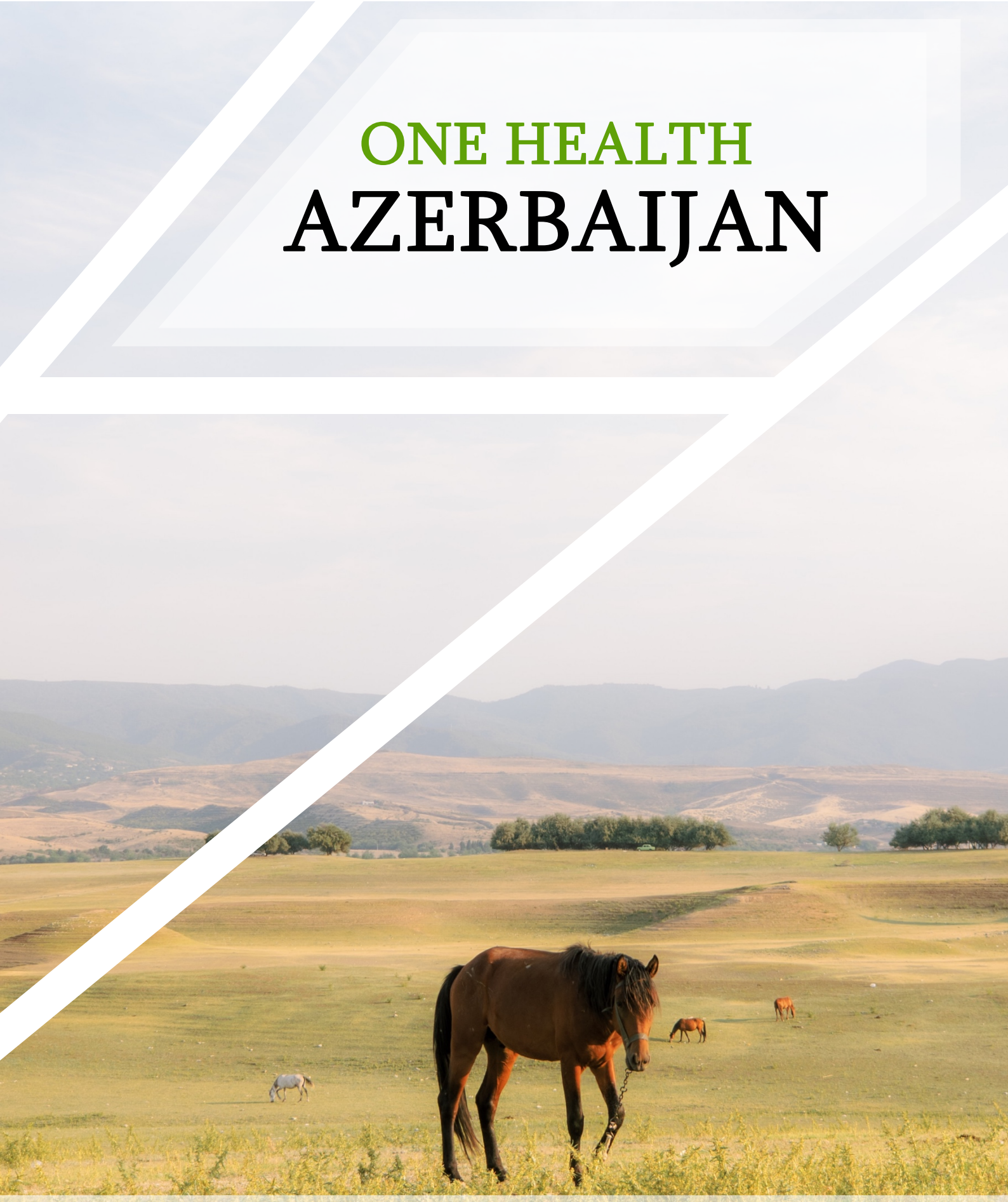
ONE HEALTH
AZERBAIJAN



An Assessment of One Health Operations and Capacities

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1 TABLE OF CONTENTS

2 ACRONYMS

ADAU	Azerbaijan State Agricultural University
AFSA	Azerbaijan Food Safety Agency
AFSI	Azerbaijan Food Safety Institute
AIRS	Animal Identification and Registration System
AMR	Antimicrobial Resistance
AQTI	Azərbaycan Qida Təhlükəsizliyi İnstitutu
BI	Institute of Botany (under Ministry of Science and Technology)
BNSR	Biosurveillance Network of the Silk Road
BSL-2	Biosafety Level 2
CBD	Convention on Biological Diversity
CBEP	Cooperative Biological Engagement Program
CBRN	Chemical, Biological, Radiological, and Nuclear
CCHFV	Crimean Congo Hemorrhagic Fever Virus
COVID-19	Coronavirus Disease
CPHR	Center for Public Health and Reforms
CVL	Central Veterinary Laboratory
DMS	Defense, Military, and Security
DTRA	US Defense Threat Reduction Agency
EID	Emerging Infectious Disease
EIDSS	Electronic Integrated Disease Surveillance System
EUROBAT	Agreement on the Conservation of the Populations of European Bats
FAO	Food and Agriculture Organization of the Unites Nations
FMD	Foot and Mouth Disease
GDP	Gross Domestic Product
HFI	Human Footprint Index
IHR	International Health Regulations
JEE	Joint External Evaluation
IoZ	Institute of Zoology (under Ministry of Science and Technology))
MCM	Multisectoral Coordination Mechanism
MENR	Ministry of Ecology and Natural Resources
MOA	Ministry of Agriculture of Azerbaijan

MOH	Ministry of Health Republic of Azerbaijan
MS&E	Ministry of Science and Education
NAPHS	National Action Plan for Health Security
NGO	Non-governmental Organization
NITAG	National Immunization Technical Advisory Group
NVIS	National Veterinary Information System
PACS	Pathogen Asset and Control System
PPE	Personal Protective Equipment
PVS	Performance of Veterinary Services
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SC-FELTP	South Caucasus Field Epidemiology and Laboratory Training Program
