MODULE

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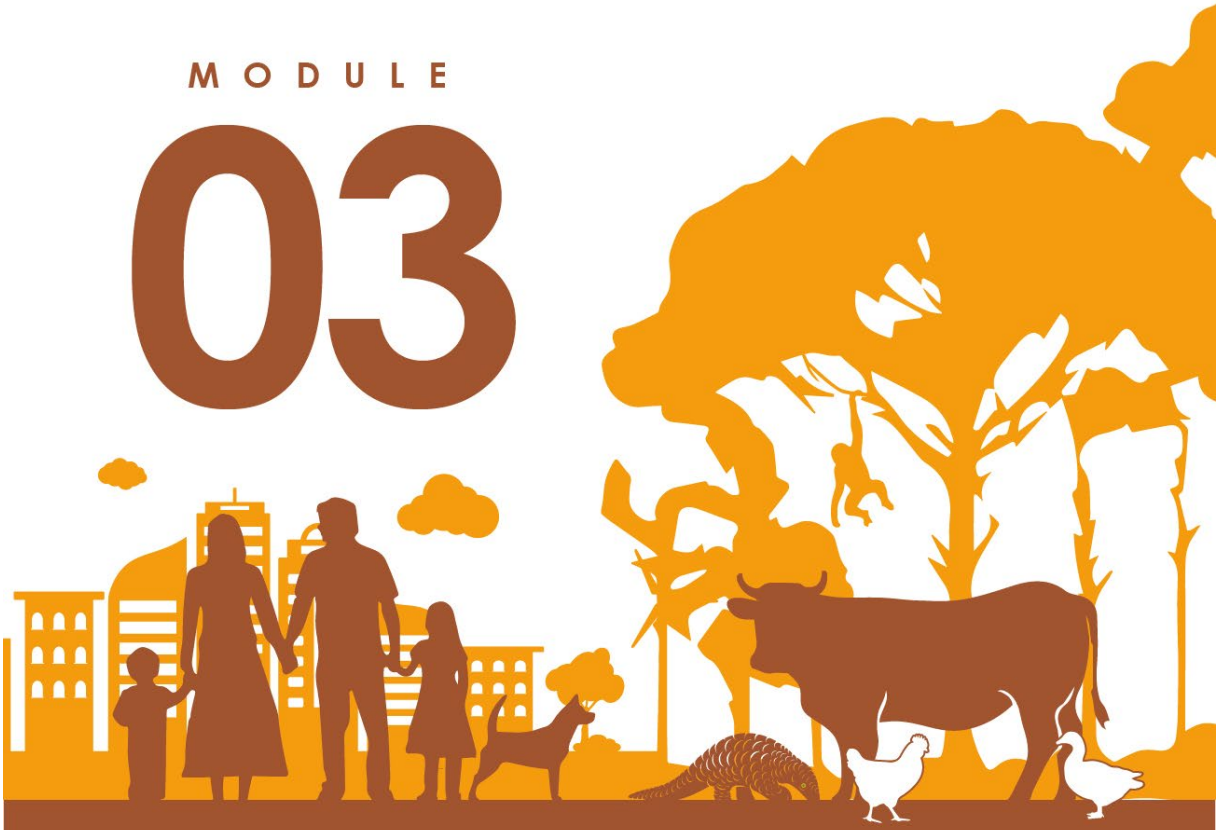

Efforts to Prevent Transboundary Disease Outbreaks in the Southeast Asia Region

Co-Authors
Yoganand Kandasamy & Dominic Travis

EFFORTS TO PREVENT TRANSBOUNDARY DISEASE OUTBREAKS IN THE SOUTHEAST ASIA REGION

Introduction

Many global agreements and processes have been created to support domestic animal trade and disease risk, while very few exist for wildlife trade. Within the context of zoonotic epidemic prevention, we propose the application of a transboundary approach to address the challenges associated with wildlife and wildlife trade (legal and illegal). This approach presents a unique opportunity to achieve a mutually beneficial outcome: countering biodiversity loss while enhancing disease risk management.

Recognizing that the implementation of control points cannot be achieved by a single discipline, ministry, or agency, we emphasize the need for collaborative efforts across the entire wildlife trade supply chain. To ensure comprehensive risk reduction, it is imperative to develop and implement controls and standards at a systems level. Such an endeavor requires a profound understanding of the system itself, coupled with the establishment of effective partnerships for the implementation of prevention and mitigation strategies.

The problem statement underscores the critical role of biodiversity, encompassing macro and micro-organisms alike, in maintaining the health of ecosystems. However, a significant driver of the extinction crisis is wildlife trade, which not only contributes to biodiversity loss but also disrupts the flow of ecosystem services essential to the well-being of communities in the Southeast Asia region. Moreover, wildlife trade creates favourable conditions for the emergence and transmission of zoonotic diseases, leading to increased risks of epidemics at local, regional and global levels.

In light of these challenges, it is important to seek solutions that address the interconnected goals of reducing biodiversity loss and sustaining public health. This chapter aims to achieve the following key objectives:

1. Develop a comprehensive understanding of the concept of transboundary in the context of One Health and its practical application to zoonotic disease risk reduction.
2. Analyse and highlight existing successful cases of transboundary collaboration within the Southeast Asia region, serving as proof of concept in preventing disease transmission.
3. Conceptualize wildlife trade as a transboundary system in Southeast Asia, exploring efforts to understand and regulate this complex system effectively.
4. Advocate for a transboundary approach to regulating wildlife trade in Southeast Asia, emphasizing its potential to promote public health, conserve biodiversity, and promote ecosystem services for local and global communities.

Throughout this module, we delve into the transboundary dimensions of spillover risk within wildlife trade supply chains, recognizing the complex interdependencies and connections that demand collaborative and coordinated efforts to mitigate the outbreak of transboundary diseases. By examining case studies and analyzing existing strategies, we aim to provide insights into the transformative potential of transboundary approaches to counter zoonotic spillover of high consequence pathogens in the Southeast Asia region.

UNDERSTANDING THE CONCEPT OF TRANSBOUNDARY AND ITS APPLICATION TO DISEASE RISK REDUCTION

The Significance of Transboundary Approaches to Disease Risk Reduction

In the realm of disease risk reduction, One Health approaches allow us to operationalize transboundary solutions to address the complex challenges posed by infectious disease. These approaches recognize the need for collaborative efforts to counter problems complex or vast enough to cross geopolitical and ecological borders, and encompass the interconnectedness between human, animal, and environmental health. By embracing a transboundary perspective, we can effectively manage and mitigate the risks associated with disease transmission.

The Role of Microbial Diversity in Understanding Transboundary Disease Spread

We live in a world covered by invisible microbes, the diversity of which is difficult to quantify (Achtman & Wagner, 2008). Microbial diversity encompasses a wide range of unicellular organisms, including bacteria, archaea, protists, and fungi, thriving throughout the biosphere (Figure 3-1). These microorganisms define the limits of life and create conditions conducive to the survival and evolution of all living beings (Dunlap, 2001). This diverse microbial ecosystem provides invaluable benefits to humans known as "ecosystem services," directly contributing to well-being and sustainability (Natural Capital and Ecosystem Services). Understanding the vast range of microbial diversity is essential not only for comprehending the architecture of ecosystems and their functions, but also to the dynamics of emerging and transboundary diseases (Gibbons and Gilbert, 2016). By. By exploring the interplay between microbes, hosts, and their environment, we can gain insights into the pathways and mechanisms through which microbes, and thus diseases, exist and spread across boundaries (e.g., species, habitats, built environments, etc.).

