Case Study
ASSAM STATE, INDIA
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# ACRONYMS AND ABBREVIATIONS

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<th>Description</th>
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<tr>
<td>ABRL</td>
<td>Penn State’s Applied Biological and Biosecurity Research Laboratory</td>
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<td>ASDMA</td>
<td>Assam State Disaster Management Authority</td>
</tr>
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<td>CADRAD</td>
<td>Centre for Animal Disease Research and Diagnosis</td>
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<tr>
<td>COVID-19</td>
<td>Coronavirus disease caused by the SARS coronavirus 2 (SARS-CoV-2)</td>
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<td>CWC</td>
<td>Centre for Wildlife Conservation Management and Disease Surveillance</td>
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<td>DAHD</td>
<td>Department of Animal Husbandry and Dairying</td>
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<td>EIDs</td>
<td>Emerging Infectious Diseases</td>
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<td>EVD</td>
<td>Ebola Virus Disease</td>
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<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
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<td>FSSAA</td>
<td>Food Safety and Standards Authority of Assam</td>
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<td>IBA</td>
<td>Important Bird Areas</td>
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<tr>
<td>ICAR</td>
<td>Indian Council of Agricultural Research</td>
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<td>ICMR</td>
<td>Indian Council of Medical Research</td>
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<td>IDSP</td>
<td>India’s Integrated Disease Surveillance Program</td>
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<td>IVRI</td>
<td>Indian Veterinary Research Institute</td>
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<td>LHDC</td>
<td>India’s Livestock Health and Disease Control Scheme</td>
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<td>MOAFW</td>
<td>Ministry of Animal and Farmer Welfare</td>
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<tr>
<td>MOEFC</td>
<td>Ministry of Environment, Forest and Climate Change</td>
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<tr>
<td>MOFAHD</td>
<td>Ministry of Fisheries, Animal Husbandry and Dairying</td>
</tr>
<tr>
<td>MOHFW</td>
<td>Ministry of Health and Family Welfare</td>
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<tr>
<td>NADRS</td>
<td>India’s National Animal Disease Reporting System</td>
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<td>NCDs</td>
<td>Non-Communicable Diseases</td>
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<td>NCDC</td>
<td>National Centre for Disease Control</td>
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<tr>
<td>NERDDL</td>
<td>India’s Northeastern Regional Disease Diagnostic Laboratory</td>
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<tr>
<td>NIVEDI</td>
<td>National Institute of Veterinary Epidemiology and Disease Informatics</td>
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<tr>
<td>SARS</td>
<td>Severe Acute Respiratory Syndrome</td>
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<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<td>WHO</td>
<td>World Health Organization</td>
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<tr>
<td>WOAH</td>
<td>World Organisation for Animal Health (previously known as OIE)</td>
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In May 2022 the World Organisation for Animal Health started officially using the acronym WOAH. Before its official acronym was OIE which stands for Office International des Epizooties.
I. Executive Summary

The term “One Health” refers to an integrated approach that sustainably balances the health of people, animals, and the ecosystem, and it is a key element for pandemic prevention. Old and new health threats demonstrate how our changing interactions with animals and the environment affect development outcomes. In a post-COVID-19 world, where emerging infectious diseases (EIDs) are becoming more frequent and worsening in impact, preventing pandemics should be a primary focus for policymakers, public health officials, and citizens. This case study targets policymakers and teams within the World Bank and other organizations who aim to prevent future outbreaks by adopting a One Health approach. It also aims to analyze the health situation in Assam State, the progress it has made toward implementing a One Health approach, identifies vulnerabilities and drivers, and presents key recommendations to prevent future pandemics.

ONE HEALTH IN ASSAM STATE, INDIA

Assam State is among the states in India most vulnerable to potential disease outbreaks. The causes are many, including extreme climate events, unequal access to healthcare for most of the rural population, constant interaction among wildlife, livestock, and humans, and increasing migration. Therefore, the success of a One Health approach requires joint action among various sectors, acknowledgement of vulnerabilities and the drivers of potential pandemics, and identification of hotspots for zoonoses and potential areas for collaboration among sectors.

At the federal level, the Government of India is making strides toward creating the enabling environment for the implementation of a One Health approach, but there are major gaps in coordination, cooperation, and communication. Despite Assam's vulnerability to pandemics, only a few solution-based approaches and collaborations are in place during emergencies and outbreaks.

In Assam State, deteriorating environmental conditions stemming from extreme climate events could increasingly influence people’s decisions to migrate, making the State more vulnerable to circulating pathogens, social, political, economic, and demographic vulnerabilities, and weaken its health sector. Infectious disease threat events are increasing in frequency in Assam. The region has distinct climate variations, creating conditions conducive for the transmission of zoonotic diseases, and certain pathogens may be more prevalent because of scarce veterinary and medical services and suboptimal sanitation infrastructure.

