) (see Chapter 5 and Annex 5 for further details on applying these methods and examples of relevant tools). These activities, including zoonotic disease prioritization, should be done jointly, and lists of priorities agreed on by all relevant sectors.

The actions previously mentioned on rabies, brucellosis and tuberculosis, for example, relate mostly to animal sector-specific activities that benefit human health but did not necessarily require joint measures, nor intensive coordination between sectors. However, a number of factors of emergence or re-emergence of diseases (e.g., practices contributing to pathogen spillovers), change in geographical repartition, speed of spread, pathogenicity, host range, etc., call for a stronger and more systematic pooling of expertise and use of technologies and processes. Similarly, the role of environmental factors and decisions in disease occurrence or avoidance is not routinely considered, and thus can be widely expanded for integration into control programs. A few examples of approaches are mentioned below:

- Satellite remote sensing, in particular to capture climate variables and environmental factors (e.g. vegetation cover, soil type, water levels/drainage)
- Health data and reporting via mobile phones or apps (including animal morbidity and mortality reports by hunters and park rangers for wildlife disease investigation)
- Integrated/linked databases for human and animal health and environment
- Staff cross-disciplinary exchanges — secondment between ministries
- Cross-ministerial integration of prevention, preparedness and response for disease control — plans and programs

²³ For example, the US CDC developed a “One Health Zoonotic Disease Prioritization” tool.

- Implementing health and environmental impact assessments and safeguards prior to projects, including economic cost projections that consider short and long-term risks and externalities
- Disease emergence insurance, with cost based on risk mitigation to incentivize risk reduction strategies, and with legal liability for outcomes
- Building incentives for zoonotic disease risk-reduction strategies — loans, lower insurance premiums, penalty structures to promote risk avoidance, and demonstrating value to worker productivity
- Including integrated health and environment risk-reduction strategies as a measure of credit-worthiness

High-tech or advanced joint strategies or incentives may not easily be implemented at the early stages of systems strengthening. From the lessons learned through the avian influenza global program, among all joint activities that were carried out by the different services involved, one was considered of critical importance: communication. This was not only a means of preventing public panic and enabling an orderly response to outbreaks, but also helped to avoid the kinds of confidence-related economic losses that had been experienced following the SARS crisis. Communication can and has been a good starting point for technical One Health committees to brainstorm on priorities, gaps, roles and responsibilities, in order to further elaborate messages for peace and crisis times.

3c. Specific Methods and Tools and Examples for Operationalizing One Health

The specific process for operationalizing One Health may depend on many factors (e.g. existing capacity, stakeholders already collaborating, infrastructure needs, particularly country-level priorities/context). However, some broad components are likely to underpin the process at some point of operationalization. The following are among the key steps for making the One Health approach operational among countries and international agencies. They are adapted from those identified at a World Bank technical event taking stock of lessons from the GPAI, “*Towards One Health: New Approaches to Managing Zoonotic Diseases*”.²⁴

At the country level:

- Identifying in-country champions
- Making the case for early identification and control of zoonotic diseases
- Assessing the needs of the services
- Joint priority setting and preparedness planning, including the identification of disease or risk hot spots
- Establishing the appropriate enabling regulatory and political, institutional and financial conditions, including their integration among human, animal and environment sectors
- Developing educational curricula, in particular at the university level, which integrate human, veterinary and ecosystems health
- Establishing the appropriate financial instruments

At the international agencies level:

- Creating increased awareness and making the case for One Health by preparing and disseminating economic analysis of disease impacts and enhancing advocacy mechanisms. Improving collaboration among international technical agencies, including regulatory and political, institutional and financial integration among human, animal and environment sectors.

²⁴ <http://siteresources.worldbank.org/EXTARD/Resources/336681-1242670845332/TowardsOneHealth.pdf>

- Identifying sustainable funding systems to support low income countries to cover the investment cost.
- Strengthening research capacity.

The following resources and programs demonstrate different capacity and technical enablers that can feed in along these different steps. These form the heart of the Operational Framework, intended to serve as a global library of technical analysis, guidance, diagnostic instruments, operational knowledge and other resources that may be undertaken voluntarily by countries (e.g. external assessments) or may reflect country obligations (e.g. official reporting). The library brings together the collected knowledge of World Bank, WHO, OIE, and other partners as well as the practical lessons derived from international experience in implementing health systems strengthening programs. It is complemented by detailed information on sources of technical expertise as well as resources that may be available (from the World Bank and other donors) for national and regional human-animal-environment health strengthening initiatives. There may be multiple overlapping planning tools at country level, some but not all of which take One Health into consideration; different entry points and objectives will necessitate different tools, but TTLs should be aware of the suite of offerings, particularly those which may not be routinely incorporated into single-sector operations but may have high value addition. While it should be recognized that this list is by no means complete, as there are undoubtedly additional relevant and useful initiatives not captured here, the following section and an expanded list in Annex 5 intend to be an initial offering of resources of high utility for practitioners planning to undertake health systems strengthening at the human-animal-environment interface, for knowledge exchange to assist in mobilization of technical and financial resources.

Figure 3.4: Map of resources, tools and initiatives to assist in operationalizing One Health

One Health resources can be characterized by their main domain and where they broadly fit in the process of operationalizing One Health. While certain steps typically precede or follow others (e.g. capacity needs may inform country planning and prioritization), these may not be static (for example, project activities or risk analysis may lead to identification of additional capacity or regulatory needs). Figure shows examples; a more complete list of programs, policies, and tools are listed in Annex 5.



Regulatory Frameworks

- **International Health Regulations (WHO):** a binding legal instrument requiring member states to report certain disease outbreaks and public health events.
- **Terrestrial and Aquatic Animal Health Codes and Manuals (OIE):** standards relating to animal health and zoonoses; enforced by the World Trade Organization under the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS).
- **Convention on Biological Diversity:** a multilateral environment agreement (hosted under United Nations Environment) for the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from the use of genetic resources.
- **Framework Convention on Climate Change:** a multilateral agreement to stabilize greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system. The Paris Agreement is under the Convention.
- **Convention on International Trade in Endangered Species of Wild Fauna and Flora:** a multilateral environment agreement providing international trade protections to more than 35,000 species of animals and plants to safeguard them from over-exploitation.
- **Codex Alimentarius (FAO and WHO):** voluntary international food standards, guidelines and codes of practice intended to contribute to the safety, quality and fairness of international food trade.
- **Sendai Framework for Disaster Risk Reduction:** a 15-year voluntary, non-binding agreement for whole-of-society action for substantial reduction of disaster risk and losses in lives, livelihoods and health, and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.
- **Voluntary international country action plans** are being developed to meet voluntary disaster risk reduction targets for 2015-2030.
- **National policies:** countries may have national guidelines that implement international frameworks or country-specific regulations (e.g. related to land planning, national disaster risk reduction regulations, national reporting requirements, endangered species protections, etc.)

Capacity Assessments

- **Joint External Evaluation for the IHR Monitoring and Evaluation Framework (WHO):** intended to assess country capacity to prevent, detect and respond to public health threats independently of whether they are naturally occurring, deliberate or accidental.
- **Performance of Veterinary Services (OIE):** tool to establish level of performance in Veterinary Services, identify gaps and weaknesses in their capacity to comply with OIE international standards, form a shared vision with stakeholders (including the private sector) and establish priorities and carry out strategic initiatives.
- **Disaster Risk Management Capacity Assessment Tools:** Tools to assess risks and vulnerabilities and to inform capacity needs for strengthened risk reduction.
- **National capacity audits:** country-specific assessments.

Planning Tools

- **National Action Plans for Health Security:** five-year multi-sectoral plan guiding a country's health security activities and investments necessary for accelerating the implementation of the WHO International Health Regulation.
- **One Health Zoonotic Disease Prioritization:** a tool that allows a country to use a multi-sectoral approach to prioritize endemic and emerging zoonotic diseases of greatest national concern that should be jointly addressed by human, animal and environmental health ministries.
- **Health Security Financing Assessment Tool:** World Bank tool to help countries identify critical constraints and opportunities to strengthening financing systems that accelerate and sustain progress towards effective health security. It can accompany assessments (e.g. JEE, PVS) to track and monitor progress over time.
- **Performance of Veterinary Services Gap Analysis:** quantitative evaluation of a country's needs and priorities based on the outcome of the independent external evaluation of the country Veterinary Services using the OIE PVS Evaluation Tool.
- **National Biodiversity Strategies and Action Plans:** principal instruments for implementing the UN Biodiversity Convention at the national level. The Convention requires countries to prepare a national biodiversity strategy (or equivalent instrument) and to ensure that this strategy is mainstreamed into the

planning and activities of all those sectors whose activities can have an impact (positive and negative) on biodiversity.

- **National Adaptation Plans (NAPs):** process for countries to identify their medium- and long-term climate change adaptation needs and develop and implement strategies and programs to address these needs. The objectives are: to reduce vulnerability to the impacts of climate change, by building adaptive capacity and resilience; and to facilitate the integration of climate change adaptation, in a coherent manner into relevant new and existing policies, programs and activities (particularly development planning processes and strategies) within all relevant sectors and at different levels, as appropriate.
- **National Action Plans on Antimicrobial Resistance (AMR):** country action plans aligned to the strategic objectives of the Global Action plan on AMR that reinforces standards and decisions by the WHO, OIE and FAO, which emphasize awareness and understanding, knowledge and evidence base strengthening, reduced infection incidence, optimized use in humans and animals, and the economic case for sustainable investment.
- **Disaster Risk Reduction National Plans:** country action plans are being developed to meet voluntary disaster risk reduction targets for 2015-2030.

Expert Networks

- **IHR Committees and Roster of Experts (WHO):** appointed expert members.
- **OFFLU (OIE and FAO):** network of expertise on animal influenza.
- **Working Groups, Commissions (e.g. OIE and FAO networks):** appointed expert members with varying responsibilities, from keeping member states informed on current issues to revision of official standards.
- **IUCN Commissions:** six IUCN Commissions unite 16,000 volunteer experts from a range of disciplines to assess the state of the world's natural resources and provide the Union with sound know-how and policy advice on conservation issues. One health-related initiatives include the Species Survival Commission Wildlife Health Specialist Group and Commission on Ecosystems "Red List of Ecosystems."

Implementation Resources

- **Projects:** e.g. REDISSE, a World Bank program to strengthen cross-sectoral capacity for collaborative disease surveillance and epidemic preparedness in West Africa, and mobilize response to crisis or emergency.
- **Global Financing Facility:** partnership to accelerate global efforts to end preventable maternal and child deaths and improve the health and quality of life of women, children and adolescents by 2030 (hosted at the World Bank).
- **World Animal Health and Welfare Fund (the OIE World Fund):** mobilizes funds for the purpose of projects of international public utility relating to the control of animal diseases, including those affecting humans, and the promotion of animal welfare and animal production food safety (e.g. through enhancements in the performance of veterinary services, including needs identified the PVS Gap Analysis).
- **Global Environment Facility (GEF):** first established through the World Bank, it is now a global partnership that provides funding to assist developing countries in meeting the objectives of international environmental conventions. The GEF serves as the "financial mechanism" to five conventions, which are the Convention on Biological Diversity (CBD), United Nations Framework Convention on Climate Change (UNFCCC), Stockholm Convention on Persistent Organic Pollutants (POPs), UN Convention to Combat Desertification (UNCCD), and Minamata Convention on Mercury.
- **Nationally Determined Contributions (NDCs):** financial support mechanism for country National Adaptation Plans. The NDCs spell out the actions countries intend to take to address climate change — in terms of both adaptation and mitigation. They become binding when a country ratifies the Paris Agreement.
- **Bilateral aid agreements**

Information Sharing and Reporting

- **World Animal Health Information System (WAHIS) (OIE):** an early warning system to inform the international community, by means of "alert messages," of relevant epidemiological events that occurred in OIE member countries, and a monitoring system in order to monitor OIE-listed diseases (presence or absence) over time, consistent with OIE member reporting requirements.
- **Global Early Warning System (GLEWS):** a joint FAO-OIE-WHO initiative for monitoring data from existing event-based surveillance systems and to track and verify relevant animal and zoonotic events to aid in coordinated risk assessment.

- **DesInventar (UNISDR):** a tool for the generation of National Disaster Inventories and the construction of databases of damage, losses and in general the effects of disasters (health disasters are included, as well as damage to healthcare infrastructure, livestock, and more).
- **Sendai Monitor (UNISDR):** a tool for countries to annually report their progress to achieve the seven global targets for DRR as outlined in the Sendai Framework.
- **ProMED Mail:** an Internet-based reporting system dedicated to rapid global dissemination of information on outbreaks of human, animal or plant infectious diseases and acute exposure to toxins.

3d. Integration into Project Planning and Scoping

Every health, agriculture or environment and natural resources project or program could, feasibly, consider options for integrating One Health strategies from the outset so that wider benefits can be realized. While the World Bank Environment and Social Safeguards (2012-2016 revision process; See Annex) consider some relevant dimensions of community health and biodiversity separately, these could be broadened to consider links between health and environment.

Disease prevention can be encouraged while also building public health system resilience for all hazards, consistent with the prevent-detect-respond-recover spectrum (see Chapter 5). For example, synergies could include joint surveillance for known and novel diseases to track progress in preventing and controlling endemic diseases while also gaining a baseline assessment of pathogens that could potentially spill over to humans in the future.

Projects and interventions

Specific financing mechanisms for public health systems strengthening at the human-animal-environment interface will vary by project or program objective (see accompanying operational manual). For example, the IDA18 replenishment includes pandemic preparedness planning under its commitments; Program-for-Results (P4R) financing may target uptake of biosecurity strategies; and Development Policy Loans (DPL) may implement policy reform to incorporate health assessments into land use planning. Multiple instruments may be used for implementing One Health approaches; the appropriate one(s) will be identified during project scoping.

There are three phases essential to integration of One Health aspects in any project or intervention (Table 3.5). The first relates to establishing baseline data and identifying areas of focus, and would relate to project identification, appraisal and approval phases within the Bank. The second relates to engagement and planning for the areas of focus, and most closely correlates to the implementation. The third relates to monitoring and reporting progress, updating plans, and potential new areas of focus. A set of examples are provided; additional guidance for TTLs can be found in the accompanying operational manual.

Table 3.5. Project Intervention Phases for Integration of One Health Considerations

PHASE 1 Project Identification and Preparation	PHASE 2 Implementation	PHASE 3 Completion
<input type="checkbox"/> Problem scoping and determination of relevant sectors/ministries, stakeholders and partners	<input type="checkbox"/> Deploy diagnostic tools to refine focus areas	<input type="checkbox"/> Measure and report progress against core One Health indicators and project objectives through a transparent and public mechanism

<ul style="list-style-type: none"> □ Assess basic capacities of institutions, individuals, and technical and physical infrastructures (e.g., via JEE, PVS, Environmental Health Capacity Assessment tool, etc.) 	<ul style="list-style-type: none"> □ Engage with staff, expert networks, communities and other relevant stakeholders about One Health approaches, such as data sharing, sentinel surveillance, and risk mitigation 	<ul style="list-style-type: none"> □ Review areas of focus and update plans
<ul style="list-style-type: none"> □ Assess costs and benefits associated with One Health approach(es) to address problem 	<ul style="list-style-type: none"> □ Develop systematic plans to establish timelines, actions and monitoring mechanisms, that reinforce prevention, detection, response and/or recovery capacity 	<ul style="list-style-type: none"> □ Measure added value from application of One Health (or lack of One Health approach)
<ul style="list-style-type: none"> □ Identify country-specific risk drivers that contribute to key local vulnerabilities 	<ul style="list-style-type: none"> □ Communicate with institution(s), health professionals, local communities about the strategies and their role for risk mitigation; build sustainability 	<ul style="list-style-type: none"> □ Measure integration or uptake of One Health strategies into planning processes and/or practice
<ul style="list-style-type: none"> □ Assess risk mitigation opportunities in relation to disease, as well as broader outcomes (e.g. food and nutrition security, livelihoods, environmental protection, education, trade and travel) 	<ul style="list-style-type: none"> □ Review existing and planned funding commitments (e.g. via GEF, GFF) for coordination and synergy 	<ul style="list-style-type: none"> □ Identify lessons learned for their integration in follow-up operations

Within the first phase of project intervention, One Health approaches should consider a number of early assessment areas for public health systems strengthening, including the existing human, animal and environmental health and management capacities and gaps and the opportunities for coordination among them. Additionally, it should seek to identify country-specific risk factors for known and emerging disease threats as well as opportunities for greater public health resource efficiency; costs and benefits of

prevention, detection, response and recovery investments and ongoing financing; risk mitigation; and broader outcomes (e.g. food and nutrition security, livelihoods, environmental protection, education, trade and travel).

Country capacity building tools and uni- and multi-sectoral planning processes (see examples in Figure 3.4) provide relevant baseline and targeted capacity and gap assessments and can be used to identify synergies with existing country initiatives. Chapter 5 showcases the use of such tools and other operations under key building blocks along the prevent-detect-respond-recovery spectrum. Guidance on One Health-specific indicators and upscaling to inform evaluation (Phase 3) are found in Chapter 6.

At an institutional level, One Health approaches could be reinforced through coverage in standing mechanisms, such as Systematic Country Diagnostic reports, Public Expenditure Review, specific program reports (e.g. Health System Financing), internal budgeting, and strategy statements.

3e. Climate and Health relations

The World Bank and its partners have developed substantial operational guidance for climate change mitigation and adaptation strategies, including for climate-sensitive diseases (see Table 3.4 for examples) and other direct and indirect consequences for health (e.g. associated with air pollution or nutrition and water insecurity). These include the “Investing in Climate Change and Health” series (World Bank 2017a,b,c), “Reducing Climate-Sensitive Disease Risks” (World Bank 2014), as well as Climate and Disaster Risk Screening Tools²⁵ and Recovery Hub.²⁶

They feature key actions and assessments that can be employed by practitioners along the prevent-detect-respond-recover spectrum that this Operational Framework uses, including to identify vulnerability hotspots for priority action, build risk reduction into the design of programs, transition to climate-smart healthcare for resilience, and prepare for post-disaster health risks and recovery (see Annex 5 for additional examples and links to key climate and health tools and guidance documents). Tools can also be utilized for climate early warning risk management to target upstream drivers of disease (Tables 3.6 - 3.7).

Many of these resources have strong relevance for One Health, already offering applications for multi-sectoral collaboration, many which intersect with agricultural production and ecosystem management. They should be consulted to provide greater detail and in particular to identify relevant tools, needs and safeguards for the specific country or disease contexts the TTL is working in. This Operational Framework intentionally avoids duplication of this existing resource base, seeking to be used in complement and highlighting additional relevant topics at the human-animal-environment interface. In particular, it reinforces the importance of and opportunities for action on the upstream drivers of climate-associated diseases and vulnerabilities from climate change as a threat multiplier, aiming at shifting from reactive public health systems to preparedness for resilience, including disease prevention and health disaster risk reduction.

²⁵ <https://climatescreeningtools.worldbank.org>

²⁶ <https://www.gfdrr.org/recovery-hub>

Table 3.6 WHO assessment of potential impact of climate change on three significant diseases

DISEASE	PATHOGEN	VECTOR	MECHANISM OF ACTION AND PREDICTED IMPACT OF CLIMATE CHANGE
Malaria	<i>Plasmodium falciparum</i>	Various <i>Anopheles</i> mosquitoes (particularly <i>A. gambiae</i>)	Influenced by both temperature and rainfall, so complex and nonlinear (also strongly related to economic growth): expansions to some new geographies likely (particularly in Asia and South America) but transmission declines in hotter temperatures
Dengue fever	Dengue virus (flavivirus)	Primarily <i>Aedes aegypti</i> and <i>Aedes albopictus</i> mosquitoes	Likely expansion of geographical range, particularly in Sub-Saharan Africa (although also strongly related to economic growth)
Diarrheal diseases	Multiple (e.g., <i>E. coli</i> , rotavirus, salmonella)	Multiple	Limited data make predictions challenging but likely temperature-related increase in mortality, particularly in South Asia and Sub-Saharan Africa

Table 3.7 Select early warning risk management tools

TOOL	SOURCE	GENERAL OR HEALTH SECTOR-SPECIFIC	YEAR
Heatwaves and Health: Guidance on Warning-System Development	World Meteorological Organization and World Health Organization	Health	2015
Using Climate to Predict Infectious Disease Epidemics	World Health Organization	Health	2005
Developing Early Warning Systems: A Checklist	United Nations International Strategy for Disaster Reduction	General	2006
Guidelines on Early Warning Systems and Application of Nowcasting and Operation Warnings	World Meteorological Organization	General	2010
Implementing Hazard Early Warning Systems	Global Framework for Disaster Risk Reduction	General	2011
Climate Information and Early Warning Systems Communications Toolkit	United Nations Development Programme	General	2016

Box 3.3 Country Assessment of Environmental Health Services

Despite strong connection to human and animal health, environmental aspects of the human-animal-environment interface have received limited coverage, at least in part due to limited capacity in this area of environmental management (in contrast to other key areas such as air pollution). Using examples from parallel assessment tools and expert input and resources, the World Bank is developing a tool for Country Assessment of Environmental Health Services aimed at helping establish standardized criteria for assessing national environmental health capacity. It expands the current remit of what is typically considered under environmental health to address the drivers of disease and optimize risk management strategies.

The assessment would inform investment needs (whether by internal government or external donors) to support sustained public health systems strengthening at the human-animal-environment interface. Building on the existing scope of environmental health, the assessment emphasizes broadening intersections with veterinary and human health priorities and capacities toward a “One Health” approach.

4. ONE HEALTH ENTRY POINTS

As previously mentioned in this document, there is no “one best way” to strengthen public health systems at the human-animal-environment interface. Each health threat has its own dynamics, its own causes and effects, and suitable control measures (see section below). The Operational Framework acknowledges this reality and outlines measures and approaches to ensure that whatever the point of departure, those seeking to address health threats reach a common destination — a more resilient and adaptive public health system.

This chapter reviews diseases and AMR case studies to emphasize the variability in the importance of each sector for understanding and managing risk. In some cases, only one or two sectors may be needed; in others, involvement of all three One Health domains (human, animal health and environment health) may be necessary; while in some cases, the particular role of some sectors may not be apparent (for example, when the natural reservoir for a disease is unknown). The chapter also presents another example of entry point through the strengthening of a specific function of the health systems (preparedness). **The target is public health system-wide strengthening to be agile enough to address all hazards; to do this, countries need strong human, animal, environmental health/management systems and coordination between them to even determine which sectors are relevant.**

Examples below showcase diverse interactions. Two of these scenarios dive deeper into examples on how some parts would be operationalized to move toward solutions.

4a. Same Microbes, Different Contexts — Where to Intervene?

The concept of One Health is often visualized through a Venn diagram showing three circles representing the human, animal and environment domains and their overlap (Figure 4.1). To accurately represent the domains and their interactions, the size of each circle varies by specific disease, transmission factors, and other contextual considerations (including ecological dimensions but also social, cultural and economic factors). In some cases, the role of animals or environment will be null (human outbreaks of measles); in others, highly relevant (Leptospirosis), and may change over time (as demonstrated by the concept of different “stages” of zoonotic disease toward global emergence)²⁷. What is important is that a multi-sectoral approach is taken to fully understand and optimize intervention point(s) for best value. The overwhelming and integral connections between human, animal and environmental health warrants such a One Health approach to address a wide range of current and anticipated challenges for public health systems.

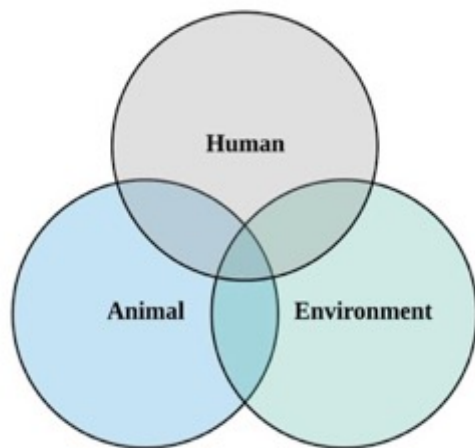


Figure 4.1 General One Health Venn diagram visualization. The size (relevance, involvement) of the circles may change based on the specific disease and/or context. Additional disciplines often have important roles in disease determinants/drivers, burden or interventions.

²⁷ Wolfe, Dunavan and Diamond classified these stages from 1-5: no natural transmission from animals to humans (stage 1, e.g. wildlife-only agents), to only human-to-human transmission (stage 5, e.g. HIV). *Nature*, 2007. These classifications may be dynamic, as seen with the trajectory of the West Africa Ebola outbreak.

The following case studies (see Annex for additional examples) demonstrate the importance of context for application of One Health in addressing different diseases and helps countries optimize their approach — noting that these may not be static for an individual disease or outbreak, as risk management targets may shift over different stages of the prevent-detect-respond-recover spectrum (see Chapter 5).

Nipah virus disease: Nipah virus was first detected in 1998 in Malaysia in the appearance of fatal human encephalitis cases. Japanese Encephalitis was initially suspected as the causal infection, but routine control measures (human vaccination, vector control) did not stem the outbreak. Further diagnostic investigation ultimately indicated infection with Nipah virus, with transmission from Pteropid “flying fox” bats (the likely reservoir) to swine via contaminated fruit from an orchard near the pig housing. The bats were thought to be attracted to the farm by the fruit trees, particularly in light of limited food availability in forest areas. Intensive pig farming facilitated rapid spread, amplifying in pigs and spreading to their human handlers. The outbreak spread to additional states when farmers in the outbreak region sold their pigs, dispersing the infection to other states in the country. Infections were later detected in Singapore in abattoir workers handling pigs imported from Malaysia. The outbreak ultimately resulted in the culling of more than one million pigs, at least 100 human deaths, and economic impacts of more than \$500 million (World Bank 2012). The many stages of transmission and spread in this outbreak demonstrate how context changed throughout the course and where different interventions may have yielded different outcomes — beginning with landscape change and farming practices, possible human exposure/protection measures, how livestock culling compensation policies could have avoided or reduced risk of trade-associated spread, and more.

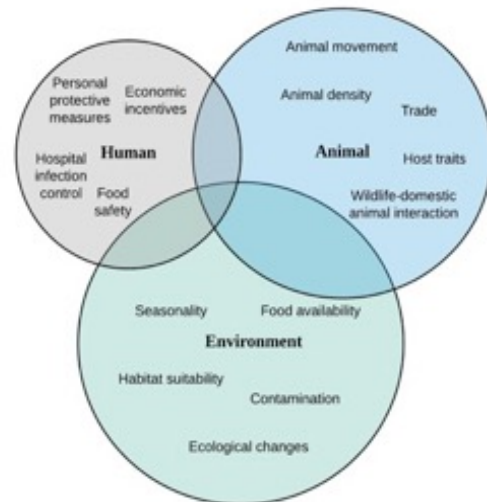


Figure 4.2 Flying fox bats serve as the natural reservoir for Nipah virus and have a direct role in recurring spillover events in Bangladesh. Hospital-acquired human-human spread has been documented, but appears limited. Thus, animal and environmental contamination factors warrant emphasis.