SDICC	Special Dangerous Infection Control Center
SVCS	State Veterinary Control Service
TESSy	The European Surveillance System
UNECE	United Nations Economic Commission for Europe
USAID	United States Agency for International Development
US CDC	United States Centers for Disease Control and Prevention
USD	United States Dollar
VSRI	Veterinary Scientific Research Institute
WAB-Net	Western Asia Bat Research Network
WHO	World Health Organization
WOAH	World Organisation for Animal Health
WWF	World Wildlife Fund

3 EXECUTIVE SUMMARY

'One Health' concepts aim to optimize the collective health of people, animals, and ecosystems. This holistic approach can help to strengthen health security within and between countries, including being better able to predict, detect, respond, and recover from shared health threats. By recognizing the interdependence of humans, domestic and wild animals, plants, and ecosystems, multiple, often siloed, sectors can align under a common agenda. Health threats that cross the human-animal-environmental interface are becoming increasingly common, as most emerging human pathogens recognized over the last 50 years are zoonotic (i.e., of animal origin) and linked to wildlife hosts. To efficiently address the emergence of new disease (like SARS-CoV-2), while managing the burden of endemic ones, a multisectoral One Health approach should be considered.

Azerbaijan has made notable strides in incorporating One Health concepts into its national biosurveillance and biodefense efforts, but there are opportunities to bolster these efforts through enhanced cross-sector communication, planning, surveillance, and capacity building. Based on an in-depth literature review, an interactive two-day workshop, and three-day regional meeting with Azerbaijani One Health stakeholders held in Tbilisi Georgia, this report outlines those opportunities and provides recommendations for integrating One Health concepts into routine health-related activities.