Considering the main drivers that increase interactions among humans, livestock, and wildlife, recommendations were developed at the human, animal, and environment levels. For humans, promoting access to healthcare, increasing vaccination rates, and coordinating legal and institutional frameworks will improve health outcomes. For animals, increasing disease surveillance, promoting access to India’s National Animal Disease Reporting System (NADRS), strengthening partnerships, and increasing the use of technologies for livestock are key measures to take. For the environment, conducting flood prevention technical studies, incorporating best practices to reduce the negative effects of land-use change, protecting biodiversity, and reducing deforestation should be prioritized to reduce pandemic risk.

Implications of One Health must be understood for collaboration and coordination to succeed. Governments at the highest levels need to integrate their efforts with various ministries and organizations to achieve desired results.
II. The One Health Approach

The term One Health refers to an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals, and ecosystems (Figure 1). It recognizes the connections and interdependency among the health of humans, domestic and wild animals, and the wider environment, including ecosystems.

This approach aims to mobilize multiple sectors, disciplines and communities at different levels of society to work together to foster well-being, tackle threats to health and ecosystems, and address the need for clean water, energy and air; safe and nutritious food; climate change resilience, and sustainable development (FAO, OIE, UNEP, and WHO 2021).

Emerging infectious diseases (EIDs) are becoming more frequent and worsening their social and economic impacts, exposing the world to repeated pandemic threats. The yearly probability of an occurrence of extreme epidemics may increase up to threefold in the coming decades (Marani et al. 2021). In 2020, the global economy contracted by 4.3% because of COVID-19, which amounts to about USD$3.6 trillion worth of lost goods, services, and other outputs (Figure 2).

Old and new health threats, resulting in pandemic risks, demonstrate how our changing interactions with animals and the environment can affect development outcomes. Interactions among people, animals, and the environment have changed: the human population is increasing, intensive farming practices are growing, environmental disruptions and deforestation are worsening, and the movement of animals and animal products has shifted because of increased trade.

Preventing pandemics should be a primary focus for policymakers, public health officials, and citizens. Implementing a One Health approach will improve countries’ ability to effectively prevent, detect, respond, and recover from outbreaks, prepare for future pandemics, and accomplish development goals such as improved health and economic security, climate resilience, and food safety.
Almost 75% of EIDs in humans have their origin in animals (domestic or wild).

Less than 100 outbreaks per year until the 1980s, to 400+ since 2000.

SARS (2003): $30–50 billion
H1N1 (2009): $45–55 billion
EVD (2014): $10–53 billion
Zika (2015): $7–18 billion


FIGURE 2: EIDs impact snapshot

SARS: Severe Acute Respiratory Syndrome; H1N1: Swine Flu (primarily caused by the H1N1 strain of the flu virus); EVD: Ebola Virus Disease; Zika: Zika Virus; COVID-19: Coronavirus disease caused by the SARS coronavirus 2 (SARS-CoV-2)
III. Assam State, India: A SNAPSHOT

Assam State is among the states in India most vulnerable to potential outbreaks. The causes are many: extreme climate events, unequal access to healthcare for most of the rural population, constant interaction among wildlife, livestock, and humans, and increasing migration. The State has yet to make headway on certain public health goals. For example, it has not controlled diseases that can be prevented by vaccination such as Japanese Encephalitis, while other disease control programs such as the Tuberculosis Control Program cannot be successful if people’s nutrition, lifestyle, and social environment are not prioritized. (Priyadarshini 2016).

As a primarily rural State with increasing urbanization and expanding commercial activity, Assam is India’s gateway to Northeast India and a vital link for trade with Southeast Asian countries (Figure 3). Assam is the most populous state in Northeast India with more than 31 million people (Census 2011). Approximately 86% of the population live in rural areas, while growing industrialization, expansion of commercial activity, and the tendency of immigrants to live near towns are fueling urbanization.

Agriculture is the most important economic activity and the main source of livelihoods for more than 80% of the population, but livelihoods from raising livestock and dairy farming have grown significantly. Agriculture represents 54% of the total land area and plays a big role in Assam’s revenue generation and socio-economic condition. However, livestock are an integral part of local diets and of the mixed-farming systems that characterize agriculture in Assam (Barbaruah 2012). From 2010 to 2019, meat production in Assam grew from 32 to 50 thousand tons annually, but there is still a large shortfall of meat consumption when compared with India’s nationally recommended food intake (Dep. Of Animal Husbandry, Dairying, and Fisheries 2019). Aquaculture has been a major focus of agricultural development since the mid-1990s, and yields have increased but continue to fall short of domestic demand.