The virus has also led to human infections in Bangladesh, with near-yearly outbreak events seen in the country since 2001, but via an entirely different transmission pathway — in this case, through bat contamination (likely saliva, feces, or urine) of raw date palm sap, a delicacy for human consumption in parts of the country. As outbreaks occur in the winter and spring, seasonality is thought to play a factor, likely linked to the harvest season and bat population or viral shedding determinants. While outbreaks have clearly indicated the presence of bat-human transmission via the sap, disease consistent with Nipah virus has also been documented in farm animals fed highly contaminated date palm sap, with subsequent Nipah infections diagnosed in people — though this route of transmission in Bangladesh has not been definitively confirmed (Luby et al. 2009). Either way,

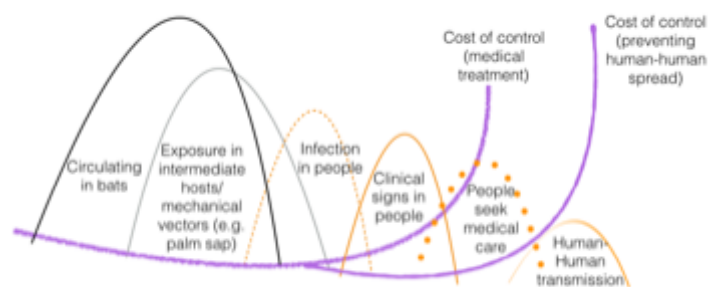


Figure 4.3 General transmission curves for Nipah virus in Bangladesh

protecting the sap from roosting bats that feed on it (such as via bamboo shields) may help yield a safer product. While apparently an uncommon transmission route for the virus, hospital-acquired Nipah infections have also been observed in India, reinforcing the importance of infection control measures in this setting.

Operational applications: Based on these different contexts, consideration moves into actual operations: what has been done, or could be done or refined, to resolve the situations? For example, for Nipah virus in the Malaysia-Singapore outbreaks, we can highlight two important components at the wildlife-livestock-human interface: farm biosecurity and early disease detection capacity (Table 4.1).

Table 4.1 Operational targets for Nipah virus control (targeting transmission risk in agricultural settings)²⁸

Target problem identified	Key points in the One Health operationalization	Potential actions
Close contact between livestock and wildlife species	farm biosecurity	<input type="checkbox"/> training farmers on good practices <input type="checkbox"/> legislation <input type="checkbox"/> subsidies to improve livestock facilities
Delays in the diagnosis	improving the laboratory diagnostic capacity	<input type="checkbox"/> equip hospitals and veterinary labs <input type="checkbox"/> promote robust laboratory networks including reference laboratories
Difficulties in understanding of the epidemiology	establishing collaborations between the human health professional, veterinarians and wildlife specialists	<input type="checkbox"/> sharing real-time information on unusual disease events <input type="checkbox"/> establishing protocols between animal and human health services to meet regularly <input type="checkbox"/> establishing common disease information systems

Thus, this example reminds us the relevance of maintaining biosecurity in livestock to avoid contact with wildlife species, which is also valid for other diseases such as AI. These biosecurity improvements would be operationalized through training to farmers on good practices, legislation and subsidies to improve livestock facilities. In the case of novel etiological agent such as Nipah virus, with unusual illnesses in animals and humans, it is essential to have an open-minded approach and close collaboration/coordination between the human health professional, veterinarians and wildlife specialists to reach a diagnosis and to understand the epidemiology of the disease (Looi and Chua 2007). Thus, it is important to maintain an early detection disease system, through sharing real-time information on unusual events, which should also account for the occupational risks and enough diagnostic capacity. Sharing information could be achieved by establishing a routine protocol between animal and human health services, or even by sharing disease information systems. The diagnostic capacity can be achieved by improving the laboratory diagnostic capacity, which does not necessarily imply to equip each hospital with all the

²⁸ The example in Table 4.1 is specific to the context of the transmission pathway from the Nipah outbreak in Malaysia. The particular problems, One Health operations, and action steps for risk management may differ depending on country or situation (for example, the transmission pathway for past Nipah virus outbreaks in Bangladesh — largely via ingestion of raw date palm sap — may require different approaches than those for transmission in agricultural settings).

laboratory tests but to promote robust laboratory networks including reference labs. Animal movement traceability would be another working point needed to resolve this problem to control the spread of disease through livestock; and in order to facilitate the culling of animals, any contingency plans should include mechanisms to compensate farmers for the loss of animals.

Ebola virus disease: First reported in 1976, Ebola hemorrhagic fever (Ebola virus disease) has been linked to more than 20 subsequent known outbreaks. These have been highly fatal, but limited mostly to rural villages in close proximity to rainforest in Central Africa. The West Africa Ebola outbreak beginning in December 2013 took a markedly different trajectory, developing into an urban epidemic under health systems that were unprepared to detect and control the disease (in large part due to lasting impact from conflict and instability in the region). More than 28,000 cases and 11,310 deaths were reported as of October 2016. While the initial source was speculated as bats roosting in a village tree, control in the human population to prevent further human-to-human spread became the critical action in this outbreak (changing burial and care-taking practices, enabling hospitals with infection control, and modifying social practices such as hand-shaking). Population analyses of this large-scale outbreak continue to reveal new symptoms and transmission routes not previously associated with the virus. While a travel-imported case in Lagos, Nigeria, raised concerns about spread potential in Africa’s most populated city, highly effective contact tracing, disease screening, media campaigns, and related public health measures quickly contained the outbreak.

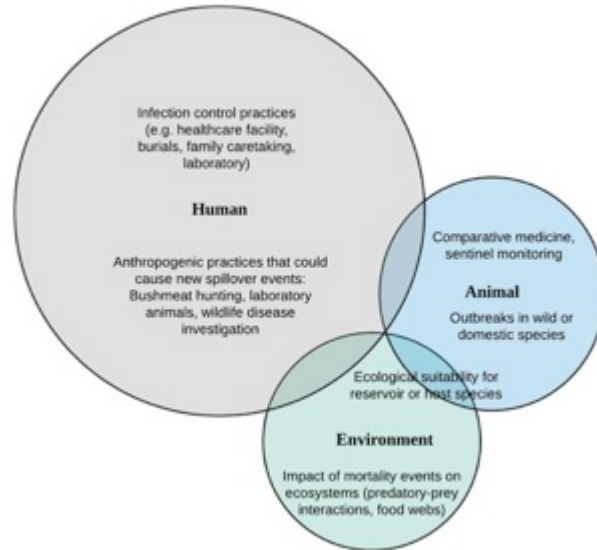


Figure 4.4 Example of a human Ebola virus outbreak, where containing human-to-human spread is of immediate relevance. Animal and environmental factors and impacts may still be relevant for long-term or emerging risk (new spillover events).

As the scale of the West Africa outbreak was being realized, a separate, unrelated Ebola virus outbreak (also of the Zaire strain) beginning in July 2014 in the Democratic Republic of Congo, traced back to butchering an infected monkey, was rapidly diagnosed and contained (limited to 66 cases), attributed in large part to country preparedness capacity (especially in laboratory infrastructure/personnel and contact tracing). Index cases in prior outbreaks have also been linked back to bushmeat hunting and butchering for food consumption. Field studies in the Republic of Congo and Gabon have indicated that gorilla, chimpanzee or duiker mortality events caused by Ebola virus infections preceded human cases, demonstrating potential early warning and prevention strategies in working with hunters who can both avoid harvesting non-human primate carcasses and aide in sentinel monitoring networks (LeRoy et al. 2004; Olson et al. 2012). Given this link to some wild species, wildlife trade in bats and non-human primates is thus thought to be a risk factor for transmission. Non-invasive or minimally invasive methods of screening, such as fecal screening, may also effectively detect viral infections that may be circulating in non-human primates (Reed et al. 2014).

Other strains of Ebola virus have been observed in different contexts — for example, Tai forest virus was first diagnosed in 1994 in a scientist who conducted a necropsy of a dead chimpanzee in Cote d’Ivoire. Ebola Reston virus has been detected in monkeys and pigs in or imported from the Philippines. Laboratory infections in humans have also occurred with several different strains. Such different

transmission settings and practices (e.g. hunting, field investigation, hospital, laboratory) demand different prevention and control measures. However, the recurring pattern of initial spillover infection from animal to human — and the spread potential and economic impact evidenced in the West Africa epidemic — suggest that action at the human-animal-environment interface is a clear starting point to address the risk of future Ebola virus outbreaks. Human encroachment into wild habitat and interaction with wild species should thus be minimized to the extent possible — with particularly important conservation and health synergies given the significant die-offs in critically endangered gorillas due to Ebola virus over recent decades, as well as other pressures they face in parallel (wildlife trade, habitat loss). In the case of ongoing outbreaks in humans, however, high transmissibility paired with high disease burden and fatality require strong public health and medical services to prepare for and rapidly respond with effective control measures.

White Nose Syndrome: The fungus responsible for White Nose Syndrome has caused bat colony population die-offs of more than 90 percent in parts of the United States. First detected at a cave in New York state in 2006 (Blehert et al. 2009), the fungus visually manifests as a white facial growth and interrupts hibernation, eventually leading to overactivity and possible starvation (Reeder et al. 2012). Survival of the fungus is limited by its temperature sensitivity, persisting in caves with a narrow temperature range. The source of the introduction into and spread of the fungus in the Northeastern United States is thought to be via humans (e.g. likely contamination from clothing used for caving, indicating insufficient biosecurity measures for this particular pathogen). Bat-to-bat spread has resulted, causing widespread population declines. Contrary to its detrimental effects on North American bats, however, the fungus has been detected in Europe with no apparent impact. Instead, European bat populations are mainly threatened by loss of habitat and food availability as well as pesticide poisoning, though protections afforded through intergovernmental treaties (e.g. UNEP’s EUROBATS Convention) have helped promote their survival. While the fungus is only transmissible among certain species of bats [stage 1], it presents indirect risks to human health: loss of the ecosystem services that bats provide, namely pest control and pollination. These services are valued at upwards of \$4 billion per year in North America (Boyle et al. 2009), underpinning agricultural food production, as well as potentially aiding in vector-borne disease control. While wildlife biology, natural resource management, ecology and mycology experts will most directly intervene to control the fungus causing White Nose Syndrome, the potential human benefit of maintaining bat populations — as well as the role of humans as the vector for the introduction of the fungus — demonstrate a One Health link even in the context of wildlife-only diseases.

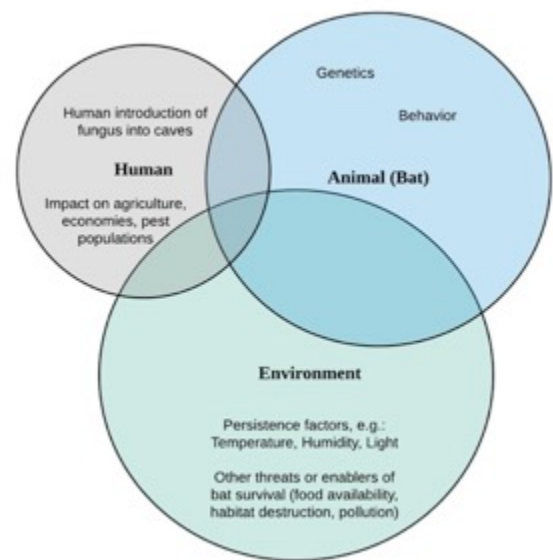


Figure 4.5 Ecologists are typically at the forefront of addressing wildlife diseases like White Nose Syndrome. Although not transmissible to humans, it may have indirect, long-term impacts for human health through loss of ecosystem services.

Antimicrobial Resistance: AMR is recognized as a threat to human and animal health. Just as many antimicrobial drugs are derived from nature, development of resistance is also a naturally occurring phenomenon. Yet the volume and certain types of antimicrobial use and waste management practices of antimicrobials allow for selection pressures to support their rapid development and dissemination, with strong relevance to human, animal and environment sectors. Resistant microbes do not respect borders; they circulate through human travel and through trade in livestock (including fish) and livestock products.

They can also spread through food products and in the environment, for instance in waterways and in migrations of wild birds and other wildlife. Unmonitored waste containing antimicrobials can be generated by pharmaceutical manufacturers, hospitals and livestock producers — all such waste can promote AMR in microbes in the environment. When drug-resistant pathogens infect people and animals, the pathogens and their AMR genes can continue to spread by human-to-human, animal-to-human, and animal-to-animal pathways (by means of vectors like mosquitoes and rats); and in the environment, including in water from aquaculture farms, sewage, and animal and other wastes from farms and slaughterhouses. In addition to these numerous routes, AMR can spread “horizontally,” because drug-resistant microbes can transfer resistance genes to other microbes, including across microbe species (World Bank 2017).

The entry points for addressing antimicrobial resistance clearly differ widely; for example, hospital-acquired resistant strains will likely fall squarely in the human health sector. But antimicrobial usage in other settings — agriculture and aquaculture — is highly relevant at the human-animal-environment interface. Human resistance to the medically important antibiotic Colistin was seen in pig handlers following its use as a growth promoter for pig production in China, detected shortly after in several other continents, with at least partial dissemination through the food chain and travel suspected (Olaitan et al. 2016). Aquaculture is projected to have a major role as a source of protein in human diet in response to increasing demand. Therapeutic and prophylactic use of antimicrobials in aquaculture, often administered through food, can result in large portions of un-metabolized antimicrobials entering aquatic environments via undigested food and via feces and potentially settling in sediment, and may alter microbial and other biological diversity (Buschman et al. 2012). In this scenario, environmental authorities have high relevance for understanding and managing risk around the persistence, dispersion and possible transmission of resistant bacterial strains. Similarly, waste management practices, typically within the domain of the environment sector, may inform actions aimed at AMR containment in the human and animal health sectors. Depending on the context and type of bacterial strain, the dynamic between the three circles could be different; humans and animals will be most relevant in some cases; the environment plays a role in others.

Pandemic preparedness: In addition to disease-specific entry points, One Health approaches can be applied through broader, horizontal program objectives, such as pandemic preparedness planning. The ideal starting point for disease preparedness planning will always be upstream prevention of an outbreak before it occurs in the human population, but countries may not be able to fully implement prevention strategies immediately or may be tackling existing outbreaks where there may be value in concurrently developing prevention and response capacities. Thus, all steps along the prevent-detect-respond-recover spectrum should be considered when constructing country preparedness plans, and a One Health approach to each of these stages has merit in considering holistic measures that promote strong preparedness (see chapter 5).

Countries may face multiple hazards; there may be concern over travel-imported disease as well as locally acquired known and novel infections. Strong capacity for hospital- and community-based surveillance and contact tracing in the human population is especially important for outbreaks with human-to-human spread. Some diseases may pose recurring risk of spillover (e.g. rabies virus from domestic dogs); others may be seen for the first time (e.g. Middle East Respiratory Syndrome in 2012) or appear in a new place. Exercises such as risk profiling and disease prioritization (see Chapter 5) can provide a starting point for public health systems to identify pathways for preparedness for both endemic and emerging diseases; systems can also be reinforced by integrating all-hazards planning. Information from a number of sectors also inform more robust risk assessment and management. Using environmental data for example, documenting wild species habitat range can help identify where high-risk species are and identify risk factors (and possible risk reduction practices or policies) that may facilitate disease spillover from animals to humans. Similarly, the environment sector may have critical information available on habitat suitability

for potential introduced species (e.g. invasive alien species) that could serve as disease vectors. Therefore, in the One Health Venn diagram, the environment sector circle may be prominent in certain facets of preparedness planning.

Cross-sectoral data integration and interpretation may provide more comprehensive risk and impact assessment findings. In addition to risk assessment, the animal health and environment sectors may help identify and report unusual morbidity and mortality events that could signal risk to humans. Their surveillance and laboratory capacity may also be a resource for the human health sector (and vice versa) in providing routine screening for sentinel detection, as well as surge support in health emergencies. On the risk management side, some measures will likely emphasize prevention in human populations (e.g. hospital sanitation, safe burials, reduced contacts with wildlife, and reducing unnecessary antimicrobial use in healthcare settings or improving medication compliance to reduce development of antimicrobial resistance, and border surveillance for human cases). At the same time, information from other sectors has utility for both prevention of and response to outbreaks. The experience gained from the implementation of the GPAI showed that established communication between the relevant sectors was critical to help swiftly identify and implement outbreak response measures, e.g. contain the movement of diseased animals and their products. Information from other sectors may also have utility for local land use and infrastructure planning to support preparedness. For example, the introduction of human settlements in extractive industry site may attract pest animals that pose disease risks to workers (e.g. Lassa fever). Anticipating risks early in the process can help build in risk mitigation, or at least identify needed capacity for effective response, into development projects.

4b. Bringing it all together

While these case studies differ from one another in many facets (see Annex for additional examples) — e.g. their objectives, causal agent, manifestation, risk factors, geographic spread, and in some cases their funders for management efforts — they all demonstrate possible opportunities and reinforce that there is no one set formula for operationalizing One Health. One Health in public health systems creates the space for assessing relevance of sectors and taking the appropriate actions for the specific context and objectives for optimal outcomes. This provides flexibility in operational efforts to adapt to specific country and disease contexts, allowing countries to select the tools and approaches most useful and pertinent for strengthening public health systems at the human-animal-environment interface. It should be recognized that relevant experts and stakeholders may vary widely based on given country and specific disease (e.g. public health and healthcare workers, ecologists, veterinarians, farmers, hunters, miners), but the foundational mechanisms for engaging the range of relevant stakeholders should be flexible enough for information sharing and coordination with other sectors. As shown in the next chapter, One Health approaches can be built into foundational building blocks to help prepare for diseases at the human-animal-environment interface, whether endemic, emerging or pandemic threats.

5. TECHNICAL GUIDANCE FOR OPERATIONALIZING ONE HEALTH

This chapter presents foundational building blocks to develop One Health interventions that may be implemented at varying levels of specificity (e.g. for a particular pathogen prioritized for preparedness) or broadness (e.g., any pathogens that could be present or introduced in a country). Countries may vary significantly in their baseline capacity, organizational design, infrastructure, risk profiles and experience with endemic, emerging and pandemic threats. Lessons learned from future country experiences will be used to build on and help refine this initial guidance.

Ideally, all steps along the prevent-detect-respond-recover spectrum should be considered when operationalizing a One Health approach. While avoiding excessive duplication, some degree of redundancy should be viewed as positive in endemic, epidemic and pandemic disease preparedness so that there are multiple critical control opportunities, especially as capacities so far are generally weak globally. Capacity building is integral for operationalizing and sustaining all foundational building blocks.

A step-wise approach with building blocks is proposed below (Table 5.1), though these may necessarily be applied at different stages. The scope of each stage is as follows:

1. Prevent (refers to the component to avoid the introduction of the disease);
2. Detect (those components that contribute to finding and identifying the disease);
3. Response (includes those components aiming to contain and control the disease);
4. Recover (those components needed to re-establish a disease-free status once the disease has been controlled).

Table 5.1: Building blocks along the prevent-detect-respond-recover spectrum

Domain	Stage			
	Prevent	Detect	Respond	Recover
i. Mapping of stakeholders, roles and responsibility	Assessment: IHR MEF (country self-assessment and JEE), OIE PVS, World Bank Health Security Financing Assessment Tool	Assessment: IHR MEF (country self-assessment and JEE), OIE PVS, World Bank Health Security Financing Assessment Tool	Assessment: IHR MEF (country self-assessment and JEE), OIE PVS, World Bank Health Security Financing Assessment Tool	Assessment: IHR MEF (country self-assessment and JEE), OIE PVS, World Bank Health Security Financing Assessment Tool
	Technical entities conducting research; sectoral and geographic distribution of active surveillance; risk assessment; health disaster risk reduction planning and implementation	Technical and non-technical entities contributing to passive surveillance (including private sector networks); distribution of laboratory services and results reporting channels	Technical and non-technical entities in public health and healthcare systems e.g. hospitals, government outbreak investigation teams, IGOs, civil society; NGOs and other groups (including private sector) impacted by disease event, contingency funders	Changes in mandates and chain of command Private sector role in resilience Resources for recovery
	Resources for mitigation and surveillance	Resources for laboratory services	Resources for outbreak investigation/control and treatment	

ii. Financial and Personnel Resources	<p>Routine funds</p> <p>Contingent funds: Enhanced resource allocation based on deficits identified in baseline assessments (e.g., JEE, OIE PVS, Health Security Financing Assessment Tool)</p> <p>Expertise: Entomology, wildlife disease, veterinary, pathogen/disease diagnostics, safeguard assessors</p> <p>Source of funds: Government budgets, research grants (e.g. pathogen discovery) and development projects (e.g. REDISSE)</p>	<p>Routine funds</p> <p>Case-based surveillance and laboratory investigation</p> <p>Expertise: human medical and public health (including Community Health Workers), pathogen/disease diagnostics</p> <p>Source of funds: Government budgets and development projects (e.g. REDISSE)</p>	<p>Contingent funds: Emergency resource mobilization for treatment, investigation, contain and control</p> <p>Surge capacity available and deployed (national, regional or international)</p> <p>Expertise: human medical and public health (including Community Health Workers), pathogen/disease diagnostics</p> <p>Source of funds: government emergency funds; Contingency Fund for Emergencies; Crisis Response Window; Pandemic Emergency Financing Facility</p> <p>Possible law enforcement or military deployment for order</p>	<p>Contingent funds: Enhanced resource allocation based on deficits identified in after-action review</p> <p>Source of funds: recovery financing, (e.g. Catastrophe Deferred Drawdown Option, CAT-DDO)</p>
--	---	--	---	--

<p>iii. Communication and Information</p>	<p>Access to information for risk assessment and mitigation: List of pathogens in country; list of known disease hosts and reservoirs in country; prior finding of exposure in country (e.g. antibodies to pathogen); risk forecasting e.g. weather data for climate-sensitive diseases</p> <p>Contacts established between ministries</p> <p>Chain of command for information reporting</p> <p>Population-specific and sensitive messaging (e.g. gender or cultural)</p>	<p>Chain of command for information reporting and verification</p> <p>Regional risk profile</p> <p>Population-specific and sensitive messaging (e.g. gender or cultural)</p>	<p>Chain of command for information reporting and action</p> <p>Pre-identification of risk factors likely to facilitate spread; multi-sectoral awareness of relevant risk and response protocols</p> <p>Ongoing coordination among authorities and between relevant ministries, affected sectors, logistical players (e.g. medical supply chain, treatment centers, vaccine producers, security), the media, and the public</p> <p>Population-specific and sensitive messaging (e.g. gender or cultural)</p>	<p>Multisectoral resilience planning and prioritization</p> <p>After-action review and refinement of communication/information dissemination strategies</p> <p>Population-specific and sensitive messaging (e.g. gender or cultural)</p>
--	---	--	--	--

iv. Technical Infrastructure	<p>National, regional or international access to laboratory diagnostics (known and novel)</p> <p>Sentinel surveillance in animals (wild or domestic) or vectors and investigation</p> <p>Hazard identification and risk mitigation</p> <p>Risk mitigation at points of entry</p> <p>Identification of vulnerable populations (heightened risk and/or disproportionate impact from risk management options)</p>	<p>National access to laboratory diagnostics (known pathogens and toxicology); confirmatory analysis at reference laboratory, if needed</p> <p>Disease prioritization</p> <p>Detection at point of entry</p> <p>Identification of vulnerable populations</p>	<p>Risk management for disease control, including via contact tracing, awareness campaigns, etc.</p> <p>Medical treatment, where relevant</p> <p>Control at point of entry</p> <p>Containment to reduce potential for cross-border spread</p> <p>Identification of vulnerable populations</p>	<p>Health systems strengthening (general)</p> <p>Risk mitigation measures, e.g. universal vaccination campaigns</p> <p>Climate-smart and other resilient healthcare infrastructure</p> <p>Risk assessment refinement (e.g. with new epidemiological analyses)</p> <p>Continued medical treatment provision, where relevant</p> <p>Biosafety (facility and personnel)</p> <p>Identification of vulnerable populations</p>
-------------------------------------	--	--	---	--

v. Governance	<p>Legally-mandated reporting to national authorities to inform risk analysis (e.g., prior to publication)</p> <p>No gaps in relevant authority (e.g. coverage of human, domestic animal and wildlife health)</p> <p>Disease risk included in environmental and social impact assessment, and risk mitigation built into high-risk practices (e.g. safeguards in land use planning)</p> <p>Economic evaluation of risk management options</p>	<p>Initial reporting to national and international authorities (e.g. per the IHR and OIE reporting requirements)</p>	<p>Outbreak update reporting to national and international authorities (e.g. per the IHR and OIE reporting requirements)</p> <p>Risk adaptation (e.g. change in regulations, forced quarantine, etc.)</p> <p>Economic evaluation of risk management options</p>	<p>Demonstration of disease-free status</p> <p>Biosafety regulations (e.g. laboratory standards and certifications)</p> <p>Economic evaluation of risk management options</p>
----------------------	---	--	---	---

The following section provides further detail on the above-mentioned building blocks. While presented separately in distinct stages, effective interventions rely on the individual pieces coming together to support dynamic public health systems in practice, with strong connections within and between the systems, providing continuous feedback loops for optimal functioning (for example, findings obtained during outbreak investigations in the response phase may directly inform risk assessment and management to guide prevention efforts).