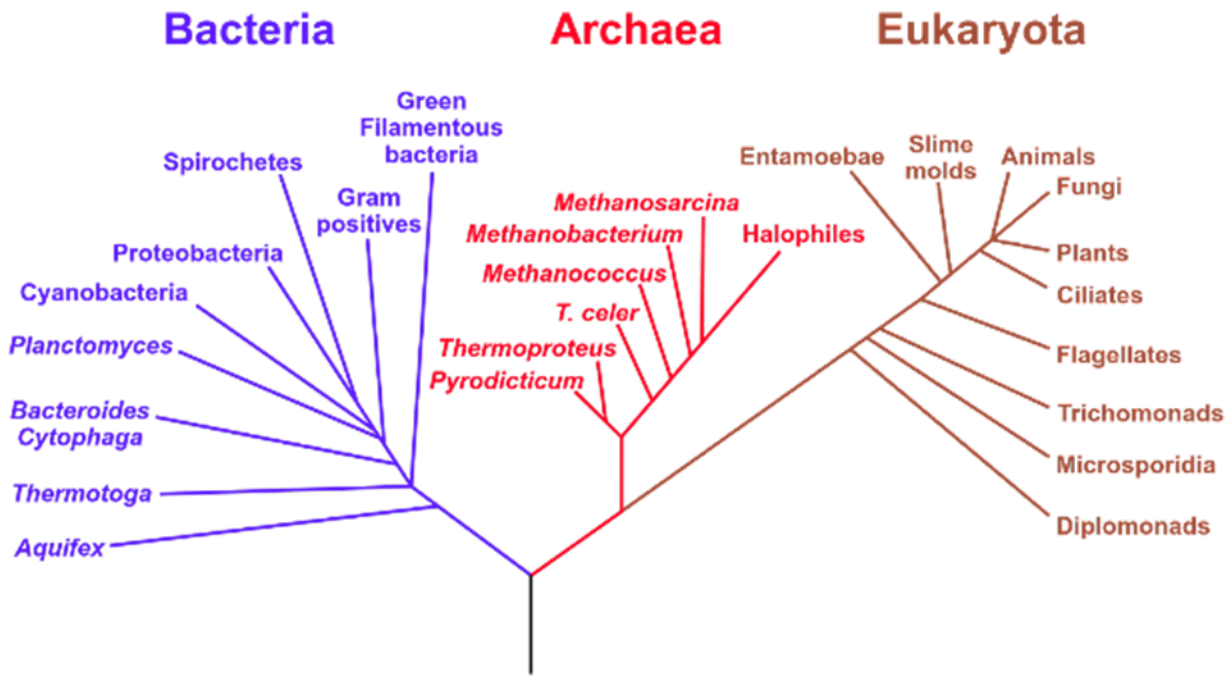

FIGURE 3-1 A phylogenetic tree of living things, based on RNA data, showing the separation of bacteria, archaea, and eukaryotes proposed by Woese et al (1990). Image modified by Eric Gaba, NASA Astrobiology Institute.

While humans and other mammals harbour immense microbial biodiversity, only a fraction of these microbes cause disease in humans (National Research, 2007). According to the Microbiology Society (2013), it is estimated that less than 1% of bacteria cross the human defensive "boundary" and cause harm. The relationship between host, microbes and the environment are complex, as depicted by the epidemiological triad concept (Figure 3-2). These intricate systems interactions can result in increased health and vigor (e.g., a healthy microbiome) or lead to disease and pathology. Considering the diversity of potential pathogens and pathways for spread, comprehending the ecology of transboundary diseases becomes a complex task, necessitating the examination of mechanisms at cellular, organismal and systems levels.

FIGURE 3- 2 The complexity of Transboundary Diseases - Understanding the Epidemiological Triad: Host, Microbe, and Environment. Adapted from McDowell (2015)

Transboundary Disease Outbreaks: Patterns and Implications

Transboundary disease outbreaks are characterized by highly transmissible infectious diseases capable of rapid spread to new geographical areas (Gongal et al., 2022). Originating in one country, these diseases can cross borders and impact the livelihoods of populations in other countries (Gongal et al., 2022). The focus of the infectious disease "transboundary community" has been on animal disease emergence, spread, and the resulting economic consequences. Journals like the "*Journal of Transboundary and Emerging Diseases*" are part of a growing wave of publications addressing the diagnosis, prevention, and management of infectious diseases that pose economic threats to animals and humans worldwide. They reflect the increasing recognition of the necessity to approach these issues on a larger, more collective scale, alongside journals dedicated to One Health, ecosystem health, and planetary health.

Integrating Transboundary Approaches into the One Health Framework

Transboundary approaches are essential in addressing the complex challenges posed by infectious diseases and play a significant role in disease risk reduction. The One Health framework embodies the principles of transboundary approaches, by recognizing the interconnectedness of human, animal, and environmental health while promoting integrated efforts to address health challenges at the interface. By integrating transboundary approaches within the One Health paradigm, we can foster collaboration, cooperation, and innovative solutions in disease risk reduction. This integration enables us to adopt a multi-scale way of thinking and develop holistic strategies to prevent and control transboundary diseases, ultimately protecting the health and well-being of human populations (Ribeiro et al., 2019).

EXISTING CASES OF TRANSBOUNDARY COLLABORATION TO PREVENT SPILLOVER

Transboundary Partnerships

Understanding the risk, prevention, and control of emerging diseases presents a complex and dynamic challenge, often characterized by numerous boundaries - both physical and conceptual (Madhav et al., 2017). Collaborative approaches to address transboundary disease issues are frequently advocated, yet translating these concepts into effective practice remains a formidable task for health and policy professionals. In the realm of global health, the past two decades have witnessed the emergence of transboundary collaboration, often synonymous with the term "One Health" (FAO 2008 ; Asokan 2015). However, it is important to acknowledge that other commonly used terms and approaches exist, including planetary health, ecosystem approaches to health, participatory epidemiology, socio-biological methods/models, mixed methods, team science, systems approaches, and more, also contribute to this vital field.

Ideally, the implementation of such a paradigm would have been initiated by a theory of change, followed by partnership development, training, and subsequent implementation and evaluation. In reality, the process has developed in reverse in most places. However, theories of change, implementation roadmaps, and evaluation strategies for One Health have been developed. Hueston et al. developed one of the initial "theories of change" during a Rockefeller Bellagio retreat in 2010, drawing upon themes and lessons synthesized from over fifty demonstration projects worldwide (Hueston et al., 2013). More recently, the One Health High-Level Expert Panel (sponsored by WHO) published a comprehensive plan (OHHLEP 2022). One of the most user-friendly implementation road maps was published by The World Bank (Berthe et al., 2018). The European Network for Evaluation of One Health conducted a series of workshops and published case studies on comprehensive programmatic evaluation. Additionally, several large scale and regional One Health workforce partnerships, training and implementation plans exist (Table 3-1).

The intent behind this section is to delve into the existing transboundary partnerships that are actively engaged in the prevention of zoonotic spillover. These partnerships represent real-world models of collaboration, offering valuable insights into how we can collectively address the pressing challenge of zoonotic disease transmission. By examining their achievements and approaches, we can gain a deeper understanding of how to strengthen global health systems and enhance our collective capacity to respond effectively to transboundary disease challenges.

TABLE 3-1. Key Transboundary Partnerships in Zoonotic Spillover Prevention

Organization Name	Description
One Health Joint Plan of Action (2022-2026)	Effective collaboration among FAO, UNEP, WHO, and WOAH has significantly reduced the risks of zoonotic epidemics through a unified approach, emphasizing prevention, early detection, and response.
Southeast Asia One Health University Network (SEAOHUN)	Regional collaboration among 92 universities in Southeast Asia not only trains a new generation of One Health professionals but also promotes interdisciplinary cooperation critical for preventing and mitigating zoonotic spillover.
Association of Southeast Asian Nations (ASEAN)	ASEAN's commitment to One Health and its implementation plan for the agricultural-human interface demonstrates the power of regional health collaboration in effectively preventing, detecting, and responding to animal health emergencies.
The Food and Agriculture Organization-Emergency Centre for Transboundary Animal Diseases (FAO-ECTAD)	FAO-ECTAD's integrated approach, focusing on capacity building, has enhanced diagnostic capabilities, responded to outbreaks, and strengthened animal health systems across over 37 countries, illustrating the importance of transboundary partnerships in building resilience.
Preventing Zoonotic Diseases Emergence (PREZODE)	PREZODE's international initiative to understand zoonotic diseases risks and implement innovative methods showcases the value of ecosystem-level actions and community engagement in preventing and mitigating emerging zoonotic diseases.
Emerging Pandemic Threats (EPT)	EPT, a USAID program, emphasizes regional cooperation and cross-border information sharing, highlighting the importance of collective global health systems for early detection and response to pandemic threats, such as COVID-19.

