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EXECUTIVE SUMMARY

Reducing Pandemic Risks at Source

Wildlife, Environment
and One Health Foundations
in East and South Asia



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Executive Summary

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Foreword

The majority of human infectious diseases are of animal origin, and many recent emerging infectious diseases (EIDs), such as HIV/AIDS, the Nipah virus, severe acute respiratory syndrome (SARS), highly pathogenic avian influenzas (HPAIs), and Ebola virus disease share a common feature: their wildlife origin. Wildlife-originated EIDs are also increasing in frequency over recent decades. As shown by the ongoing COVID-19 pandemic, the impacts of EIDs disproportionately affect the poor and other vulnerable groups, increasing inequality and threatening decades of development progress. The acceleration of EID events of epidemic and pandemic potential calls for a paradigm shift in how we manage and interact with our natural and built environments, while stressing the urgency to develop and implement comprehensive One Health approaches to achieve optimal health outcomes. Furthermore, it is important to recognize the interconnections between people, animals, plants, and their shared environments.

East and South Asia, renowned global hotspots for disease emergence, have suffered from and continue to experience major economic impacts from outbreaks. A team comprised of experts from the World Bank and FAO, and leading wildlife and One Health experts from around the world have worked together to analyze the causes. This report outlines the risks of EIDs of wildlife origin and proposes how to reduce emerging pandemic threats at their source; it includes background material, state-of-the-art knowledge, and recommendations for strengthening systems to prevent, detect, and manage EID outbreaks caused by wildlife trade, wildlife farming, food systems, and habitat degradation. Furthermore, it examines the scope of existing policy frameworks, institutional mandates, level of multisectoral engagement, investments, wildlife-health information systems, and capacity building related to wildlife in the context of emerging disease risks.

Despite being the origin of most zoonotic EIDs, the wildlife aspects of One Health systems have often been overlooked – this report provides the necessary blueprint for countries in East and South Asia on how to build or strengthen their One Health systems as a long-term priority, while implementing targeted risk-reduction activities. In addition, it presents a strong economic case for investing in the prevention of a pandemic at source. Investing in the prevention of wildlife-originated EIDs at source is extremely cost-effective and can also provide a link, as well as leverage biodiversity and animal health system initiatives to meet broader objectives.

This report complements the findings of a related, joint World Bank/FAO report to be published simultaneously. The second report analyses the drivers of zoonotic and emerging infectious diseases in the animal-sourced food systems, and offers strategic recommendations for preventing their spread in animals and humans using a cross sectoral approach. We hope these reports will engage policy dialogues with countries in East and South Asia, regional institutions, and the international community, while contributing to the growing pool of knowledge and practice in this area. Finally, our goal is to trigger investments in policy, institutions, and capacity building for the strengthening of One Health approaches in the region and globally.

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Abbreviations and acronyms

ASEAN	Association of Southeast Asian Nations
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
EID	Emerging infectious disease
FAO	Food and Agriculture Organization of the United Nations
HPAI	Highly pathogenic avian influenza
OIE	World Organisation for Animal Health
SARS	Severe Acute Respiratory Syndrome
WHO	World Health Organization

Executive summary

Emerging infectious diseases (EIDs) are infections associated with new or significantly-expanded geographic scope or spread of zoonotic, vector-borne, and drug-resistant pathogens. These diseases pose a formidable threat to human and animal health and economies. The majority of human infectious diseases have animal origins, and of those, most recent EIDs are tied to wildlife and are increasing in frequency.

This report outlines the risks of EIDs from wildlife and provides guidance in building systems to reduce emerging pandemic threats at their source in East and South Asia. It provides background material, definitions, state-of-the-art knowledge, and recommendations for countries to initiate or strengthen systems to prevent, detect, and manage EID outbreaks from wildlife. It examines the scope and gaps of institutional mandates, programs, and investments related to wildlife in the context of emerging disease risk. The recommendations are geared toward high-level policy dialogue aiming to provide a blueprint for how to strengthen the “wildlife” pillar in “One Health” systems. The report complements and deepens an associated report (World Bank and FAO 2021, in print) that analyzes risks of diseases spreading from domestic animals and wildlife to human and gaps in animal health services.

Interaction with wildlife is the origin of most recent epidemics and pandemics. Rapidly growing pressures on ecosystems and biodiversity are associated with changing interactions among species, increasing opportunities for new outbreaks of epidemic and pandemic potential.

Wildlife-originated human EIDs can exact tremendous health and economic costs on individuals and their families, on nations, and on the global economy (Figure 1). HIV/AIDS, Plague, Nipah virus, Severe acute respiratory syndrome (SARS), Highly Pathogenic avian influenzas (HPAIs), and Ebola virus disease together have cost the world over USD 680 billion since 1994. Recent International Monetary Fund estimates shows that prolonged impact of COVID-19 into the medium term could reduce the global GDP by a cumulative of USD 5.3 trillion over the next five years, further to the estimated loss in output relative to the pre-pandemic projected path of USD 11 trillion during 2020-21. McKinsey estimates that by 2025, COVID-19 will have cost the world between USD 16 trillion and USD 35 trillion. The impacts of these EIDs commonly affect the poor and other vulnerable groups disproportionately, increasing inequality and threatening decades of development progress. For example, COVID-19 has halted progress in poverty reduction in East Asia and the Pacific for the first time in two decades, with an estimated 32 million people in the region unable to escape poverty as a result of the pandemic.

The impacts of EIDs commonly affect the poor and other vulnerable groups disproportionately, increasing inequality and threatening decades of development progress

Box 1. Defining One Health



One Health is a collaborative, multi-sectoral, and transdisciplinary approach — working at the local, regional, national, and global levels — with the goal of achieving optimal **health** outcomes while recognizing the interconnections between people, animals, plants, and their shared environments. **One Health systems** include elements or components combined to prevent, prepare, detect, respond to, and recover from threats to human health, animal health, and environmental health.