The intensification of agriculture has decreased the land area, especially forests, available for other uses. From 2001 to 2020, the total area of humid primary forests—naturally regenerated forests of native tree species where there are no clearly visible indications of

1 In 2014, 51% of the total cases of encephalitis in India were reported from Assam. Assam was the first State in the country to start a Japanese Encephalitis Adult vaccination program and the pilot project for it was undertaken in Sivasagar in 2011.
human activity—decreased by 7.4%, while tree cover decreased by 9.8% since 2000 (Global Forest Watch). Depletion of forest resources and increased erosion have led the Government to impose logging bans and enact other legislation to reestablish the State’s woodlands. Additionally, farmers experience significant losses to their crops from raiding by wild species such as elephants and predation of livestock by wild carnivores (Hopker et al. 2020). Although the growth in agriculture has tremendous importance for the economy of Assam, the ecological impacts of the changing land use and agricultural growth need to be considered in agricultural policy development.

Environmental degradation, human migration, and increasing urbanization resulted in rapid ecological changes in Assam. Animal health faces growing challenges, but access to veterinary services and medicines is limited by financial and geographic constraints (Hopker et al. 2020). Despite interventions for disease management, diseases like malaria and lymphatic filariasis persist. In northeastern India, various factors lead to zoonoses, which are diseases transmitted by animals to humans, and certain zoonotic diseases like toxoplasmosis and gnathostomiasis are increasing, which requires improved inter-sectoral disease control coordination for better health outcomes (Das et al. 2018).

2 Primary forests are defined as “naturally regenerated forests of native tree species where there are no clearly visible indications of human activity, and the ecological processes are not significantly disturbed” (FAO and UNEP 2020).
IV. Identifying vulnerabilities and main drivers

Deteriorating environmental conditions stemming from extreme climate events could increasingly influence people’s decisions to migrate, making the State more vulnerable to circulating pathogens, social, political, economic, and demographic risks, and a weakened health sector.

Assam State is extremely vulnerable to climate events such as earthquakes and flooding. However, the risk of pandemics stems not only from the effects of climate change and natural disasters, but also from the lack of prevention and preparedness for EIDs. The following section identifies these vulnerabilities and hotspots for EIDs and explains the main drivers of risk.

A. THREE CORE VULNERABILITIES

1. Climate risks

The State of Assam is among the Indian States most vulnerable to climate change, which exacerbates its underlying susceptibility to pandemics and negative health outcomes. Besides being prone to high-intensity earthquakes, Assam faces worsening rainfall patterns from climate change, which cause a chain reaction of increased erosion, landslides, unexpected droughts (Ziegler 2013), and floods (Zaman 2021, Government of Assam). The average annual loss of land from erosion is nearly 8,000 hectares. The Assam State Disaster Management Authority (ASDMA) reported that about 1.6 million people in 1,536 villages across 21 districts were severely affected by the floods of June-July 2020.

Flooding and erosion are the most acute in the country.
2. Migration: humans and animals

There is a steady international migration into Assam and an increasing number of internally displaced people from floods. In 2014, Assam had 345,000 internally displaced persons, a population that is expected to grow along with international migrants (The Economic Times 2015). This migration creates problems such as pressure on land, environmental degradation, shortage of food, land fragmentation, and ethnic clashes (Regon 2020).

In addition to people migrating within and across borders, domestic animals, wildlife, and migratory birds also move across the borders of neighboring countries (Pratidin 2021). In Assam, there are 46 Important Bird Areas (IBA) (besides wildlife sanctuaries) but they are being reduced because of illegal activities such as poaching and encroachment.

There have been reports that these birds carried avian influenza virus and were responsible for the spread of disease.

3. Poor health security and lack of prevention

Both communicable and non-communicable diseases (NCDs) are prevalent in Assam State. (Das 2011). When examining health outcomes, vast differences between rural and urban areas become evident. Although there is some overlap on root causes of poor health, such as improper sanitation, pollution, and lack of safe drinking water, health services in urban areas provide better outcomes. People in rural areas also suffer from scarce medical facilities in terms of infrastructure, medicine, and medical professionals. For example, about 17% of tea garden workers in Assam have tuberculosis, and drugs for its treatment are often hard to find and afford in some areas. (Priyadarshini 2016).

Impact of COVID-19

The COVID-19 pandemic affected a large section of Assam’s population regardless of people’s health and economic status. While its impact on health has been more direct, the economic impacts have been widespread. An assessment of Assam’s economic and health conditions before and after the pandemic struck the country found that the total loss of GDP was an estimated USD$4.4 billion. More importantly, the human cost of the pandemic has affected overall development vulnerability in Assam. Assam has been a high-risk State throughout the pandemic, according to all the indices.

Assam does poorly in terms of the percentage of households covered under health financing schemes or health insurance, infant mortality rates, the percentage of institutional births and of households with improved drinking water sources and sanitation facilities. COVID-19 exacerbated these pre-existing vulnerabilities, while social distancing and lockdown measures have been compromised by these weaknesses (Government of Assam 2014).