The primary agencies in charge of protecting human, animal, and environmental health in Azerbaijan is the Ministry of Health (MOH), Ministry of Ecology and Natural Resources (MENR), and the Ministry of Agriculture (MOA). Other sectors including the Ministry of Science and Education (MS&E), Ministry of Defense, and nongovernmental organizations also conduct One Health research, aid in wildlife surveillance, and help set biosecurity priorities and policies. These sectors have a history of largely operating independently, but with Azerbaijan being a relatively small country, informal cross-sector communication exists even when formal collaborative means are not optimally functioning. Despite this independence each sector has implemented several health-related capacity assessments, developed national plans, passed relevant laws and regulations, and implemented biosurveillance research projects in their field (Table 1). Azerbaijan, however, has not yet completed a Joint External Evaluation of IHR Core Capacities (although it is in progress), nor a National Action Plan for Health Security. Moreover, dissemination of assessment findings and progress on completing national plans could be made more accessible as most capacity assessment reports and related documents are not publicly available. By fulfilling all the recommendations from capacity assessments, and completing a NAPHS, it is expected to result in more cost-effective approaches as Azerbaijan shifts more toward prevention of health threats instead of a typical reliance on response.

Table 1. Completed plans and assessments

PLAN OR ASSESSMENT	COMPLETED? (YEAR)
JEE	Yes (2023)
PVS Evaluation	Yes (2008)
PVS Evaluation Follow-Up	Yes (2015 & 2022)
PVS Gap Analysis	Yes (2011)
PVS Legislation	No
IHR-PVS Bridging Workshop	Yes (2013)
NAPHS	No
STAR	Yes (year)
OHZDP	Yes (2015)
National AMR Action Plan	No
NBSAP	Yes
JRA	No

JEE = Joint External Evaluation; PVS = Performance of Veterinary Services; IHR = International Health Regulations; NAPHS = National Action Plan for Health Security; STAR = Strategic Toolkit for Assessing Risks; OHZDP = One Health Zoonotic Disease Prioritization Exercise; AMR = Antimicrobial Resistance; NBSAP = National Biodiversity Strategy and Action Plan; JRA = Joint Risk Assessment.

Regarding biosurveillance, systems for zoonotic disease surveillance are in place for both human and animal health sectors. Azerbaijan uses an Electronic Integrated Disease Surveillance System, which provides real-time disease reporting on 50 notifiable diseases, to exchange health information between government ministries. Among the notifiable diseases, 11 have been classified by the Ministry of Health as especially dangerous infections. They are anthrax, avian influenza, botulism, brucellosis, plague, varicella, tick-borne encephalitis, tularemia, viral hemorrhagic fevers, rabies, and cholera. While the Ministry of Health and Ministry of Agriculture (Veterinary Services) both use EIDSS, shared visibility of veterinary and human data has not been established to conduct joint zoonotic disease investigation. Moreover, the animal health sector also recently launched an Animal Identification and Registration System and National Veterinary Information System to track livestock 'from farm to table' to ensure food and livestock safety. The notable progress on livestock surveillance is a critical part of early zoonotic disease detection, and there is opportunity to integrate wildlife and environmental monitoring and surveillance, which currently remains nascent. Incorporating additional environmental health and wildlife focused stakeholders into biosurveillance could result in improved understanding of environmentally related drivers of disease emergence and aid in future research and spatial risk assessments for zoonoses.

Despite an improvement in cross-sector collaboration and data sharing, including implementing EIDSS, there is no national One Health body or coordination mechanism to formally organize across sectors. There are however several core organizations – Ministry of Agriculture, Ministry of Environment and Natural Resources, Food Safety Institute, and the Ministry of Science and Education – that collaborate on One Health activities. Other institutions including the Special Dangerous Infections Control Center within the Ministry of Health, Ministry of Defense, academic institutions, and NGOs also have a shared interest in One Health research and projects. With so many institutions engaged in projects at the human-animal-environmental health interface, a well-

developed interagency coordination body could aid in aligning all stakeholders under a unified One Health agenda to strengthen collaborative processes.