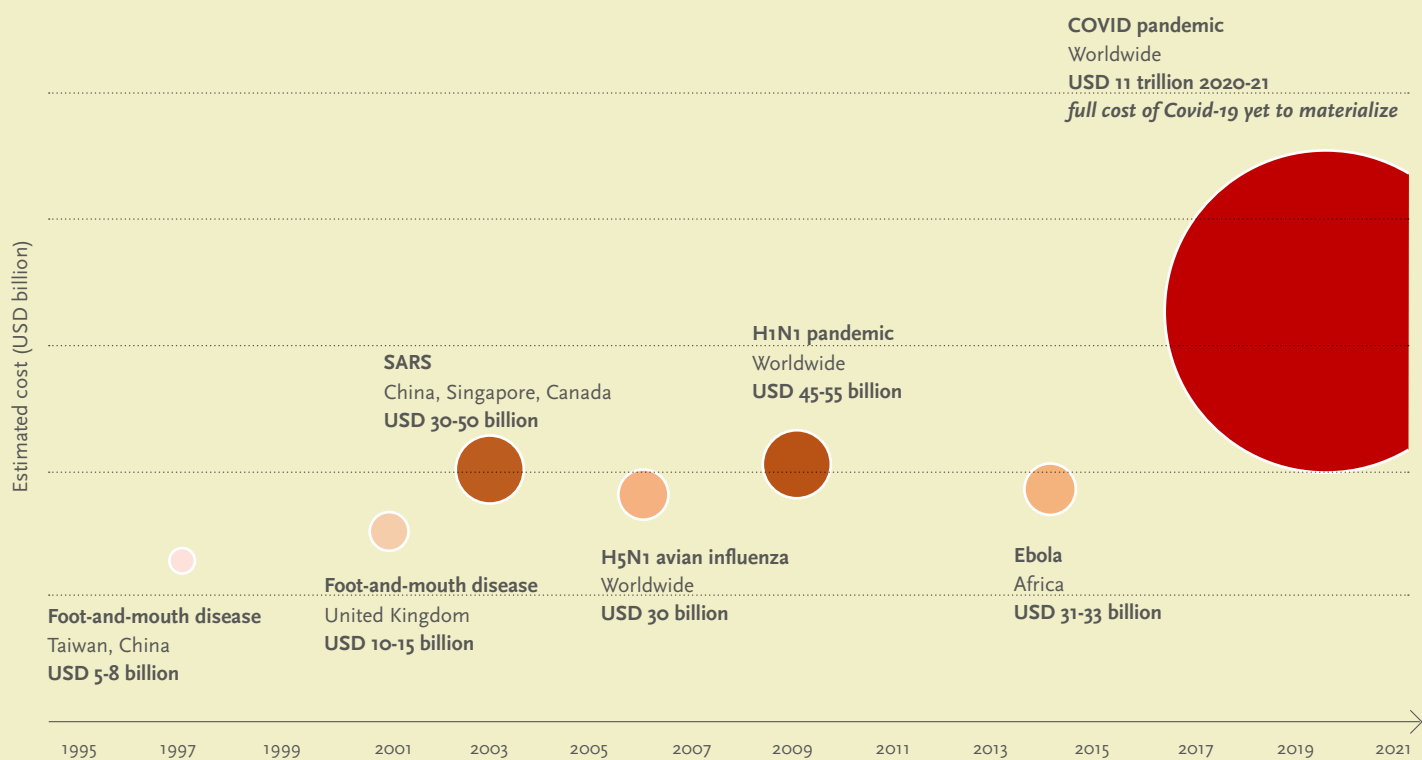


Figure 1. The rising global costs of animal disease and human health epidemics 1995-2021, including some of wildlife origin.

Source: Bio-era, adapted by the Authors

Investing in prevention of wildlife-originated human EIDs at source is extremely cost-effective. As illustrated by previous events (including the current COVID-19 pandemic, suspected to be of zoonotic origin), the costs associated with the *response* to an EID are extremely high (estimated in the trillions of US dollars globally), with severe and lasting impacts on countries' economies and incalculable human suffering. There is therefore a strong economic case for investing in pandemic *prevention* at source (with costs estimated in the millions to billions of US dollars globally). Investing in prevention at source is particularly cost-effective when optimizing and leveraging existing investments in biodiversity, forests, food safety, and veterinary and public health services. Such investments also bring co-benefits, such as in climate change mitigation and adaptation, biodiversity conservation, and related environmental services, creating an even stronger economic rationale for action. The current business-as-usual cycle of neglect and panic is not sustainable, and generates large negative externalities. Investments in improved pandemic prevention are thus to be viewed as public goods, delivering benefits that can be felt both within and across national boundaries. The cost of inaction is high.

East and South Asia must prioritize EID risk reduction at both the national and regional levels

East and South Asia are known global hotspots for EID emergence. This is due to a combination of high population density, livestock production, wildlife abundance, high levels of land use changes, deforestation, and habitat fragmentation. These regions have suffered and continue to experience major economic impacts from outbreaks. They also are undergoing large-scale and rapid landscape, trade, consumption, and demographic changes. Therefore, East and South Asia must prioritize EID risk reduction at both the national and regional levels (Figure 2).

Although most EIDs originate through close contact between humans and wildlife, wild animals do not present an inherent risk, risk is created by human activities in the region that change the ecology and evolution of infectious diseases as well as changing contact opportunities. The most direct and cost-effective way to reduce EID risk is for people to avoid practices that increase the likelihood of pathogen spillover from wildlife. Prevention strategies also may have considerable co-benefits in the form of biodiversity conservation and improved ecosystem services, likely improved livestock production yields, and other direct and indirect benefits across the Sustainable Development Goals.



Figure 2. Predicted distribution of zoonotic disease emergence risk from wildlife (adjusted for reporting bias).