5a. Mapping of stakeholders, Roles and Responsibility

While intersecting with (or inherent in) several of the following building blocks, stakeholder mapping is an essential first step in ensuring coordination with relevant parties and resources, and in identifying gaps and building synergies for a public health system to be prepared for pandemic and epidemic threats. There are varying approaches and levels of detail for stakeholder, network and system mapping (see Chapter 3 regarding use in national arrangements for One Health and Annex 5 for specific tools), but the key objective is that they provide an orientation to roles and responsibilities, as well showcase the flow of decisions and their relevant resource flows (i.e. where money is held and how it is mobilized according to need, which may include a different sector). One Health coordination mechanisms in place can be elucidated here. At the same time, they may indicate where there may be beneficial sharing of information and/or resources (such as expanding existing laboratory capacity to facilitate human and agricultural health partners to work together and maximize shared resources instead of developing separate facilities). They have may utility for addressing specific priority diseases, informing risk assessment, as well as examining capacity and planning for hypothetical scenarios (e.g. as part of simulation exercises):

- *Stakeholder* analysis identifies groups or individuals that may impact or be impacted by a decision, bringing their perspectives and values to the table. It may help in assessing types of mechanisms in place (or lacking) for routine, ad hoc, and emergency communication and mandates. For example, stakeholder analysis informs communication strategy and messaging; communication goals for stakeholder engagement may differ based on level of hazard and emotion of affected stakeholders (e.g. times of crisis versus precautionary communication) (see OIE 2015). Multi-sectoral partnerships identified or formed in the process of National Action Planning for Health Security may be a useful input for stakeholder mapping, and vice versa²⁹; country capacity evaluations may also inform on relevant entities and coordination.
- *System* mapping (i.e., describing a system, typically visually through a flow map, for a given disease, risk factor or geographic unit) examines how components (including stakeholders) interact. It may also showcase areas of knowledge gaps, and/or inform critical control points to reduce risk.

While operational emphasis is primarily placed on national or local level in the context of this Framework, coordination with regional stakeholders is also relevant for One Health. In addition to transboundary disease prevention, detection and control (via risk profiling), regional support can include resource access and sharing (e.g. laboratories, personnel training). While human, animal and environmental health sectors are emphasized under One Health, other sectors also may be relevant at national level for effective operations. Within the World Bank, for example, collaboration could benefit from collaboration across global practices (GPs) (e.g. to consider broader aspects of alternative policies and potential effects on social inclusion, resilience, gender mainstreaming, education and other areas) with involvement of economists, water, sanitation and hygiene (WASH) programs, IFC (private sector), and disaster risk management.

5b. Financial and Personnel Resources

Preparedness for known and novel diseases, as well as other public health functions, relies on sufficient human and financial resources. The outcomes of strategic assessments (e.g. the JEE for the WHO International Health Regulations Monitoring and Evaluation Framework, OIE PVS, World Bank Health Security Financing Assessment Tool, Capacity Assessment for Environmental Health Services) can help inform existing capacity needs to guide financing and staffing.

Potential surge capacity needs should be assessed (e.g. in the case of equipment failure, temporary loss of personnel, in emergency situations, etc.). The financing mapping provided by the World Bank Health Security Financing Assessment Tool assesses funding sources, flow of spending, funding levels, and fund recipients, with the first section of the assessment conducting a stakeholder mapping exercise, determining key players in health security in a country along with governance and coordination mechanisms (see Box 5.1). Findings can help inform the role of financing, system operations, and coordination on health security to outline the way forward for countries to strengthen their efforts to prevent, detect, respond and recover from disease threats. While filling gaps may require upfront investments, economic effectiveness (e.g., reduced burden of endemic disease on health and livelihoods, avoided cost of environmental degradation, avoided costs of pandemics) should be considered, particularly in

Box 5.1 Health Security Financing Assessment Tool (HFSAT)

Structure

- *Health security organization and institutional arrangements*
- *Country macro-fiscal context*
- *Health security budgeting and resource allocation*
- *Financing for health security components (JEE-specific action packages)*
- *Efficiency and suitability of health security financing*

²⁹ See <https://extranet.who.int/spp/country-planning>

prevention and recovery investments (see Chapter 2). The HSFAT (Box 5.1) is intended to be repeated periodically to help monitor the development of sustainable health security financing over time.

Appropriate staffing composition may vary by factors such as country size and particular risks. Routine (recurrent) costs to cover ongoing operations (during “peace-time”) should be provided in annual budgets, including supplies and services for maintaining surveillance capacity and skills (e.g., vehicles, fuel, laboratory reagents); when costs are compiled for each disease or department, costs may be prohibitive, but resources for systems-level operational capacity may help promote efficient use of resources (e.g., laboratories shared by ministries) (see Table 5.2, as well as Chapter 2 on value added from One Health). Mechanisms should also be established proactively to enable access to contingent (e.g., emergency or investment) funds. For the latter, there may be several different funding mechanisms (country and external donors), some with triggers for resource mobilization. Response (or contingency) financing should include compensation arrangements to farmers for animals culled (when relevant), personnel resources needed to carry out rapid slaughtering and carcasses disposal, and other measures to promote disease containment. Investment financing may proactively build system capacity; Regional Disease Surveillance System Enhancement (REDISSE)³⁰ is an example of a World Bank program oriented to strengthening human and animal disease surveillance and preparedness. Investments in other sectors may also be highly relevant to preparedness (e.g. access to reliable electricity helps enable dependable laboratory functioning).

In addition to government entities, external institutions (e.g. private sector and non-profit) can have a critical role in operations and partnerships. In particular, networks of private practitioners (human health and veterinary professionals notably) can provide valuable surveillance capacity. Facilitating the establishment of such networks could be an excellent way of operationalizing the One Health concept, while saving resources in the long term, as those practitioners will be on the front line for early detection of threats, while providing most of the costs by themselves (vehicles, fuel, small equipment and material, etc.) and reducing the need for the governments to post permanent civil servants in these areas. Similarly, research has often been a leading force in cross-sectoral collaborations. Investment in surveillance and laboratories activities may be linked to research activities, and inter-sectoral dialogue and prioritization exercise/joint areas for action may drive new research.

Table 5.2: Examples of cost items for field and laboratory operations; many can potentially be shared across programs (for multiple disease) and/or sectors, promoting efficient resource use.

Items	Human Disease	Livestock Disease	Wildlife/Environment Disease
Field Operations	Lodging/housing; Vehicle/fuel; Sampling supplies; Disinfectants; Cold chain; Personal protective equipment; Data recording/ Database		
		Taxon-specific sampling equipment	Taxon-specific sampling equipment (e.g. mist nets for bats, rodent traps)
Diagnostic/Laboratory Operations	Infrastructure (e.g. freezer, electricity); Lab equipment (PCR machine, Pipettes, Reagents, etc); Cleaning supplies (anti-contamination); Personal protective equipment; Bio-waste management		

³⁰ REDISSE: <http://projects.worldbank.org/P154807?lang=en>

	Zoonotic pathogen diagnostic tests		
		Non-zoonotic pathogen tests (e.g. FMD)	
	Disease-specific assays (e.g. HIV, measles)	Disease-specific assays (e.g. Schmallenberg)	Disease-specific assays (e.g. White Nose Syndrome)
	Toxicological assays		

5c. Communication and Information

The importance of coordinated communication and information dissemination in risk analysis and risk management cannot be understated; indeed, it offers a key potential area for added value from One Health approaches.³¹ While human health authorities are directly suited to detect disease in humans, other authorities may be beneficial partners in disease prevention, sentinel detection and response. For example, wildlife authorities (such as park rangers or law enforcement officials managing protected species confiscations in market, ports or other settings) may be on the front lines for detection of wildlife morbidity and mortality events that may have sentinel value for human health. Communication and data-sharing mechanisms to notify public health authorities could help document patterns of wildlife and livestock disease that signal risks for human health. Also beneficial are simulation exercises allowing for implementation of measures to pre-empt human cases. Similarly, the commerce ministry may be a key partner in tracking flow of products entering the supply chain to prevent further dissemination of a contaminated product, and there may be opportunities for implementing screening and control measures at points of entry with the travel sector (among many other possible collaborations). **Incorrect information may have inadvertent economic (e.g. trade or travel impacts), environmental (e.g. culling), social (e.g. stigma) or other consequences that can potentially worsen the situation. Thus, effective messaging must be in place for accurate, transparent and coordinated information flow to the public, ensuring credibility to counter potential misinformation. In some cases, full information about the risk is not known initially and assumptions may be incorrect; it may be important to highlight uncertainty.**

The importance of having disease information systems that could contribute to share real time, and suitable, information among the different stakeholders across stages should be emphasized. Regular meetings between ministries are also important during the “detection” stage for coordinated messaging across entities, including ministries. Communication strategy planning and testing may be built into training and simulation exercises. After-action reviews also offer an opportunity to assess communication strategies, taking stock of lessons learned and refining plans for future events. Crucially, there must be sustained resources to support effective communications.

Communication strategies should take into account stakeholder analysis findings, ensuring bi-directional communication pathways with stakeholders to optimize efficacy and efficiency of messaging and promote feasibility and success of risk management approaches. The media is often a key stakeholder, and proactive coordination with media outlets may be important to avoid unwarranted public fear (see National Academy of Medicine 2017 for additional information on lessons learned and recommended

31 Communication itself was identified as a pillar of One Health in GPAI, structured around public awareness and information; for examples of country strategies developed under the program, see: <http://documents.worldbank.org/curated/en/527421468329073537/pdf/940430WPOBox385430B0GPAI0Final00PUBLIC0.pdf>

approaches). Certain populations may have heightened risk (e.g. based on occupation, socio-economics, etc.) In addition, information — as well as its delivery — should be gender- and culturally sensitive and specific to ensure it reaches those who need it and is effectively received.

5d. Technical Infrastructure

One Health approaches can optimize infrastructure for disease prevention, detection, response and recovery through core services in public health including disease risk analysis, surveillance, prioritization, outbreak investigation and response, and control and containment. Recovery efforts, too, should be designed with these components in mind to promote sustainable capacity for future risk management and/or reduction. The following sections review One Health aspects that should be included when designing and maintaining these activities. Specific tools (e.g. those presented in Chapter 3 and Annex 5) can help countries strengthen these dimensions of their public health systems, particularly to better aim at upstream disease prevention and risk mitigation (for example, including health outcomes in environmental impact assessment to inform land use planning).

Risk analysis

One Health can facilitate a risk-based approach. This advances the prevailing approach in current public health systems, which often reacts to impacts (seen now), versus risks (in the future). Better understanding and anticipating risk — whether existing or emerging — can help build in risk mitigation options to reduce reliance on resource-intensive response. Risk analysis³² can be applied to any range of possible hazards. For pandemic preparedness, the scope is infectious diseases with high spread potential in a human population. Risk analysis can be useful at several different stages of an outbreak depending on exposure routes, potential for an outbreak crossing state or country borders, changes in pathogen virulence over time, etc. Context can be more specific as it gets to sub-national level (i.e. state or community). Multiple agencies and/or sectors/stakeholders should be involved in conducting a robust risk analysis to account for likelihood and impact of a given risk, factors that shape the risk, and management options.

Risk analysis should take into account the drivers of disease emergence (typically practices that allow for pathogens to “jump” from one species to another, enabled through contact and potentially boosted by genetic selection pressures or “amplification” in an intermediate species that allows for more efficient spread to humans) and human-human or vector-borne spread (e.g., urbanization, medical/public health system breakdown). It can inform and be refined by targeted surveillance efforts.

Level of risk depends on mitigation practices employed, e.g. hand washing with soap, PPE use, safe handling/butchering, vaccination, high risk avoidance (e.g. avoidance of certain species), adequate heating of meat, etc. Risk management practices can be implemented to reduce risks. These could include regulations (e.g., prohibited import of certain species, market sanitation requirements, distance required between orchards and livestock, and other biosecurity policies), changes in individual behavior (e.g. hand washing, boiling water), or changes in business or industrial practices. These management strategies should account for cultural, gender, occupational or other factors that may affect acceptability of decisions. Reinforcing the dynamic interactions and feedback loops inherent in preparedness along the prevent-detect-respond-recover spectrum, risk assessment should be routinely reviewed and updated as needed (for example, to account for increasing trade and travel connectivity between rural and urban settings and how this may change disease risk). Coordination structures may build in monitoring

³² Several risk analysis frameworks are available; see resources section at end of chapter for suggested references.

indicators or triggers for changes in assumptions about risk that signal the need to revisit steps in the risk analysis process (whether in risk profiling, stakeholder engagement, or management activities).

Risk analysis for pandemic threats in a given country should include factors such as:

- Country-level drivers of disease emergence, introduction and spread
- Environmental data – e.g. climate/weather monitoring³³, species range
- Prior reports of pathogens (or antibodies suggestive of pathogen exposure) or illness in the country and/or region
- Socio-economic, cultural and occupational practices that may shape risk
- Possible public health and/or animal health interventions and adaptation measures, taking into account feasibility and acceptability
- Access to medical facilities and availability/absence (and efficacy) of treatment

Resources such as the WHO’s Strategic Tool for Assessing Health Risks (STAR) can also help countries identify and prioritize hazards to support health emergency planning, and targeted guidance is available for risk assessment and management on a range of One Health-relevant topics (e.g. for risk of disease introduction via agricultural imports) (see Annex 5 for additional examples). Scenario planning can also build on risk factors identified to identify country- or locally specific vulnerabilities and help shape pragmatic preparedness plans that address multiple hazards. High-risk interfaces should be identified for both emergence and spread of disease in a country (spanning from areas of land use change to points of entry); mapping of areas of elevated risk along with capacity/infrastructure can help identify vulnerabilities as well as target mitigation measures (see Figure 5.1 for example).

Box 5.2 Lessons from recent disease emergence and spread can inform hazard identification and risk profiling. For example: What unique cultural, societal, religious, economic or other practices could facilitate human-to-human spread, such as “hospital shopping” (e.g. MERS in Korea in 2015) or burial practices (Ebola in West Africa)?

Surveillance

Public health surveillance is defined as “ongoing, systematic collection, analysis and interpretation of health-related data essential to planning, implementation and evaluation of public health practice.”³⁴ Public health surveillance systems should be equipped to tackle a range of objectives for surveillance, including: i) emerging, re-emerging and epidemic-prone pathogens; ii) monitoring endemic diseases and their control, including sentinel surveillance for drug (e.g. AMR) and insecticide resistance; and iii) disease elimination including documentation. Relevant data includes information to target surveillance, specimen collection, and diagnostic screening for a given set of disease agents (certain pathogens or toxins) or proxies (e.g., antimicrobial residues). Many countries routinely conduct surveillance, with particular objectives on healthcare settings and in meeting reporting obligations for international agricultural trade or food safety (e.g. under the OIE Terrestrial or Aquatic Code or the FAO-WHO Codex Alimentarius). In general, surveillance is typically oriented to specific disease(s) or symptoms. Surveillance remains crucial for outbreak investigation and management (e.g. in contact tracing) and demonstrating freedom of disease. Surveillance may target early detection of potential hazards —

³³ Certain diseases are known to be sensitive to climate changes; therefore, there are interventions that can be taken using climate data for forecasting and to address upstream climate-associated drivers of disease.

³⁴ Definition from WHO (http://www.who.int/immunization/monitoring_surveillance/burden/vpd/en/)

including via animal or environmental indicators (e.g. the USAID Emerging Pandemic Threats PREDICT project) — or document prevalence of known diseases.

Box 5.3 Example: Sentinel Monitoring in Non-Human Primates

Passive surveillance has been utilized to monitor risk of several highly pathogenic zoonotic diseases. For example, dead howler monkeys were detected outside of a wildlife sanctuary in Bolivia, leading to rapid screening and detection of a flavivirus later determined to be Yellow Fever virus. In response, public health action was taken, with human vaccination and awareness campaigns launched rapidly to prevent potential human cases. In Gabon and the Republic of Congo, chimpanzees and gorillas have suffered declines due to Ebola virus prior to human cases, with some human outbreaks linked to hunting, butchering or consumption of infected carcasses. Detection of wildlife morbidity and mortality events may indicate disease risk to humans. Active surveillance may detect pathogens in apparently healthy animals, including natural reservoirs, helping to inform risk assessment and target high-risk practices that could potentially facilitate spillover of high-consequence pathogens.

A key application of One Health is strengthening surveillance systems at the human-animal-environment interface to facilitate improved understanding, detection and risk management at this interface. Whereas surveillance capacities are at least well defined for the human and domestic animal (via agriculture or veterinary services) health sectors, surveillance capacities and operations in the environment (including wildlife) domain generally are limited to date, representing a key area for expansion at national level.

Detection is a critical piece of surveillance, all the way from targeting sample collection site to laboratory diagnostic and interpretation to information sharing and changing prevention and response strategies. Planning should include the logistical factors to promote successful surveillance, such as via proper cold chain maintenance, safe sampling practices, biosafety measures for movement of diagnostic specimens, access to laboratories, and communications.

Health systems should be sensitive enough to differentiate between:

- known and novel pathogens
- toxicological versus infectious agents, especially because initial symptoms may be similar
- accidental versus deliberate release of biothreats in a susceptible population,³⁵ i.e., by having a sufficient baseline established.

Some foundational capacity may assist in detection capabilities. For example, existing arbovirus surveillance capacity (e.g. entomological expertise, trapping and storage systems) may be readily expanded to screen for additional pathogens or vectors. Countries without current laboratory capacity for pathogen screening (including known and novel pathogens) should establish access to international reference laboratories that can conduct confirmatory testing (even if there is capacity in government or research laboratories, additional partnerships enable surge support).

³⁵ Definition of biothreats applies to pathogens or toxins per http://www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/A_Biological_Threat_Reduction_Strategy_jan2012.pdf

Prioritization

Given finite resources, countries may want to consider defining priority diseases for multi-sectoral collaboration to help target investments for measurable outcomes. The CDC's One Health Zoonotic Disease Prioritization tool, for example, provides a process for bringing together multi-sectoral partners in a country representing human, animal and environmental health (typically implemented through a workshop process leading to a list of the top five priority pathogens — whether emerging or endemic — for a country broadly based on a set of locally appropriate criteria determined by attendees) (see Box 5.4).³⁶ Prioritization provides a useful starting point for targeting resources and building capacity to address the top zoonotic disease concerns for a country, which can help it be better prepared to respond to new risks (e.g. novel diseases that could emerge in the future). This process also allows multi-sectoral partners to capitalize on the prioritization process and have discussions about next steps for the newly prioritized zoonoses in terms of identifying areas for multi-sectoral engagement in building capacity and developing control and prevention strategies. Ebola in West Africa, SARS-CoV, MERS-CoV, and H7N9 are just a few examples of the viruses that were previously unknown in a region or globally before their recent emergence. While prioritization can help address existing diseases that threaten public health, countries must also have prevention and preparedness strategies against the threat of emerging diseases.

Box 5.4 One Health Zoonotic Disease Prioritization in Cameroon

Using a semi-quantitative tool (see Rist et al. 2014), a list of zoonoses specific to Cameroon was generated, with ranking criteria established: 1) The state of the disease in humans, domestic animals, wildlife or environment in Cameroon; 2) Mortality, morbidity, and disability in humans; 3) The potential to spread rapidly amongst animals and humans; 4) Economic, environmental, and social impacts; and 5) Capacity for detection, prevention, and control of the zoonoses in the country. Through this process, Rabies, Anthrax, Avian Influenza, Ebola Virus Disease, Marburg Hemorrhagic Fever and Bovine tuberculosis were selected as priority diseases.

Outbreak investigation and response

Outbreak investigation and response typically involves a mix of surveillance, communication, medical treatment, and depending on the extent of the outbreak and its prioritization, surge in personnel, logistics, and financial resource needs (general guidelines are well established, e.g. development of a case definition, hypothesis testing, etc.) Contact tracing can be employed to track and contain the spread of the disease. While containment (see below) should be the key focus of outbreak investigation, epidemiological investigation and trace-back to the index case (first known case) will ideally determine the initial source of introduction or spillover; this information also may help identify a source of potential future outbreaks.

In addition to surveillance during outbreak investigation, the use of extended epidemiological analyses (identifying determinants, time-space distributions, etc.) has strong value together with outbreak investigation. In particular, these may elucidate transmission cycles, as well as identify patterns to inform on natural prevalence and circulation — ultimately informing targeting prevention and control measures.

³⁶ See <https://www.cdc.gov/onehealth/pdfs/zoonotic-disease-prioritization-workshop.pdf>

Control and containment

Appropriate control and containment measures are highly dependent on the disease. Personnel should be trained and equipped with safe practices (e.g. personal protective equipment). Police or military deployment may be called on to assist in health disaster response (e.g. for screening checkpoints at borders, deploying relief resources, engineering treatment centers). Some approaches may be counterproductive in outbreak control; as part of risk analysis and risk management processes, ongoing risk communication to relevant stakeholders (typically including the media) should promote the flow of science-based information and be aware of possible negative consequences (e.g. stigma, hesitancy to report possible cases for fear of forced quarantine or admonishment of valued cultural practices, etc.) Where relevant for transmission cycle or impact of control options, animal health and environment sector should be consulted, with possible impact to these and other sectors factored into control decisions (e.g. regarding consistency with international trade standards, risk of ecosystem degradation, etc).

Public health services should identify key institutions and/or leaders in communities, and ideally have proactive discussions about risk and appropriate response in the case of an outbreak. Community health workers can be a key source of this information and may be trusted in the community; they may have a critical role in contact tracing and disease control during an outbreak. Stakeholder analysis can elucidate key groups prospectively or during emergencies, and should be accompanied by (or include) infrastructure and risk mapping. Given concerns over international spread of disease, points of entry and exit should be defined and incorporated into disease surveillance and control planning, considering the potential introduction of pathogens via both people and animals (domestic, agricultural or wild).

Holistic Approach to Recovery

Effective recovery entails strengthening capacity to address future disease threats (i.e., “building back better”), but can be greatly aided or weakened by response measures in many sectors. For example, policies for livestock compensation may affect spread of animal diseases, and certain responses aimed at disease control may have long-term effects on ecosystems. On the health systems side, investing in training and infrastructure that can be sustained and advanced in the recovery phase will help in continuity. Recovery for other disasters may also create new public health risks. Investments in recovery should consider potential consequences over the long term — positive and negative — for current and future health risks and ability to prepare for health threats, with risk mitigation measures built in. For example, establishing new livestock systems should include built-in biosecurity measures and minimize burden to the ecosystem. These One Health considerations complement detailed operational guidance for post-disaster health sector recovery, from policy, planning, financial and implementation activities (GFDRR 2017), together offering opportunities for progress toward the 17 Sustainable Development Goals (Figure 1.7) and an all-hazards approach under the Sendai Framework for Disaster Risk Reduction.

5e. Governance

Regulations and other policies are important components of a country’s prevention, detection, emergency response and recovery plans. A country may face competing stakeholder interests, such as promoting accountability, transparency, and risk-informed decision-making. Governance structures could cover, at a minimum:

- Establishing designated legal mandate and chain of command for disease risk analysis and response. While multiple sectors are integral to reducing risk and promoting effective response to health disasters, designated authority can help promote coordination and safe, effective practices;
- Meeting obligations to national, regional or international reporting structures, such as the International Health Regulations, World Organisation for Animal Health, and National Biodiversity

Strategies and Action Plans. As international researchers may be working in a country and may generate findings relevant for risk analysis, it is crucial that their findings be accessible to government authorities. Legal mandates for reporting to relevant government authorities should be established and reinforced as part of permitting, ethics and publishing processes. This should be maintained for research in “peace-time” as well as in emergency situations;

- Regulatory protocols for movement of genetic material to ensure timely diagnostics, while also maintaining consistency with access and benefits sharing under the Nagoya Protocol;
- Biosafety standards and certifications support (including proper safeguards in facilities storing or working with dangerous pathogens, e.g. Biosafety Level 2-4 laboratories);
- Proper waste management for biohazards;
- Inclusion of disease risk in environmental and social impact assessment and land use planning;
- Risk reduction policies (e.g. meat inspection, prohibited hunting and sale of specific high-risk species) such as ecosystem-based approaches to adaptation and mitigation;
- Economic evaluation of risk management options (see Chapter 2), including consideration of potential externalities of development decisions and disproportionate impact on vulnerable populations to promote cost-effective and equitable decision making
- In line with climate-smart and other resiliency planning, avoiding placement of medical treatment and laboratory facilities in areas with elevated vulnerability to service disruptions (e.g. prone to flooding).

Box 5.5 Gender in One Health

Gender (contributing to overall equity) is an important cross-cutting dimension of operationalizing One Health that can help optimize its added value. This document provides selected examples of many possible gender-specific considerations. For example, addressing gender-specific risks and dynamics can promote maternal and child health (Chapter 1), reduce disease impacts (Chapter 4), and ensure that risk mitigation and communication efforts reach populations with elevated risk (Chapters 5-6). Gender analysis for emerging zoonotic disease highlights differences in exposure, division of labor, and resources and decisions. For example, through their occupational or household roles, women may be responsible for family farming or food preparation that can result in exposures, and less agricultural extension support may be available for smallholder compared to commercial farming. Ownership and decision-making power (such as over animal vaccination) and compensation for animal sale or loss may be unequal for men and women (WHO 2011). There also may be gender-specific biological risks; for example, women may be more susceptible to infection with malaria during pregnancy, and may face other risk factors including compromised immunity from comorbidities. Social structures may affect access to information by males and females, so risk communication must be delivered in a way that reaches those who need it. Gender balance and equality in the workforce and in other settings is critical for increasing awareness and gender-sensitive actions, and should be an overall project goal (the REDISSE project includes an indicator on “the percentage of women benefiting from the project's overall activities and from activities specifically addressing their needs whenever possible”). Gender-disaggregated data on risk and intervention acceptability and impact should be included as a key input for effective risk assessment and management — whether assessing a single hazard, designing a country adaptation plan, or planning communications campaigns.

5f. Other relevant aspects to consider

Vulnerable populations

Certain populations may have disproportionate exposure to disease risks, whether from initial spillover or spread.³⁷ These may include factors such as occupation, cultural or religious affiliation, socioeconomic status, health status, or gender. For example, women may serve in care-taking roles (as a formal profession or informally, e.g. familial) that put them into close contact with infected patients; farm and abattoir workers or veterinarians may be in direct contact with sick livestock, and extractive industry workers may come into close contact with wildlife or its urine/feces in caves. Fragility, conflict and violence can exacerbate risk and impact. Migrants new to an area may be immunologically naïve to endemic diseases and may potentially introduce diseases; and refugee or internally displaced populations may have high population density with limited infrastructure, leaving them vulnerable to disease exposure. Factors such as lack of access to sanitation, hygiene, housing and health services may also affect prevalence, contributing to perpetuation of poverty in some populations (e.g. as seen with neglected tropical diseases). Planning should be inclusive of these populations where risks may be heightened.

Redundancy

One Health approaches may offer multi-sector efficiency benefits; at the same time, the collaboration and coordination of multiple sectors may help build in positive redundancy to reinforce public health system preparedness capacity for all hazards in peacetime and during emergencies. For example, human and animal health laboratory teams may help provide surge capacity for one another. At the same time, country and regional/international coordination can be highly useful — as seen with reference laboratories for quality control as part of training initiatives or to rule out contamination or cross-reactivity that could provide false positives or negatives, and/or the incorrect differential diagnosis. In some cases, it may be warranted to take rapid action on suspicion of a serious disease where the consequences could otherwise be dire (e.g., viral hemorrhagic fever that spreads rapidly, including in healthcare settings); in others, it may be acceptable to seek more thorough testing before mobilizing a full response (e.g. mild symptoms with low/no fatality, indications of limited spread potential). Opportunities for capacity reinforcement can be informed by stakeholder analysis/mapping processes.