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4 Assam undertook several initiatives in healthcare including The Assam Public Health Act, 2010, Assam Act No XII of 2010, but the State has yet to make headway on certain public health goals.
B. RISK HOTSPOTS FOR EMERGING INFECTIOUS DISEASES

Heat maps of predicted relative risk distribution of zoonotic EID events (Figure 6 - Allen et. al 2017) show that the districts along the Brahmaputra River have a high risk of these events. These districts coincide with areas that experience floods and rainfall accumulation and include Dhubri, Goalpara, Barpeta, Nalbari, Kamrup, Darrang, Udalguri, Boka, Chirang, Kokrajhar, Morigaon, Nagaos, Soitpur, Biswanath, and Karbi Anglong West.

C. MAIN DRIVERS OF EIDS

Infectious disease threat events are increasing in frequency in Assam State. Northeast India has distinct climate variations, creating conditions conducive for the transmission of zoonotic diseases. Certain pathogens may be more prevalent in this area where veterinary and medical services are scarce and the sanitation infrastructure is suboptimal, causing significant veterinary, medical, and/or public health problems. Furthermore, in recent years a considerable number of zoonotic parasites and new emerging diseases have been recorded in human and animal populations in Northeast India (Chellajah, Satbigea and Kumar 2019). The main drivers of emerging infectious diseases in Assam are shown through interactions among livestock, wild and domestic animals, people, and the environment (shown in figure 6).

1. Drivers that increase interactions between livestock and wildlife

Livestock-wildlife conflict: Growing human-wildlife conflict results in livestock-wildlife conflict. As the livestock sector grows toward wildlife habitats, domestic animals (as well as humans) are attacked by wildlife in competition over territory (Choudhury 2009).

Additionally, encroaching livestock and farming in wildlife areas are increasing the risk of outbreaks. Livestock production in Assam is characterized by rural smallholder production using indigenous cattle, buffalo, pigs, goats, and chickens. There are also pockets of nomadic systems of rearing animals, mostly on the fringes of the forests, which increase contact with wildlife and prompt the emergence and movement of pathogens (Barbaruah 2012).

Illegal meat shops and wet markets, where fresh meat, fish, produce, and animals are sold, can spread contagious diseases because of unhygienic conditions. Considering the reported cases of the African swine fever in Assam, the Food Safety and Standards Authority of Assam (FSSAA) started enforcing hygienic and sanitary practices (Times of India 2020). However, unregulated illegal wet markets still exist in many parts of Assam. Through a program called “Operation Wet Market,” carried out by the Wildlife Crime Control Bureau in July 2021, several markets in Guwahati were targeted to raise awareness on the danger of transmission of zoonotic diseases (Northeast 2021).

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5 Emergence of diseases such as paragonimiasis, fasciolopsiasis, taeniasis/cysticercosis, hydatidosis, toxoplasmosis, cryptosporidiosis, gnathostomiasis, dracunculiasis and other helminthic infection poses a serious threat to human and animal health (Chellajah, Satbigea and Kumar 2019).
2. Drivers that increase interactions between humans and wildlife

Illegal trade of wild animals: Assam has experienced an increase of illegal trade of exotic animals across international borders, putting India at risk of a zoonotic disease outbreak (Nabarun Guha 2021) because neither quarantine rules nor hygiene protocols are typically followed. There were multiple instances in 2021 when exotic animals were seized by different enforcement agencies across Northeast India, including the seizure by Assam Police of exotic animals usually found in the Amazon rainforest in Brazil.

Growing human-wildlife conflict: Human-wildlife conflict is widespread in rural areas in Asia and Africa, but habitat loss and development in places like Assam have put more urban residents at risk (Das 2013). In Assam, wildlife species are threatened by local inhabitants (Ulman et al. 2020). Mammals, birds, and reptiles compete with humans for living space and food, resulting in loss of crops and livestock and increased risk from zoonotic pathogens (Choudhury 2009).

Conflicts between humans and wildlife leads to increased wildlife hunting in northeastern India, which has both economic and cultural importance. For example, some tribes and laborers in tea gardens hunt as cultural practice. However, subsistence hunting has
increased significantly over the years, but this increase has been driven by human-wildlife conflict (Ulman et al. 2020).

**Urbanization:** As urbanization grows, human settlements encroach into wildlife territory and increase the risk of disease outbreaks. The National Institute of Virology has detected the Nipah virus in fruit bats in Assam (Yadav et al. 2018). Large fruit bat roosts have been found near human settlements (e.g., Dhubri), although no human cases have been reported in the State yet.

**Urbanization is also responsible for a decline of biodiversity—**from land fragmentation (the division of land into smaller parcels used for different purposes) to habitat loss—and for exposure to zoonotic diseases as urban areas encroach on lands previously untouched by humans (Aggarwal and Ramachandran 2020).

3. **Drivers that increase interaction between humans and livestock**

**Conditions in livestock facilities:** Agricultural activities that cause pollution include confined animal facilities, known to be breeding grounds for diseases if health measures are not followed.