Source: Allen et al. (2017)

NOTE: Final boundary between the Sudan and South Sudan has not yet been determined. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

Overall, many countries in East and South Asia are ill-prepared to prevent the next pandemic, as they lack comprehensive One Health systems that include wildlife and environmental health. This report is focused on low- and middle-income countries in the region. While substantial progress has been made in addressing disease threats linked to domestic animals, attention to the role of wildlife and environmental determinants — and appropriate risk reduction strategies — is limited in the region, instead relying on “end of the transmission chain”, reactive public health responses, leading to preventable outbreaks, often with high societal and human costs. Strategic, long-term investments are needed to develop, and/or enhance, wildlife health systems for effective EID risk monitoring and reduction. Adequate risk monitoring helps to identify hotspots that require greater attention in the design and implementation of prevention, detection, and response efforts.

Adequate risk monitoring helps to identify hotspots that require greater attention in the design and implementation of prevention, detection, and response efforts

This report provides two main sets of recommendations for countries in East and South Asia, related to building or strengthening their One Health systems as a long-term priority, and to implementing targeted risk-reduction activities along the way. Recommendations are specific for wildlife-origin EID risks, noting that animal (including domestic), environmental, and human health each have a much broader scope relevant for action under One Health systems in the region, including action on other sources of EIDs, endemic and non-communicable disease threats, conservation objectives, and food and water safety and security. The implementation of these two sets of recommendations should be closely coordinated, with risk-reduction activities as a short-term priority to achieve immediate prevention gains, and long-term One Health systems-building as fundamental for long-term, continuous improvement.

(i) Mainstreaming wildlife into One Health systems. This set of recommendations constitutes the main contribution of this report. It calls for significantly improving the entire range of detection and response systems around wildlife health to inform epidemiological analyses and other risk assessments; risk-based prevention strategies; and integration and coordination of wildlife health aspects with the more developed human and domestic animal health disciplines to ensure cross-cutting capacity and improved outcomes. A stronger, more comprehensive One Health system that integrates all disciplines involved in the origin and transmission chain is the basis for determining relevant sources of risk and developing appropriate risk-reduction interventions in a collaborative way.

(ii) **Reducing root causes of EID risks from human practices in at least three priority areas: wildlife trade, food systems, and habitat loss.** Wildlife farming and trade, and unsafe food systems, force wildlife — and the pathogens they carry — into close contact with humans and livestock, increasing spillover risks. Contact can also be indirectly increased through deforestation, habitat fragmentation, and ecosystem degradation, particularly in hotspot areas, all of which have been identified as underlying processes at the genesis of EIDs from wildlife. The priority strategies to reduce the risk of the next pandemic at source are: shifting the paradigm in how wildlife trade, production, and consumption are understood and managed, including through behavior change; and reversing pervasive land use change trends that threaten biodiversity and exacerbate spillover risks.

Main findings and recommendations

This report includes detailed findings and recommendations across the entire span of activities to monitor and respond to EIDs of wildlife origin. The following key messages were identified for countries in East and South Asia.

- Expand the scope of systems dealing with EID risks to include wildlife considerations.
- Adopt a range of specific laws and regulations, institutional improvements, sustainable investments, and improved coordination between sectors related to monitoring and response to those disease risks.
- Identify practices that increase exposure to EID pathogens (such as wildlife trade, food systems, and habitat loss), and implement targeted measures to minimize said exposure.

Comprehensive development of the One Health system is an iterative, medium-to-long term process, more often requiring political and technical leadership rather than large investments

For many countries in the region, these measures constitute an ambitious agenda. Over time these steps could dramatically reduce the risks of pandemics. Where countries' institutional capacity is limited, these actions can be sequenced (see Figure 3). The hotspots for increased exposure to EID pathogens need to be identified in a timely manner (calling for short-term improvements in detection and risk-assessment systems), and exposure-reduction activities in those hotspots implemented without delay (through a risk-based approach to prioritize interventions, with wildlife trade and food systems as known, high-risk practices). Comprehensive development of the One Health system is an iterative, medium-to-long term process, more often requiring political and technical leadership rather than large investments (for example, for the formulation of laws or improving coordination between sectors). Reversing the widespread habitat fragmentation and loss in the region, and restoring key ecosystems and ecosystem functions, should also be seen as an ongoing priority requiring commitment, vision and leadership.

1. Mainstreaming wildlife into One Health systems

National One Health systems

The key finding of this report is that national systems in the region are weak in their ability to assess and manage EID risks associated with wildlife, thus perpetuating a reactive versus preventive stance for pandemic and epidemic threats. Six systemic gaps commonly found are listed below.

- Policy frameworks:** Existing policies and regulations do not enable One Health approaches to meaningfully include wildlife considerations, leading to lack of clarity on related institutional mandates and leadership.
- Institutions:** Gaps in the policy framework result in unclear or non-existent institutional mandates in responsibility and authority over comprehensive coverage for disease risks of wild animals across species and settings (both captive and wild). Countries often lack a defined government authority/ ministry responsible for wildlife health.
- Multi-sectoral collaboration:** Although EID risks often originate in animals, health disciplines for wildlife, domestic animals, and humans are usually managed by different sectors, which do not systematically collect and share relevant information. This results in a siloed approach to EID prevention and management.
- Investment:** Countries in the region do not make adequate or sustained investments in wildlife health as a discipline. This results in the lack of a dedicated capacity assessment and financing mechanism and prevents wildlife health considerations from being included into the One Health approach.



LAO PEOPLE'S DEMOCRATIC REPUBLIC
 Monitor lizards, squirrels and wild birds for sale in Attepeu, Lao People's Democratic Republic.
Photo credit: WWF / K. Yoganand



VIET NAM
 In and around the Tam Dao Market area, northern Viet Nam. 2014.
Photo credit: Sulma Wame



SRI LANKA
 Indian Flying Fox Bat prepares to eat the orange fruit on the beach in Hikkaduwa, Sri Lanka.
Photo credit: Jan Arendtsz.
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INDONESIA
 Burnt and degraded forest within
 Tesso Nilo National Park,
 Riau Province, Sumatra, Indonesia.
*Photo credit: Flore de Preneuf /
 World Bank*



VIET NAM
 In and around the Tam Dao Market
 area, northern Viet Nam. 2014.
Photo credit: Sulma Wame



INDONESIA
 Extreme Meat Market selling all kind
 of meat, Tomohon, North Sulawesi,
 Indonesia. 2014
*Photo credit: Misbachul Munir /
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v. Wildlife health information systems: Wildlife disease and pathogen surveillance activities are often ad hoc and tailored to exploratory research or a narrow group of species or diseases. This results in a piecemeal effort rather than supporting long-term strengthening of national systems for sustained and routine early warning and risk reduction.

vi. Training and career development: there are typically no defined and well-funded pipelines for applied training opportunities in the context of a One Health system. This leads to poor recognition of One Health's role as part of government operations, and limited career advancement opportunities.