One Health Joint Plan of Action (2022-2026)

The importance of collaborative partnerships in addressing transboundary disease issues cannot be overstated. The One Health Quadripartite joins the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP), the World Health Organization (WHO) and the World Organization for Animal Health (WOAH), serves as an excellent example of such partnership . The One Health Quadripartite has recognized the need for unified action and has endorsed the new One Health definition provided by One Health High Level Expert Panel (OHHLEP), as well as the definition of spillover prevention ((OHHLEP), 2023). In line with their commitment, they have launched the One Health Joint Plan of Action (2022 - 2026), and will release its implementation guidelines. Among the six action tracks, track 2 aptly named "Reducing the risks from emerging and re-emerging zoonotic epidemics and pandemics", aims to minimize the local and global impacts of such outbreaks. This involves understanding the linkages and drivers of spillover, implementing upstream prevention measures, and strengthening One Health surveillance, early warning, and response systems.

The One Health Joint Plan of Action benefits from the support of various activities carried out by FAO and WOAH. For instance, FAO's Field Epidemiology Training on Wildlife, Environment, Biodiversity and Ecosystems enhances the capacity of the natural resource management and environment sector to participate in an interoperable manner with human and animal professionals (FAO, 2022). This training aligns with national baselines and institutional settings, providing crucial support for One Health policies, legislation and interventions. The training is formulated based on the assessment by the Environment Sector Country Mapping and Needs Assessment Tool to align with national baseline and institutional setting.

WOAH, founded as OIE, as the international organization responsible for developing standards, guidelines and recommendations for animal health and zoonoses (WOAH Terrestrial and Aquatic Animals Codes and Manuals), plays a vital role in this partnership. They have published several guidelines and training manuals, such as the Training manual on wildlife diseases and surveillance. WOAH's Global Programme for Capacity Building focuses on strengthening wild animal health capacity, and their establishment of sub-regional wildlife health networks, including Southeast Asia, exemplifies their dedication to fostering regional collaborations. WOAH's regional activities are summarized at the "Wildlife Health Networking" site.

The One Health Joint Plan of Action, developed through a participatory process, serves as a prime example of how transboundary partnerships can effectively counter and mitigate the risk of zoonotic spillover and transboundary disease outbreaks. This initiative has not only fostered cooperation, communication, capacity building, and coordination across all sectors responsible for addressing health concerns at the human-animal-plant-environment interface, but it has also yielded concrete results. The goal of the alignment of the efforts of the FAO, the UNEP, the WHO, and the WOAH, the One Health Quadripartite is the reduction of the risks of emerging and re-emerging zoonotic epidemics and pandemics.

The key takeaway from this initiative is that through collaboration, shared knowledge, and a holistic approach that considers the interconnectedness of humans, animals, and the environment, we have a powerful tool to prevent and control zoonotic diseases. As we work to develop a comprehensive guide for zoonotic disease prevention, we should emphasize the importance of international partnerships like the One Health Quadripartite in sharing effective strategies for safeguarding public health.

Southeast Asia One Health University Network (SEAOHUN)

In Southeast Asia, several noteworthy examples of transboundary One Health efforts have emerged. One such early network operating in the region is the Southeast Asia One Health University Network (SEAOHUN) (Gongal, 2013). Established in late 2011, SEAOHUN brings together 92 universities across eight Southeast Asian countries, namely Myanmar, Cambodia, Indonesia, Laos, Malaysia, Philippines, Thailand and Vietnam. Its primary objective is to train a new generation of One Health professionals. SEAOHUN plays an active role in collaborating with various partners, including the USAID Strategies to Prevent (STOP) Spillover project (late 2020 to present) and a myriad of other partners on both individual country initiatives and regional endeavors. By fostering partnerships, SEAOHUN aims to strengthen capacity-building efforts and promote collaborative research and education in the field of One Health.

Through its extensive network of universities and engagement with diverse stakeholders, SEAOHUN serves as a vital platform for fostering collaboration, sharing knowledge, and implementing coordinated actions to effectively address zoonotic spillover and transboundary disease outbreaks in Southeast Asia. The success of the partnership between SEAOHUN and various organizations underscores the potential for transboundary cooperation and underscores the vital role of regional networks in tackling shared challenges. By harnessing the combined expertise and resources of universities across Southeast Asia, SEAOHUN is not only training a new generation of One Health professionals but also facilitating interdisciplinary collaboration that is essential for preventing and mitigating zoonotic diseases.

The key takeaway from SEAOHUN's efforts is that regional networks and partnerships, like SEAOHUN, have the potential to drive meaningful progress in preventing and controlling zoonotic diseases.

Association of Southeast Asian Nations (ASEAN)

The Association of Southeast Asian Nations (ASEAN) has committed to implementing One Health initiatives to prevent future pandemics. The recent ASEAN Leaders Declaration featured a strong commitment to One Health, aiming to foster stronger regional health collaboration among member countries. In 2022, ASEAN created and ratified an implementation plan titled "ASEAN Strategy for Exotic, Emerging, Re-emerging Diseases and Animal Health Emergencies" that specifically addresses the agricultural-human interface. This strategy envisions the ASEAN region effectively preventing, detecting, and responding to animal health emergencies through a collective responsibility for animal health security.

The strategy focuses on enhancing the ASEAN Animal Health Emergency Preparedness (AHEP) and response capacity by improving core public health systems, increasing regional connectivity and coordination, and investing in ongoing performance improvement. It focuses on nine essential animal health functional areas necessary for AHEP, including risk mitigation and response operations.

Furthermore, this document is designed to harmonize with other national and international frameworks and initiatives within the region and globally such as ACCAHZ, AVEG, AIGA, ALDF, GAHP, GFTADS, GHSA, and APHCA, to foster collaboration on zoonoses using the One Health approach (Table 3-2).

TABLE 3-2. Regional and Global Zoonotic Disease Frameworks

Abbreviation	Title	Function
ACCAHZ	ASEAN Coordinating Centre for Animal Health and Zoonosis	The inception of ACCAHZ dates back to 2012, aims to effectively address the rising threat of the emergence and transmission of zoonotic diseases.
AVEG	ASEAN Ad-Hoc Veterinary Epidemiology Group	The AVEG has been recommended to integrate with the ACCAHZ. At present, AVEG is in the process of crafting preliminary capabilities and fostering networks across Southeast Asia

Abbreviation	Title	Function
AIGA	Avian Influenza Group in ASEAN	The AIGA represents an expansion of one of the earliest animal health collectives within ASEAN, namely the HPAI Taskforce, which was founded back in 2004. A concept note has gained approval concerning the evaluation of the execution of the roadmap towards achieving an HPAI-Free ASEAN Community by 2020, along with future strategies for the prevention and control of Avian influenza in the ASEAN region.
ALDF	ASEAN Laboratory Directors' Forum	The ALDF is dedicated to the enhancement of Laboratory Capacity Building and Networking in Southeast Asia.
GAHP	Good Animal Husbandry Practices	ASEAN GAHP for Layers and Broilers is a standard for good animal husbandry practices for broiler and layer production in the ASEAN region. The standards in ASEAN GAHP mainly aimed at preventing or minimizing food safety incidents.
GFTADS	Global Framework for the progressive control of Transboundary Animal Diseases	The GFTADS is a joint initiative from the FAO and WOAH that aims to initiate and support regional cooperation for the control of transboundary animal diseases.
GHSA	Global Health Security Agenda	The GHSA serves as a catalyst for progress toward the vision of attaining a world safe and secure from global health threats posed by infectious diseases.
APHCA	Animal Production and Health Commission for Asia and the Pacific	THE APHCA supports sustainable improvement in rural livestock agriculture and resource use through information sharing, disease control, enhanced organizational efficiency, the diversification of farm production, supply chain development and other initiatives.

ASEAN's commitment to One Health and its implementation plan for the agricultural-human interface exemplify the importance of transboundary partnerships in addressing zoonotic spillover. By embracing the One Health approach and fostering collaboration across borders, ASEAN is taking significant steps towards building a resilient and unified response to transboundary disease outbreaks within the region. At the human-wildlife interface, the ASEAN Senior Officials on Forestry adopted the ASEAN Strategy for Preventing Transmission of Zoonotic Diseases from Wildlife Trade in October 2022.

The Food and Agriculture Organization-Emergency Centre for Transboundary Animal Diseases (FAO-ECTAD)

The Food and Agriculture Organization-Emergency Centre for Transboundary Animal Diseases (FAO-ECTAD) is another notable partnership committed to the principles of One Health. The regional office of FAO-ECTAD embraces an integrated approach that emphasizes increased multidisciplinary and intersectoral cooperation, capacity building and development, and effective communication.