Co-benefits

Strengthening capacity at any of the prevent-detect-respond-recover steps can support improved ability to also address other health threats, such as antimicrobial resistance, chemical exposures and endemic diseases. There may be multiple benefits to society beyond public health (e.g. avoided damages for agricultural production, tourism, trade and travel).

Planning for Replication and Expansion of the Benefits of One Health approaches

When successful strategies advance a community or country's capability to prevent, detect, respond to and recover from disease threats, the World Bank is in a position to gather good practices and offer

³⁷ See, for example, “categories of populations vulnerable to the health impacts of climate change” <http://www.who.int/globalchange/publications/vulnerability-adaptation/en/>

guidance to help transfer them to other settings. This is a critical measure to optimize investment gains, both in terms of predicting what will or will not work and adapting strategies as needed to promote success in other settings. Without upscaling, there may be effective interventions widely available, but still poor implementation or outcomes persisting in many countries (for example, rabies and brucellosis remain human and animal health challenges despite known disease control strategies).

While the ultimate goal is systems-level operationalization where One Health is fully embedded in work flows and decision-making and robust enough to respond to all hazards, applying One Health to specific diseases may provide a meaningful step in the process, helping to nurture collaborations across sectors, develop mechanisms for information and resource sharing, and show value for specific disease outcomes. However, even such disease-specific collaborations “in peacetime” (e.g., for addressing known endemic, rather than emerging, diseases) may provide a useful premise for responding to emerging or evolving threats. Existing surveillance, diagnostic and communications capacity established from addressing one disease may translate to addressing others. One prime example is vector-borne disease surveillance, where utilizing platforms for a known disease in region (e.g., West Nile virus, malaria) may be mobilized to survey for novel infections circulating (e.g., Zika virus), or at least inform on the distribution of species and population abundance as a proxy for possible circulation. Efficiencies may also be possible diagnostically (e.g., panels employed for Ebola detection that also screen for other causes of febrile illness).

In the context of human health, such gains are well recognized; for example, Nigeria’s success in mobilizing polio eradication campaigns assisted in its extremely effective control of Ebola virus when introduced via an infected passenger. The challenge, of course, remains to build in other sectors. But such examples, too, are not unprecedented,³⁸ as seen with DRC’s response to its Ebola outbreak in 2014: a concurrent, unrelated event as the intensity of the West Africa event was being realized, with the initial transmission event traced back to the zoonotic origin (handling of an infected monkey for human consumption) and diagnostic capacity infrastructure helping to mobilize rapid detection, investigation and containment. Looking even more upstream at prevention of spillover, Bolivia’s experience with its first detection of Yellow Fever virus in howler monkeys in the country, in which staff with One Health training at a wildlife sanctuary detected and reported the presence of six monkey carcasses, leading to rapid specimen collection and investigation and risk communication. An initial diagnosis was made rapidly, and prevention measures, including human vaccination, vector control and media campaigns on risk avoidance were implemented within eight days of the reporting of the carcasses, and no human cases were associated with the outbreak. Many partners — from the wildlife sanctuary staff, to surveillance teams, to government, intergovernmental and university partners, had a role in the response. Coordination networks may be valuable in novel diseases with unknown zoonotic potential — as seen with the 2011 emergence of Schmallenberg virus in several European countries, in which human and animal health authorities from the European Commission developed coordinated case definitions.³⁹ Existing platforms can employ training drills for known and unknown threats, helping to foster preparedness capacity for multi-hazard or all-hazards events.

Upscaling potential is envisioned on a country level, but may also happen on an individual (e.g. farm) level, if resources saved from reduction of economic burden of one disease are reinvested to address

³⁸ “One Health in Action”: http://www.ecohealthalliance.org/wp-content/uploads/2016/10/One-Health-in-Action-Case-Study-Booklet_24-October-2016.pdf

³⁹ “Schmallenberg virus- Guidance Document on the Priority Actions to be Undertaken in the EU in the Next Months” https://ec.europa.eu/food/sites/food/files/animals/docs/ad_control-measures_ssmall_20120207_wrkng-doc.pdf

others, or if practices employed to address specific diseases in turn automatically address others (e.g. via improvements in biosecurity, greater recognition and attention to disease risk factors).

As One Health is operationalized, additional examples of such efficiencies will likely be demonstrated; their compilation and analysis can inform the value proposition for One Health as a tenant of good practice in development aide for strengthening public health systems at the human-animal-environment interface.

6. OTHER OPERATIONAL COMPONENTS

6a. Institutional and Technical Implementation

Overview

This section illustrates what implementation of a country One Health project would be expected to look like in general (whether World Bank or other donor-financed). In creating a One Health project or effort, institutional and implementation arrangements will vary from country to country. Each will need to adapt arrangements to their specific situation based on risk profile, existing structures, related policies, past experience, and identification of human, animal, and environmental health factors. Most projects will be executed by at least two ministries (though ideally the three responsible for human and animal health and environment at a minimum), under an inter-ministerial framework for strategy, policy, advocacy and project management. One ministry will likely be designated responsible for overall implementation and reporting. Each ministry will be given the responsibility to undertake specified activities in line with their formal portfolio functions, recognizing that such assignments may be modified as a government reviews and revises how it delegates, budgets and integrates new activities and local government authorities in the provision of services. While implemented directly through national arrangements, external arrangements may also help support project success.

National arrangements

Different ministries within countries are of course responsible for different needs. Typically, these exist according to conventional disciplinary silos — environment, health, agriculture, finance, etc. The approach advocated for in this document requires the linking up of these different ministries to address their shared needs. This is not a new concept; there is precedent in ministerial cooperation for many important health-related issues: disasters, pollution, food supply and many others.

The challenge is not in identifying that there is a need, but in operationalizing shared ownership to drive added value. An additional challenge is improving understanding of how and why these health issues should be addressed collectively, given historical approaches. Some countries have led the way on this, e.g. many already have veterinarians within health ministries and public health specialists in agriculture departments. There are, however, many other avenues to improve this integration and align government stakeholders, including through internal and external leadership and collaboration.

Internal working arrangements must be articulated and put in place for One Health initiatives to take hold to ensure their oversight, guarantee connections are fostered at an early stage, and promote sustainable coordination mechanisms. There may be existing collaborations to leverage toward this goal, and similarly, achievements in this realm may also benefit other internal programs; for example, as climate animal-human health work is inherently inter-sectoral and multi-regional, transecting GPs, CCSAs and Bank regions, it is imperative to establish this structure up front to maximize input, review and effective project development. Countries will differ but to effectively coordinate strategy, policy and implementation undertaken by the public sector and by private actors engaged in human-animal-environment health and management, a high level Inter-Ministerial Committee (IMC) or its equivalent will be needed to provide oversight of cross-sectoral technical and policy collaboration. It should have the active participation of the Ministry of Finance. Planning and stakeholder engagement should also take into account and include the active external participants such as non-governmental donors and technical assistance providers, UN and regional organizations, the private sector, institutes and academic institutions. These may be major funders, technical experts and data/information, or service delivery providers.

Crucially, a One Health approach should not be understood as conducting all activities together at all time. As the REDISSE project demonstrates, rather than the execution of programs together, One Health can be used for cross-evaluation of public health system needs for strengthening as well as disease-specific challenges in planning, monitoring and communications. Within ministries, projects aimed at operationalizing One Health will generally enhance: i) capacity to provide leadership at national and sub-national levels; ii) capacity for the day-to-day administration of project activities, such as determining human, infrastructure, equipment resource needs and use, processing procurement activities, and administering withdrawal and disbursement procedures; iii) reporting in their specified area of responsibility, iv) monitoring and evaluating implementation activities, which include collection, analysis, reporting and dissemination of the data on inputs, outcomes and impact from the various sources, and, v) strengthening the national and sub-national levels monitoring system and evaluation based on identified gaps and weaknesses. A ministry will build on existing ministerial organizational relationships and assign tasks given present mandates determined by project needs. It is likely that key ministries will need existing structures strengthened with recruitment of additional staff and improved facilities. The same will be the case for local levels. Monitoring and evaluation of outcomes/results will be of great importance to a project of this nature. Each engaged entity will likely have its own set of meaningful objectives, targets, benchmarks, and key performance indicators (see Chapter 5 for progress monitoring examples).

Political commitment can be expected as a key factor in progress toward national One Health operations. Decision-making power, resources and mandates may be held by certain ministries, which must see the value of investing (whether financially, time-wise or via information flow) in coordination with other departments and ministries for sustained commitment. Stakeholder Analysis (or “mapping”), a methodology used to facilitate institutional and policy reform processes by accounting for and often incorporating the needs of those who have a “stake” or an interest in the reforms under consideration, can help elucidate these various elements to identify mandates, connections and gaps. With information on stakeholders, their interests and their capacity to oppose reform, reform advocates can choose how to best accommodate them, thus assuring policies adopted are politically realistic and sustainable (for more details on this approach, please see Chapter 5). Stakeholder analysis is an essential foundation before taking a One Health approach in any situation in order to identify all the relevant sectors and disciplines for the One Health initiative or issue at hand. The approach should also emphasize that stakeholders identified are required throughout the activity to ensure sustained commitment, including through identifying indicators for measuring progress.

External partner arrangements

The international community will follow the government’s lead and play a key but contributory role at country level to guide national action plans that respond to endemic infectious disease outbreaks, help in meeting International Health Regulations and OIE Standards and other commitments related to transboundary animal, human diseases or environmental (e.g. climate, protection of ecosystems) health aspects, and are aligned with international environmental agreements such as the Convention on Biological Diversity or the Ramsar Convention on Wetlands. These are core national public sector functions, and at the same time considered “global public goods” that require a combined national, regional and global response, each of which can benefit from the engagement of the international community.

Of great importance are the specialized intergovernmental agencies, which provide support to countries for the prevention, surveillance and detection (including diagnostic laboratories) of diseases through normative standards and guidance, technical tools and training, advice on use of economic and costing analysis tools, and assistance with information technology tools and applications (among many others). OIE, WHO and FAO are the principal international agencies responsible for human and animal health,

but there are many others that provide valuable information and assistance and should be drawn upon in the design and support to implementation of Bank-financed projects (Figure 3.4 highlights key tools, and Annex 5 provides TTLs with examples of the known main funders, technical agencies and institutions).

The OIE-FAO-WHO Tripartite Agreement, signed in 2010, formalizes collaboration between the three agencies and recognizes their joint responsibility to address zoonotic and other high-impact disease risks and other health risks at the human-animal-ecosystem interface. Ongoing collaboration includes annual strategic meetings, joint engagement on technical topics, frequent communication on areas of common interest, and mechanisms to facilitate information sharing and assessment (such as the Global Early Warning System for Health Threats and Emerging Risks at the Human–Animal–Ecosystems Interface, or GLEWS). The three institutions have different mandates and different levels of decentralization, affecting how activities are carried out. WHO is quite strongly decentralized with strong regional and country offices. National obligations under the IHR combined with WHO’s strong country presence support early detection and response for emerging diseases and regional engagement. FAO is less decentralized, with several strong regional offices and many country offices. FAO regional and national staff also support national disease detection and response efforts as well as providing capacity building in agriculture and animal production. OIE has a small workforce available at the regional and country level, but a large network of experts, national focal points, collaborating centers and laboratories, in line with their normative mandate. Environmental aspects are increasingly — but not routinely — considered in Tripartite technical activities, for example consideration of wildlife migration patterns in evaluating zoonotic influenza risks. Routinely including technical expertise and experience from the environment sector would improve outcomes for many health concerns at the human-animal-environment interface. All of these efforts would benefit from regular, sustainable funding and even stronger strategic coordination and leadership.

In addition to technical agencies themselves, initiatives developed through the international community may help in implementation and/or mobilization of resources. The establishment of the Global Health Security Agenda, OIE’s World Fund for Animal Health, the World Bank’s Pandemic Emergency Facility and IDA18 support for country “preparedness” plans and projects, bilateral programs, and increased involvement of foundation and faith-based organization are emerging examples of dynamic funding for a growing variety of promising programs. These opportunities need to be taken into account as a country moves forward in One Health and optimizing synergies with concurrent and related initiatives.

Additionally, the non-governmental community includes a number of service providers that can complement or supplement national services and knowledge. During the early stages of the Ebola outbreak in West Africa, Médecins sans Frontières and other private charities responded quickly to need. Such non-governmental crisis responders offer both knowledge and possible assistance to countries, and may be able to help mobilize additional resources. Having memoranda of agreement prepared with such entities “in peacetime”, before an outbreak, can expedite responses when needed.

6b. Monitoring and Evaluation — Measuring Progress of One Health-Related Programs and Interventions

Indicators to measure One Health operations — and their value — are not yet widely established at country and international institution levels, given the challenge of monitoring inputs contributed and benefits conferred across multiple sectors (see Chapter 2). Past and current World Bank projects provide examples and experience from their Results Framework for developing intermediate and outcome indicators for One Health programs (see Annex 7). These are relevant to the prevent-detect-respond-phases in Chapter 5.

Indicators may vary by type and scale of program (see Table 6.1). **While each program/project may**

have its own specific objectives, and uni-sectoral indicators may be useful for measuring specific public health program outcomes, a core set of One Health indicators on multi-sectoral effective coordination should be sought for consistency and comparison to better evaluate and further strengthen value-added applications of One Health. These should evaluate systems, coordination, planning, training to work together, and lastly, disease-specific targets that can help to crystallize discussions. Building on prior World Bank programs (see Annex 7), following core indicators are proposed:

Proposed One Health Core Indicators

- 1) IHR annual self-assessments, JEE and PVS assessments that are up to date
- 2) Progress made towards establishing an active, functional regional One Health platform (e.g. number based on five-point Likert scale)
- 3) Multi-hazard national public health emergency preparedness and response plan developed and implemented (e.g. number of countries that achieve a JEE score of four or higher)
- 4) Applied epidemiology training program in place (such as FETP) that jointly includes human disease epidemiologists and domestic and wildlife veterinarians
- 5) Disease-specific targets (for example, for Tuberculosis, brucellosis, Ebola risk, etc.)

In general, World Bank projects will involve indicators for 1) collaboration of systems, 2) global objectives, or 3) national priorities, in which these core One Health indicators can fit. A project may capture one or several types of indicators. These may be viewed as three main types of indicators based on the scope of their objectives (See Annex for additional examples):

Table 6.1 Example indicators based on scope of objectives.

Type	1. Collaboration of systems	2. Global issues	3. National issues
Description	Assessing system performance and collaboration	Broad objectives	National priorities
Example Topics	Public health system capacity	Global challenges/threats to global public good where major solutions are typically broadly transferrable (with administration adapted to local context): Global health security, tackling AMR, global elimination of dog-mediated human rabies, ending AIDS epidemic)	Country-specific challenges; Entry points for One Health may be highly context-specific (e.g., variations in Nipah virus transmission pathways in Malaysia and Bangladesh necessitate different sectoral involvement and interventions)

Example indicators	Level of capacity for meeting reporting obligations; laboratory functioning; formation of national platforms; provinces with multi-sectoral preparedness plans with multi-sectoral approval	Number of new cases; number of international epidemics	Country-level prevalence or incidence
---------------------------	---	--	---------------------------------------

Additional capacity tools, many which include indicator-based assessments (e.g. the WHO’s Joint External Evaluation for the IHR Monitoring and Evaluation Framework), are showcased in Chapter 3. On a systems-wide level, indicators may be aggregated to assess overall effectiveness. Annual outcomes may include number of outbreaks, overall case or mortality counts, Disability-Adjusted Life Years (DALYs), health system expenditures for zoonotic and vector-borne diseases, productivity losses from disease, and GDP growth loss from disease (or gain from absence of disease). It is possible that improving public health systems may also initially detect more outbreaks and cases as the true baseline is established, especially where vital records or case detection/diagnosis were previously limited; however, over time, changes will be detectable against the baseline. Also, it cannot be overstated that the sustainability of cross-sectoral collaboration in public health systems will be a meaningful indicator itself, promoting permanence (embedded through professional culture and operational shifts) — as opposed to ad hoc, short-term capacity improvements often seen during past outbreaks but not maintained as a foundation to address future threats.

6c. World Bank Environmental and Social Safeguards

Within the World Bank there are existing tools where One Health approaches can be applied to optimize risk management for public health at the human-animal-environment interface; client countries can also apply or adapt these in their internal processes. Safeguard frameworks are a key example. Since establishment in 1994, the World Bank’s Environmental and Social Safeguard Policies have been considered a cornerstone of its support to sustainable poverty reduction. The objective has been to prevent and mitigate undue harm to people and their environment in the development process. These policies provide guidelines for World Bank and country beneficiary staff in the identification, preparation and implementation of programs and projects. The consensus is that the effectiveness and development impact of projects and programs supported by the World Bank has substantially increased as a result of attention to these policies. The safeguard policies have often provided an entry for the participation of stakeholders in project design, and have been an important instrument for building ownership among local populations. In 2016 the World Bank issued its most recent revisions of its safeguards systems, following a prior 2006 revision, to be adopted in 2018.

The revised safeguards⁴⁰ will affect World Bank treatment of human-animal-environment interface aspects. **In essence, One Health aligns with the overall goal of the revised World Bank safeguards —**

⁴⁰ http://consultations.worldbank.org/Data/hub/files/consultation-template/review-and-update-world-bank-safeguard-policies/en/materials/the_esf_clean_final_for_public_disclosure_post_board_august_4.pdf

to better protect people and environment — and the emphasis on risk- and impact-based approaches that promote long-term sustainable development. The coverage of specific environmental health topics (e.g. invasive alien species), as well as sustainable management of natural resources more broadly, significantly expands coverage of biodiversity and land quality considerations that will help advance strengthening of public health systems at the human-animal-environment interface. They may also provide a platform for additional aspects to be considered, including aspects of zoonotic disease risk. Examples of safeguards particularly relevant to this Framework (ESS2, ESS3, ESS4, ESS6, ESS10) are highlighted in Annex 8, noting further application and alignment with existing One Health tools.

6d. Risks

The purpose of this section is to highlight areas of investments where past experience and the nature of the project or programs suggested that special attention may be required. The sections below are illustrative general narratives for anticipating and mitigating risk that may potentially be pertinent in One Health investments. These can be incorporated into the risk categories under the World Bank’s Risk Framework, the Systematic Operations Risk-Rating Tool (SORT),⁴¹ which assesses risk to a project’s own success as well as risks that may result from project operations; an example from REDISSE is provided in Box 6.1.⁴²

⁴¹ <http://documents.worldbank.org/curated/en/450751468184738008/The-World-Bank-s-risk-framework-for-operations-update-on-the-first-year-of-implementation>

⁴² See Project Appraisal Document for additional information:

<http://documents.worldbank.org/curated/en/965001467305866621/Africa-Regional-Disease-Surveillance-Systems-Enhancement-REDISSE-Project>

Box. 6.1 Systematic Risk-Rating for REDISSE

Risk Category Rating

1. Political and Governance	Substantial
2. Macroeconomic	Substantial
3. Sector Strategies and Policies	Moderate
4. Technical Design of Project or Program	Substantial
5. Institutional Capacity for Implementation and Sustainability	High
6. Fiduciary	Substantial
7. Environment and Social	Substantial
8. Stakeholders	Substantial
9. Other	n/a
OVERALL	Substantial

8. Stakeholders-Substantial: The project is both regional and multi-sectoral and there are a large number of stakeholders with diverse and sometimes non-compatible agendas providing technical, financial and commodity support to countries in the sub-region, especially the three countries most affected by the 2014/2015 EVD Epidemic. In this sort of environment, there is the risk of inefficiency, duplication of effort and overburdening the client with reporting and other requirements from multiple donor partners. In order to mitigate these risks, close and continuous collaboration among partners is required and the World Bank's convening power will be highly instrumental to forging a coalition of national, regional and global technical and financial institutions to support the disease surveillance and response agenda in West Africa. The World Bank has already demonstrated that it is well placed to mobilize substantial financing for this multi-sector initiative and to convene premier technical and financial partners engaged in the field of disease surveillance including the U.S. Centers for Disease Control (CDC), the World Health Organization (WHO), the World Organisation for Animal Health (OIE), the African Development Bank, bi-lateral development partners and private foundations, including the Mérieux Foundation and the Bill & Melinda Gates Foundation.

Examples of possible risks and mitigation measures in One Health investments:

- Institutional Capacity for Implementation and Sustainability: staff responsible for human-animal-environmental health and management may not have the full skill sets, technical knowledge and capacity to execute proposed interventions. *Possible measures:* as a pre-condition to Bank financing, a multi-sectoral institutional capacity assessment would identify critical gaps and minimum requirements to inform technical assistance. Assessment tools (such as those referred to in Chapter 3 and Annex 5 of this Operational Framework) would be applied to provide costing estimates for the program as a whole and gap-filling needs. Technical assistance and training may be available through the World Bank and external partners, e.g., OIE, WHO, FAO, UNEP, regional bodies, bilateral and multilateral donors, and major non-governmental funders/technical providers, such as the Gates Foundation, EcoHealth Alliance, UC Davis One Health Institute, IUCN, among others.
- Institutional Capacity for Implementation and Sustainability: laboratory capacity in terms of facilities, skilled staff, testing and related supplies may be lacking and may hamper project effectiveness. *Possible measures:* support for laboratories should be provided in conjunction and consultation with

the government, its national institutes and relevant partners, as well as with other external stakeholders. On a regional basis, there may be opportunities to leverage WHO, OIE and FAO reference laboratory capacity for training as well as a resource for rapid outbreak investigation. These laboratory networks may be particularly pertinent to wildlife and plant disease investigations, where resources as well as laboratory access for broad screening are frequently lacking for threatened and endangered species (as a result, wildlife mortality events may go undiagnosed). The reference laboratory structure also supports consistency with the Nagoya Protocol on Access and Benefits Sharing.

- Institutional Capacity for Implementation and Sustainability: sustainability may not be guaranteed as other government priorities may press for resources. There is the possibility that the government's senior-most public sector leadership will diminish their support, both in political and budgetary terms for ongoing endemic/pandemic/AMR prevention, detection and response activities, especially if there is no outbreak of an infectious disease. *Possible measures:* country centered planning, ownership and leadership of all internal and external stakeholders, coupled with regular information exchange, dialogue, and ongoing mobilization of international commitment, resources, would ameliorate the prospect of declining interest. A high level Inter-Ministerial Committee could also be designated to coordinate policy and technical efforts, clarify the new roles and responsibilities of the public sector entities, maintain subject visibility and awareness, and engage with regional and global actors.
- Technical Design: selected interventions may not prove to be appropriate or effective in supporting the country in its ability to address human-animal-environment health and management challenges (see Chapter 4 on context). *Possible measures:* peer-review(s) for evidence-based project activities should be conducted through a Quality Enhancement Review process at preparation stage, but also along project implementation phases. This is a growing field of development science with new tools and techniques rapidly emerging. Therefore, the project components should allow for modification/moderate redesign without requiring significant restructuring efforts.
- Technical Design: regular and reliable monitoring may be challenging due to the absence of extensive experience in this area, the need to integrate existing monitoring systems by public sector implementers, the dispersed nature of activities, and the difficulty in collecting and providing timely information. *Possible measures:* resources may be needed to develop an effective monitoring system that addresses human-animal-environment health aspects, operational aspects and project management performance.
- Fiduciary: Other donor support may not be as robust as needed. *Possible measures:* building on state party commitments to the International Health Regulations and Global Health Security Agenda, projects may benefit from actively seeking and taking into account donor plans for technical assistance, training and financing (while recognizing the role of the Inter-Ministerial Committee to shoulder responsibility for donor complementarity and coordination). The World Bank could closely assist the government with other cooperating partners to develop and implement a strategy to ensure longer-term financial sustainability of component activities and improve efficiency of national resources.
- Stakeholders: even with careful selection of interventions and strong national-level commitment, the project may not translate into action at local levels. *Possible measures:* implementation planning should explicitly address local participation and decision-making, taking into account decentralization policies and the status of their adoption to include decentralized authority (province, district, municipality, organized community entities) engagement, including planning and identification of resources to be provided, their activity and reporting responsibilities.

Conclusion

Recent disease crises — including Ebola and Highly Pathogenic Avian Influenza viruses — demonstrate close human-animal-environment health links. Current wide-scale environmental degradation is placing increasing pressure on both human and animal populations and reducing resilience, including risk of emerging infections and greater vulnerability to known diseases. In addition to the direct burden on health, endemic and emerging diseases can have wide-ranging impacts on local and global economies and social dynamics, affecting a range of development priorities (e.g. agriculture, education, nutrition). Countries require strong, resilient public health systems at the human-animal-environment interface to address these existing and future threats to health.

One Health offers an approach to yield added value from the collective strengthening of human, animal and environmental health systems to enable their coordination and collaboration to address threats at the human-animal-environment interface for effective prevention, detection, response and recovery. Doing so directly supports existing broad and specific initiatives, such as the Sustainable Development Goals, the Sendai Framework for Disaster Risk Reduction, the attainment of universal health security, and global action on tackling antimicrobial resistance.

There are many existing standards, tools, expert networks, and other resources that users can draw from to strengthen public health systems at the human-animal-environment interface. Intended as a knowledge product, this Operational Framework provides a compendium on One Health, reviewing applications of One Health, showcasing relevant tools, main actors, initiatives and examples to date, and presenting key ways forward for operationalizing One Health on that basis. Building on past and current multi-country programs (e.g. GPAI, REDISSE) and in-house expertise, the World Bank is exceptionally well-placed to lead in supporting client countries in their public health systems strengthening to counter existing (e.g. neglected tropical diseases) and emerging threats. Users are encouraged to share lessons learned to help refine approaches to optimize health of humans, animals and the environment for improved development gains.

ANNEX 1: Addressing Broader Developmental Issues through One Health Investments

Many of the factors related to disease emergence, re-emergence and spread — such as expanding livestock production, mixing of livestock species, encroachment by settlers into wild forest areas, and peri-urban livestock keeping — are intimately linked to livelihoods, often those of very poor people. While rural communities aspire to improve the health of their families and their animals, they may have little or no access to human or animal health services. Women, who are often key small livestock keepers, are particularly marginalized from support services. Poor people are also confronted with common human and animal disease problems that are a far greater persistent priority to them than concern over potential epidemics or pandemics — even if they are aware of those risks.