East and South Asia countries reviewed in this report do not have national systems fully able to address EIDs from wildlife sources. Increasing institutional capacity to understand disease risk, expanding surveillance, and enabling wildlife practitioners to work closely with veterinary and public health personnel will support multi-sectoral benefits. The status of proposed key indicators for the countries reviewed in this report is summarized in Table 1. Evidence or lack of national-level indicators is not intended to reflect performance or completeness and is not comprehensive but rather qualitative (with progress in any given country as a result of the COVID-19 outbreak not being recorded in the table). Further assessment may be warranted, as many initiatives have been ad hoc or limited in scope rather than reflecting systematic development of a risk-based, sustained approach.

Table 1. Country comparison of proposed representative indicators for wildlife health systems (as of 2020).

Indicator	Countries showing evidence of indicator*
Policies (such as for livestock or land use development) account for disease risk from wildlife	China, Malaysia (for Nipah virus)
Institutional mandate for managing wildlife disease/pathogen risk	China, Indonesia, Malaysia, Thailand, Viet Nam
Wildlife authority included in national One Health body*	Indonesia, Malaysia, Thailand, Viet Nam
Mechanism for inter-agency coordination if authority for risk management is shared	China, Malaysia, Thailand
Risk analysis process in place for assessing and managing risk at wildlife-domestic animal and wildlife-human interfaces	Viet Nam
Plan/strategy in place for systematic surveillance and risk reduction	Thailand, Viet Nam
Dedicated budget for wildlife disease system	China, India, Malaysia
Wildlife monitoring network	China, Indonesia, the Lao People's Democratic Republic, Malaysia, Thailand
Access to laboratory for testing wildlife specimens	China, India, Indonesia, the Lao People's Democratic Republic, Malaysia, Thailand, Viet Nam
Wildlife disease database	Indonesia
Alert system in place for early warning and response	Indonesia
Pipeline for wildlife veterinary/para-veterinary workforce in non-zoo settings	India, Malaysia, Thailand
Applied field epidemiology training program for wildlife surveillance and investigation	China, Thailand

* NOTE: Evidence of national-level indicator (which represents existing activities beyond avian influenza virus monitoring) is not intended to reflect performance or completeness. Any progress as a result of a response to COVID-19 is not reflected in the table. Countries surveyed include China, India, Indonesia, the Lao People's Democratic Republic, Malaysia, Thailand and Viet Nam.

Table 2. Key recommendations for wildlife inclusion in One Health systems strengthening



Institutions

- *Wildlife risk-informed policies:* Include wildlife-specific disease risks in existing policies, such as land use planning, livestock or wildlife development activities, wildlife/eco-tourism, and biodiversity impact assessments. Regulate high-risk species/interfaces (for example, the wildlife trade) in national and regional natural resource protection policies and enforcement efforts.
- *Clear institutional mandates:* Map existing mandates against relevant risk interfaces to reveal areas of coverage as well as gaps, and define clear institutional responsibilities for authorities in charge of wildlife health. Develop a dedicated institutional mandate to assess and manage wildlife risks aimed at emerging disease prevention and detection.
- *Promote multi-sectoral collaboration:* Include wildlife and environment sector representatives in coordination of risk assessment and reduction. Ensure wildlife units are involved in the development of programs, plans, and protocols relating to EID risk assessment and management and broader health security initiatives.



Information systems

- Review existing evidence on disease and pathogens in each country and region to identify baseline risks and knowledge gaps, and to determine initial priorities.
- Establish/strengthen wildlife disease and pathogen surveillance systems.
- Ensure access to a sustainable annual budget sufficient to maintain wildlife health services, and a dedicated process for emergency funding and capital investments.



Capacity building

- Develop an assessment tool and a funding instrument to strengthen capacity and implementation to address identified deficits.
- Develop a dedicated and robust training base for World Organisation for Animal Health (OIE) National Focal Points for Wildlife and equivalent positions with responsibilities for wildlife disease risk management.
- Formalize and incentivize wildlife health/disease management with authority and career advancement opportunities.

Countries should refine institutional mandates for wildlife disease and pathogen risk management. Mandates should be mapped against risk factors and interfaces to reveal areas of coverage and gaps. Wildlife and environment sector representatives must be included in national and regional multi-sectoral coordination platforms and initiatives. Where they exist, national One Health bodies provide efficient coordination. But these initiatives also require dedicated attention to involving the wildlife and environment sectors in assessment, planning, prioritization, in-service training, and implementation.

Developing wildlife health services to cover EID risk monitoring and reduction requires strategic, long-term support and investments. Efforts to detect and monitor risk can be concentrated in three areas: wildlife sources, wildlife-livestock-human interfaces, and human behavior change. Each of these requires targeted focus and stakeholders to assess and respond to known and novel threats. Core components of surveillance and laboratory, trained workforce, financing, information management, communication, risk assessment and management, and governance systems must be tested and trialed to make them ready for emergencies, ideally leveraging and coordinating investments in other sectors.

Three pillars of action are recommended for strengthening One Health systems against wildlife-origin EID risks in East and South Asia: institutions, information systems, and capacity building (Table 2). Key recommendations for each pillar are summarized below. Given the nascent stage in the development of One Health systems in the region, these recommendations apply broadly to all countries. Specific priorities for system strengthening may vary by country, and should be dictated by specific risk assessments. Section 5 of the Main Report expands on the recommendations.