Established in 2005, FAO-ECTAD operates as part of the Food and Agriculture Organization of the United Nations (FAO) and focuses on planning and delivering animal health emergency and development programs to more than 37 countries. Its primary goal is to prevent and mitigate the impact of animal diseases using a One Health approach.

In its pursuit of enhancing animal health collaboration within the framework of One Health, FAO-ECTAD places significant emphasis on strengthening the capacity of the animal sectors. Through targeted interventions and initiatives, FAO-ECTAD supports training programs that have reached nearly 6000 professionals and has contributed to enhancing the diagnostic capabilities of 90 laboratories in 22 countries. Additionally, in 2021 alone, FAO-ECTAD played a crucial role in responding to over 400 outbreaks of priority diseases in 19 countries.

To ensure sustainability, FAO-ECTAD actively supports the review and formulation of enabling policies and legislation frameworks. It also assists in the formulation of contingency and response plans against priority animal diseases, national action plans on antimicrobial resistance (AMR), and other One Health-related policies and legislation.

The achievements of FAO-ECTAD illustrate the vital role that transboundary partnerships play in building capacity, fostering collaboration, and implementing comprehensive strategies to address zoonotic spillover effectively (Figure 3-3).

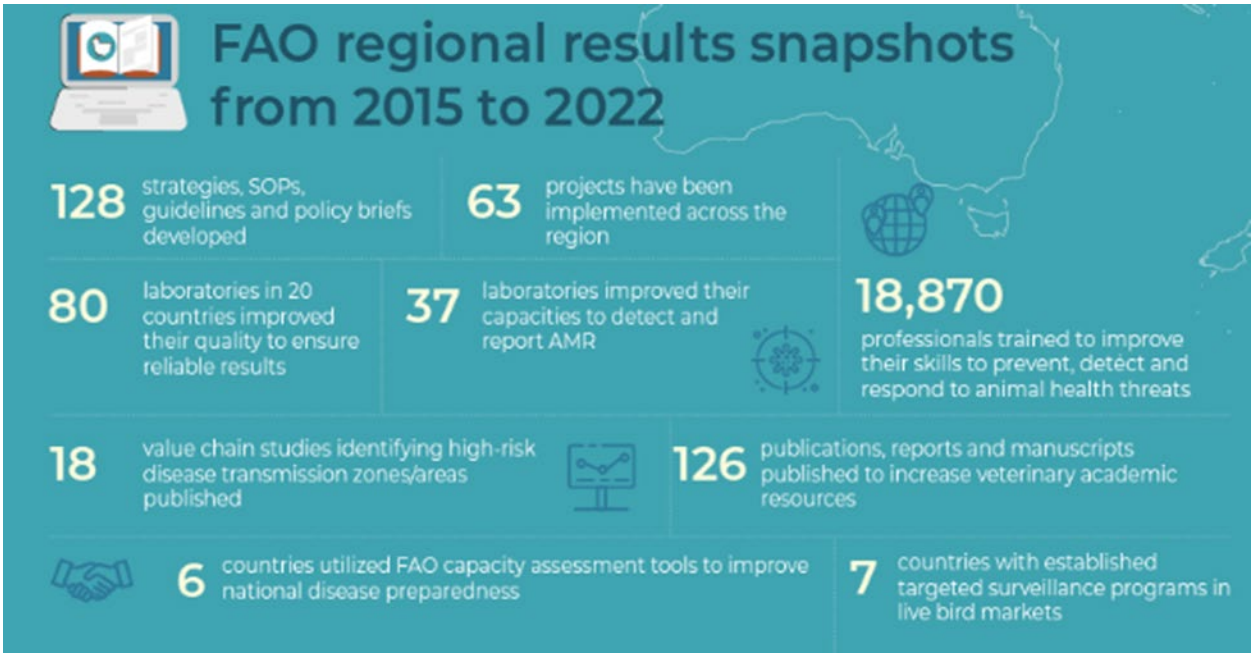

FIGURE 3-3 FAO Regional Results, 2015-2022 (FAO, 2022)

Preventing Zoonotic Diseases Emergence (PREZODE)

PREZODE (PREventing ZOonotic Disease Emergence) is an international initiative launched in 2021 and created to understand the risks of emergence of zoonotic infectious diseases, to develop and implement innovative methods to improve prevention, early detection, and resilience and to ensure rapid response to the risks of emerging infectious diseases of animal origin. The group is developing a research framework to understand the macro processes and drivers leading to zoonosis emergence in the context of global changes. PREZODE helps coordinate a large portfolio of regional, national, and international projects and programs concerning the emergence of zoonotic infectious diseases and implement innovative methods to improve prevention and mitigate emergence risk.

For example, PREZODE has launched PREACTS (PREzode in ACTion in the global South). This global project is divided into several regional programs such as PREACTS-AFRICAM, which is the first phase of PREZODE, involving four African countries (Cameroon, Guinea, Madagascar, and Senegal) and Cambodia. The second phase of PREZODE, which is ASAMCO, involves six countries: Lao PDR, Thailand, Democratic Republic of the Congo (DRC), Haiti, and Costa Rica. Working with national authorities, non-governmental organizations, research institutions and local communities and administrations, PREZODE has developed innovative actions to prevent and reduce the risk of emerging zoonotic diseases at the level of ecosystems and human - wildlife interface.

Emerging Pandemic Threats (EPT)

The "Global Health Security Program" in the Emerging Threats Division Emerging Pandemic Threats (EPT) division was launched by the United States Agency for International Development (USAID) in 2009, with the aim of detecting and responding to potential pandemic threats. The program focused on identifying and mitigating the risk of emerging and zoonotic infectious diseases. The EPT program sought to increase viral discovery; strengthen laboratory and surveillance systems in countries at high risk for outbreaks; and support training of health workers to detect and respond to outbreaks. It also worked with local governments and communities to sensitize the need for a One Health approach.

Working in over 100 countries, the EPT program placed a strong emphasis on the transboundary nature and threat of emerging diseases; promoting regional cooperation and collaboration by supporting the establishment of regional disease surveillance networks, facilitating information sharing across borders, and promoting joint response efforts to outbreaks. The theory of change was that by promoting regional cooperation and strengthening the capacity of partner countries, a collective more resilient global health system will emerge. These essential capacities and connectivities supported the early detection and timely response to the COVID-19 pandemic.

The current iteration of the EPT program (the third five-year cycle) continues a transboundary approach, supporting a number of solutions-oriented programs. STOP Spillover is a 5-year project aimed at 1) Understanding the risk factors that contribute to viral spillover from animals to humans; 2) Implementing interventions at spillover points to prevent zoonotic disease; 3) Assessing risk reduction practices and policies to prevent spillover and mitigate amplification and spread of disease. The One Health Workforce – Next Generation (OHW-NG) project continues support for the SEOHUN network to continue developing One Health competencies

among students so they are field-ready. They have performed activities like simulation activities to enhance the capabilities of the current local workforce for various ministries to work together and respond to zoonotic disease using the One Health approach.

Case studies and other efforts

In the previous section, we explored examples of transboundary partnerships to prevent spillover and described the significance of One Health partnerships in tackling shared health challenges. We learned about various successful initiatives and organizations that have been working to enhance preparedness and response to transboundary disease outbreaks. In this section, we delve deeper into specific cases in Southeast Asia, where noteworthy instances of transboundary collaboration and communication have resulted in decreased likelihood or severity of disease outbreaks.

Case example 3-1: The Cambodia-Vietnam Avian influenza Outbreak of 2021

In February and March of 2021, wild bird mortality events were detected by rangers and communities in three sites within protected wetlands of Cambodia, involving more than 1,700 Asian openbill storks, egrets, pond-herons, and cormorants. These areas have notable interfaces between wild water bird colonies and domestic duck flocks (Figure 3-4). An investigation was conducted by government and non-government partners from the animal health and environmental sectors. The cause was confirmed to be an outbreak of highly pathogenic avian influenza (HPAI) H5N1 in Cambodia and Vietnam; genetic sequencing identified the virus to be clade 2.3.2.1c. This clade is considered endemic in poultry in the region, and further analyses of sequencing data from Cambodia's dead Asian openbill storks showed genetic similarities to virus found in domestic poultry in Vietnam in 2019, suggesting a possible spillover and transboundary outbreak (Dane, 2021; Euromeat News, 2021).