**Increasing pressure on the livestock sector:** The growing population and lack of economic opportunities are increasing the pressure on the agriculture and livestock sectors. This situation leads to intensification of the agricultural sector, including increased production, and the fragmentation of land holdings, which cause serious damage to the land and economy of Assam State. Under the Policy for Private Investment Promotion in Livestock Sector in Assam (Government of Assam 2020), private investment in the livestock sector is expected to increase. These conditions lead to increased contact with pets and farming animals, making the State a hotspot for emerging zoonotic diseases.

4. **Factors that exacerbate outbreaks**

**Climate and environmental changes affect infectious disease occurrence (WHO 2003).** Variations in weather from climate change, including flooding and droughts, influence the emergence and re-emergence of infectious diseases, and weather events affect the timing and intensity of disease outbreaks. Climate change scenarios include a changed distribution of infectious diseases with warming, and outbreaks are associated with weather extremes. Loss of crops is also associated with climatic extremes, as several varieties of vegetables, edible ferns, and certain rice varieties—an integral part of diets in Assam—are fast disappearing from increasing temperature and erratic rainfall (Rahman 2016).

**Nutrition can be a critical determinant of infectious disease susceptibility and progression (Civitello et al. 2018).** Undernutrition often reduces the development and effectiveness of immune responses that can limit or clear infections. The relationship between infectious disease and nutritional status also can function in reverse because many parasitic infections place demands on host nutrition, causing undernutrition when food is limited (Rohr et al. 2019). The current trend of rapid, unplanned urbanization puts pressure on water and other resources, resulting in infrastructure challenges. For example, contaminated drinking water and improper sanitation mean that diarrhea, dysentery, cholera, typhoid, hepatitis, and E. coli are dominant during the monsoon season when protozoa and bacteria are rampant and overflow from sewage.
V. One Health in Assam State

The success of a One Health approach requires joint action among various sectors, acknowledgement of the vulnerabilities and drivers of potential pandemics, and identification of hotspots for zoonoses and potential areas for collaboration among sectors. This case study attempts to fill that gap: it addresses how actors came together in Assam State, which components are missing, and the main drivers and vulnerabilities to emerging infectious diseases at the human-animal-ecosystem interfaces. It also assesses viable targeted interventions to reduce risks.

A. ENABLING ENVIRONMENT TO IMPLEMENT A ONE HEALTH APPROACH

At the federal level, the Government of India is making strides toward creating the enabling environment for the implementation of a One Health approach, but it has yet to percolate well into the States. One Health policies and initiatives typically go to State Governments as advisories or in the form of schemes sponsored by the central government. However, through the different institutional structures established in India and Assam (Annex 1), there could be a strong support system for the operationalization of One Health that would include the Livestock Health and Disease Control Scheme (LHDC), the National Animal Disease Reporting System (NADRS), and the Northeastern Regional Disease Diagnostic Laboratory (NERDDL), part of the Assam State Department of Animal Husbandry and Veterinary. Annex II provides a brief overview of the institutional and legal framework in Assam, relevant to One Health.

A main challenge that should be addressed is the major gap in coordination, cooperation, and communication, especially when tackling the issues of financing and monitoring and evaluation between the federal and State Governments. When inter-sectoral collaborations and coordination are not institutionalized, several important aspects of tackling zoonotic diseases are bound to be overlooked.

B. EXISTING EFFORTS

Despite Assam’s vulnerability to pandemics, only a few solution-based approaches and some collaborations are in place during emergencies and outbreaks (Yasobant et al. 2019), and there are limited efforts in Northeastern India, mainly in Assam State. One positive example is Penn State’s Applied Biological and Biosecurity Research Laboratory (ABRL), together with the Bill and Melinda Gates Foundation and the United States Defense Threat Reduction Agency’s Biological Threat Reduction Program, which worked with India’s Department of Biotechnology, Ministry of Science and Technology (DBT - MS&T) to help the Indian Government launch a One Health Initiative at the One Health India Conference of 2019.

Recently, the Indian Council of Medical Research (ICMR) and Indian Council of Agricultural Research (ICAR) established a National Institute of One Health at Nagpur, Maharashtra. However, so far, their studies are focusing on Central India region. ICMR also organized a virtual symposium: “One Health in India: Research informing biosafety, preparedness and response,” with the objective of becoming a starting point for wide-ranging, multi-stakeholder discussion and collaboration (Ministry of Health 2021). The Government of India also announced the creation of a high-level steering committee on eco-health initiatives. The ICMR will host the committee’s Secretariat, which will also be supported by the National Institute of One Health.

In October 2021, the DBT—MS&T supported a Program on ‘One Health’ (2021), which consists of 27 organizations including Assam Agricultural University
and wildlife agencies, aimed at carrying out surveillance of zoonoses and transboundary pathogens in India, including in northeastern India.