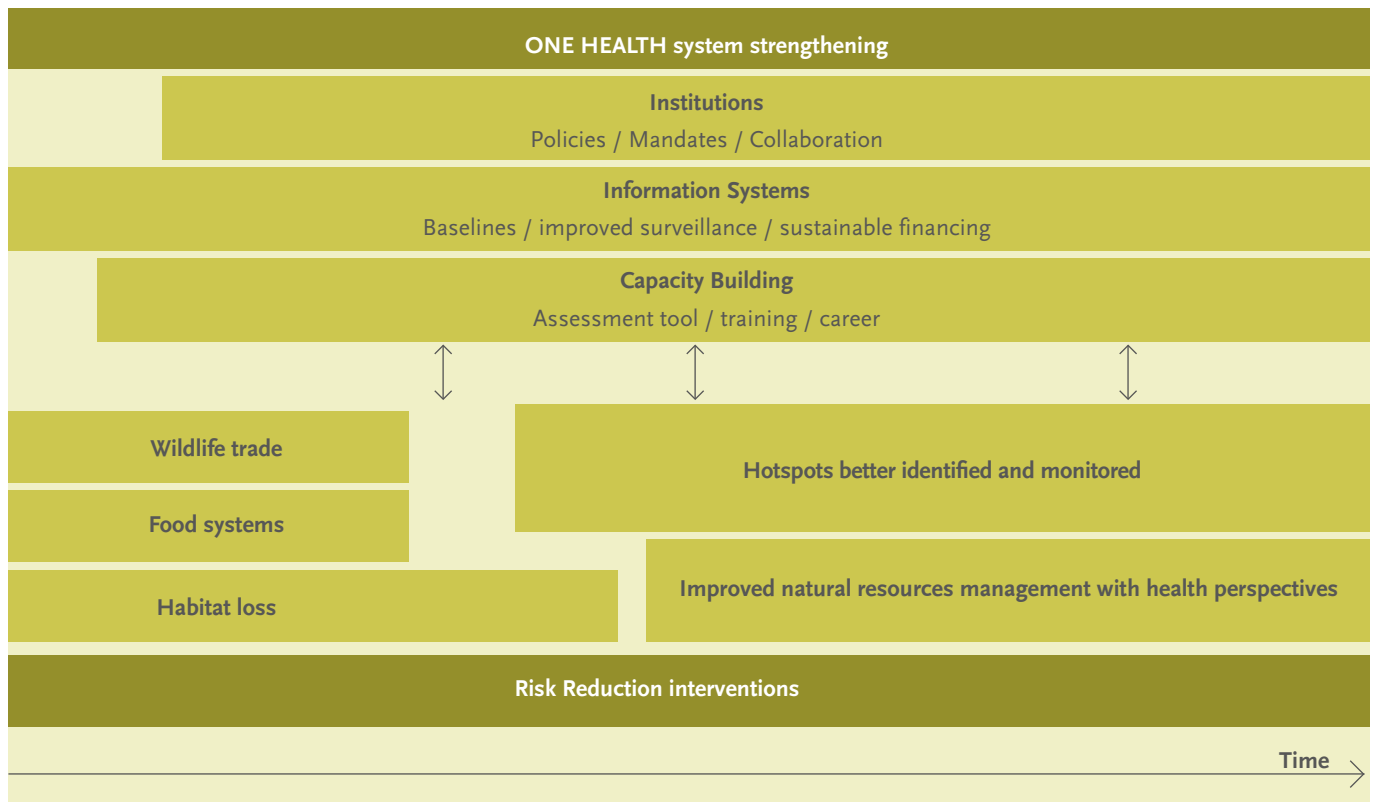


Figure 3. Suggested, qualitative schematic with sequencing of activities to strengthen the One Health system with systematic risk reduction actions *Source: Authors*

The case for regional One Health coordination

The lack of regional and international One Health systems contributes to important information potentially being missed in risk assessment and national decision-making. In addition to national shortcomings in One Health systems, there is no global authority ultimately responsible for wildlife health, disease, and pathogens, depriving countries of help in shaping their national implementation efforts. Transboundary disease and health security initiatives, including around wildlife value chains, need a coordinated, regional approach. Regional One Health systems are also needed to: harmonize trade standards within countries; incorporate disease standards into national and regional wildlife enforcement networks; establish regional and global databases of disease/pathogens; share and centralize information on risks; and provide surveillance and diagnostic support. Further justification for a regional approach is provided in the wildlife trade and habitat loss sections.

Creating and embedding wildlife health systems expertise at the regional level will facilitate a comprehensive risk-reduction approach and access to needed capacity. One potential avenue for regional action could be through the Association of Southeast Asian Nations (ASEAN), in line with its “Comprehensive Recovery Framework and Implementation Plan,” which includes the implementation of the ASEAN Guidelines for Detecting and Preventing Wildlife Trafficking. Regional coordination can support countries in operationalizing One Health and create a clear role for wildlife health systems in prevention, detection and response. The development of regional expertise on wildlife health — for example through institutions such as the Thailand National Wildlife Health Center, whose goal is to become an OIE collaborating center in wildlife health — would be a much-needed asset for the region.

Regional coordination can support countries in operationalizing One Health and create a clear role for wildlife health systems in prevention, detection and response

Partners and technical agencies can play a key role to help countries assess capacity and funding deficits and track benchmarks to strengthen national wildlife health services. A key challenge for identifying needs for strengthening wildlife health programs is the lack of a dedicated capacity assessment tool that complements the public health and animal health tools from the World Health Organization (WHO) and the World Organisation for Animal Health (OIE). Tracking competency and investment needs will put the wildlife and environment sector on an equal footing with other sectors and will inform program design. Benchmarking should be iterative, with follow-on planning, multi-sectoral bridging exercises, and technical implementation support.