Following these reports, wildlife health experts in Vietnam began conducting active surveillance for avian influenza virus in two protected areas which were selected based on their diversified wild bird populations, including resident and migratory bird species, and their proximity with Cambodia. This parallel investigation in Vietnam led to the discovery of further wild bird mortalities (Dane, 2021; Euromeat News, 2021).

These significant wildlife health events in Cambodia and Vietnam demonstrate how a structured network of multisectoral stakeholders is essential for efficient communication and a coordinated response during a transboundary outbreak. Subsequent HPAI cases in both poultry and humans in 2023, documented by WHO, were also preceded by wild bird mortalities. However, these precursor cases in the wild did not prompt proactive measures like those in 2021, underscoring the need for continued coordination, including at sub-national levels in risk prone areas. Based on these past experiences and similar response efforts in the countries since then, engaging on-the-ground personnel from the environmental sector is recommended. Mobilizing a country's existing wildlife health surveillance network, or laying the groundwork to establish one, is also key to rapid detection and response of mass mortality events in wild birds. By conducting transboundary communication between network stakeholders, these H5N1 outbreaks, and others since, were identified and investigated promptly.

FIGURE 3-4 Wild and domestic birds easily intermix in rural areas. Photo credit Wild Conservation Society (WCS), Lao PDR.

Case example 3-2: Collaborative Efforts to detect African Swine Fever (ASF) in Southeast Asia: Laos, Cambodia, and Vietnam in 2019

African swine fever virus (ASFV) continues to devastate domestic pig populations following its introduction into Southeast Asia in 2019 and subsequent rapid spread across the region (Mighell and Ward, 2021). Although not zoonotic, ASFV has severe effects on animal welfare and human food and economic security. A recent example of the importance of cross-disciplinary collaborative actions was the discovery of ASF in wild pig populations following initial reports of the disease in domestic pigs in Laos, Cambodia, and Vietnam (Denstedt et al., 2021). Government and non-governmental stakeholders in each country, including livestock

officers and forest rangers, conducted investigations in rural communities adjacent to wild boar habitat and experiencing mass mortality events in their domestic pigs at the time (Figure 3-5) (Denstedt et al., 2021). Risk factors for ASF spillover into wild boar were documented and, building on existing protocols from the livestock sector, mechanisms for reporting sick and dead wild boar were established. Active surveillance was conducted, including wild boar fecal sample collection by forest rangers on patrol. However, these methods were not effective or efficient in detecting ASF. Ultimately, operationalizing passive surveillance reporting systems for sick and dead wild boar, particularly systems involving rural communities, was the most effective strategy for detecting viruses in wild boar specimens. Laos was the first to detect ASF in free-ranging wild boar, and the experiences and methods pertaining to this investigation in Laos were shared with neighboring networks in Cambodia and Vietnam. Both neighboring countries detected cases of ASF in wild boar shortly thereafter.

Based on these experiences, it is recommended to engage communities early and often when ASF is suspected to be infecting animals inside wild boar habitats both from an efficiency standpoint and for cost-effectiveness. The efforts of these pilot networks, established under the WildHealthNet initiative, ultimately led to the first detection of ASFV in wild pigs in Southeast Asia and ushered in increased dialogue, monitoring, and surveillance efforts in other locations.

There are eleven endemic wild pig species found in Southeast Asia and the Pacific but little is known about the distribution and impact of ASFV on these populations (Luskin et al., 2020). Aside from the direct threat to wild pig population numbers, their decline may trigger cascading impacts for apex predators, plant communities, and the livelihoods of many communities living within proximity to wild pig habitat. Other mass mortality events in wild boar have since been detected anecdotally in other forests in these countries and others in the region. However, surveillance networks have not yet been established around every possible habitat, and therefore no formal reporting, investigations, or response were conducted when these events were detected. By establishing and scaling up cross-sector surveillance, policy instruments specific to wildlife health, and practical response systems, a clearer picture can be gained of the distribution and level of impact ASF is having on the region's wild pigs and what practical measures can be taken to reduce the ongoing risk of spillover and spillback (Luskin et al., 2020).. The FAO, WOAH, and IUCN issued a joint communiqué recognizing the importance of wildlife health surveillance and a One Health approach to tackling ASF, calling on governments in the Asia-Pacific region to develop stronger policies and take action (FAO, 2021).

FIGURE 3-5 Rural pig farming in Southeast Asia (Denstedt et al., 2021).

Case example 3-3: Collaborative Efforts to detect African Swine Fever (ASF) in Southeast Asia: Laos, Cambodia, and Vietnam in 2019

Malaria has been a long-standing health challenge in the Greater Mekong Subregion (GMS), which includes countries such as Cambodia, Laos, Myanmar, Thailand, Vietnam, and parts of China. The GMS is known for its high malaria transmission rates and the presence of drug-resistant malaria strains, particularly *Plasmodium falciparum* (Sattabongkot et al., 2022).In response to this regional health threat, the Mekong Malaria Elimination (MME) program was established in 2017, aimed to promote cross-border collaboration and communication among the GMS countries to accelerate malaria elimination efforts and contain the spread of drug-resistant malaria strains. The MME program works in close collaboration with the WHO country offices, the WHO Global Malaria Programme, national malaria programmes, and partners (WHO, 2022). The Malaria Elimination Database is a cornerstone of the MMR program. The regional platform collects monthly malaria data at the district and lower levels, such as sub-districts and health facilities, using 2010 data as the baseline. Access to this database enables countries in the Greater Mekong subregion to strengthen surveillance, enhance monitoring and evaluation, analyze malaria distribution and trends, and share data through monthly epidemiological summaries and annual bulletins (WHO, 2024).

Case example 3-4: Foot and Mouth Disease on Continental Southeast Asia

Foot and mouth disease (FMD) is a major animal health problem within Southeast Asia. Although Indonesia and more recently the Philippines have achieved freedom from FMD, the

disease remains endemic on continental Southeast Asia. Control of FMD within SEA would increase access to markets in more developed economies and reduce lost productivity in smallholder and emerging commercial farmer settings (Blacksell et al., 2019). However, despite many years of vaccination by individual countries, numerous factors have prevented the successful control of FMD within the region, including unregulated 'informal' transboundary movement of livestock and their products, difficulties implementing vaccination programmes, emergence of new virus topotypes and lineages, low-level technical capacity and biosecurity at national levels, limited farmer knowledge on FMD disease recognition, failure of timely outbreak reporting and response, and limitations in national and international FMD control programmes (Blacksell et al., 2019).. The South-East Asia Foot and Mouth Disease (SEAFMD) Campaign was formally established in 1997 to control and eradicate FMD in the sub-region, including Cambodia, Lao PDR, Malaysia, Myanmar, the Philippines, Thailand, Indonesia, and Vietnam. In 2010, Brunei, China, and Singapore also joined the Campaign, thereby expanding its geographic coverage. Consequently, SEAFMD was renamed the South-East Asia and China Foot and Mouth Disease (SEACFMD) Campaign. Mongolia was accepted as its 12th member in 2016. This Campaign is currently at Phase 6 (2021 to 2025). During this phase, the new Roadmap 2021-2025 will guide countries to base the implementation of their national FMD plan on science, while taking account of achievements and lessons learnt from previous phases (SEACFMD, 2021).

WILDLIFE TRADE AS A TRANSBOUNDARY SYSTEM IN SOUTHEAST ASIA AND THE ATTEMPTS TO UNDERSTAND AND REGULATE THE SYSTEM

Understanding Wildlife Trade as a Transboundary System

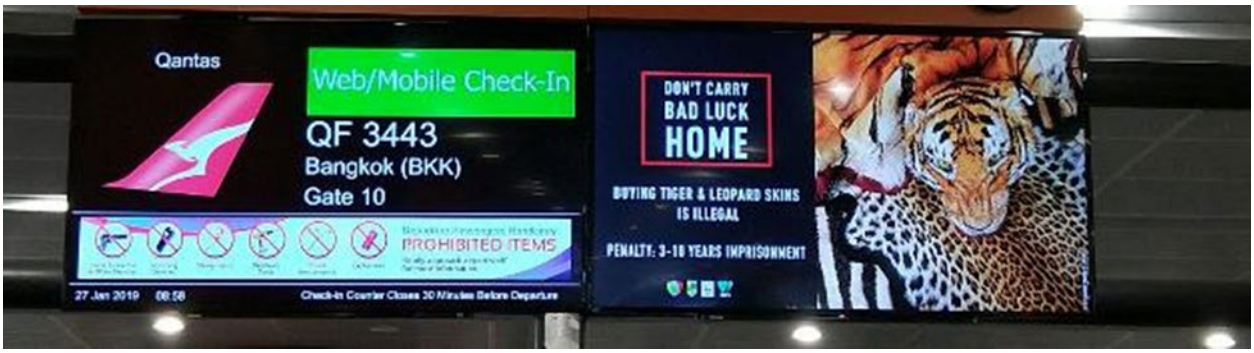

FIGURE 3-6 Public outreach messages at Yangon Airport, Myanmar, discouraging travelers from illegal trade and trafficking of wildlife products. Photo credit K. Yoganand.