In addition, Assam Agricultural University with its two constituent Veterinary colleges (at Khanapara, Guwahati, and Lakhimpur with Departments of Veterinary Microbiology and Veterinary Public Health) provides research and diagnostic support to the State Government in addition to training veterinary staff.
VI. One Health actions: Recommendations

Primarily, at the country level, a national policy and implementation framework for One Health and a strategic standard operating manual at the state level should be developed. The next operational step for adopting an inter-sectoral One health approach in Assam would be the constitution of One Health Committees (OHC) at the State and district levels. It would be best to pilot these committees and adopt them in a phased manner after deliberations through wider consultations. Finally, there is a need to embed One Health education within university and professional education and training programs. Integrated training across medical and veterinary fields is essential to coordinate knowledge among professional communities.

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**FIGURE 8:**
Key recommendations to prevent EIDs through a One Health approach

<table>
<thead>
<tr>
<th><strong>HUMANS</strong></th>
<th><strong>ANIMALS</strong></th>
<th><strong>ECOSYSTEM</strong></th>
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<tr>
<td><strong>Constitution of One Health Committees (OHC) at the State and district levels</strong></td>
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<tr>
<td><strong>Short-term interventions</strong></td>
<td><strong>Medium-term interventions</strong></td>
<td><strong>Long-term interventions</strong></td>
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<tr>
<td>Public awareness campaigns</td>
<td>Increase vaccination</td>
<td>Improve access to healthcare</td>
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<tr>
<td>Coordination between Federal and State offices</td>
<td>Develop a One Health surveillance system</td>
<td>Promote a coordinated legal and institutional framework</td>
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<td></td>
<td>Improve animal disease surveillance</td>
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<td>Integrate zoonotic diseases control programs</td>
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<td>Improve enforcement</td>
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<td>Adopt early warning systems</td>
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<td>Improve resilience to floods</td>
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A. HUMANS

Short-term interventions

1. Launch public awareness campaigns

Public education campaigns are essential to reaching everyday people in India about vaccination and other health measures. Professional bodies like the Indian Medical Association and the Indian Veterinary Association can jointly develop informative materials about these life-and-death measures. Increased awareness among farmers, livestock managers, and environmentalists regarding the One Health approach and zoonotic diseases could have positive outcomes.

2. Increase coordination between Federal and State offices

The potential unification of the National Animal Disease Reporting System (NADRS)—part of the Livestock Health and Disease Control (LHDC) Scheme—and the Northeastern Regional Disease Diagnostic Laboratory (NERDDL)—part of the Assam State Department of Animal Husbandry and Veterinary—could help improve health outcomes.

Similarly, the Integrated Disease Surveillance Program (IDSP) and National Animal Disease Reporting System (NADRS) should develop appropriate mechanisms and coordination, cooperation, and communication to build and use a common database for zoonoses of interest to both the human and animal sectors (including wildlife) such as anthrax, rabies, and influenza.

Medium-term interventions

3. Improve prevention through increased vaccination

Increasing vaccination rates of Assam residents should be a priority. India has invested strategically in routine immunization, through which there have been tremendous health gains, and the Universal Immunization Program did well in Assam and West Bengal several decades ago. As of January 2022, nearly half of eligible people in Assam was fully vaccinated against COVID-19 (Nahn 2021 and Mishra 2022). However, vaccine shortages, problems with outreach to rural areas and a strong digital divide emerged as key obstacles in the COVID-19 vaccine effort.

4. Develop a One Health surveillance system

India has an Integrated Disease Surveillance Program (IDSP) and a National Animal Diseases Reporting System (NADRS), but these systems need a roadmap and a strategic approach so they can integrate into a One Health Surveillance system and can develop a disease registry as a by-product.

Long-term interventions

5. Improve access to healthcare

Despite the recent increase in the number of rural hospitals, constraints remain in serving the rural population, making healthcare a major handicap in Assam. Some of the constraints include:

i. Lack of sufficient numbers of resident doctors and supporting hospital staff. Doctors and staff tend to live and work in nearby urban areas for better living conditions and quality of education.

ii. Lack of residential housing.

iii. Lack of infrastructure, including basic equipment for hospitals, and power shortages.

iv. Inconsistent supply of medicines and essential items to hospitals.

v. Poor hospital maintenance.

Enhanced healthcare access through a stronger network of hospitals should be provided in hotspot districts such as those along the Brahmaputra River (Dhupri, Goalpara, Barpeta, Nalbari, Kamrup, Darrang, Udalguri, Baks, Chirang, Kokrajhar, Morigaon, Nagaos, Soitpur, Biswanath, and Karbi Angliong West) to prevent and mitigate outbreaks.
6. Promote a coordinated legal and institutional framework

The lack of coordination in the legal and institutional framework—especially the institutions that explicitly involve biodiversity and wildlife health—leads to gaps in operationalizing a One Health framework in India. India has taken some initiatives to tackle growing problems such as antimicrobial resistance, zoonotic diseases, and food safety using the One Health approach, but there are several challenges in implementation. The major bottlenecks include absence of a legal framework, poor coordination among governmental and private agencies, poor data-sharing mechanisms across sectors, and limited budget.