2. Reducing root causes of EID risks from human practices

Systems strengthening is a pathway of iterative build-up and improvement that countries should follow, based on their capabilities and specific circumstances

Identifying, reducing and risk-proofing human activities that change the ecology and evolution of infectious diseases and increase human exposure to pathogens is paramount in preventing pandemics at source. The previous section discussed how to strengthen One Health systems at country and regional levels with sufficient capacity and inputs from wildlife health authorities to support detection, prevention and early action on the root causes of EID risks. Systems strengthening is a pathway of iterative build-up and improvement that countries should follow, based on their capabilities and specific circumstances. As systems improve over time, the ability to better identify hotspots and vulnerabilities and act promptly will also improve. The following section illustrates key relevance and entry points for three known root causes driving risk in the region (wildlife trade and farming, unsafe food systems, and habitat degradation), showing how One Health systems can be operationalized to support pandemic prevention, and offers tailored recommendations for risk reduction in each.

Wildlife trade

Wildlife trade is a high-risk interface because it creates artificial interactions between multiple species in ways that can promote the transmission of pathogens. East and South Asian countries are primary destinations of the international wildlife trade. Given the variety and volume of species traded, minimizing informal and better managing formal wildlife trade in the region, including through risk monitoring, are therefore necessary for pandemic prevention.

Most existing national and international wildlife trade regulations such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), while important for sustainability objectives, are not designed specifically to reduce disease risks. Environment and law enforcement sectors have helped to assess and address threats to biodiversity and ecosystems, including wildlife trafficking. However, these activities are not formally paired with health considerations at present. Although the trade in animals in response to international demand markets is increasing in scale and complexity, there are no effective regional mechanisms to manage disease threats from the regional wildlife trade (beyond sanitary trade standards such as OIE's listed diseases for animals), representing a missed opportunity.

Food markets are significant risk multipliers, concentrating many potential sources of risk within the wildlife value chain. Markets are often the final point of sale in the value chain, and typically aggregate animals from multiple sources, sometimes opportunistically. While many points of the wildlife trade value chain can have risk, several notable characteristics of markets include: holding of live or dead animals, or animal products in crowded conditions; multiple species present; low or no hygiene, sanitation, or cold storage practices; on-site slaughter; and a high-density human setting.

If not properly designed and enforced, bans may drive the trade into illegal trafficking, which is less traceable and more difficult to control

Wildlife trade demand reduction for high-risk species requires buy-in and adoption of behavior change. Regulations are unlikely to be successful without stakeholder input to the design of interventions, informed by social science methods and socio-economic considerations. If not properly designed and enforced, bans may drive the trade into illegal trafficking, which is less traceable and more difficult to control. Blanket bans overlook the nuances of disease risk, which is not uniform across species, settings, practices, and uses, and consumer motivations or needs, and thus are unlikely to be sustainable or effective, given their impact on livelihoods and because they overlook the complexity of the wildlife trade.

Efforts to reduce EID risks from wildlife trade, wildlife farming, and wildlife commercialization, need to prioritize specific species and practices. A tiered approach that considers both high-risk groups and species, and high-risk practices should be the basis for possible interventions:

1) Target high-risk groups and species. A wide range of species are traded in the region. In general, mammals (primates, bats, rodents, some small carnivores) and some birds (especially waterfowl) are of greater concern for emerging diseases of pandemic potential than are reptiles, amphibians, and fish. Strong regulations, enforcement and demand reduction efforts against harvest, trade, and consumption of bats and primates should be viewed as a minimum standard. For wildlife farming, designation of permitted species should be based on risk assessment.

2) Target high-risk practices. Holding, slaughter, and use of live animals throughout the value chain present inherent hazards, but the level of risk varies. Introducing safer practices in wildlife trade from source to end use can limit the potential for exposure and transmission.

Addressing the full value chain, from source to end consumer, provides risk monitoring and intervention opportunities at multiple critical control points. Three main recommendations are provided below and complete list is provided in Section 3 of the Main Report.

- Conduct outreach with communities and wildlife breeders of high-risk species to reduce market for high-risk wildlife products and create buy-in for risk reduction.
- Ban sale of live animals in market settings and move slaughter activities off-site.
- Develop legislation, capacities, and infrastructure leading to prohibiting the hunting, sale and keeping of bats and primates.

Food systems

The world's nearly eight billion people rely on food systems on a daily basis. Interactions with food systems look different across the world, shaped by a mix of infrastructure, regulatory, socio-economic, livelihood, environmental, and cultural and religious traditions and factors, with resulting disparities in food safety and security. Disease risk related to wild animal sources can occur along the chain of food supply and acquisition, preparation, and consumption. While there are some similarities to domestic animal food system risk factors, the live wild animal trade adds risk factors along its value chain or when products or personnel are engaged with other market systems. A more comprehensive, risk-based approach will need to go beyond the common domestic animal farm-to-table chain to reach other pathways and entry points.

There are many possible sources of wild-associated disease risk in food systems. For EIDs specifically, risk pertains most to certain species and practices. Examples of key pathways for emergence include:

- **Wildlife hunting, rearing, slaughter, or handling:** In most circumstances, the major concern for emergence of high-consequence viral and bacterial pathogens is via exposure to live or freshly-slaughtered high-risk animals, particularly bats, rodents, and primates. Wildlife hunters and transporters, as well as others involved in the handling, slaughter, and preparation, are at elevated risk.
- **Perpetuation via intermediate host species:** Poor biosecurity allows for wildlife-livestock contamination, which may be further disseminated through the livestock value chain.
- **Contamination and consumption:** Ingestion of infectious material can lead to food-borne disease. Food-borne illness is often linked to bacterial and parasitic infections, including crops contaminated by wild animals. Recent contamination of surfaces by wildlife also can be a source of exposure to viral infection.

In some regions of the world, wild meat from terrestrial animals represents a primary source of protein on which populations depend. A substantial volume of wild meat is harvested for subsistence or sold locally to populations with few affordable protein alternatives. At the same time, growing demand is also driven via urban, wealthier populations willing to pay a higher price for wildlife as a luxury product. This collective volume of wild meat, little of which is processed and distributed to consumers with any modern hygiene practices, provides a constant opportunity for human exposure to food-borne pathogens.