Wildlife trade is an interconnected system that operates across borders, making it a transboundary issue of significant concern (Figure 3-6) (Keskin et al., 2023). Southeast Asia, known for its exceptional biodiversity, harbors numerous endangered and threatened species of flora and fauna (Hughes, 2017). However, the region's widespread trade and consumption of wildlife increases the risk of zoonotic spillover and other negative consequences due to close contact facilitated by wildlife trade. The trade, both legal and illegal, and formal and informal, poses substantial environmental impacts, drives species extinction and threatens ecosystem services. The increased contact through wildlife trade can lead to zoonotic spillover, where

pathogens are transmitted from animals to humans. This risk increases as the length and complexity (i.e. number of human-animal interfaces) of the supply chain increases.

Legal Trade

These are trade activities that comply with national and international laws and regulations. It involves obtaining the necessary permits, licenses, and documentation required from the governing authorities. Legal wildlife trade operates within the framework of established laws and regulations, ensuring that the trade activities are conducted in a lawful and regulated manner. The effectiveness of these operations depends on monitoring, compliance management and, as with all aspects of regulated trade, effective law enforcement. However, sustainability is not considered in most wildlife trade laws, except in the case of the CITES regulated trade. Globally, much of wildlife trade is governed by national laws, they remain outside of CITES and do not consider sustainability in a methodical way.

An example is the legal export of 476,000 live long-tailed macaques (*Macaca fascicularis*) over 10 years (from 2010 to 2019) (Figure 3-7), predominantly by Southeast Asian countries such as Cambodia, Vietnam, Indonesia, and China and Mauritius (Hansen et al., 2022). Most of them were imported by the U.S., Japan, China, France, and the U.K. (Keeling, 2023).

FIGURE 3-7 A long-tailed macaque mother and infant foraging along a road in Pahang state in peninsular Malaysia. Human travellers often feed the monkeys with human food and this creates an unnecessary interface and risky close contact between them. Photo credit K. Yoganand

Illegal Trade

These are trade activities that violate national and international laws and regulations. Illegal wildlife trade operates outside the boundaries of formal regulations and often involves poaching, smuggling, and illegal sales of protected or endangered species. It is considered a serious threat to biodiversity and conservation efforts (WWF, 2024).

Elephant ivory

Examples include trafficking and illegal sales of elephant ivory, rhino horn, pangolin scales, and tiger bones (Figure 3-8) (TRAFFIC, 2024). More than 63,000 kg of illegal elephant ivory seizures from 2003 to 2014 have implicated Malaysia as part of the trade route, with Malaysia itself seizing some 19,000 kg of ivory during this period (Koshy, 2020;Traffic International, 2024).

FIGURE 3-8 Replica of illegal wildlife parts and products including rhino horns and a tiger skull on display at the Vientiane international airport to educate travellers about the illegality of buying and carrying these products. Photo credit K. Yoganand

Bear bile

Sun bears and Asiatic black bears (Figure 3-9) are illegally captured from forests and held in captivity by traders to extract bile from their gallbladders (Hall, 2019).

FIGURE 3-9 An Asiatic black bear held in captivity in the Golden Triangle Special Economic Zone in Lao P.D.R. Illegal bear bile farms and restaurants offering bear paw soup on their menu were known to operate nearby. SOURCE: K. Yoganand

Live macaques

In November 2022, the U.S. Department of Justice indicted several persons involved in illegally sourcing live long-tailed macaques from the protected areas of Cambodia, falsely labeling them as captive-bred and exporting more than 1,500 of them from Cambodia to the U.S. (Grimm, 2022).

Crocodile skins

In Malaysia, there is legal export of farmed crocodile skins to international markets (Figure 3-10). Malaysian crocodile farms that engage in this trade are required to obtain permits and licenses from relevant government agencies. This trade involves exporting crocodile skins from farms that adhere to Malaysian wildlife regulations and international agreements, like the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). In a recent incident reported by The Star (Vanar, 2019), authorities in Sabah successfully foiled an attempt to smuggle 220 crocodiles from Indonesia to a Malaysian crocodile farm.

FIGURE 3-10 Some seized crocodiles were found at a swamp area in Kampung Pasir Putih in Tawau, Malaysia (The Star ; Vanar, 2019)

Informal Trade

These are trade activities that occur outside formal, regulated channels and may not always fully comply with regulations. Informal trade can take on various forms, including both legal but unregulated and unauthorized trade of wildlife species. This type of trade is often small-scale and localized, involving local communities or individuals trading to generate livelihood or household income. It can also include unregulated or unauthorized trade of wildlife species, leading to potential conservation and sustainability concerns (The World Bank Blog, 2022; The World Bank and WCS, 2006).

Bamboo Rats

In Lao PDR, small-scale farming of bamboo rats takes place in many households, typically in rural areas. Many species of rodents, such as bamboo rats (Figure 3-11), are traded for consumption or use in traditional medicine and to do so is not illegal and it requires no formal documentation nor is it regulated (Greatorex et al., 2016; The World Bank and WCS, 2006).

FIGURE 3-11 Rodents are commonly sold in local fresh markets along with fish, frogs, various insects, and vegetables in Lao PDR, such as at this organic market in Vientiane city. Photo credit K. Yoganand

Songbirds

In many countries in Southeast Asia and particularly in Indonesia, catching from the wild, keeping (sometimes breeding), and locally trading songbirds such as the magpie-robin, white-rumped shama (Figure 3-12), and orange-headed thrush is a well-known tradition. The songbirds are highly sought after for their melodious songs and are used in bird song competitions. However, in the island of Java, millions of households are involved in this trade (Marshall et al., 2020), resulting in severe declines and local extinctions of several bird species, a phenomenon known as the 'Asian songbird crisis' (CITES, 2015).

FIGURE 3-12 The White-rumped Shama, a commonly traded songbird in southeast Asia. Photo credit K. Yoganand

Wildlife trade supply chains that move wildlife from source sites to large urban markets constitute evolutionary mixing vessels that mix viruses from different species, potentially generating novel pathogens through genetic processes such as reassortment and recombination. Trade of wild animals in markets, in particular live mammals and birds, creates environments where species (including humans) that normally would not frequently or ever come into contact with one another (nor do so in such high numbers) are in close and sometimes immediate proximity, sharing space and pathogens (Lin et al., 2021). Similarly, wildlife farms where large numbers of animals are raised close together and in frequent contact with people are also potent sites for emergent diseases (Espinosa et al., 2020).

In Asia, wild meat consumption as a dietary necessity is less prevalent than in other parts of the Global South and is consumed often as a luxury item or used in traditional medicine. Local Communities in many countries in Asia also still hunt wild species as a source of food or income. Wildlife traded on a commercial scale to satisfy the significant urban demand for wildlife products, both within and far outside the region, continues to drive unsustainable take on already-depleted wildlife populations and habitat. This, in turn, deprives livelihoods and household incomes for local communities who rely on natural resources as important sources. Addressing the legal and illegal wildlife trade is crucial for preventing transboundary disease outbreaks (Rush et al., 2021). The illegal wildlife trade (IWT) often involves the capture, transport, and sale of live animals, increasing the risk of disease transmission from animals to humans. Improving animal welfare, strengthening wildlife health monitoring, and encouraging sustainable use can help reduce the risk

of disease outbreaks. In addition, strengthening law enforcement efforts to combat illegal wildlife trade and related crimes can help reduce the spread of zoonotic diseases (UNODC, 2020).