Surveillance therefore needs to be embedded within health management at the community level, and it needs to account for local livelihoods. This entails the use of bottom-up approaches that recognize the needs of those most directly concerned. Local communities have to be persuaded to become involved and to remain so over time. Special efforts are often required to reach certain groups within the community, especially women. Communications programs that both raise public awareness and deliver timely information that the community-audience finds useful and relevant are essential. Community-driven development (CDD) projects in particular can be instrumental in fostering this level of local engagement. In the Livestock and Community Driven Development Portfolio Review 2004-2008, 13 CDD projects addressed animal health, five addressed waste management, and three food safety.

The following should be considered in the design of follow-on One Health investments:

- Animal diseases, the lack of adequate food hygiene, and resulting food borne illnesses can threaten human health, disrupt markets and trade, reduce productivity and deepen poverty. Improving the management of livestock with a view to preventing and controlling diseases can provide significant economic, social and human-health benefits for the poor and for society at large.
- Public animal-health and food-safety systems need to recognize that the impacts of livestock disease and food-borne illnesses vary across countries and production systems depending on their economic status. The capacities of different groups to respond to these challenges, and the incentives needed to encourage them to do so, must be considered in the design of disease-control and risk-management strategies. Careful cost/benefit analyses are therefore required.
- In the same context, and with limited resources, regional priorities need to be established within each country. The identification of “hotspots,” i.e., areas where several of the drivers of emerging zoonotic diseases are present, with strengthened surveillance and control capabilities, might be preferable over countrywide blanket coverage.
- The technical and institutional capacity — food quality and safety laboratories, human and financial resources, national legislative and regulatory frameworks, enforcement capacity, management and coordination — to ensure compliance with international standards and, food safety. Weaknesses in the above mentioned areas not only threaten public health, but may also reduce access to global food markets. Large, strategic and sustained investment is needed in national animal-health and food-safety infrastructure in developing countries to reduce the risks to human health and to allow growth in trade and markets, in ways that can contribute to lifting small livestock keepers out of poverty.
- The above country interventions should be supplemented by global action as new pathogenic agents will continue to emerge, and the risk of spread has to be addressed specifically. An adequate global framework is necessary to address emerging and re-emerging zoonotic diseases.

Adapted from *Towards One Health* (World Bank, 2011)

ANNEX 2: One Health, EcoHealth, Planetary Health and Veterinary Public Health: A Deeper Dive

One Health, EcoHealth, Planetary Health, and Veterinary Public Health are among the terms that have gained traction in the international community as approaches to address health threats and challenges at the human-animal-environmental health interface. The approaches are similar in all, promoting a more thorough and integrated understanding of the links between humans, animals and/or the environment, including the anthropogenic forces acting on ecosystem dynamics. In addition, each reinforces the importance of collaborating across sectors and broadening the scope of health and its determinants.

One Health

One Health (OH) is a collaborative approach increasingly utilized by governments, intergovernmental agencies, academic institutions and non-profit organizations. One Health, broadly, can be defined as “the collaborative efforts of multiple disciplines working locally, nationally and globally to attain optimal health for people, animals and our environment (AVMA 2008).” It represents a paradigm shift in developing and implementing health interventions that proactively engage different health-related disciplines, such as human medicine, veterinary medicine and environmental health sciences (Karesh & Cook, *Foreign Affairs*, 2005, Osofsky et al. 2005a, b, 2008; AVMA 2008; WHO 2008). By integrating diverse approaches and perspectives, One Health aims to improve health for people, domestic animals, wildlife and ecosystems, simultaneously transecting spatial and temporal dimensions. This approach considers co-benefits and co-challenges so that solutions with multiple bottom lines can be achieved, whether they are for humans, animals, plants or ecosystems.

The origins of OH are rooted in the management and emergence of zoonotic disease threats. While the “Manhattan Principles” originally outlined the connections among infectious diseases, the environment, human well-being and economic development efforts, there has been a less robust engagement from environmental sciences in utilizing the platform for more mutual benefit. EcoHealth, Planetary Health, and One Health espouse a holistic understanding of health and champion interdisciplinary, systemic approaches. While One Health is often applied to address infectious diseases, all three have wide potential application.

Recently, a number of global OH policy relevant actions that have raised the profile of the approach and stimulated connections through fora for professional introductions and relationship-building. For example, in recent years, four International One Health Congresses have been held (two in Australia, and one each in Thailand and The Netherlands); the Global Risk Forum hosted One Health summits in Davos, Switzerland; two One Health Conferences in Africa have been hosted; the World Bank published its second volume of its One Health report, “People, Pathogens, and Our Planet,” underscoring economic impacts and opportunities (World Bank 2012); the World Medical Association and World Veterinary Association co-signed a memorandum to collaborate on One Health (WMA 2012); and the World Veterinary Association released a position paper (WVA 2014). Notably in 2008, the World Organisation for Animal Health (OIE), Food and Agriculture Organization (FAO), and the World Health Organization (WHO) with the World Bank, UNICEF and UN System Influenza Coordination released a joint strategic “One World, One Health” framework for the tripartite partnership addressing infectious diseases at the animal–human–ecosystems interface, such as highly pathogenic avian influenza, anthrax and Rift Valley fever virus (FAO, OIE, WHO et al. 2008; FAO/OIE/WHO 2010, Barrett and Bouley 2014). The World Bank’s flagship publication, the 2014 World Development Report (WDR) on *Risks to Development*, dealt with three major global risks: climate change, pandemics and financial crises. The WDR argued that livestock health is an essential precondition for improved management of pandemic risk.

The Pan American Health Organization (PAHO) has emphasized the governance aspects of One Health (essentially One Health understood as the “inter-sectoral, inter-programmatic and interdisciplinary governance of initiatives needed to promote and protect the health of people, animals and the environment

in an integrated manner”). To that end, PAHO member states have also stated their commitment to contribute to the elimination of health inequities by applying the "One Health in all policies" approach as a strategy to address all social, economic and environmental health determinants, and to promote sustainable wellbeing for the population (PAHO 2016).

EcoHealth

EcoHealth originates in ecosystem approaches to health and resilience thinking. It emphasizes science at the intersection of ecology and health through an ecosystems approach, which is strategy for the integrated management of land, water and living resources that supports conservation, sustainable use and equity. Its trans-disciplinary approach (e.g. encouraging development of a common language/understanding between disciplines) has gained attention in the research community to address a wide range of topics in relation to health, including wildlife disease, pandemic prevention, waterborne and water-related disease, household air pollution, land use change, community health, urban health, and wildlife trade, and other health topics resulting from ecosystem degradation including noncommunicable diseases, food security and micronutrient deficiencies. It is inclusive of the ecological and social determinants of health. The International Society for Ecology and Health (IAEH) organizes the journal *EcoHealth* and hosts biennial conferences; a joint One Health Congress-EcoHealth Conference was held in Melbourne in December 2016.

Planetary Health

In followup to the manifesto “From Public Health to Planetary Health” signed by thousands of professionals, a report by the Rockefeller Foundation-*Lancet* Commission on Planetary Health released in July 2015 frames planetary health as the achievement of global health, well-being and equity through human societies that operate within the boundaries of natural systems that we depend on (Whitmee et al., *The Lancet*, 2015). Within the frame of natural systems and planetary boundaries, the discipline calls for research and solutions to address the drivers of global environmental change leading to recent widespread ecosystem degradation (defined as a proposed current epoch: the Anthropocene). Planetary Health thinking considers threats to ecosystem services provided by natural systems, such as those expected and already being seen from climate change, nitrogen and phosphorus pollution, biodiversity loss, human-induced changes to biogeochemical cycles, and changes in land use and soil erosion. It emphasizes sustainable solutions to address human-driven factors (e.g. pressures currently seen from human consumption and urbanization). Resilience – the ability to prepare for, recover from, and adapt to disturbance — is a major component of Planetary Health. *The Lancet Planetary Health* journal was launched in April 2017.

Veterinary Public Health

Veterinary Public Health (VPH) was defined in 1974 as “a component of public health activities devoted to the application of professional veterinary skills, knowledge and resources to the protection and improvement of human health” (WHO and FAO 1975). Because VPH activities must be carried out in close partnership with other public health efforts to ensure positive health outcomes, a WHO Study Group in 1999 redefined VPH and the scope of its collaborative efforts as “the sum of all contributions to the physical, mental and social well-being of humans through an understanding and application of veterinary science” (WHO 1999). Although VPH might be perceived as a corporative veterinary intrusion into a medical realm, its goal is fully consistent with public health and reinforces core capacities.

ANNEX 3: The World Bank and Its History with One Health

The World Bank Group has supported coordinated emergency responses that have changed the way in which affected countries and international agencies view their roles and responsibilities. The One Health approach adopted in the GPAI has also raised expectations in our clients and partners. But our experience to date shows that, while coordinated multi-sectoral responses can enhance the efficacy and efficiency of disease response, they have been extremely difficult to sustain without a long-term and dedicated approach, and have not moved from reactive emergency response to proactive prevention.

What approach will help the World Bank protect the poor from the diseases of tomorrow? The World Bank Group faces a choice: accept the high-impact/low-sustainability tradeoff and the huge human and economic losses of recurrent emergency responses, or commit to supporting systemic prevention efforts that will deliver substantial long-term health and economic benefits. Adoption of the One Health approach may conceptually be consistent with the commitment of the HNP Global Practice to focus on health systems. Equally, One Health is ultimately an approach that supports sustainable development and resilience of economies and communities.

The One Health approach holds the promise of delivering a broad range of ancillary benefits in public health and in the sustainable development of rural economies. Greater collaboration between animal and human health professionals is required to address the incidence of antimicrobial resistance (AMR). Stronger public health systems will help ensure progress toward universal health coverage (UHC) and that coming generations are not forced to shoulder the crippling burden of disease and the poverty that so often results. One Health approaches would also help draw together and make more effective the strands of work addressing food security, food safety, nutrition and increased trade. Indeed, there is scope for mainstreaming One Health approaches in ongoing and new operations to increase effectiveness and sustainability of measures to address multi-sectoral concerns relevant to public health, nutrition, agricultural competitiveness and transformation of livestock production systems, pasture management, environmental health, biodiversity conservation, food safety and food security.

The World Bank Group: to lead or to follow? Our clients are increasingly convinced of the benefits of developing shared capacity in disease surveillance and the establishment of laboratory networks. Many of the World Bank's principal partners are supportive of — and often already supporting — One Health approaches: the EU, UN, Australia, Canada, France, Netherlands, United Kingdom, and the United States. At their summit in June 2015, G-7 leaders declared: “We are strongly committed to the One Health approach, encompassing all areas – human, and animal health as well as agriculture and the environment.” Other countries, including China, India, Indonesia and Vietnam, as well as many others in Central Asia, South Asia, Southeast Asia, Central Europe and Africa, have rapidly moved to adopt One Health approaches. Moreover, many have acknowledged the evident benefits of World Bank involvement and support for this transition.

Adapted from *Zoonotic disease prevention and control, one health, and the role of the World Bank* (World Bank, 2012)

ANNEX 4: Examples of Relevant Areas for Action

A variety of issues may benefit from coordination among human, animal and environmental health sectors. Neglected zoonotic diseases, antimicrobial resistance, food safety and vector-borne diseases are four examples of domains relevant to the human-animal-environment interface with strong rationale for action.

Neglected zoonotic diseases (NZDs) are a subset of neglected tropical diseases (NTDs). Zoonoses are diseases naturally transmitted between vertebrate animals and humans. Their management needs integrated approaches and application of veterinary science, which are part of the NTD strategic approach to transmission control. The term “neglected” highlights that diseases affect mainly poor and marginalized populations in low-resource settings.

Addressing this group of diseases requires collaborative, multi-sectoral efforts of human and animal health systems in considering the complexities of the ecosystems where humans and animals co-exist and the many environmental determinants that affect risk. Preventing and mitigating their occurrence in humans requires control and, where feasible, elimination of the diseases in their animal reservoirs. In the context of this Framework, rabies, brucellosis, and anthrax are considered among the neglected zoonotic diseases, given their persistent burden on health and livelihoods and their animal and environmental transmission factors.

In May 2013, the 66th World Health Assembly adopted resolution WHA66.12 on NTDs, which calls for intensified, integrated measures and planned investments to improve the health and social well-being of affected populations. Action on NZDs will support progress in addressing overall neglected tropical diseases, which thrive mainly among the poorest populations.

Source (adapted from): http://www.who.int/neglected_diseases/diseases/en/

Antimicrobial resistance (AMR) is a global concern. According to the WHO, FAO, OIE, and other authorities, the main reasons are:

- AMR kills. The death rate for patients with serious infections is about twice that in patients with infections caused by non-resistant bacteria.
- AMR hampers the control of infectious diseases. Patients and infected animals remain infectious longer, increasing the risk of spreading superbugs to others.
- AMR threatens a return to the pre-antibiotic era. Many infectious diseases may become untreatable and uncontrollable, in some cases with high risk of spread in populations of humans or livestock in wide geographic areas or the entire world.
- AMR increases the costs of health care. When available at all, treatment with second-line or later drugs is more expensive, sometimes dramatically so. It is invariably less effective. Thus, costs per patient are higher, but outcomes tend to be worse. There are more patients, each is more costly to treat, and with higher costs, more people will have no access to treatment at all. The longer duration of illness and treatment, often in hospitals, increases health-care costs even more.
- AMR diminishes the achievements of modern medicine by reversing health care gains. Without effective drugs for care and prevention of infections, treatments such as organ transplantation, cancer chemotherapy and major surgery will become so risky as to stop being available

- AMR reduces incomes and takes a toll on families. Illness and premature death lead to economic losses as workers are not able to work and farmers and herders lose their livestock. When a growing proportion of the human population suffers from protracted illness, achieving goals to expand health care coverage for the poor will become harder — and even impossible, either because no treatment will be available or because the increasing number of patients will outstrip health care capacity. In many poor countries, AMR will further increase the proportion of people without access to care. Illness, disabilities caused by incurable infections and premature deaths will impose economic and social burdens on families, especially where safety nets do not exist or are fragile.
- **AMR puts all countries at risk, so controlling it is a global public good, and all countries should follow the recommendations of the WHO Global Action Plan** in order to robustly combat antimicrobial resistance. AMR threatens health security and food security, and damages trade and economies. Global trade and travel allow superbugs to spread rapidly by human travelers and livestock and food product shipments to neighboring and distant countries. Many resistant microbes will be capable of causing pandemics (in humans) and panzootics (in livestock) in the interconnected 21st Century world.
- Antimicrobial agents are essential to treat human and animal diseases, and should also be considered as a priority and a global public good. A lack of prudent and responsible use of antimicrobials will threaten their efficacy and exacerbate AMR.
- **Inadequate public health policies accelerate and worsen AMR.** AMR is driven by many interconnected factors, so single, isolated interventions have little impact and coordinated actions are required. WHO and other authorities list these as the main underlying factors that accelerate the emergence and spread of AMR:
 - Lack of a comprehensive and coordinated response at the global and country levels; Extremely or very weak animal and human public health systems in many developing countries and poor or no collaboration between these systems, especially for AMR surveillance and monitoring;
 - Lack of political commitment;
 - Lack of national financial resources allocated to/invested in combatting antimicrobial resistance;
 - Lack of capacity-building programs for national public health and veterinary services;
 - Poor infection prevention and control practices;
 - Insufficient diagnostic, prevention and therapeutic tools;
 - Inadequate legislation and control of counterfeit drugs;
 - Inadequate systems to ensure quality and uninterrupted supply of medicines;
 - Inadequate systems to ensure proper waste management to prevent dissemination of antimicrobial residues in the environment;
 - Inappropriate use of antimicrobial medicines, including in animal husbandry;
 - Lack of education and public communication on the appropriate use of antimicrobials.

Food Safety affects the health and lives of people around the world — an estimated 600 million people experience food-borne illness annually, leading to more than 400,000 deaths and loss of 33 million DALYs from food-borne pathogens and chemical contamination. Unsafe foods may include uncooked animal products, marine biotoxins in raw or under-cooked shellfish, and animal or plant-source food contaminated with feces, as well other sources of contamination along the supply chain. In some cases, food and nutrition security may play a role in risk (e.g. higher vulnerability based on dependency on certain foods, acquisition or preparation practices). A One Health approach is imperative in food safety: in addition to bioaccumulation of toxins that may occur along the food chain (for example, with mercury or dioxins), the majority of emerging food-borne pathogens are zoonotic (often bacterial), and risk may change with transformation of food production systems without adequate biosecurity (for example, as seen with some Highly Pathogenic Avian Influenza viruses). Strengthening public health and veterinary services may directly and indirectly lead to improved food safety measures (e.g. improved sanitation, residue control, detection of contamination and/or risk, strengthened regulation and enforcement, risk reduction measures such as enhanced biosecurity during rearing, slaughter and preparation) as well as inform response measures (distinguishing the route of disease transmission to confirm food-borne illness and help determine the contaminant). Sentinel surveillance via animal, plant, or environmental sampling may indicate the presence of food-borne contaminants and inform public, animal or environmental health response.

Sources: WHO (<http://www.who.int/mediacentre/factsheets/fs399/en/>) and Institute of Medicine (US) “Improving Food Safety Through a One Health Approach” (<https://www.ncbi.nlm.nih.gov/books/NBK114504/>)

Vector-borne diseases are illnesses caused by pathogens and parasites in human populations. Every year there are more than one billion cases and more than one million deaths globally from vector-borne diseases such as malaria, dengue, schistosomiasis, human African trypanosomiasis, leishmaniasis, Chagas disease, yellow fever, Japanese encephalitis and onchocerciasis. Vector-borne diseases account for more than 17 percent of all infectious diseases. Distribution of these diseases is determined by a complex dynamic of environmental and social factors. Globalization of travel and trade, unplanned urbanization and environmental challenges such as climate change are having a significant impact on disease transmission in recent years. Some diseases, such as dengue, chikungunya and West Nile virus, are emerging in countries where they were previously unknown. Changes in agricultural practices due to variation in temperature and rainfall can affect the transmission of vector-borne diseases. Climate information can be used to monitor and predict distribution and longer-term trends in malaria and other climate-sensitive diseases

Source: WHO (<http://www.who.int/mediacentre/factsheets/fs387/en/>)

ANNEX 5: Examples of key resources/sources of information

Assessment and Prioritization Tools

Title	Origin	Subject	Description	Date	Source	Links to other tools/ initiatives
Tool for the Evaluation of the Performance of Veterinary Services	OIE	Animal Health	Tool to assist Veterinary Services to establish their current level of performance, to identify gaps and weaknesses in their ability to comply with OIE international standards, to form a shared vision with stakeholders (including the private sector) and to establish priorities and carry out strategic initiatives.	Sixth edition 2013	http://www.oie.int/support-to-oie-members/pvs-evaluations/oie-pvs-tool/	World Animal Health Fund provides resources for country capacity building; Global Health Security Agenda
Joint External Evaluation for the IHR Monitoring and Evaluation Framework	WHO	Human Health	Tool intended to assess country capacity to prevent, detect, and respond to public health threats independently of whether they are naturally occurring, deliberate, or accidental	2016	http://apps.who.int/iris/bitstream/10665/204368/1/9789241510172_eng.pdf	OIE PVS Pathway; Global Health Security Agenda; CDC's Disease Prioritization tool to guide selection of known diseases for capacity emphasis

One Health Zoonotic Disease Prioritization tool	U.S. CDC	Disease prioritization	A semi-quantitative tool that generates a list of country-specific zoonoses, with ranking criteria established to identify ~5 priority diseases for multi-sectoral collaboration. Typically implemented through a workshop that brings together human, animal, environment, and other relevant sectors.	2016 (Initial tool 2014)	https://www.cdc.gov/onehealth/pdfs/zoonotic-disease-prioritization-workshop.pdf	Global Health Security Agenda; Joint External Evaluation
Strategic Tool for Assessing Health Risks (STAR)	WHO	Assess risk; Emergency plans	The tool objectives are: 1) provide a systematic, transparent and evidence-based approach to identify and classify priority hazards in a particular setting; 2) for each hazard, to define its level of risk and the national preparedness actions to mitigate its health consequences; 3) inform health sector preparedness and response planning in line with agreed inter-agency standards. The process is overseen by a facilitator, with strategic risk assessments conducted at the start of the risk management cycle.		http://www.afrro.who.int/en/liberia/presentation-materials/item/8864-liberia-conducts-integrated-risk-profiling-of-public-health-threats-with-who-support.html	International Health Regulations; Joint External Evaluation; Emergency Preparedness and Response Plan

International Standards and National Implementation Plans

Name	Creator	Subject	Description	Source	Links to other tools/initiatives
IHR	WHO; Binding instrument for human health	Public Health	Core surveillance and response capacities at the primary, intermediate and national level, as well as at designated international ports, airports and ground crossings	http://apps.who.int/iris/bitstream/10665/43883/1/9789241580410_eng.pdf	Joint External Evaluation for IHR monitoring
Terrestrial and Aquatic Health Code	OIE	Animal Health	International standards for the sanitary safety of international trade in terrestrial animals and aquatic animals	http://www.oie.int/international-standard-setting/overview/	OIE PVS Gap and Pathway Analysis; World Fund for Animal Health
Environmental resolutions	United Nations Environment Assembly	Environment	Global decision-making body on the environment	http://web.unep.org/unea	
Environment and Social Safeguards	World Bank	Protect people and the environment and promote sustain-able development	Assessment as part of project appraisal	http://consultations.worldbank.org/Data/hub/files/consultation-template/review-and-update-world-bank-safeguard-policies/en/materials/the_esf_clean_final_for_public_disclosure_post_board_august_4.pdf	
National Biodiversity Strategies and Action Plans	CBD, UNEP and UNDP	Bio-diversity	Principal instruments for implementing the Convention at the national level. The Convention requires countries to prepare a national biodiversity strategy (or equivalent instrument) and to ensure that this strategy is mainstreamed into the planning and activities of all those sectors whose activities can have an	https://www.cbd.int/nbsap	Convention on Biological Diversity

			impact (positive and negative) on biodiversity.		
National adaptation plan (NAP)	UN FCCC	Climate change	Continuous, progressive, and iterative country-driven process to identify medium- and long-term adaptation needs and developing and implementing strategies and programmes.	http://unfccc.int/adaptation/workstreams/national_adaptation_plans/items/6057.php	Paris Agreement
National Adaptation Programmes of Action (NAPAS)	UN FCCC	Climate change	Process for least developed countries (LDCs) to identify priority activities that respond to their urgent and immediate needs with regard to adaptation to climate change - those needs for which further delay could increase vulnerability or lead to increased costs at a later stage. Recognizes grassroots communities as the main stakeholders.	http://unfccc.int/national_reports/napa/items/2719.php	Paris Agreement
Sendai Framework for Disaster Risk Reduction	UNISDR	Disaster risk	15-year voluntary, non-binding agreement for whole-of-society action for reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.	http://www.unisdr.org/we/coordinate/sendai-framework	National Action Plans for Disaster Risk Reduction

Conferences and Training Workshops

Title	Creator	Subject	Description	Date	Source	Links with other tools/ initiatives
IHR-PVS Pathway National Bridging Workshop	WHO and OIE	Animal and public health; capacity; stakeholder mapping	Workshops bring together human and animal health services of hosting countries to build on the assessments conducted in respectively the human health and animal health sectors, explore options for improved coordination and jointly strengthen their preparedness for, and control of, the spread of zoonotic diseases.	2014-		PVS; IHR
Regional Workshops on The Interlinkages Between Human Health and Biodiversity	CBD with WHO	Biodiversity; health	Workshops in Manaus, Brazil and Maputo, Mozambique aimed at aimed to foster collaborative work on the critical linkages between biodiversity, ecosystems, and public health, stimulate the development of effective strategies, and enhance the implementation of related international commitments	2012	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4111881/pdf/10393_2014_Article_959.pdf	CBD-WHO Joint Work Program

RISMA (Inter-American Meeting in Health and Agriculture at Ministerial Level)	PAHO	Agriculture; Health	<p><u>The Pan-American Health Organization (PAHO) hosts the “Inter-American Ministerial Meeting on Health and Agriculture” (RISMA), bringing together ministers of Agriculture and Health, representatives of food producers and consumers, and international organizations. The RISMA 17 was held in Paraguay and covered topics including zoonoses and antimicrobial resistance, under a theme of “One Health and Sustainable Development Goals”. The 2016 events are posted online in English and Spanish</u></p>	2012	http://www.paho.org/hq/index.php?option=com_content&view=article&id=1257%3A2008-rimsa-inter-american-meeting-at-ministerial-level-on-health-agriculture&catid=2104%3Acontent&Itemid=40387&lang=en	CBD-WHO Joint Work Program
One Health Inter-Ministerial Meeting To Address Zoonotic Diseases and Other Related Public Health Threats	WHO Regional Office for Africa and the Economic Community of West African States (ECOWAS), FAO, OIE, USAID, U.S. CDC, and other partners	Agriculture; Human Health	<p>Ministers from the human health, animal health and wildlife sectors; shared lessons learned and endorsed a communiqué on One Health implementation by governments and institutional partners</p>	2016	http://www.afro.who.int/en/diseases-outbreaks/publications/5097-communicue-one-health-dakar-2016.html	Tripartite agreement

Global Conference on Wildlife “Animal Health and Biodiversity—Preparing for the Future	OIE	Animal Health	Brought together human, domestic animal and wildlife experts to examine the growing threats emerging and re-emerging disease	2011	http://www.oie.int/for-the-media/press-releases/detail/article/oie-global-conference-on-wildlife-animal-health-and-biodiversity-preparing-for-the/	Tripartite agreement
--	-----	---------------	--	------	---	----------------------

<p>The CDC One Health Office sponsors, attends, and participates in national and international meetings promoting One Health.</p>	<p>Hosted on CDC's website</p>		<p>The CDC One Health Office sponsors, attends, and participates in national and international meetings promoting One Health. To date, a series of meetings have been organized by a number of diverse global institutions from the academic, government, non-government, and private sectors which provide an important forum for bringing together national and international specialists to focus on policies and implementation of a One Health approach. These meetings have built a strong case for One Health by striving to identify the true added value of an integrated approach to preventing and detecting emerging and re-emerging diseases. The website provides brief summaries for several meetings that have transpired over the last decade to describe the narrative of the One Health concept to date.</p>	<p>2004-2014</p>	<p>http://www.cdc.gov/onehealth/basics/history/meetings.html</p>	<p>CDC's One Health Office and partners</p>
<p><u>Inter-national One Health and EcoHealth Congresses</u></p>	<p>Inter-national Association for Ecology and Health and One Health Platform</p>		<p>Scientific congress on integrated approaches to human, animal and environment challenges. Past conferences have been held separately; 2016 Congress will be held jointly.</p>	<p>2006</p>	<p>http://oheh2016.org/welcome-message/</p>	