Reducing wildlife-sensitive risk factors by transitioning to safer practices is a key prevention strategy. Phasing out consumption of wild-sourced high-risk species (especially, bats, rodents, and primates) is a priority. Over time, transitioning to alternative nutritional sources and reducing consumption of wild animal products can reduce EID risk as well as contribute to biodiversity conservation. In addition to standard food safety practices, three key risk mitigation measures for EIDs linked to wildlife in food systems are provided below (see Section 3 of the Main Report for a complete list).

- Ensure mandates and resources are in place to identify and address all high-risk interfaces in food systems.
- Monitor disease and conduct pathogen surveillance through meat inspections at point of sale or upstream in the value chain (farm, market, and slaughterhouse).
- Enhance hygiene and biosecurity measures at critical control points, and work with relevant stakeholders to find suitable alternatives to hunting, handling, and butchering of high-risk species.

Habitat degradation and loss

Fragmentation of forests and other ecosystems creates edges, with greater chance of exposures along the perimeter between humans, livestock, and wildlife

Wide-scale land conversion and encroachment on wildlife habitat are associated with approximately one-third of recent zoonotic disease emergence events. The practices typically associated with ecosystem changes allow for changing interactions between humans and other species, with resulting disease consequences. Fragmentation of forests and other ecosystems creates edges, with greater chance of exposures along the perimeter between humans, livestock, and wildlife. Expansion of human settlements, intensification of agricultural and livestock production, and extractive industries such as logging or mining often result in habitat degradation and loss. In South East Asia, the changes are of striking proportions, among them an average loss of 1.3 million hectares of forest annually from 1990–2010, largely for forest goods and agricultural expansion to meet growing urban population demands.

Climate-induced changes in land cover and land use, or extreme weather events, may shift species behavior and ranges, in the process changing ecosystems and disease threats. In general, climate change may act as a threat multiplier for other drivers. The tightly coupled links between climate conditions and species abundance and behavior are likely to affect risk, in ways that are hard to predict and potentially impactful.

Land planning processes, including project appraisals, must systematically factor in disease risk and impact assessment. A development project may be a direct or indirect driver of disease risk. Examples include mining that disrupts a cave ecosystem, road building that allows forest access and increases hunting, and newly-cleared landscapes with livestock-rearing activities. Prohibiting certain activities or redesigning plans from the onset can reduce disease risk.

Specific recommendations include:

- Integrate disease and environmental impact projections into cost-benefit calculations for potential development projects and potential intervention strategies.
- Require personal protective equipment when people are exposed to potential wildlife risks, such as when harvesting bat guano, visiting cave sites, and working in fields such as mining and logging.
- Minimize forest fragmentation and limit encroachment on wildlife habitat, especially in high exposure areas such as forests, grasslands, and wetlands.

Disease and pathogen monitoring programs must include wildlife habitats for ecosystems that face planned development, or that contain a high degree of human or domestic animal encroachment. With proper training, park rangers and natural resource practitioners can provide front-line inputs to surveillance systems to detect disease events and alert authorities. In particular, countries should:

- Engage rangers, hunters, and local communities in wildlife disease surveillance by encouraging them to report diseased and dead animals.
- Ensure monitoring systems are available to communities near forest areas to help detect infection and clinical illness.
- Improve early warning systems to better prevent, detect, and respond to changing threats and impacts, including those related to climate change.

Ecosystem preservation is the most direct route for avoiding disease risks that result from changes to ecosystems, habitats, and species

Habitat protection measures should prioritize and promote health protection. This could be reflected for example in National Biodiversity Strategies and Action Plans. Ecosystem preservation is the most direct route for avoiding disease risks that result from changes to ecosystems, habitats, and species. Preserving biodiversity may in some cases assist in disease buffering, as well as ecosystem services such as pest and vector control that aid regulation of disease. Disease risk reduction should be calculated into the benefits of designing and managing protected areas. Similar approaches are already used to include other ecosystem services in environmental management strategies, including prioritizing the preservation of land with high mammalian biodiversity and designating off-limits areas for activities based on risk (for example, land planning and policies around distancing of bat roosting sites and livestock rearing sites).



MYANMAR

Along Dawei road, smoke rises from a man-made wildfire in a forest to clear land for a replacement plantation, commonly betal-nut or rubber, near Wah-Taw village, Myanmar.

Photo credit: Minzayar Oo / WWF-Myanmar



INDONESIA

The Pramuka bird market is the biggest bird market in Jakarta, Indonesia, 2017

Photo credit: Lauren Suryanata / Shutterstock



Lao People's Democratic Republic
Hog badger being sold by the roadside in Kasi district, Vientiane Province, Lao People's Democratic Republic.
Photo credit: Michael Brocklehurst



INDIA
Baby Pangolin, India
Photo credit: Positive Snapshot / Shutterstock



CAMEROON
A pangolin and a porcupine for bushmeat on sale at the side of the road in Yaoundé, Cameroon.
Photo credit: Andrew Walmsley/TRAFFIC