The rat trade in Cambodia demonstrates the transboundary nature of many types of wildlife trade. Indeed, wildlife trade, whether legal or illegal, formal or informal, operates across borders and poses significant risks, including zoonotic spillover and ecosystem threats. The rat trade in Cambodia intertwines local practices of hunting and consuming field rats with a cross-border supply chain that supports multiscale trade. This complex system highlights the potential consequences of close contact facilitated by wildlife trade, as it reveals a significant prevalence of confirmed cases of Coronavirus among rodents destined for human consumption (Huong et al., 2020). By examining the rat trade (see box), we can gain insights into the interconnectedness of wildlife trade chains and their potential role in disease outbreaks, while also considering the diverse perspectives and trade-offs related to food security, species protection, and global sustainability.

The illegal trading of the critically endangered Sunda Pangolin is another example of the transboundary nature of wildlife trade in Southeast Asia. The demand for pangolins and their body parts, driven by cultural and medicinal beliefs, has resulted in extensive illegal hunting and trade across the region (Archer et al., 2021). This trade not only drives the extinction of pangolin populations but also poses significant risks to public health. Pangolins carry viruses closely related to known human pathogens, including those associated with SARS-CoV-2 and MERS (Shi et al. 2022). The dynamic and unsupervised environment created by the illegal pangolin trade, including the illegal hunting and trapping, transportation in stressful conditions, unsafe handling during butchering and local market sales, provides opportunities for viral recombination, replication, and spillover (Gupta et al., 2022). With an estimated million pangolins illegally traded each year (Grein, 2024), efforts to combat this trade have proven challenging, highlighting the need for a multifaceted approach that balances economic and livelihood concerns, species conservation, and transboundary cooperation.

Reviewing these case studies, we emphasize the broader issue of wildlife trade as a transboundary system and its implications for zoonotic disease outbreaks. The rat trade and the illegal trading of pangolins serve as specific examples that illustrate the interconnectedness of wildlife trade chains, the risks of close contact between different species and the potential consequences for public health. This reinforces the importance of understanding and regulating wildlife trade, minimizing trade in certain high-disease risk taxa as a prevention strategy, and designing and enforcing biosecurity standards along the supply chain to counter zoonotic spillover disease outbreaks in Southeast Asia.

EXISTING REGULATORY EFFORTS ADDRESSING WILDLIFE TRADE IN SOUTHEAST ASIA: OVERVIEW OF POLICY CHANGES AND DEVELOPMENTS

Public policy is “a set of interrelated decisions taken by a political actor or group of actors concerning the selection of goals and the means of achieving them” (Jenkins, 1978). The development, consultation to gain buy-in, and implementation require a sound evidence base, and governance structures to ensure implementation and accountability.

WHO CA+

Intergovernmental policies are complex and take years to develop. However, this should not stop the process. In recognition of the shortcomings of the international community to respond effectively to the COVID-19 pandemic in a timely manner, the World Health Assembly established an Intergovernmental Negotiating Body (INB) to establish a WHO convention, agreement or other instrument on pandemic prevention, preparedness, and response ("WHO CA+"). Most notably, the agreement recognises that a One Health approach is needed to strengthen synergies with other existing legal or non-legal instruments to address drivers of pandemics, including increased risks at the human-animal-environment interface. The agreement also includes a commitment to strengthen surveillance systems and laboratory capacity to detect and minimize spillover events associated with zoonotic neglected tropical and vector borne diseases from wildlife or domesticated animals (WHO, 2023; FAO, 2023).

Wildlife Directive in Vietnam following the Covid-19 Pandemic

Following the COVID-19 pandemic, Vietnam issued a directive (29/CT-TTg) including measures to restrict wildlife trade and consumption, banning the import of live wild animals and wildlife products (WildAid, 2020). The directive aimed to restrict wildlife markets (Figure 3-13) and prohibit hunting activities that include the transport, slaughter, selling, buying, storing, and consumption of wildlife animals (WildAid, 2020; FAO, 2023).The Ministry of Agriculture and Rural Development primarily led these efforts and coordinated with relevant agencies, while the Ministry of Public Security strengthened enforcements with other ministries, provincial and city authorities tasked with specific roles for implementation. A Pandemic Prevention Task Force composed of representatives of the Vietnam government, multilateral organizations (FAO, WHO, UNEP), NGOs and several embassies also pushed to develop, strengthen and enforce all legal measures required to phase out commercial trade and consumption of wild birds and mammals. This action represents an example of the government mobilizing dozens of normally siloed ministries and agencies to address spillover within the wildlife trade. The government mobilisation was the insititution of a One Health Partnership, led by three ministries (MARD, MoHealth and Ministry of Natural Resources and Environment). This OHP has a current 5-year plan 2021-2025, and in 2021 established a Technical Working Group on Wildlife and Pandemic Prevention. Since then, Vietnam has reviewed the implementation through multi-sectoral, multi-stakeholder workshops and will be developing a National Action Plan to control the trading activities of wildlife flora and fauna species in the period of 2023 – 2030 (TRAFFIC, 2023).

FIGURE 3-13 Vendor and animals in wildlife market. Photo credit WCS Viet Nam.

WCS's Counter Wildlife Trafficking:

The Wildlife Conservation Society's Counter Wildlife Trafficking program operates in 32 countries along major trafficking supply chains with locally led programs working in partnership with governments, in-house law enforcement and criminal justice expertise. The focus of this effort is to end those elements of the commercial trade business with the highest risk, eliminating pathogens along the animal supply chain of certain species and products. The process includes a combination of grounds-up initiatives such as combating illegal wildlife trade through the Wildlife Crimes Unit, a partnership between Indonesia and civil society, and advising governments on policies associated with deforestation or establishing new protected areas for wildlife. For example, the number of breeding waterbirds, e.g. the Oriental darter, in the flooded forest of Prek Toal on Cambodia's Tonle Sap (Figure 3-14) has increased significantly through the combined efforts of WCS, Cambodian Ministry of Environment, and local people (WCS, 2024; WCS, 2022).

FIGURE 3-14 Bird colonies commonly found in regions of Southeast Asia. Photo credit Prek Toal Bird Sanctuary

Adoption of Wildlife Health Surveillance into National Policy in Laos

The Lao PDR-Cambodia One Health Surveillance and Laboratory Network or LACANET (EU-funded) and WildHealthNet (US Defense Threat Reduction Agency-funded) (Figure 3-15) initiatives led by the Ministry of Agriculture and Forestry in Laos, together with WCS, formalized the Standard Operating Procedure for Wildlife Health Surveillance at the ministerial level in 2022. This network sets the operating standards for wildlife health surveillance to guide surveillance and management of disease information in wildlife and provides practical guidance on early case detection, risk assessment and response to wildlife illness or death. The network successfully connects people who encounter wildlife, including villagers and staff at animal rescue centers, with scientists, decision makers and stakeholders who can take action to analyze disease threats. A National Wildlife Health Surveillance Committee was created to establish central governance over these interactions (LACANET, 2024; WCS, 2021).

FIGURE 3-15 *TBA*

WildHealthNet

Wildlife health surveillance can be used for early detection of disease threats, including zoonoses and health threats directly impacting wildlife populations, although most efforts in the region have had limited scope and duration. WildHealthNet is an example of a cross-sectoral and trans-disciplinary approach to build and implement effective, sustainable national wildlife health surveillance systems exist (Pruvot et al., 2023). This initiative in Cambodia, Laos, and Vietnam is building national wildlife health surveillance strategies from the ground up, implementing systems for reporting wildlife morbidity and mortality events detected in local wildlife trade markets, wildlife rescue centers, and protected areas where human-wildlife interfaces exist (Pruvot et al., 2023).

FIGURE 3-16 WildHealthNet initiatives leverage veterinary and wildlife health expertise to safeguard biodiversity in Southeast Asia. Photo credit WildHealthNet.

The objective is to ensure early detection and response to events which may negatively impact the health of humans, livestock, and/or wildlife populations themselves. The approach brings together human, animal, and environmental health sectors that each hold part of a national One Health surveillance system solution (Figure 3-16). These sectors form a network that is supported by international frameworks, data management systems, capacity bridging, and technical training, to meet the challenge of providing locally relevant solutions that can be scaled globally. Different wildlife morbidity and mortality event reporting mechanisms were piloted to inform the development of national Standard Operating Procedures (SOPs) in Laos and Cambodia. Through these pilot networks, outbreaks of African swine fever in wild boar, Lumpy skin disease in endangered banteng, and highly pathogenic avian influenza (H5N1) outbreaks in wild bird colonies were discovered and investigated. In the case of Laos, WildHealthNet resulted in the drafting of an SOP for Wildlife Health Surveillance which was adopted into national policy and the official establishment of a National Wildlife Health Surveillance Committee in January 2023. The WildHealthNet approach, novel both in its scale and sustainability, has laid groundwork unique in the One Health field which allows for continued wildlife health surveillance on a national scale in Laos, Cambodia, and Vietnam today exist (Pruvot et al., 2023).