<p><u>4-Way Linking Program</u></p>	<p>FAO-OIE- WHO</p>	<p>Animal Health</p>	<p>To strengthen national capacity for risk assessment at the human-animal interface, the FAO, OIE and WHO have developed the Four-Way Linking Project. The initiative links across four “streams” of data: epidemiologic and laboratory information – including where and when events took place- for both animal and human health to facilitate joint risk assessment. The process involves a review mission and workshop with partners from across the four streams to establish a national-level joint framework for data sharing, risk assessment and risk communication.</p>	<p>2011</p>	<p>http://www.who.int/influenza/human_animal_interface/EN_GIP_FourWay_HAI_2013.pdf</p>	<p>Tripartite agreement</p>
<p>High-Level Technical Meeting to Address Health Risks at the Human-Animal- Ecosystems Interfaces</p>	<p>FAO, OIE and WHO</p>		<p>Interministerial meeting; Participants from the different sectors considered and came to agreement on cross-sectoral technical and policy approaches to address the mutual priorities and on the next steps for moving forward to implement these approaches.</p>	<p>2011</p>	<p>http://www.fao.org/docrep/017/i3119e/i3119e.pdf</p>	<p>Tripartite agreement</p>

Networks

Title	Creator	Subject	Description	Date	Source
Network for the Evaluation of One Health	EU COST Action and RVC	Evaluation	Through a series of working groups, NEOH will assess effectiveness and value of One Health and generate evidence to motivate implementation of methods by policy makers and other stakeholders	2014-2019	http://neoh.onehealthglobal.net
One Health Alliance of South Asia	Rockefeller Foundation and EcoHealth Alliance	Infectious diseases	A regional platform of scientists and policy makers from wildlife, livestock, and human health sectors from Bangladesh, India, Nepal, and Pakistan. The Steering Committee focuses on study, prevention and control of high priority viral pathogens of public health significance and of national and trans-national interest (e.g. rabies, avian influenza, Nipah virus, etc.)	2009-	http://www.ecohealthalliance.org/program/ohasa
Wildlife Health Specialist Group	IUCN Species Survival Commission	Wildlife Health	Global group of >300 wildlife health experts working in the scope of conservation	1984-	http://www.iucn-whsg.org/
Inter-agency Liaison Group on Bio-diversity and Health	UN Bio-diversity Convention and WHO	Biodiversity, ecosystems and health links	Convened under the CBD-WHO Joint Work Programme, brings together technical experts to strengthen collaboration and policy coherence, and maximize synergies between key agencies working at the intersection between human health and biodiversity	2016-	https://www.cbd.int/health/ilg-health/default.shtml

Information Sharing and Risk Analysis Resources

Title	Creator	Subject	Description	Date	Source	Links with other tools/ initiatives
<u>GLEWS (the Global Early Warning System)</u>	FAO-OIE-WHO	Data sharing	<u>A Joint FAO-OIE-WHO initiative for monitoring data from existing event-based surveillance systems and to track and verify relevant animal and zoonotic events to aid in coordinated risk assessment</u>	2006-	http://www.glews.net/	Tripartite Agreement
ProMED	International Society for Infectious Disease	Data sharing	An Internet-based reporting system dedicated to rapid global dissemination of information on outbreaks of infectious diseases and acute exposures to toxins that affect human health, including those in animals and in plants grown for food or animal feed.	1994-	http://www.promedmail.org	
Health-Map	Boston Children's Hospital	Data sharing	Through an automated process, updating 24/7/365, the system monitors, organizes, integrates, filters, visualizes and disseminates online information about emerging diseases in nine languages	2006	http://www.healthmap.org/	USAID Emerging Pandemic Threats PREDICT project surveillance data: http://www.healthmap.org/predict/
Guidelines and Manual of Procedures for Wildlife Disease Risk Analysis	IUCN-OIE	Wildlife health	Science-based processes and tools available for wildlife disease risk analysis and their application to a broad range of contemporary issues, including human-wildlife interactions, domestic animal-wildlife interactions and the impacts of massive ecological change on biodiversity conservation	2014	https://portals.iucn.org/library/node/43385	
Red List of Ecosystems	IUCN	Ecosystem health	global standard for assessing ecosystem risk, in terms of threat of ecosystem collapse	2014-	http://iucnrle.org/	

Projects and Programs

Title	Creator	Subject	Description	Date	Source	Links with other tools/ initiatives
<p>REDISSE 1 (P154807) REDISSE 2 (P159040) REDISSE 3 (P161163)</p>	<p>World Bank</p>	<p>Surveillance systems</p>	<p>Program (implemented through a series of Projects) to strengthen cross-sectoral capacity for collaborative disease surveillance and epidemic preparedness in West Africa, and mobilize response to crisis or emergency; three phases are planned</p>	<p>2015-2023</p>	<p>http://www.projects.worldbank.org/P154807?lang=en http://projects.worldbank.org/P159040?lang=en</p>	<p>GHSA; Reinforces capacity for IHR and OIE reporting obligations</p>
<p>Emerging Pandemic Threats</p>	<p>USAID</p>	<p>Emerging disease detection and prevention</p>	<p>One Health surveillance, policy, platform support, and workforce development in 32 disease emergence ‘hotspot’ countries</p>	<p>2014-2019</p>	<p>https://www.usaid.gov/what-we-do/global-health/pandemic-influenza-and-other-emerging-threats</p>	<p>GHSA; Reinforces capacity for IHR and OIE reporting obligations</p>
<p>Participatory One Health Disease Detection</p>	<p>Skoll</p>	<p>Surveillance; Community Engagement</p>	<p>A team of veterinarians, public health officers, livestock officers, community volunteers, technologists, economists, social scientists, and geographic information systems (GIS) experts developed smartphone and web applications for community members to report unusual disease events in backyard and wild animals and humans. Volunteers report potential human or animal disease outbreaks or environmental hazards through the PODD mobile app. These disease reports lead to a local response from health experts who collect lab samples from the disease source in the community and/or send preventive materials such as vaccines.</p>	<p>2014-</p>	<p>http://endingpandemics.org/projects/participatory-one-health-digital-disease-detection-podd/</p>	<p>GHSA; Reinforces capacity for IHR and OIE reporting obligations</p>

Evidence Reviews/Publications

Title	Creator	Subject	Description	Date	Source	Links with other tools/ initiatives
Connecting Global Priorities: Biodiversity and Human Health, a State of Knowledge Review	WHO and CBD	Biodiversity, eco-system and health links	Review of connections as they relate to Food and Nutrition, Infectious Diseases, Non-communicable diseases, and more. Addresses drivers of disease and proposes solutions in the context of the Sustainable Development Agenda.	2015	https://www.cbd.int/health/stateofknowledge	CBD-WHO Joint Work Program and Liaison Group on Biodiversity and Human Health
Healthy Environment Healthy People	UNEP	Environmental health	Thematic report released for the UNEA-2 meeting	2015	http://www.unep.org/about/sgb/Portals/50153/UNEA/K1602727%20INF%205.pdf	United Nations Environment Assembly
Commission on Planetary Health	<i>The Lancet</i> and Rockefeller Foundation	Environmental health	Reviews current and anticipated pressures on health from changes to natural	2015	https://www.rockefellerfoundation.org/report/safeguarding-human-health-anthropocene-epoch/	Planetary Health Alliance
One Health <i>Scientific and Technical Review</i>	OIE	Animal Health	Special edition with contributions from governmental representatives, organisational heads and experts on these issues from around the world provide insights and experiences that lead readers through the progression of 'One Health' from concept to perspectives to practice	2014	http://web.oie.int/boutique/index.php?page=ficprod&id_produit=1308&fichrech=1&lang=en	

Agreements and Decisions

Title	Creator	Subject	Description	Date	Source	Links with other tools/initiatives
Tripartite Agreement	WHO-OIE-FAO	Human health; animal health	Premise for international collaboration between the 3 organizations aimed at coordinating global activities to address health risks at the human- animal-ecosystems interfaces.	2011	http://www.who.int/influenza/resources/documents/tripartite_concept_note_hanoi_042011_en.pdf	Global Early Warning System (GLEWS) OFFLU Network of Expertise on Animal Influenza
COP12 Decision XII/21	UN Biodiversity Convention	Biodiversity	Recognizes value of the “One Health” approach to address the cross-cutting issue of biodiversity and human health, as an integrated approach consistent with the ecosystem approach (decision V/6) that integrates the complex relationships between humans, microorganisms, animals, plants, agriculture, wildlife and the environment	2014	https://www.cbd.int/decision/cop/default.shtml?id=13384	CBD-WHO Joint Work Programme and Liaison Group on Biodiversity and Human Health

Academic Programs

Title	Creator	Subject	Description	Source
One Health Diploma or MSc Program	Royal Veterinary College, University College London, and London School of Hygiene and Tropical Medicine	Education	One Health post-graduate degree with a focus on infectious diseases	http://www.rvc.ac.uk/study/postgraduate/one-health
One Health Institute	University of California, Davis	Education; Re-search	The Institute, which is based out of the School of Veterinary Medicine hosts local and international projects at the interface of animals, people and the environment, and manages several programs including the Wildlife Health Center.	http://www.vetmed.ucdavis.edu/ohi/
One Health Central and East Africa (OHCEA)	USAID Emerging Pandemic Threats with 14 institutions	Education	Network of seven public health and seven veterinary Higher Education Institutions that are located in the Democratic Republic of Congo, Ethiopia, Kenya, Rwanda, Tanzania and Uganda. OHCEA activities are derived from the overall goal of generating future leaders that have the capacity to address complex health challenges using the One Health Approach.	http://ohcea.org
Thailand One Health University Network (THOHUN) and South East Asia University One Health Network (SEAOHUN)	USAID Emerging Pandemic Threats with six institutions	Education	THOHUN focuses on pre-service workforce training and strengthening outbreak response capacity in Thailand. The regional network, SEAOHUN, is composed of 10 universities and 14 faculties from Thailand, Vietnam, Malaysia, and Indonesia. These institutions have jointly exchanged academic resources and advance innovative teaching methodologies, as well as shared professional expertise.	http://thohun.org

Center for One Health Education Advocacy Research and Training	Kerala Veterinary and Animal Sciences University	Education	Acts as a consortium comprising of different partnering institutions from Kerala, with a mandate to establish a facility for One Health training and research and implement One Health strategies.	http://www.coheart.ac.in
<u>Curriculum criteria</u>	U.S. Council on Education in Public Health	Public health	One Health Public Health Capacities—“ <i>Explain an ecological perspective on the connections among human health, animal health and ecosystem health (eg, One Health)</i> ”. To be operational by end of the 2018.	http://ceph.org/criteria-revision/
One Health program	Duke University	Education; Re-search	Duke University hosts a One Health program, inclusive of a One Health training program, and projects in China, Mongolia, Romania, and Singapore.	http://sites.globalhealth.duke.edu/dukeonehealth/

Data Aggregation and Interpretation Tools

Name	Creator	Subject	Description	Date	Source	Links with other tools/ initiatives
Accessing Spatial Data to Study Biodiversity and Devise Protection Strategies in Zimbabwe	UNPulse Lab Kampala, with the NBSAP Forum, UNDP, Zimbabwe Government	Land use planning	Spatial tool to support Zimbabwe's implementation of National Biodiversity Strategies and Action Plans. Bringing together information including Key Biodiversity Areas, ecosystem classifications, and endangered species status, the tool can inform decision making for land use planning; possible health risks that may result from changes to particular ecosystems may be considered.	2017	http://www.unglobalpulse.org/projects/spatial-data-biodiversity-tool	NBSAPs
Knowledge Junction	European Food Safety Authority (EFSA)	Risk assessment	Open-source platform for showcasing frameworks and data inputs from risk assessments undertaken by EFSA on a range of topics (zoonoses, plant health, pollination, vector-borne disease, toxicology, etc.)	2016-	https://zenodo.org/communities/efsa-kj?page=1&size=20	GHSA; OIE; foodborne illness reduction initiatives
Flight Risk Tracker (FLIRT)	EcoHealth Alliance	Bio-security; Disease expansion via travel	Network analysis tool that enables detailed examination of flight networks based scheduled commercial flights and their number of seats; also provides a platform for passenger simulations.	2016-	flirt.eha.io	GHSA; IHR

Program-Specific Example: Antimicrobial Resistance:¹

Title	Creator	Subject	Description	Date	Link
“Recommendations for Controlling Antimicrobial Resistance” Terrestrial Animal Health Code (Chapters 6.6-6.10)	OIE	Veterinary use of antibiotics in agriculture	Standards for prudent use and screening	2016	http://www.oie.int/index.php?id=169&L=0&htmfile=chapitre_antibio_introduction.htm
Codex Alimentarius, Code Of Practice To Minimize And Contain Antimicrobial Resistance	FAO-WHO	Anti-microbial use in food production/ food safety	Information on risk analysis and use parameters, links to surveillance guidance, responsibilities of different sectors	2005	http://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252Fstandards%252FCAC%2BRCP%2B61-2005%252FCXP_061e.pdf
“Antimicrobial Resistance” Action Package	GHSA	Anti-microbial resistance prevention	Program to develop an integrated and global package of activities to combat antimicrobial resistance, spanning human, animal, agricultural, food and environmental aspects	2014; 5-year target	https://www.ghsagenda.org/packages/pl-antimicrobial-resistance

¹ These resources complement broader strategic plans and definition of the problem, such as the FAO Action Plan on Antimicrobial Resistance 2016-2020 (<http://www.fao.org/3/a-i5996e.pdf>), the OIE Strategy on Antimicrobial Resistance and the prudent use of antimicrobials (http://www.oie.int/fileadmin/Home/eng/Media_Center/docs/pdf/PortailAMR/EN_OIE-AMRstrategy.pdf), and the World Bank report on the economic implications of AMR (World Bank 2017).

Repository of guidance documents	Health-care without Harm; WHO, UNDP, UNEP, and others	Waste management	Practices for management of healthcare facility waste	N/A	https://noharm-global.org/issues/global/waste-treatment-and-disposal
Risk Analysis for Antimicrobial Resistance Arising from the Use of Antimicrobial Agents in Animals	OIE	Anti-microbial use in agriculture	Guidance on exposure assessment from waste and other sources	2016	http://www.oie.int/index.php?id=169&L=0&htmfile=chapitre_antibio_risk_ass.htm
National Action Plans on Antimicrobial Resistance (AMR)	WHO	Anti-microbial resistance	Country action plans aligned to the strategic objectives of the Global Action plan on AMR that reinforces standards and decisions by WHO, OIE and FAO, which emphasize awareness and understanding, knowledge and evidence base strengthening, reduced infection incidence, optimized use in humans and animals, and the economic case for sustainable investment.	2015	http://www.who.int/antimicrobial-resistance/national-action-plans/en/

Program-Specific Example: *Climate and Health Tools*

Title	Creator	Subject	Description	Date	Link
Climate and Disaster Risk Screening Tools	World Bank	Project enhancement tool	Platform for reviewing projects to integrated and assess climate and disaster risk	Ongoing	https://climatescreeningtools.worldbank.org/
Recovery Hub	Global Facility for Disaster Risk Reduction	Disaster resource platform	Resource library of disaster and health, inclusive of climate and environmental considerations	2017	https://www.gfdr.org/recovery-hub
WHO Country Climate and Health Profiles	World Health Organization	Country level climate and health assessments	Country-specific climate change and health reports detailing impacts, risks, and opportunities	Ongoing	http://www.who.int/globalchange/resources/countries/en/
WHO Climate and Health Resource List	World Health Organization	Tools and knowledge	Resource listing of WHO climate and environment and health reports and operational guidance	Ongoing	http://www.who.int/globalchange/resources/en/
“Investing in Climate Change and Health” series	World Bank	Program and inter-vention tools	Guidance to enable establishing climate and health programs, conduct assessments, determine geographic scope, and supply interventions/tools	2017	http://blogs.worldbank.org/health/connecting-climate-change-and-health-better-development
Reducing Climate-Sensitive Disease Risks	World Bank	Climate-sensitive diseases	Knowledge resource and toolkit for reducing climate sensitive disease risks in humans and animals	2014	http://documents.worldbank.org/curated/en/486511468167944431/Reducing-climate-sensitive-disease-risks

ANNEX 6: A few examples of One Health in Practice

<i>Case Study Example</i>	<i>Core Focus</i>
Integrated surveillance for Rift Valley fever	
<p>Specific weather patterns, in particular El Niño-Southern Oscillation (ENSO) events, have been correlated with outbreaks of Rift Valley fever virus in East Africa. However, outbreaks in West Africa or in the Republic of South Africa (RSA) have not followed a similar pattern, resulting in devastating impacts on animal and human health. To improve understanding of RVF transmission cycle dynamics in the region, an integrated surveillance study was initiated in RSA in 2014 that includes human, livestock, wildlife, mosquito and soil sampling, vegetation indexing, and temperature and precipitation monitoring. Funded by the U.S. Defense Threat Reduction Agency and jointly led by EcoHealth Alliance and the Centre for Emerging and Zoonotic Diseases under the RSA National Institute for Communicable Diseases, the project promotes interdisciplinary collaboration among animal and human health, wildlife, defense, climate, soils, behavior, and ecology experts from national, state, academic, NGO and funder institutions. The anticipated study findings are intended to inform predictive strategies, potentially enabling targeted vaccination and other preventive measures. http://www.ecohealthalliance.org/program/rift-valley-fever</p>	<ul style="list-style-type: none"> -Integrated surveillance -Multi-sectoral collaboration -Prediction and prevention
Early identification of Yellow Fever risks	
<p>Through a collaboration established under the USAID Emerging Pandemic Threats PREDICT project in Bolivia, staff at a wildlife sanctuary near Santa Cruz, Bolivia, reported findings of Howler monkey carcasses. Rapid testing detected a mosquito-borne flavivirus, later identified as Yellow Fever virus, as the cause of the die-offs. Non-human primate mortality from the disease had not been previously reported in the country, but a general awareness of wildlife and zoonotic disease risks and existing collaboration infrastructure between sanctuary staff, university partners, NGOs, and the government prompted effective response. Prevention strategies (human vaccination and awareness campaigns) were implemented, and no humans were infected. In addition to enabling timely conservation responses, monitoring of wildlife can provide a sentinel value to humans and other animals through proactive identification of threats. http://www.vetmed.ucdavis.edu/ohi/local_resources/pdfs/chapters/17_predict_bolivia.pdf</p>	<ul style="list-style-type: none"> -Multi-sectoral collaboration -Awareness -Early detection and risk mitigation response -Sentinel monitoring
Companion Approach for cross-sectoral collaboration in health risks management in SEA – (ComAcross)	

<p>The purpose of this project funded by the European Union is to develop an integrated One Health approach at the Human/Animal/Environment interface in Southeast Asia (Thailand, Laos, Cambodia), using four “model diseases” that will function as case studies. A participatory approach (participatory modeling) will be used to improve the health of Southeast Asian local communities through routine collaboration and communication schemes between One Health (OH) traditional actors (human and animal health sector) and non-traditional actors (natural resources and rural development sector) at local, national and regional level in Southeast Asia. The participatory approach also will establish a self-sustainable OH community of practices attractive to other Southeast Asian countries, starting from existing OH regional and national initiatives to develop an operational and analytic framework for a true multi-sectoral collaboration.</p> <p>http://www.grease-network.org/meetings-workshops2/workshops-meetings/2014/comacross-project-s-kick-off-meeting</p>	<ul style="list-style-type: none"> -Multi-sectoral collaboration -Community-based participatory approach -Information sharing
<p>Four-Way Linking Project to Assess Health Risks at the Human-Animal Interface</p>	
<p>To strengthen national capacity for risk assessment at the human-animal interface, the FAO, OIE and WHO have developed the Four-Way Linking Project. The initiative links across four “streams” of data: epidemiological and laboratory information — including where and when events took place — for both animal and human health to facilitate joint risk assessment. The process involves a review mission and workshop with partners from across the four streams to establish a national-level joint framework for data-sharing, risk assessment and risk communication. It is being implemented in countries with endemic H5N1 avian influenza and associated human cases, with an ultimate goal of a national Four-Way Linking Task Force to sustain the initiative and apply the approach more widely.</p> <p>http://www.who.int/influenza/human_animal_interface/EN_GIP_FourWay_HAI_2013.pdf</p>	<ul style="list-style-type: none"> -Multi-sectoral collaboration -Information sharing -Coordinated risk assessment
<p>One Health Alliance of South Asia (OHASA)</p>	
<p>Comprising scientists and policy makers from wildlife, livestock, and human health sectors representing Bangladesh, India, Nepal and Pakistan, OHASA represents a cohesive network working to develop trans-boundary and interdisciplinary approaches to preventing and controlling zoonotic disease outbreaks such as avian influenza, rabies, and Nipah virus in the region. Communication and cooperation is promoted through meetings, workshops, research and information exchange. Several member countries have also established individual One Health initiatives to address national priorities. For example, Bangladesh has a One Health initiative commissioned under the authority of the government. http://www.ecohealthalliance.org/programs/24-one_health_alliance_of_south_asia_ohasa</p>	<ul style="list-style-type: none"> -Regional and national priorities -Multi-sectoral collaboration -Information sharing
<p>One Health Network South Asia</p>	
<p>The One Health Network-South Asia was created to enhance capacity in epidemiology and biosecurity in the South Asia region. This network is an overarching nexus connecting country-based One Health Hubs, collaborative epidemiological projects, and other collaboration groups across South Asia. The network comprises Bangladesh, Bhutan, India, Sri Lanka, Nepal, Pakistan and Afghanistan.</p> <p>http://www.onehealthnetwork.asia/</p>	<ul style="list-style-type: none"> -Epidemiology education -Multi-sectoral collaboration

One Health Central and Eastern Africa (OHCEA)	
OHCEA was formed in 2011 and is a network of 14 Public Health and Veterinary Higher Education Institutions that are located in six countries in the Eastern and Central African region — Democratic Republic of Congo, Ethiopia, Kenya, Rwanda, Tanzania and Uganda. They work in close collaboration to institutionalize new approaches and training curricula leading to the development of sustainable health systems. http://www.onehealthnetwork.asia/	-High Education -Multi-sectoral collaboration
One Health Strategic Plan in Rwanda	
The Rwanda "One Health Strategic Plan" lays out the role of the One Health Steering Committee, which assumes overall coordination and oversight for implementation of the strategy as drawn explicitly from the nation's HPAI experience. The plan includes an "illustrative" organizational chart that reflects Prime Minister engagement.	-National policy
National Secretariat in Cameroon	
An Arrêté — formalized on June 15, 2015 — creates a permanent secretariat for the national prevention and fight against emerging and re-emerging zoonoses. Technical implementation support comes from USAID Emerging Pandemic Threat partners.	-National policy

Annex 7: Project Indicators

The following examples are extracted from the Regional Disease Surveillance Systems Enhancement Project (REDISSE) (2016-2023) and the Global Program for Avian Influenza Control and Human Pandemic Preparedness and Response (GPAI) (2006-2013), two highly relevant One Health programs. REDISSE, co-led by HNP and Agriculture Global Practices, with climate change a cross-cutting topic, primarily measures project and country-level program objective and intermediate indicators using the Likert scale (1-5) annually over five years, with end targets.

REDISSE Project Indicators⁴⁴

<i>PDO Indicators</i>
Progress towards establishing an active, functional regional One Health platform (Number based on five-point Likert scale)
Laboratory testing capacity for detection of priority diseases: number of countries that achieve a JEE score of 4 or higher (Number)
Progress in establishing indicator and event-based surveillance systems: number of countries that achieve a JEE score of 4 or higher (Number)
Availability of human resources to implement IHR core capacity requirements: number of countries that achieve a JEE score of 3 or higher (Number)
Multi-hazard national public health emergency preparedness and response plan is developed and implemented: number of countries that achieve a JEE score of 4 or higher (Number)
Progress on cross-border collaboration and exchange of information across countries: number of countries that achieve a score of 4 or higher (Number)
<i>Intermediate Indicators</i>
Interoperable, interconnected, electronic real-time reporting system: number of countries that achieve a JEE score of 4 or higher (Number)
Laboratory systems quality: number of countries that achieve a JEE score of 4 or higher (Number)
Surveillance Systems in place for priority zoonotic diseases/pathogens: number of countries that achieve a JEE score of 3 or higher (Number)
Workforce Strategy: number of countries that achieve a JEE score of 4 or higher (Number)
Specimen referral and transport system: number of countries that achieve a JEE score of 4 or higher (Number)
Applied epidemiology training program in place such as FETP: number of countries that achieve a JEE score of 4 or higher (Number)
Systems for efficient reporting to WHO, OIE/FAO: number of countries that achieve a JEE score of 5 (Number)

⁴⁴ See Project Appraisal Document Results Framework for description of indicators:
<http://documents.worldbank.org/curated/en/965001467305866621/Africa-Regional-Disease-Surveillance-Systems-Enhancement-REDISSE-Project>

Mechanisms for responding to infectious zoonoses and potential zoonoses are established and functional: number of countries that achieve a JEE score of 4 or higher (Number)
Veterinary human health workforce: number of countries that achieve a JEE score of 4 or higher (Number)
Regional surge capacity and stockpiling mechanisms established (capacity based on five-point Likert scale)
Number of policy briefings on the status of Disease Surveillance and Response in the region presented at meetings of ECOWAS Heads of State and relevant Ministers (Health, Agriculture, Finance, and Environment)
Turnaround time from date of specimen collection to date of results returned for priority diseases: number of countries with a turnaround time of three days or less (Number)
Citizens and/or communities involved in planning/implementation/evaluation of development programs (Yes/No)
Total number of project beneficiaries and percent female

Table 6.2: Global Program for Avian Influenza Control and Human Pandemic Preparedness and Response (GPAI) Program Indicators⁴⁵

GPAI Program Objective	Outcome Indicators	Use of Outcome Information
To minimize the global threat posed by HPAI infection and other zoonoses in domestic poultry and to prepare for, control and respond to an influenza pandemic and other infectious disease emergencies in humans.	<p>National integrated preparedness, control and response plans prepared and accepted by WHO, OIE and FAO.</p> <p>Improving trend in global poll of experts available to provide technical support for HPAI readiness and response.</p> <p>Contained and diminishing pattern of HPAI infection in poultry and humans.</p>	<p>Preparation of acceptable plans will indicate country, regional, and global preparedness and help gauge where donor support is most needed.</p> <p>Availability of technical experts is key to provide timely and effective support to countries in need.</p> <p>Epidemiological tracking is essential to manage HPAI effectively.</p>
PDO (for country/countries participating in GPAI)	Outcome Indicators	Use of Outcome Information

⁴⁵ Only select indicators are shown; see Program Framework Document for full listing: <http://siteresources.worldbank.org/EXTAVIANFLU/Resources/3124440-1172616705424/Avian-Flu-PAD.pdf>
Per the Program Framework Document, roman numerals refer to component; letters refer to sub-components.