One Health in practice: selected examples

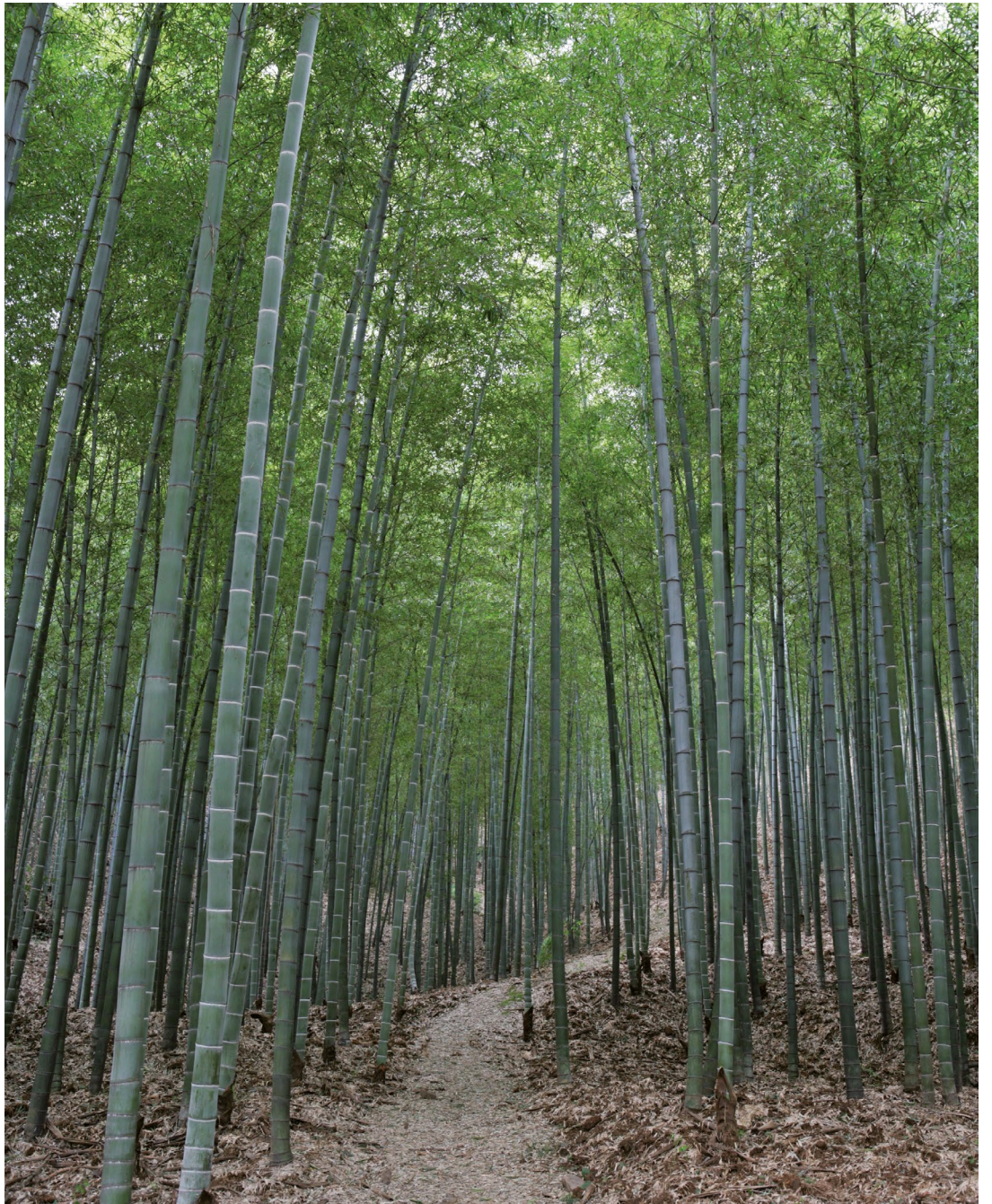
The emergence of Nipah virus in Malaysia in 1998–99 occurred when pig farms and fruit orchards were placed at the edge of tropical forests and native fruit bat habitat, with resulting bat-pig-human disease transmission. The detection of this transmission chain required collaboration between experts from forestry, wildlife (bats), veterinary (pig) and human health. Detection and characterization led Malaysia and Thailand to institute a policy of distancing fruit orchards and pig production, devoting additional attention and resources to surveillance programs, as well as identifying areas at high risk of disease spillover. It also led to intensive extension services and outreach, with farmers outside of these areas being encouraged and supported to take on alternative agricultural livelihoods. Malaysia's experience and strengthening of their One Health system, policies, institutional mandates and information systems around Nipah virus risk can be considered a good practice example with lessons for others in the region.

In Bangladesh, a National One Health Strategic Framework and Action Plan for Infectious Diseases was developed in 2012, with joint approval from the Ministry of Health and Family Welfare, the Ministry of Fisheries and Livestock, and the Ministry of Environment and Forestry. A national One Health Secretariat has been formed, with a rotating chair position among the three government agencies, ensuring efficient convening of stakeholders for planning exercises, information sharing, and outbreak investigation. This shared ownership maintains important political will among ministries, guides external partner priorities and resources, and promotes awareness and collaboration to address areas of weak capacity in a recognized EID hotspot. This example illustrates how better planning, coordination and collaboration are often affordable and can be achieved through political will and decisive action, without necessarily incurring high costs.

Better planning, coordination and collaboration are often affordable and can be achieved through political will and decisive action, without necessarily incurring high costs



CHINA
Agriculture and forest landscape in
China, 2014
Photo credit: Steve Harris / World Bank



CHINA
Bamboo patch. China, 2007
Photo credit: Wu Zhiyi / World Bank

Emerging infectious diseases (EIDs) are infections associated with new or significantly-expanded geographic scope or spread of zoonotic, vector-borne, and drug-resistant pathogens. The majority of EIDs have animal origins, and of those, the most recent EIDs are tied to wildlife. They are also increasing in frequency, with reoccurring outbreaks causing epidemics and pandemics exacting tremendous health and economic costs on individuals, nations, and the global economy. Strategies to reduce EID risks and better prevent future events from happening, need to comprehensively include wildlife - and the multiple interactions between wildlife, domestic animals, and humans - in a holistic way. 'One Health' addresses this, with the goal of achieving optimal health outcomes while recognizing the interconnections between people, animals, plants, and their shared environments. In this report, we explore the root causes of pathogen spillover and disease emergence from wildlife to humans in East and South Asia, we review existing strengths and gaps of One Health systems, and provide recommendations to improve their performance by better including wildlife considerations. We describe human practices that increase exposure to pathogens, and specific, tangible actions to reduce risks along the chain, prioritizing the wildlife trade, food systems, and the environment. The report argues that investing in prevention of wildlife-originated human EIDs at source is extremely cost-effective, and is thus to be viewed as a public good, with benefits within and across national boundaries. The cost of inaction, by contrast, is very high.

**Reducing Pandemic
Risks at Source
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