Advocating For a Transboundary Approach to Wildlife Trade in Southeast Asia

The rapid expansion of wildlife trade in Southeast Asia has brought both economic and biodiversity conservation concerns (Felbab-Brown, 2011; Nijman, 2009). Outbreaks of zoonotic diseases, most notably the COVID-19 pandemic, have underscored the risks associated with wildlife trade and its severe impact on public health (CRS, 2021). This section explores the urgent need for collaborative efforts among countries to address these challenges collectively. Sharing knowledge, enhancing law enforcement, and integrating health professionals in wildlife management will safeguard public health, conserve biodiversity, and effectively counter the emergence of zoonotic diseases in the Southeast Asia region.

Strengthening Wildlife Trade Law Enforcement in the Context of COVID-19

China's response to the risks associated with wildlife trade in the wake of the COVID-19 pandemic has been marked by significant action. In February 2020, the Chinese government implemented a comprehensive ban on the trade and consumption of wild vertebrate animals , a crucial step to prevent the transmission of zoonotic diseases from wildlife to humans (Koh et al.,

2021). By prohibiting the trade and consumption of wild animals, China aimed to reduce the likelihood of future outbreaks and safeguard public health (Koh et al., 2021).

According to CNN (2020), a government-sponsored report in 2017 by the Chinese Academy of Engineering reported that China's commitment to addressing wildlife trade extends to exerting control over wildlife farming, a lucrative industry estimated to be worth around $73 billion and employing over one million people (Westcott, 2020). This action indicates that China recognizes the economic significance of the wildlife farming industry accompanied by willingness to prioritize public health and conservation over economic considerations.

Vietnam, a neighboring Southeast Asian country, faces similar challenges in terms of wildlife trade (Luong, 2022). Like China, Vietnam has experienced the expansion of wildlife farming and trade, which has contributed to both economic growth and biodiversity conservation concerns (Thuy et al., 2021; USAID, 2024). Taking a transboundary approach, countries in Southeast Asia, including China and Vietnam, could collaborate to strengthen wildlife trade law enforcement, enhance regulations, and implement stricter monitoring systems. Such collaboration would help mitigate the risks of zoonotic disease transmission and contribute to the conservation of endangered species in the region.

By sharing knowledge, resources, and best practices, China and Vietnam, along with other countries in Southeast Asia, can work together to develop comprehensive strategies that effectively address the complex issue of wildlife trade. Cooperation in law enforcement, developing regulations, and monitoring would help ensure that a ban on wildlife trade is effectively implemented and enforced, reducing the risk of future zoonotic disease outbreaks and promoting both public health and biodiversity.

Enhancing Wildlife Trade Control and Monitoring for Public Health

Wildlife trade represents one of the most important, expanding, and uncontrollable interfaces for emerging disease spillover. Due to extreme complexity, it is one of the most complicated aspects of pandemic prevention to address (Hilderink and de Winter, 2021). To enhance wildlife trade control and monitoring for public health, the following recommendations are made.

Clarifying Intervention Opportunities Based on knowledge, attitude, and practices

To effectively address the complex challenges associated with wildlife trade and its impact on public health, it is crucial to clarify intervention opportunities based on the knowledge, attitudes, and practices of various stakeholders (Vigilla-Montecillo et al., 2023). By understanding these factors, we can develop targeted strategies that align with different audiences and maximize the effectiveness of our interventions.

1. **Develop a unified theory of change** on how to address shared risks in wildlife conservation and public health with respect to wildlife trade. Many groups are working on this at many scales, but efforts are still relatively siloed.
2. **Develop and train best practices for engaging local communities in win-win solutions:** species survival requires active engagement of local communities to promote conservation. One commonly identified gap in current disease prevention protocols is

the continued low awareness about the connection between zoonotic diseases and wildlife conservation in rural and remote areas.

3. **Convene transboundary fora for shared wildlife trade governance:** Pathogen surveillance and legal protection and enforcement activities have been insufficient or ineffective; therefore, it is important to further develop legislation and policy to reduce disease risks from wildlife trade.
4. **Develop combined one health surveillance and risk assessment models:** the examples above represent the beginning of a systems approach to pandemic preparedness. We must develop best practices for multi-species, One Health, monitoring programs and surveillance of emerging diseases. We must focus on how a systems approach can provide solutions to the complexity of this problem which consists of many "boundaries" (geopolitical, disciplinary, inter-species, ecotones, socio-biological, etc.) at play currently in a dynamic way. Connecting Risk-based models focused on the issue of emergence will help define and refine data needs for which monitoring and surveillance systems can be optimized. These must contain biological risk factors but should be expanded to connect social dimensions as drivers of the interface that creates risk. Connecting biological disease transmission with individual and policy level decision analysis will help us move away from the reactive to a predictive and preventive approach.

Clarifying intervention opportunities based on stakeholders' attitudes, beliefs, and practices is essential for effective wildlife trade control and public health protection. By addressing the identified gaps, convening experts, developing unified approaches, and integrating diverse perspectives, we can foster sustainable practices and promote a harmonious coexistence between human populations, wildlife, and the environment.

Integrating of Health and Wildlife Professionals

The integration of health and wildlife professionals will facilitate not only teams capable of understanding and characterizing wildlife health threats to humans but will support development and implementation of one health solutions aimed at safeguarding both animal and human health, while promoting the conservation of ecosystems. Traditionally, zoonotic diseases of wildlife origin have been under prioritized within regulatory frameworks worldwide. This fragmentation is akin to the challenges faced by neglected tropical diseases, with limited resources allocated to the interface issues between wildlife and humans. Wildlife-borne zoonotic diseases are frequently discovered in humans when they become ill or studied by animal health experts as part of veterinary or environment health disciplines. The nature of their risk is often described as 'low probability, high consequence', meaning that while the likelihood of spillover and human-human transmission may be low, the potential consequences can be severe. Thus, there is a gap in funding and preparedness, as these diseases can be easily ignored or minimized in the present (Radin and Eleftheriades, 2021). Recent global epidemic events such as SARS CoV-2, Ebola, Marburg, and others have raised awareness about the importance of addressing these issues worldwide. However, there is still a pressing need to foster more public health-wildlife partnership approaches in order to prepare for and prevent such outbreaks.

Experts in this field advocate for a holistic, transdisciplinary, systems approach known as 'Ecohealth' or 'ecological approaches to health'. Ecohealth emphasizes the interconnectedness

between humans and wild animals within the ecosystem context. It focuses on understanding how environment and ecological changes, including habitat destruction, pollution, and wildlife trade, can impact the health of wild animal populations and the risk of zoonotic disease transmission to humans. For example, Sethi et al (2023) discuss the environmental correlates, including climate change, behind the rise in infectious diseases, and call for the need for infectious disease control and preparedness. For further insights of these integrated perspectives, refer to Chapter One on One Health, which explores the connections between Ecohealth and environmental health approaches in greater detail.

CONCLUSION

At the outset of this chapter, we posed that the application of transboundary concept must be supported by the principles and practices of *One Health* - acknowledging the complexity of the epidemiological triad at multiple scales and interfaces, within a dynamic, chaotic world. We suggest that transboundary problems are not limited in scope by the traditional geographical use, but bridge across relevant domains including diversity of human culture, language, food (security and safety), politics, approaches to problems, needs, opinions, agendas, goals, desired outcomes, nature, and natural resources usage. This complexity automatically leads to a discussion of systems thinking. The goal of this discussion was to examine the idea of transboundary work and partnerships that match the complexity and scope of today's emerging diseases, including more focus on social systems, respect for cultural diversity and values, and a host of scientific disciplines. Our review of the current state of application of these principles reinforces (a) that progress is being made, and (b) the need to apply them more fully across scale - integrating local community and regional governance. We feel that focusing the next steps in the transboundary approach on the three objectives below will help fill existing gaps.

1. Continued harmonisation of methods across disciplines countries, and regions to increase teamwork for prevention and response
2. Continued fostering of more participatory wildlife monitoring and health surveillance
3. Focus on fostering development and implementation of high-level standards for and community-based examples of wildlife trade risk assessment and management.