<p>To minimize the threat in _____ (country or countries) posed by HPAI infection and other zoonoses in domestic poultry and prepare for, control and respond to an influenza pandemic and other infectious disease emergencies in humans.</p>	<p>All participating countries have in place national integrated preparedness, control and response plans which are accepted by WHO, OIE and FAO.</p> <p>Increased availability of regional experts able to develop HPAI readiness, control and response systems in individual countries.</p> <p>If infection of HPAI is found in poultry or humans, the infection does not spread beyond the initial area of infection.</p> <p>Decreased morbidity due to infection.</p>	<p>Initial plans of action to be evaluated/endorsed by WHO, OIE and FAO and subject to regular assessment thereafter (*). Regular evaluation will allow for refinement of recommended approaches and adoption of best practice and lessons learned.</p> <p>Eliminating morbidity due to AI infection is a key target of GPAI.</p>
<p>Intermediate Outcome (One per Component)</p>	<p>Intermediate Outcome Indicator (*)</p>	<p>Use of Intermediate Outcome Monitoring</p>
<p>I. Animal Health Component</p>		
<p>Component I.B: Strengthened disease surveillance, diagnostic capacity and virus research among animal population</p>	<p>Animal surveillance activities, applied veterinary research and strategic studies necessary to control and eradicate HPAI in areas at risk designed and completed.</p> <p>100 percent coverage of at-risk areas with operational community-based surveillance networks.</p> <p>75 percent average monitoring coverage in at-risk areas.</p> <p>100 percent monitoring of poultry breeding stock farms.</p>	<p>Degree of annual increase in outcome indicators to be specified in the country-specific strategy. Deviations from targets to be used as indicator of need for program adjustments.</p>
<p>II. Human Health Component</p>		

<p>Component II.B: National public health surveillance systems strengthened</p>	<p>National health surveillance for influenza virus fully developed at national level. Number of at risk regions in the country that have implemented a system for influenza virus surveillance and control. Number of laboratories available for routine influenza diagnosis, typing and sub-typing, rehabilitated and equipped, and with improved biomedical waste management systems. Availability of a laboratory that qualifies as a national influenza center. Number of public health agencies and laboratories with a computerized information and telecommunications systems in place and operational. Number of health personnel trained in influenza virus surveillance and control. Percentage of cases of influenza virus strains confirmed by laboratory analysis. Percentage of influenza virus cases and deaths notified to vital statistics. Percentage of states and local agencies submitting regular weekly and monthly reports on the influenza pandemic.</p>	<p>Degree of annual increase in outcome indicators to be specified in the country-specific strategy. Deviations from targets to be used as indicator of need for program adjustments.</p>
<p>III. Public Awareness and Information Component</p>		
<p>Component III.A: Capacity building for disease control</p>	<p>Public information on the recommended practices for control and eradication of HPAI among key target groups (e.g., poultry producers and their families) developed, tested, and disseminated. National communication strategy for pandemic influenza established and materials and messages prepared. Public information campaign launched in at-risk areas. Evidence of high level of awareness by target groups following dissemination of messages.</p>	<p>Development of a strong, sustainable human resource base is one of the most important objectives of country specific disease control strategies; the component activities will support development of this base.</p>

(*) Evaluation programs of WHO, OIE and FAO to be applied and data on indicators collected through regular assessments/audits by technical and social audit teams to measure attainment of outcomes.

The indicators that follow are from non-World Bank sources, as additional relevant examples to consider when addressing either specific diseases or aspects of strengthening systems under a One Health approach. For example, disease-specific indicators may be useful for assessment; in some cases these may align with existing monitoring to demonstrate value. Based on the disease case studies in Chapter 4, examples of indicators may include:

Table 6.3. Input and Outcome Indicators, Specific Diseases

Disease	Input Indicator	Outcome Indicator	Cost-Benefit Analysis
Brucellosis	Percentage vaccination coverage	Incidence in humans DALYs Livestock disease	-Cost of vaccination + Cost avoidance (trade loss, compensation, human illness, public system response)
Ebola	Surveillance and diagnostic capacity Hunter or conservation animal morbidity/mortality reporting	Time from detection-containment Number of cases, DALYs Early warning (detection of sentinel outbreaks in animals) Deployment of conservation measures	-Cost of sentinel surveillance and laboratory screening -Cost of mitigation actions (if any taken) +Avoided human cases (or early containment) +Avoided conservation losses

Indicators may also be useful for identifying capacity, infrastructure or process gaps to help move toward One Health capacity, though should be highly adapted to specific context:

Table 6.4. Gap Indicators, Specific Diseases (illustrative examples)

Disease	Relevant Context	Gap Indicator(s)	Possible operational indicator(s)
Rift Valley Fever	Where rainfall patterns strongly correlate with RVF risk (e.g. East Africa) Zoonotic transmission pathway(s)	Are climate/weather factor(s) included in risk analysis?	-Collaboration with weather service (e.g. monthly reports received and interpreted) -Vaccination prioritization informed by climate/ weather factors
Ebola virus	Targeting spillover from wildlife (i.e. areas where wildlife presence)	Are wildlife markets surveyed for high-risk species (e.g. bats and non-human primates)? Is there a formal channel/network for reporting wildlife morbidity/mortality events?	-Monthly screen of markets completed -Hunter education delivered to reduce trade in high-risk species -Hunter or ranger participation in reporting program (e.g. number of reports received)

Nipah virus	Targeting spillover from wildlife (i.e. areas where wildlife presence)	Is wildlife included in surveillance?	-Percentage of samples screened for Nipah from wildlife -Collaboration with date palm sap harvesters to mitigate risk (e.g. bamboo coverings)
Yellow Fever virus	Autochthonous transmission	Are entomologists involved in the investigation?	-Number of vector surveillance trips -Vector distribution maps

Tracking other (i.e. non-financial) progress and outcomes may employ existing sectoral tools, adapting those tools for closer integration with sectors, or employing new tools that can span sectors to track outcomes relevant to each. Depending on the goal, the scope of result indicators may be different (e.g. animal health versus human health outcomes). For indicators aligning with specific sectors, e.g. animal, health or environmental health, utilizing intermediate indicators may be useful to track progress as they relate to broader One Health goals (e.g. “use” of the information, process or capacity gained) (Table 6.5).

To ensure sustainable project success, it may also be useful for development and technical institutions (as well as country partners) to evaluate political will prior to project initiation, taking into account factors such as political stability and level of government seniority involved in the process, accompanied by clear milestones.

Table 6.5: Intermediate Outcome Indicators, By Sector

Program Objective	Intermediate Outcome Indicators	Use of Intermediate Outcome Level Information
<i>Animal Health</i>		
Animal health national policy framework defined and national strategy developed to prevent, detect, respond to and recover from priority diseases among the animal population	<ul style="list-style-type: none"> ▪ FAO/OIE approve a generic national policy framework and strategy ▪ Country-specific strategy, human and infrastructure requirements and information systems developed, adopted and disseminated ▪ Country action plan prepared that identifies human and financial resource needs 	<ul style="list-style-type: none"> ▪ Global level consistency and appropriateness assured ▪ Countries will have prepared, adopted and disseminated animal national health policy and action plan
Strengthened disease prevention, detection surveillance, diagnostic capacity and virus research with respect to animal population	<ul style="list-style-type: none"> ▪ Animal surveillance activities, including wildlife, and applied veterinary research and strategic studies undertaken ▪ Operational community-based surveillance network approach developed 	Annual improvement in surveillance capacity targets

Outbreak containment plan prepared	<ul style="list-style-type: none"> ▪ FAO/OIE generic Outbreak Containment Plan approved ▪ Country Outbreak Containment Plan adopted 	Annual improvement in approval and implementation of Outbreak Containment Plan
Outbreak response capacity	<ul style="list-style-type: none"> ▪ Percentage frontline veterinary services staff trained in identification and outbreak responses ▪ Reporting to OIE's World Animal Health Information System 	<ul style="list-style-type: none"> ▪ Veterinary human resource planning and training ▪ Improvement in information management
Farm biosecurity performance improvement	<ul style="list-style-type: none"> ▪ Percentage farms adopting and maintaining biosecurity measures ▪ Percentage farms adopting and maintaining longer term/structural biosecurity improvements 	Systematic farm monitoring reporting
<i>Human Health</i>		
Health sector planning and coordination enhanced to better prevent, detect, respond to and recover from priority diseases emerging from the animal population	<ul style="list-style-type: none"> ▪ Consistent with IHR core capacities, WHO provides basic national strategy concept for human health prevention, detection, preparedness and control of infectious diseases ▪ Country-specific strategies, human and infrastructure requirements and information systems developed, adopted and disseminated ▪ Country action plan prepared which identifies human and financial resource needs 	<ul style="list-style-type: none"> ▪ Global level consistency and appropriateness assured ▪ Countries will have prepared, adopted and disseminated animal national health policy and action plan
Strengthened disease surveillance, diagnostic capacity and virus research with respect to zoonotic diseases	National human health prevention, detection preparedness, and response systems with regard to potential zoonotic outbreaks prepared in accordance with WHO recommendations	(see output indicator section)
<i>Environmental Health</i>		

<p>Environmental national policy framework as it relates to human-animal-health interface defined and national strategy developed to prevent, detect, respond to and recover from priority diseases</p>	<ul style="list-style-type: none"> ▪ Consistent with Environmental safeguards, provide the basis on which countries can more directly address and prevent infectious disease threats related to environmental factors ▪ Country-specific strategies containing policies, objectives, approach, and responsible entities, information systems, and monitoring and evaluation system, developed, adopted and disseminated ▪ Country action plan prepared that identifies human, infrastructure and financial resource needs (e.g. as part of National Biodiversity Strategies and Action Plans, National Adaptation Plans) 	<p>Systematic inclusion of disease risk in planning processes (e.g. land use)</p>
<p>Strengthen understanding and response options of major environmental factors bearing on zoonotic disease transmission</p>	<p>National environmental zoonotic health prevention, detection preparedness, and response systems, integrated into other environmental activities, based on analysis</p> <p>Disease risk included in environmental and social impact assessments (and/or vice versa)</p>	<p>Countries prepare, adopt and disseminate zoonotic disease-related policies and action plan to be implemented in conjunction with or as part of other environmental objectives and consistent with environmental safeguards</p>

Annex 8: Safeguards and relevance to One Health

The Global Program for Avian Influenza Control and Human Pandemic Preparedness and Response (GPAI)

The most widespread safeguard applications are found within the GPAI experience. Because construction was not involved, nor a number of other safeguards, the experience provides an incomplete picture for what may be the case in new World Bank projects and programs in human/animal/environmental health. For instance, should new construction of laboratories, treatment centers or abattoirs be required, or, if land use becomes a factor or there is need to resettle populations to prevent or contain an outbreak, should such actions could trigger existing safeguard environmental and social assessment and management.

The “Program Framework Document for a Global Program for Avian Influenza Control and Human Pandemic Preparedness and Response” (GPAI) approved in 2005,⁴⁶ was available to all countries eligible to borrow from the World Bank, in all regions. The programmatic document for all activities identified one safeguard policy to be triggered by this multi-country effort, namely the Assessment and Management of Environmental and Social Risks (OP/BP/GP 4.01). This required significant undertakings by World Bank recipients as spelled out in an Environmental and Social Commitment Plan (ESCP), sometimes combined/referred to as an Environmental and Social Management Plan (ESMP or EMP),

⁴⁶ Report No. 34386

setting out the measures and component actions that have been agreed upon over a specified timeframe.⁴⁷ The assessment on which the Plan is based will “...identify ways...to prevent, minimize, mitigate, or compensate for adverse environmental and social impacts and enhance the positive impacts of the project.”^{48,49} Plans will vary from project to project, depending on multiple factors, including sectoral and regional impact. All GPAI supported countries dealt with OP/BP/GP 4.01, and the ESMP typically addressed two major aspects; namely i) animal health to avoid inadvertent spread during culling, transport of carcasses, animal waste and disinfectant waste management, commensurate veterinary services and poultry worker training in safe-handling procedures; and ii) human health aspects through support to diagnostic laboratories and medical facilities and staff training, vaccine distribution, handling of medical waste, tracking problems or problems in management. Some countries went further; Argentina added the Indigenous Peoples safeguard and produced an Indigenous Peoples Planning Framework (OP 4.10), while West Bank-Gaza included a Pesticide Management safeguard (OP 4.09) for any pesticide procured.

2012-2016 World Bank Safeguard Review Process

The World Bank environmental and social safeguard policies are mostly horizontally structured as stand-alone Operating Policies (OPs) and corresponding World Bank Procedures (BPs). Guidance documents are issued in an *ad hoc* manner on a need basis. Most other MDB safeguard policies are structured in a more hierarchical and integrated manner with an over-arching policy statement, governing principles and subsidiary operational safeguard requirements, consolidated environmental and social review procedures and corresponding guidance documents. For example, the African Development Bank has issued its Integrated Safeguards System (ISS) that embraces an over-arching policy statement and sets forth the key principles to which it holds itself accountable (“Comparative Review of Multilateral Development Bank Safeguard Systems”, Harvey Himberg, World Bank Operations Policy and Country Services, pp.2-3, May 2015).

Existing language in virtually all MDB safeguard systems is ambiguous as to whether the kinds of risks and impacts resulting from the absence of a plan to prevent, detect, respond to and recover from a significant infectious disease outbreak, consistent with International Health Regulations (IHR) and its core capabilities, would be explicitly an appropriate safeguard subject. All WHO State Parties approved the IHR, and thus it could be considered a national commitment to make human and animal health system improvements over a specific timeframe. (Commitments for IHR-related activities would include an effective organizational structure, and the needed laboratory, personnel and systems for monitoring infectious disease outbreaks and system performance.)

In 2012 the World Bank launched a multi-phased process to review and update its safeguard policies in order to create a more integrated safeguards framework, one that distinguishes principles from policies from procedures; enhances policy clarity and coherence; clarifies objectives and desired outcomes; improves synergy across policies; consolidates fragmented or duplicative policies; streamlines guidance, and better delineates roles and responsibilities of the World Bank and the Borrower. The objective was to strengthen the ability to monitor and supervise actual impacts on people and the environment, and to better meet the varied needs of Borrowers and help strengthen country frameworks and institutions to deliver sustainable results on the ground. This multi-year consultation process culminated in a proposal presented to the Committee on Development Efficiency in mid-2015, finalized in mid-2016, and planned for implementation in 2018. The revision package benefited from examining how other MDBs have

⁴⁷ Environmental and Social Standard 1. Assessment and Management of Environmental and Social Risks and Impacts, Draft for Consultation July 30, 2014 pages 5-64 and footnotes, et.seq.

⁴⁸ *Ib. Cit.* Page 6 paragraph 22

⁴⁹ Environmental and Social Standard 1. Assessment and Management of Environmental and Social Risks and Impacts, Draft for Consultation July 30, 2014 pages 5-64 and footnotes, et.seq.

modified or comprehensively revised their safeguard policies and, in the process, introduced additional operational requirements to assess and manage the risk associated with development assistance.

Existing policies under review included the prior eight environmental and social safeguard policies, namely: OP 4.01 Environmental Assessment, OP 4.04 Natural Habitats, OP 4.09 Pest Management, OP 4.10 Indigenous Peoples, OP 4.11 Physical Cultural Resources, OP 4.12 Involuntary Resettlement, OP 4.36 Forests, OP 4.37 Safety of Dams — as well as the Policy on Piloting the Use of Borrower Systems for Environmental and Social Safeguards (“Use of Country Systems”), OP 4.00. Most importantly for human-animal-environment interface activities are new areas that were adopted: as part of its safeguard review and update process, the World Bank addressed a number of emerging areas not covered by the prior safeguard policies. These include: climate change; disability; free, prior and informed consent of Indigenous People; gender; human rights; labor and occupational health and safety; and land tenure and natural resources. Environmental Management Plans and companion Action Plans will remain critical for both existing and prospective safeguard policy management. (The new set of safeguards has some similarities with what has been in place for the IFC since 2012.)⁵⁰

ESS4. Community Health and Safety

□ Ecosystem Services

The project’s direct impacts on ecosystem services may result in adverse health and safety risks to and impacts on affected communities. With respect to this ESS, ecosystem services are limited to provisioning and regulating services as defined in ESS1. Where appropriate and feasible, the Borrower will identify the project’s potential risks and impacts on ecosystem services that may be exacerbated by climate change. Adverse impacts will be avoided, and if they are unavoidable, the Borrower will implement appropriate mitigation measures.

[Ecosystem services that benefit health are wide-ranging, including natural resource provision — water, food, therapeutics, carbon sequestration to mitigate climate change, disease regulation, and more. Their loss may have significant and persistent economic burden, especially on local communities. One Health collaborations are necessary for understanding the spectrum of relevant ecosystem services, both in the short and long-term, to reduce negative externalities on local communities and globally]

□ Community Exposure to Health Issues

The Borrower will avoid or minimize the potential for community exposure to water-borne, water-based, water-related, and vector-borne diseases, and communicable and non-communicable diseases that could result from project activities, taking into consideration differentiated exposure to and higher sensitivity of vulnerable groups. Where specific diseases are endemic in communities in the project area, the Borrower is encouraged to explore opportunities during the project life-cycle to improve environmental conditions that could help minimize their incidence.

The Borrower will take measures to avoid or minimize transmission of communicable diseases that may be associated with the influx of temporary or permanent project labor.

[While zoonotic diseases are not specifically mentioned, in theory they are captured under “communicable” diseases. Influx of workers for employment activities could be associated with zoonotic disease risk factors such as changing food demands, including bushmeat hunting and trade or intensified animal agriculture without proper biosecurity, changes in human-domestic/feral/pest/wild animal contact, changes in waste management and attraction of pests]

□ Emergency Preparedness and Response

The Borrower will identify and implement measures to address emergency events. An emergency event is

⁵⁰ IFC Performance Standards on Environmental and Social Sustainability, http://www.ifc.org/wps/wcm/connect/115482804a0255db96fbffd1a5d13d27/PS_English_2012_Full-Documents.pdf?MOD=AJPERES

an unanticipated incident, arising from both natural and man-made hazards, typically in the form of fire, explosions, leaks or spills, which may occur for a variety of different reasons, including failure to implement operating procedures that are designed to prevent their occurrence, extreme weather or lack of early warning. The measures will be designed to address the emergency event in a coordinated and expeditious manner, to prevent it from injuring the health and safety of the community, and to minimize, mitigate and compensate for any impacts that may occur.

Borrowers engaged in projects having the potential to generate emergency events will conduct a risk hazard assessment (RHA), as part of the environmental and social assessment undertaken pursuant to ESS1. Based on the results of the RHA, the Borrower will prepare an Emergency Response Plan (ERP) in coordination with the relevant local authorities and the affected community, and will take into account the emergency prevention, preparedness and response arrangements put into place with project workers under ESS2.

An ERP will include, as appropriate: (a) engineering controls (such as containment, automatic alarms, and shut-off systems) proportionate to the nature and scale of the hazard; (b) identification of and secure access to emergency equipment available on-site and nearby; (c) notification procedures for designated emergency responders; (d) diverse media channels for notification of the affected community and other stakeholders; (e) a training program for emergency responders including drills at regular intervals; (f) public evacuation procedures; (g) designated coordinator for ERP implementation; and (h) measures for restoration and clean-up of the environment following any major accident.

The Borrower will document its emergency preparedness and response activities, resources and responsibilities, and will disclose appropriate information, as well as any subsequent material changes thereto, to affected communities, relevant government agencies, or other relevant parties. The Borrower will assist and collaborate with affected communities, relevant government agencies and other relevant parties in their preparations to respond effectively to an emergency event, especially where their participation and collaboration will be an important part of an effective response.

The Borrower will review the ERP on a regular basis, and confirm that it is still capable of addressing the potential range of emergency events that might arise in connection with the project. The Borrower will support affected communities, relevant government agencies and other relevant parties through training and collaboration, and will conduct such training in conjunction with the training provided to project workers as part of the OHS requirements under ESS2.

ESS6. Biodiversity Conservation and Sustainable Management of Living Natural Resources

□ Conservation of Biodiversity and Habitats

In areas of critical habitat, the Borrower will not implement any project activities that have potential adverse impacts unless all of the following conditions are met:

(g) A robust and appropriately designed, long-term biodiversity monitoring and evaluation program aimed at assessing the status of the critical habitat is integrated into the Borrower's management program. *[Could inform, or include, wildlife disease morbidity and mortality monitoring for conservation and sentinel human and agricultural animals]*

□ Invasive Alien Species

Intentional or accidental introduction of alien, or non-native, species of flora and fauna into areas where they are not normally found can be a significant threat to biodiversity, since some alien species can become invasive, spreading rapidly and destroying or out-competing native species.

The Borrower will not intentionally introduce any new alien species (not currently established in the country or region of the project) unless this is carried out in accordance with the existing regulatory framework for such introduction. Notwithstanding the above, the Borrower will not deliberately introduce any alien species with a high risk of invasive behavior regardless of whether such introductions are permitted under the existing regulatory framework. All introductions of alien species will be subject to a risk assessment (as part of the Borrower's environmental and social assessment) to determine the potential for invasive behavior. The Borrower will implement measures to avoid the potential for

accidental or unintended introductions including the transportation of substrates and vectors (such as soil, ballast, and plant materials) that may harbor alien species.

Where alien species are already established in the country or region of the proposed project, the Borrower will exercise diligence in not spreading them into areas in which they have not already become established. Where feasible, the Borrower will take measures to eradicate such species from the natural habitats over which the Borrower has management control.

[Invasive species may be vectors for disease and may contribute to degradation of ecosystems. In accordance with the IHR, port of entry surveillance may be warranted and may involve coordination between sectors to identify hazards and manage risk. Control and eradication measures should also consider potential effects on the health of people, agriculture and food supply, and the environment, in addition to the target species]

□ ***Sustainable Management of Living Natural Resources***

Where the project includes commercial agriculture and forestry plantations (particularly projects involving land clearing or afforestation), the Borrower will locate such projects on land that is already converted or highly degraded (excluding any land that has been converted in anticipation of the project). In view of the potential for plantation projects to introduce invasive alien species and threaten biodiversity, such projects will be designed to prevent and mitigate these potential threats to natural habitats. When the Borrower invests in production forestry in natural forests, these forests will be managed sustainably.

ESS10. Stakeholder Engagement and Information Disclosure

□ ***Requirements***

Borrowers will engage with stakeholders throughout the project life-cycle, commencing such engagement as early as possible in the project development process and in a timeframe that enables meaningful consultations with stakeholders on project design. The nature, scope and frequency of stakeholder engagement will be proportionate to the nature and scale of the project and its potential risks and impacts. Borrowers will engage in meaningful consultations with all stakeholders. Borrowers will provide stakeholders with timely, relevant, understandable and accessible information, and consult with them in a culturally appropriate manner, which is free of manipulation, interference, coercion, discrimination and intimidation.

The process of stakeholder engagement will involve the following, as set out in further detail in this ESS: (i) stakeholder identification and analysis; (ii) planning how the engagement with stakeholders will take place; (iii) disclosure of information; (iv) consultation with stakeholders; (v) addressing and responding to grievances; and (vi) reporting to stakeholders.

GLOSSARY

Biosecurity: a strategic and integrated approach that encompasses the policy and regulatory frameworks (including instruments and activities) that analyze and manage risks in the sectors of food safety, animal life and health, and plant life and health, including associated environmental risk. Bio-security covers the introduction of plant pests, animal pests and diseases, and zoonoses; the introduction and release of genetically modified organisms (GMOs) and their products; and the introduction and management of invasive alien species and genotypes. Bio-security is a holistic concept of direct relevance to the sustainability of agriculture, food safety, and the protection of the environment, including biodiversity. (FAO 2003)

Ecosystem: dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. (CBD)

Ecosystem Approach: strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. (CBD)

Ecosystem services: the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth. (UNEP)

Emerging Disease: one that has appeared in a population for the first time, or that may have existed previously but is rapidly increasing in incidence or geographic range. (WHO)

Endemic: a disease that is constantly present to a greater or lesser degree in people of a certain class or in people living in a particular location. (World Bank 2012)

Environment: the sum of all external conditions affecting the life, development and survival of an organism. Environment refers to the physical conditions that affect natural resources (climate, geology, hazards) and the ecosystem services that sustain them (e.g. carbon, nutrient and hydrological cycles). (UNEP)

Epidemic: when new cases of a disease, in a given human population and during a given period, substantially exceed what is expected based on recent experience. The disease is not required to be communicable. (World Bank 2012)

Health Security: global health security indicates the prevention of avoidable epidemics, detection of threats early, and responding rapidly and effectively. (World Bank 2017)

One Health (OH): One Health recognizes that the health of people is connected to the health of animals and the environment. The goal of One Health is to encourage the collaborative efforts of multiple disciplines and sectors — working locally, nationally, regionally and globally — to achieve optimal **health for people and animals, and our environment (CDC)**,⁵¹ PAHO defines the One Health approach as a concept that requires inter-sectoral, inter-programmatic and interdisciplinary governance of initiatives needed to promote and protect the health of people, animals and the environment in an integrated manner. *OH Operational Framework-specific definition: a collaborative approach for strengthening systems to prevent, prepare, detect, respond to and recover from infectious diseases and related public health*

⁵¹Please see Annex 2 for further discussion of One Health and related terms.

threats such as antimicrobial resistance that threaten human health, animal health and environmental health, collectively, using tools such as surveillance and reporting with an endpoint of improving global health security and achieving gains in development. While using infectious diseases/AMR as a starting point, we recognize this definition and approach is expandable for a wider scope (e.g. water and soil pollution which have animal and environment connections)

Operational continuity: ability of a system to continue working despite damages, losses or critical events. Arrangements for operational continuity are one of the main concerns of pandemic preparedness. Somewhat different is **Business continuity**, which may require stopping operations in order for the firm to survive.