Additionally, One Health should be incorporated in legislation and regulations: new legislation to facilitate implementation and coordination of One Health and the modification of existing legislation to meet the needs of One Health inter-sectoral coordination and cooperation are needed.

B. ANIMALS

Short-term interventions

1. Strengthen network of partners

There should be a strong interdisciplinary network of strategic partners to improve surveillance and monitoring, with a major focus on prevention of outbreaks. This should also involve the private sector and rural farming communities.

Medium-term interventions

2. Improve animal disease surveillance

There is a need to strengthen the animal disease surveillance system to augment One Health activities. While there is an increased focus on the prevention and prediction of diseases in human health, the animal health sector lacks proper surveillance and reporting of diseases and laboratory diagnosis. It is a major challenge setting up surveillance programs, and there is lack of support from strategic partners such as the private sector and others. Milder zoonotic diseases that pose low- and medium-risk, when not addressed, can lead to bigger, more severe outbreaks.

3. Integrate zoonotic disease control programs

India has several control programs on different human diseases such as the Revised National Tuberculosis Control Program, National AIDS Control Program, and National Vector-Borne Diseases Control Program, all controlled by the Department of Health & Family Welfare and virtually autonomous, each with its own central, state, and district officers. Establishing an integrated control program for zoonotic diseases is crucial for highly vulnerable States such as Assam. Furthermore, a good option is to improve access to the National Animal Disease Reporting System (NADRS), which is an application based on user data entry. Unfortunately, in highly rural areas like Assam, access to such applications is limited, and other technologies such as mobile apps should be used.

Long-term interventions

4. Increase use of biosecurity technology

Some livestock farms lack adequate technology to prevent diseases and improve animal living environments. Increased use of technology will help farmers gain visibility and information about their livestock, such as remote monitoring technologies, automated weighing, electronic ear tags, climate-controlled areas, and thermal imaging. The Government of Assam can leverage and broaden the scope of existing programs like the National Livestock Mission in Assam (NLM).
C. ECOSYSTEM

Short-term interventions

1. Incorporate best practices to reduce the negative effects of land-use change

To enable the reduction of land-use change and deforestation to reduce impacts from climate change, best practices from different stakeholders should be documented and mutually shared to prevent zoonotic pathogens from infecting humans.

2. Increase dialogue with communities

As the Assam Government gears up to prevent deforestation and loss of wildlife, a network to facilitate dialogue between communities and forest officials will help with enforcement and conservation.

Medium-term interventions

3. Improve enforcement of forest protection laws

The reduction of vulnerabilities like climate change from deforestation depends on stringent adoption of forest protection laws to promote forest recovery, reduce deforestation, and minimize wildlife disturbance. The Government of Assam can leverage efforts made by the Assam Project on Forest and Biodiversity Conservation (APFBC) Society Phase-II.

4. Early-warning systems

In Assam, it is critical to implement early-warning systems for natural hazards in highly vulnerable areas to diminish the impact of harmful climate events, especially in areas along the Brahmaputra River, which are highly prone to floods.

Long-term interventions

5. Improve resilience to floods

The increasing frequency of floods needs improved flood control mechanisms that will help rural communities be more resilient. Ideally, these would be long-term infrastructure programs such as retention dams. But this kind of infrastructure requires big investments and may not be possible for a river shifting its course like the Brahmaputra. Short-term measures involving communities may be preferred, such as improvement of drainage structures with detention basins near the sites.

Governments at the highest levels need to integrate their efforts with various ministries and organizations working in this domain to achieve desired results. It is essential to understand the diverse stakeholders in the healthcare system and to include individuals such as doctors, clinicians, trainers, and researchers in this endeavor to make the Indian health system more resilient. It is also important to revisit the fundamentals of the healthcare system to develop an effective strategy for One Health.

Prevention through a One Health approach—and further recommendations at the human, animal, and ecosystem levels—should also be based on additional careful analysis—by the government or implementing institutions—of alternative interventions, their associated costs, benefits, feasibility of implementation, and effectiveness in reducing risks of outbreaks of EIDs.
VII. Key Takeaways

1. The One Health approach does not necessarily need the creation of new norms or institutions. It mobilizes existing resources as smoothly as possible to respond to emerging issues.

2. One Health is a proactive, preventive approach that will help Assam, which is an extremely vulnerable State, as it is endowed with all three One Health components at the intersection of humans, animals, and the environment.

3. At the federal level, the Government of India is making strides toward creating the enabling environment for the implementation of a One Health approach, but it has yet to percolate well into the States.

4. Despite Assam’s vulnerability to pandemics, only a few solution-based approaches and some collaborations are in place during emergencies and outbreaks, and there are limited efforts in Northeastern India, mainly in Assam State.

5. In Assam, deteriorating environmental conditions from extreme climate events could increasingly influence decisions to migrate, making people more vulnerable to circulating pathogens in addition to social, political, economic, and demographic drivers and a weakened health sector.

6. The animal health sector in India suffers from a deficiency in the cadre of epidemiology staff. As a prerequisite to developing the One Health workforce, a strong epidemiology capacity-building program is required at the academic and field levels in the veterinary, wildlife, and fishery sectors.

7. Both communicable and non-communicable diseases (NCDs) are prevalent in Assam State. When examining health outcomes, vast differences between rural and urban areas become evident.

8. The main drivers of emerging infectious diseases in Assam are shown through interactions among livestock, wild and domestic animals, people, and the environment.

9. Key drivers that increase exposure through interactions between livestock and wildlife are livestock-wildlife conflict, encroaching farming into wildlife areas, and illegal wet shops and wet markets.

10. Key drivers that increase exposure through interactions between humans and wildlife are illegal trade of wild animals, growing human-wildlife conflict, increased wildlife hunting and urbanization.

11. Key drivers that increase exposure through interactions between livestock and humans are the existing poor conditions in livestock facilities and the increased pressure for growth in the livestock sector.

12. It is important to recognize factors that can exacerbate outbreaks in Assam, which include climate and environmental changes and poor nutrition.

13. Short-, medium-, and long-term Interventions have been identified at the human, animal, and environmental levels, which leverage existing institutions and programs and address core drivers of emerging infectious zoonotic diseases.
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Annex I

Institutional structures with a potential for the operationalization of a One Health approach

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<th>Actor/Stakeholder</th>
<th>Role</th>
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<td><strong>I. HUMAN HEALTH</strong></td>
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| **Ministry of Health and Family Welfare (MoHFW)** | • Coordination with other ministries  
• Support digital platforms for the reporting and visualization of surveillance data |
| National Centre for Disease Control (NCDC) part of the MoHFW’s Directorate General of Health Services | • Operates the Integrated Disease Surveillance Programme (IDSP), a national surveillance programme of potentially epidemic diseases. It also has an outbreak response component in the form of Rapid Response Teams. |
| **II. ANIMAL HEALTH** | |
| **Ministry of Fisheries, Animal Husbandry and Dairying (MoFAHD)** | • Support digital platforms for the reporting and visualization of surveillance data  
• Animal health policy: promoting plans and strategies  
• Coordination with other ministries |
| **Department of Animal Husbandry and Dairying (DAHD)** | • Deals with animal health issues |
| Livestock Health and Disease Control (LHDC) Scheme | • Implementation of vaccination programs against various diseases of livestock and poultry  
• Disease surveillance and strengthening of veterinary |
| National Animal Disease Reporting System (NADRS) | • Livestock disease reporting platform that collates information from 7,032 units across the country  
• With the scope of daily incidence reporting through a mobile application, it supports a near real-time disease monitoring and surveillance system |
| Assam State Department of Animal Husbandry and Veterinary | • Deals with the subject of animal health and is administered and manned by Veterinary officials of various cadres directing institutions concerning veterinary service delivery |
| Northeastern Regional Disease Diagnostic Laboratory (NERDDL) | • Referral laboratory for the Northeastern States, engaged in diagnosis and surveillance of various animal diseases and imparting training to scientists/veterinarians of the Northeast Region.  
• Coordinates with State Department of Animal Husbandry and Veterinary, Northeastern states, Government of India and participates in Rapid response teams |
| **Ministry of Agriculture and Farmers Welfare (MoAFW)** | • Support research and development  
• Coordination with other ministries |
| **Indian Veterinary Research Institute (IVRI)** | • Has a veterinary public health division that aims to apply veterinary knowledge to address public health concerns through its mandate that includes research on the prevention and control of zoonoses |
| Parasitology division: Centre for Wildlife Conservation Management and Disease Surveillance (CWC), and the Centre for Animal Disease Research and Diagnosis (CADRAD) | • Engages with wildlife health |
| **Indian Council of Agricultural Research (ICAR)** | • Surveillance and forecasting of zoonotic diseases |
| National Institute of Veterinary Epidemiology and Disease Informatics (NIVEDI) | • Hosts the National Animal Disease Referral Expert System (NADRES), a virtual database of livestock diseases  
• Receives data on incidences of endemic and emerging diseases of livestock and poultry through its 15 reporting sub-units across the country (NIVEDI 2015).  
• NADRES is also fed by monthly updates from state animal husbandry and veterinary agencies, which fall within the domain of the MoFAHD |
| **III. ECOSYSTEM HEALTH** | |
| **Ministry of Environment, Forest and Climate Change (MOEFCC)** | • Environmental Policy  
• Sustainability  
• Coordination with other ministries  
• Adaptation and mitigation policies |
| Assam State Department of Environment and Forest | • Conservation of forests and biodiversity in the State  
• Could leverage community engagement  
• Forest management  
• Limiting forest land diversion |
Annex II

Institutional and legal framework in Assam State, relevant for One Health: An Overview