Pandemic: an epidemic of infectious disease that is spreading through human populations across a large region — for instance, a continent, or even worldwide. (World Bank 2012)

Preparedness: state of readiness to respond to an event. Process of ensuring that an organization (1) has complied with the preventive measures, (2) is in a state of readiness to contain the effects of a forecasted disastrous event to minimize loss of life, injury, and damage to property, (3) can provide rescue, relief, rehabilitation and other services in the aftermath of the disaster, and (4) has the capability and resources to continue to sustain its essential functions without being overwhelmed by the demand placed on them. Preparedness for the first and immediate response is called emergency preparedness

Pandemic preparedness: state of readiness to respond to a pandemic (i.e., an epidemic that has already spread in a large region, or even worldwide).

Public Health systems: all public, private and voluntary entities that contribute to the delivery of essential public health services within a jurisdiction. (CDC 2014)

OH Operational Framework-specific definition: all public, private and voluntary entities that contribute to the delivery of human, animal or environmental health, whether at local, national or global scale.

Stakeholder: a stakeholder is any entity with a declared or conceivable interest or stake in a policy concern. The range of stakeholders relevant to consider for analysis varies according to the complexity of the reform area targeted, the type of reform proposed and, where the stakeholders are not organized, the incentive to include them. Stakeholders can be of any form, size and capacity. They can be individuals, organizations, or unorganized groups. In most cases, stakeholders fall into one or more of the following categories: international actors (e.g. donors), national or political actors (e.g. legislators, governors), public sector agencies (e.g. MDAs), interest groups (e.g. unions, medical associations), commercial/private for-profit, nonprofit organizations (NGOs, foundations), civil society members, and users/consumers. (World Bank)

Zoonosis (plural - Zoonoses): any disease or infection that is naturally transmissible between animals and humans. (adapted from OIE, WHO)

REFERENCES

- Aagaard-Hansen, J. and Chaignat, C.L. (2010) Neglected tropical diseases: equity and social determinants. IN: Equity, social determinants and public health programmes (Ed. Blas B and Kurup AS). World Health Organization. pp.135-157.
- Allen, H.K., Donato, J., Wang, H.H., Cloud-Hansen, K.A., Davies, J., Handelsman, J. (2010) Call of the wild: antibiotic resistance genes in natural environments. *Nature reviews. Microbiology* 8(4):251-259.
- Alonso E, Lopez-Etxaniz I, Hurtado A, Liendo P, Urbaneja F, Aspiritxaga I, et al. (2015) Q Fever Outbreak among Workers at a Waste-Sorting Plant. *PLoS ONE* 10(9): e0138817. doi:10.1371/journal.pone.0138817
- Anthony SJ et al. (2013) A Strategy to Estimate Unknown Viral Diversity in Mammals. *mBio*. 4(5): e00598-13.
- Archer et al. (2013) Epidemiologic Investigations into Outbreaks of Rift Valley Fever in Humans, South Africa, 2008–2011. *Emerging Infectious Diseases*. 19(12): 1918–1925.
- Barrett, M. and Bouley, T.A. (2015) Need for Enhanced Environmental Representation in the Implementation of One Health. *Ecohealth*. 12(2):212-9. doi: 10.1007/s10393-014-0964-5.
- BioERA/Newcomb et al. (2011) Economic Impact of Selected Diseases.
- Blehert, D.S., Hicks, A.C., Behr, M., Meteyer, C.U., Berlowski-Zier, B.M., Buckles, E.L., Coleman, J.T.H., Darling, S.R., Gargas, A., Niver, R., Okoniewski, J.C., Rudd, R.J., and Stone, W.B. (2009) Bat white-nose syndrome: an emerging fungal pathogen?: *Science*, v. 323, no. 5911, p. 227,
- Bonds, M.H., Dobson, A.P. and Keenan, D.C. (2012) Disease Ecology, Biodiversity, and the Latitudinal Gradient in Income. *PLoS Biol* 10(12):e1001456.
- Bouley, Timothy; Roschnik, Sonia; Karliner, Josh; Wilburn, Susan; Slotterback, Scott; Guenther, Robin; Orris, Peter; Kasper, Toby; Platzer, Barbara Louise; Torgeson, Kris. (2017) *Climate-smart healthcare : low-carbon and resilience strategies for the health sector*. Investing in climate change and health series. Washington, D.C.: World Bank Group.
<http://documents.worldbank.org/curated/en/322251495434571418/Climate-smart-healthcare-low-carbon-and-resilience-strategies-for-the-health-sector>
- Bouley, Timothy; Gilbert, Marius; Whung, Pai-Yei; Gall, Francois Le; Plante, Caroline (2014) *Reducing climate-sensitive disease risks*. Agriculture and environmental services discussion paper ; no. 7. Washington, DC; World Bank Group.
<http://documents.worldbank.org/curated/en/486511468167944431/Reducing-climate-sensitive-disease-risks>
- Boyles, J.G., Cryan, P.M., McCracken, G.F., and Kunz, T.H. (2011) Economic importance of bats in agriculture: *Science*, v. 332, no. 6025, p. 41-42,
- Brahmbhatt, M. and Jonas, O. (2015) International Cooperative Responses to Pandemic Threats: A Critical Analysis the *Brown Journal of World Affairs*, Spring/Summer 2015, Volume XXI, Issue II.

- Buschmann AH, Tomova A, Lopez A, Maldonado MA, Henriquez LA, et al. (2012) Salmon Aquaculture and Antimicrobial Resistance in the Marine Environment. *PLoS ONE* 7(8): e42724. doi:10.1371/journal.pone.0042724
- Butler, D. (2012) Flu surveillance lacking. *Nature* 483(7391): 520–522.
- CDC. (2011) Operationalizing “One Health”: A Policy Perspective- Taking Stock and Shaping an Implementation Roadmap. Meeting Overview, May 4-6 2010, Stone Mountain, Georgia.
- Commission on a Global Health Risk Framework for the Future, National Academy of Medicine, Secretariat. The neglected dimension of global security: a framework to counter infectious disease crises. Washington, D.C.: National Academies Press; 2016.
Available: <http://www.nap.edu/catalog/21891>
- Costa F, Hagan JE, Calcagno J, Kane M, Torgerson P, Martinez-Silveira MS, et al. (2015) Global Morbidity and Mortality of Leptospirosis: A Systematic Review. *PLoS Negl Trop Dis* 9(9): e0003898. doi:10.1371/journal.pntd.0003898
- Conteh, L., Engels, T., Molyneux, D.H. (2010) Socioeconomic aspects of neglected tropical diseases. *Lancet* 375(9710):239-247.
- Davis, M.F., Price, L.B., Liu, C.M., Silbergeld, E.K. (2011) An ecological perspective on U.S. industrial poultry production: the role of anthropogenic ecosystems on the emergence of drug-resistant bacteria from agricultural environments. *Current opinion in microbiology* 14(3):244-250.
- DFID and GalvMED (2010) DFID Research: Protecting African cattle from East Coast fever. https://www.ard-europe.org/fileadmin/SITE_MASTER/content/eiard/Documents/Impact_case_studies_2010/dfid_impact_case_study_eaf - april 2010.pdf
- European Union (2010) Outcome and Impact Assessment of the Global Response to the Avian Influenza Crisis, 2005-2010.
- FAO (2002) Manual on the Diagnosis of Nipah Virus Infection in Animals. Chapter 1: The emergence of Nipah virus. Regional Office for Asia and the Pacific.
- FAO (2012) Livestock sector development for poverty reduction: an economic and policy perspective – Livestock’s many virtues, by J. Otte, A. Costales, J. Dijkman, U. Pica-Ciamarra, T. Robinson, V. Ahuja, C. Ly and D. Roland-Holst. Rome, pp. 161.
- FAO, OIE, WHO, UN System Influenza Coordination, UNICEF, World Bank (2008) *Contributing to One World, One Health- A strategic framework for reducing risks of infectious diseases at the animal- human- ecosystems interface*. Strategic framework requested by the Ministerial Conference in New Delhi in December 2007, welcomed by the Ministerial Conference in Sharm El-Sheikh in October 2008, and urged for implementation by the Ministerial Conference in Hanoi in April 2010.
- FAO, OIE, WHO (2010) - Sharing responsibilities and coordinating global activities to address health risks at the animal-human-ecosystems interfaces - A Tripartite Concept Note, April 2010.
- Georgiev M, Afonso A, Neubauer H, Needham H, Thiéry R, Rodolakis A, Roest HJ, Stärk KD, Stegeman JA, Vellema P, van der Hoek W, More SJ. (2013) Q fever in humans and farm animals in four

- European countries, 1982 to 2010. *Euro Surveill.* 18(8):pii=20407. Available online: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20407>
- Gilchrist, M.J., Greko, C., Wallinga, D.B., Beran, G.W., Riley, D.G., Thorne, P.S. (2007) The potential role of concentrated animal feeding operations in infectious disease epidemics and antibiotic resistance. *Environmental health perspectives* 115(2):313-316.
- Global Facility for Disaster Risk Reduction. (2017) Guidance Note for Post-Disaster Health Sector Recovery. PAHO, WHO, IRP and World Bank.
- Godfroid, J., Garin-Bastuji, B., Saegerman, C. & Blasco, J.M. (2013) Brucellosis in terrestrial wildlife. *Rev. sci. tech. Off. int. Epiz.*, 2013, 32 (1), 27-42
- Grace, D., Mutua, F., Ochungo, P., Kruska, R., Jones, K., Brierley, L., Lapar, L., Said, M., Herrero, M., Phuc, P.M., Thao, N.B., Akuku, I., Ogotu, F. (2012) "Mapping of poverty and likely zoonoses hotspots." International Livestock Research Institute (ILRI). July 2012.
- Grace, D. (2014) The Business Case for One Health. *Onderstepoort Journal of Veterinary Research* 81(2) Art#725, 6 pages. <http://dx.doi.org/10.4102/ojvr.v81i2.725>
- Häsler B, Hiby E, Gilbert W, Obeyesekere N, Bennani H, Rushton J (2014) A One Health Framework for the Evaluation of Rabies Control Programmes: A Case Study from Colombo City, Sri Lanka. *PLoS Negl Trop Dis* 8(10): e3270.
- Hernandez-Mora, G., Palacios-Alfaro, J.D., and Gonzalez-Barrientos, R. (2013) Wildlife reservoirs of brucellosis: *Brucella* in aquatic environments. *Rev Sci Tech.* 2013 Apr;32(1):89-103.
- Hermans T, Jeurissen L, Hackert V, Hoebe C (2014) Land-Applied Goat Manure as a Source of Human Q-Fever in the Netherlands, 2006–2010. *PLoS ONE* 9(5): e96607. doi:10.1371/journal.pone.0096607
- Heuer, H., Schmitt, H., Smalla, K. (2011) Antibiotic resistance gene spread due to manure application on agricultural fields. *Current opinion in microbiology* 14(3):236-243.
- Hotez, P.J., Alvarado, M., Basanez, M.G., et al. (2014) The global burden of disease study 2010: interpretation and implications for the neglected tropical diseases. *PLoS neglected tropical diseases* 8(7):e2865.
- IATA (May 2006) Economic Briefing – Avian Flu. <http://www.iata.org/publications/economic-briefings/Avian-Flu-Impact.pdf>
- Institute of Medicine (IOM) (2009) Sustaining global surveillance and response systems for emerging zoonotic diseases. Washington, DC. National Research Council.
- Institute of Medicine (US) Committee on Emerging Microbial Threats to Health in the 21st Century. (2003) Microbial Threats to Health: Emergence, Detection and Response. Smolinski MS, Hamburg MA, Lederberg J, editors. Washington, D.C.
- Jonas, Olga (2014) Pandemic Risk. Finance and Development (International Monetary Fund), 16-17.
- Jonas, Olga (2013) Pandemic Risk, (Washington DC: World Bank World Development Report Background Paper), 10–11.

- Jonas, Olga; Warford, Lucas (2014) Global Program for Avian Influenza Control and Human Pandemic Preparedness and Response: Project Accomplishments. World Bank Group, Washington, DC. <https://openknowledge.worldbank.org/handle/10986/21541> License: CC BY 3.0 IGO
- Jones, K.E, Patel, N.G., Levy, M., Storeygard, A., Balk, D., Glitterman, J.L., and P. Daszak (2008) “Global Trends in Emerging Infectious Diseases.” *Nature* 451: 990-993.
- Kahn, L. (2012) The One Health Solution. Bulletin of the Atomic Scientists, a short article available at <http://thebulletin.org/web-edition/columnists/laura-h-kahn/the-one-health-solution>
- Leroy, E. M., Rouquet, P., Formenty, P., Souquiere, S., Kilbourne, A., Froment, J. M., . . . Rollin, P. E. (2004) Multiple Ebola virus transmission events and rapid decline of central African wildlife. *Science*, 303(5656), 387-390. doi:10.1126/science.1092528
- Lindahl J, Robinson T, Bett B and Grace D. (2016) Rift Valley Fever and the Changing Environment: a Case Study in East Africa. (2016) Rift Valley fever and the changing environment: A case study in East Africa. In: Bouzid, M. Examining the role of environmental change on emerging infectious diseases and pandemics. Hershey, PA: IGI Global: 178–204.
- Livestock Global Alliance (2016) Livestock for Sustainable Development in the 21st Century. <http://www.livestockglobalalliance.org/wp-content/uploads/2016/05/LGA-Livestock-for-SDGs.pdf>
- Loh, E. H., Olival, K. J., Zambrana-Torrel, C., Bogich, T. L., Johnson, C. K., Mazet, J. A. K., & Daszak, P. et al. (2015) Targeting transmission pathways for emerging zoonotic disease surveillance and control. *Vector Borne and Zoonotic Diseases*, 15(7), 432–437.
- Looi, L.M., Chua, K.B. (2007) Lessons from the Nipah virus outbreak in Malaysia. *Malays. J. Pathol.* 29, 63–67.
- Luby, S. P., Gurley, E. S., & Hossain, M. J. (2009) Transmission of human infection with Nipah virus. *Clin Infect Dis*, 49(11), 1743-1748. doi:10.1086/647951
- Karesh, W.B., Dobson, A., Lloyd-Smith, J.O., Lubroth, J., Dixon, M.A., Bennett, M., Aldrich, S., Harrington, T., Formenty, P., Loh, E.H., Machalaba, C.C., Thomas, M.J., Heymann, D.L. (2012) Ecology of zoonoses: natural and unnatural histories. *The Lancet* 380(9857): 1936-1945
- Machalaba, C, Kristine Smith, Lina Awada, Kevin Berry, Franck Berthe, Timothy A. Bouley, Mieghan Bruce, Jose Cortiñas Abrahantes, Anas El Turabi, Yasha Feferholz, Louise Flynn, Guillaume Fournié, Amanda Andre, Delia Grace, Olga Jonas, Tabitha Kimani, François Le Gall, Juan Jose Miranda, Marisa Peyre, Julio Pinto, Noam Ross, Simon Ruegg, Robert H. Salerno, Richard Seifman, Carlos Zambrana-Torrel, William B. Karesh (2017). One Health Economics to Confront Disease Threats. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 111(2):235-237.
- Margalida, A., Bogliani, G., Bowden, C. G., Donazar, J. A., Genero, F., Gilbert, M. et al. (2014) Science and regulation. One Health approach to use of veterinary pharmaceuticals. *Science*, 346(6215), 1296-1298
- Marsh, T.L., J. Yoder, T. Deboch, T. F. McElwain, G. H. Palmer. (2016) Livestock vaccinations translate into increased human capital and school attendance by girls. *Science Advances*, 2 (12): e1601410

- Marshall, B.M., Levy, S.B. (2011) Food animals and antimicrobials: impacts on human health. *Clinical microbiology reviews* 24(4):718-733.
- Meiro-Lorenzo, Montserrat; Bouley, Timothy; Kleiman, Gary; Osewe, Patrick Lumumba; Rabie, Tamer Samah; Seifman, Richard M.; Wang, Hui. (2017a) *Climate change and health approach and action plan*. Investing in climate change and health series. Washington, D.C. : World Bank Group. <http://documents.worldbank.org/curated/en/421451495428198858/Climate-change-and-health-approach-and-action-plan>
- Minjauw B, McLeod A (2003) Tick-borne diseases and poverty. The impact of ticks and tick-borne diseases on the livelihood of small-scale and marginal livestock owners in India and eastern and southern Africa. Research report, DFID Animal Health Programme, Centre for Tropical Veterinary Medicine, University of Edinburgh, UK
- Molyneux, D., Hallaj, Z., Keusch, G.T., et al. (2011) Zoonoses and marginalised infectious diseases of poverty: where do we stand? *Parasites & vectors* 4:106.
- Morse SS., Mazet JAK., Woolhouse M., Parrish CR, et al. (2012) Prediction and prevention of the next pandemic zoonosis. *The Lancet* 380:1956–1965.
- Myhre Errecaborde K et al. (2017) Piloting the One Health Systems Mapping and Analysis Resource Toolkit in Indonesia. *EcoHealth*. 14(1).
- National Academy of Medicine (2017) Building capacity to counter infectious disease threats. Workshop Summary. <http://www.nationalacademies.org/hmd/Reports/2017/building-communication-capacity-to-counter-infectious-disease-threats-proceedings.aspx>
- Nichols E, Spector S, Louzada J, Larsen T, Amezquita S, et al. (2008) Ecological functions and ecosystem services provided by Scarabaeinae dung beetles. *Biological Conservation* 141: 1461–1474.
- Ng CW, Choo WY, et al. (2009) Long-term socioeconomic impact of the Nipah Virus encephalitis outbreak in Bukit Pelanduk, Negeri Sembilan, Malaysia: A mixed methods approach. *Neurology Asia*; 14(2) : 101 – 107
- OIE (2015) Communication Handbook- Veterinary Services. http://www.oie.int/fileadmin/home/eng/Media_Center/docs/pdf/EN_Guide_de_Communication_FIN_AL.pdf
- Olaitan AO, Chabou S, Okdah L, Morand S, and Rolain JM. (2016) Dissemination of the mcr-1 colistin resistance gene. *Lancet Infectious Disease*. 16(2):147.
- Olson, SH et al. (2012) Dead or alive: animal sampling during Ebola hemorrhagic fever outbreaks in humans. *Emerging Health Threats Journal* 5 (2012).
- Pappas, G., Papadimitriou, P., Akritisis, N, Christou, L., Tsianos, EV. (2006) The new global map of human brucellosis. *Lancet Infectious Diseases*. 6(2):91-9.
- Peyre M. et al. (2015) A Systematic Scoping Study of the Socio-Economic Impact of Rift Valley Fever: Research Gaps and Needs. *Zoonoses and Public Health*. 62(5): 309–325.

- Picardeau M. (2015) Leptospirosis: Updating the Global Picture of an Emerging Neglected Disease. *PLoS NTD*. 9(9): e0004039.
- Pike, J., Bogich, T., Elwood, S., Finnoff, D.C., Daszak, P. (2014) Economic optimization of a global strategy to address the pandemic threat. *Proceedings of the National Academy of Sciences of the United States of America* 111(52):18519-18523.
- Rassy D and Smith RD. (2013) The economic impact of H1N1 on Mexico's tourist and pork sectors. *Health Economics*. 22(7): 824–834.
- Reed, PE, Mulangu, S, Cameron, KN, Ondzie, AU, Joly, D, Bermejo, M, et al. (2014) A New Approach for Monitoring Ebolavirus in Wild Great Apes. *PLoS Negl Trop Dis* 8(9): e3143. doi:10.1371/journal.pntd.0003143
- Reeder, DM, Frank CL, Turner GG, Meteyer CU, Kurta A, Britzke ER, et al. (2012) Frequent Arousal from Hibernation Linked to Severity of Infection and Mortality in Bats with White-Nose Syndrome. *PLoS ONE* 7(6): e38920. doi:10.1371/journal.pone.0038920
- Review on Antimicrobial Resistance. (2014) Antimicrobial Resistance: Tackling a Crisis for the Health and Wealth of Nations.
- Richardson, J., Lockhart C, Pongolini, S., Karesh, W.B., Baylis, M., Goldberg, T., Slingenbergh, J., Gale, P., Venturini, T., Catchpole, M., de Balogh, K., Pautasso, P., Broglia, A., Berthe, B., Schans, J, Poppy, G. (2016) Drivers for emerging issues in animal and plant health. *EFSA Journal* 14 (S1).
- Rist, CL, Arriola CS, Rubin C. (2014) Prioritizing zoonoses: a proposed one health tool for collaborative decision making. *PLoS One* 9(10):e109986.
- Roest, H., Maassen, C., van de Giessen, A., van Zijderveld, F. (2014) The Dutch Q Fever Situation - Lessons Learned? *GRF Davos Planet@Risk* 2, 166–168.
- Rostal, M et al. Benefits of a One Health approach: An example using Rift Valley fever. *One Health*.
- Roth, F, Zinsstag, J, Orkhon, D, et al. (2003) Human health benefits from livestock vaccination for brucellosis: case study. *Bulletin of the World Health Organization*, 81(12):867–876.
- Secretariat of the Convention on Biological Diversity (2014) Global Biodiversity Outlook 4. Montréal, 155 pages.
- Schreiber, PW et al. Cluster of Leptospirosis Acquired Through River Surfing in Switzerland. *Open Forum Infect Dis*. 2015 Sep; 2(3): ofv102.
- Silbergeld, E.K., Graham, J., Price, L.B. (2008) Industrial food animal production, antimicrobial resistance, and human health. *Annual review of public health* 29:151-169.
- Sorrell EM et al. (2015) Mapping of networks to detect priority zoonoses in Jordan. *Frontiers in Public Health*. 3:219.
- Taylor L H, Latham S M and Woolhouse M E (2001) Risk factors for human disease emergence *Phil. Trans. R. Soc. B* 356 983–9

- Torgerson, P.R. and Macpherson, C.N.L. (2011) The socioeconomic burden of parasitic zoonoses: Global trends. *Veterinary Parasitology* 182:79-95.
- UN System Influenza Coordination and World Bank (2010) *Animal and Pandemic Influenza: A Framework for Sustaining Momentum. Fifth Global Progress Report*. Chapter 5: Overview of One Health; Chapter 6: The Way Forward.
- United Nations (2016) Draft political declaration of the high-level meeting of the General Assembly on antimicrobial resistance. 71st Session of the General Assembly. 21 September 2016, New York, NY.
- United Nations Environment Programme (2016). Healthy Environment, Healthy People. Nairobi.
- Verdú JR et al. Low doses of ivermectin cause sensory and locomotor disorders in dung beetles, *Scientific Reports* (2015)
- White PJ, Wallen R, and Treanor J. 2014. Monitoring and Research on Bison and Brucellosis. National Park Service. https://www.nps.gov/yell/learn/nature/upload/Surveillance_Bison_2013_Final-1.pdf
- Whitmee S, Haines A, Beyrer C, et al. (2015) Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation-Lancet Commission on planetary health. *The Lancet*; 386(10007): 1973-2028.
- WHO (2006) The control of Neglected Zoonotic Diseases: A route to poverty alleviation. Report of a joint WHO/DFID-AHP Meeting; 20–21 September 2005; WHO Headquarters Geneva, Switzerland. Available: http://www.who.int/zoonoses/Report_Sept06.pdf
- WHO (2011) Taking Sex and Gender into Account in Emerging Infectious Disease Programs: an Analytical Framework. http://www.wpro.who.int/topics/gender_issues/Takingsexandgenderintoaccount.pdf
- WHO (2016) Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks. Geneva.
- WHO-CBD (2015) Connecting Global Priorities: Biodiversity and Human Health, a State of Knowledge Review. Geneva and Montreal.
- WHO-OIE (2014) WHO-OIE Operational Framework for good governance at the human-animal interface: Bridging WHO and OIE tools for the assessment of national capacities.
- WHO-OIE (2017) Handbook for the assessment of capacities at the human–animal interface, second edition. Geneva: World Health Organization.
- Wolfe, N. (2012) *The Viral Storm: The Dawn of a New Pandemic Age*. St. Martin's Griffin.
- Wolfe, Dunavan and Diamond. (2007) Origins of major human infectious diseases. *Nature* 447, 279-283
- World Bank (2005) Program Framework Document for Proposed Loans/Credits/Grants in the Amount of US\$500 million Equivalent for a Global Program for Avian Influenza Control and Human Pandemic Preparedness and Response (GPAI), Report No. 34388, December 5, 2005.

- World Bank (2007) Global Public Goods: A Framework for the Role of the World Bank, Report to the Development Committee (DC2007-0020), September 2007.
- World Bank (2008) Evaluating the Economic Consequences of Avian Influenza, by Andrew Burns, Dominique van der Mensbrugghe, and Hans Timmer, available at www.worldbank.org/flu. (Originally published in a slightly different form in the World Bank's June 2006 edition of Global Development Finance, available at www.worldbank.org/gdf2006.)
- World Bank (2010). People, Pathogens and Our Planet, Volume 1: Towards a One Health Approach for Controlling Zoonotic Diseases.
- World Bank (2011). Towards One Health: Interim Lessons from the Global Program on Avian and Human Pandemic Influenza. Outcomes of a Workshop sponsored by ARD and HNP in Vietnam.
- World Bank (2012). People, Pathogens and Our Planet, Volume 2: The Economics of One Health.
- World Bank (2012) Connecting Sectors and Systems for Health Results. Public Health Policy Note. December 2012.
- World Bank (2012) Zoonotic disease prevention and control, one health, and the role of the World Bank.
- World Bank (2014) Responding to Global Public Bads: Learning from Evaluation of the World Bank Experience with Avian Influenza, 2006-2013. Washington, DC: World Bank. Independent Evaluation Group (IEG) https://ieg.worldbankgroup.org/Data/reports/avian_flu1.pdf.
- World Bank (2015) Preparing for the Next Outbreak: Public Views on Global Infectious Diseases and Health Security. Administered by Greenberg Quinlan Rosner. <http://www.worldbank.org/en/topic/health/brief/public-views-on-global-infectious-diseases-and-health-security>
- World Bank (2017) Drug-Resistant Infections: A Threat to Our Economic Future.
- World Bank (2017) Geographic hotspots for World Bank action on climate change and health: investing in climate change and health series. Washington, D.C.: World Bank Group. <http://documents.worldbank.org/curated/en/209401495434344235/Geographic-hotspots-for-World-Bank-action-on-climate-change-and-health-investing-in-climate-change-and-health-series>
- World Bank (2017) From panic and neglect to investing in health security : financing pandemic preparedness at a national level. Washington, D.C. : World Bank Group. <http://documents.worldbank.org/curated/en/979591495652724770/From-panic-and-neglect-to-investing-in-health-security-financing-pandemic-preparedness-at-a-national-level>
- Zinsstag, J. et al. (2009) Transmission dynamics and economics of rabies control in dogs and humans in an African city. *Proc Natl Acad Sci U S A*. 106(35):14996-5001.