Compared to other parts of the world, Azerbaijan, and the Caucasus region, is not considered a hotspot for emerging infectious diseases (EID) but human-led changes in landscapes may be increasing the potential for zoonotic spillover. Several drivers of zoonotic diseases emergence and spread in Azerbaijan include land human-wildlife contract through hunting, land conversion for pastures, urbanization and construction near forest belts and water sources, deforestation (especially near Karabakh), lack of disease detection in wildlife, and weak veterinary control and regulation (especially on antibiotic use).

Finally, based on the findings of the literature review, two-day workshop, and three-day regional meeting, several actions are recommended to strengthen One Health in Azerbaijan (Table 2). Additional recommendations are in the full report.

Table 2. Recommended actions for advancing One Health in Azerbaijan

RECOMMENDATIONS	
Coordination and Governance	Formally establish a National One Health Committee that includes representatives from the Ministry of Health, Ministry of Ecology and Natural Resources, Ministry of Agriculture, Food Safety Sector, Ministry of Science and Technology, military or defense sectors, universities, and other potential One Health stakeholders.
	Finalize, renew, and implement not yet completed national plans and assessments, including a National Action Plan for Health Security (NAPHS), National Biodiversity Strategy and Action Plan (NBSAP), and Joint Risk Assessment (JRA) with a multisectoral group of government experts.
Disease Risk Reduction	Expand zoonotic disease monitoring and surveillance in wildlife using nonlethal methods.
	Enhance public communication about the importance of biodiversity preservation, and safe practices regarding interactions with wildlife.
One Health Capacity Building	Improve the transparency and timeliness of health-related information dissemination to additional sectors, departments, and academicians
	Expand joint work-training with veterinarians, environmental health specialists, epidemiologists, and other professionals across the human-animal-environmental health landscape

Overall, Azerbaijan has made substantial growth in developing its human and animal health surveillance capacity, workforce, and infrastructure, especially in the last 10 years. Further adopting One Health approaches – particularly by better integrating environmental health and wildlife sectors into One Health activities – could help strengthen the coordination and efficiency of the institutions and people that work across the human-animal-environmental spectrum in Azerbaijan.

4 INTRODUCTION

The coronavirus disease (COVID-19) pandemic has upended daily life and shed a light on the risk of emerging infectious diseases and fragility of our health systems. Like most pandemics of past, all available scientific evidence suggests that severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) likely originated from an animal and has since spilled over to humans[3-6]. Globally, most emerging human pathogens recognized over the last 50 years are zoonotic (60%), and the majority (>70%) of these emerging zoonoses are linked to wildlife hosts[7]. This highlights the need for improved multidisciplinary approaches to address zoonotic diseases (i.e., of animal origin) and other shared health threats. The emergence of zoonotic pathogens from wildlife occurs either directly via high levels of human-animal contact, indirectly through livestock hosts as 'amplifiers', or via arthropod vectors or environmental exposure. Efforts to prevent emerging zoonoses have targeted these high-risk interfaces, but to be effective they require a high-functioning, multi-sectoral, One Health approach to mitigate risk and facilitate rapid detection and response to emergence events, thereby reducing their impact[8-10].

This risk of novel disease emergence varies place by place, but it can be predictable, as certain groups of animals and environmental factors represent a higher risk to human health[7, 11, 12]. Factors that facilitate the 'spillover' of a virus from animals to humans include ecological changes to landscapes, expansion of agricultural practices without adequate biosecurity, climate change, increased trade and travel, and urbanization[7, 11]. Based on these factors, and its high diversity of understudied mammals (particularly bats and rodents), the Caucasus region – including Azerbaijan – has the potential to be an emerging infectious disease hotspot. Furthermore, as a geographic crossroads between the Europe and Asia, the Caucasus' are a critical region for global security and travel, and improved pathogen biosurveillance in this region is warranted to support rapid detection and response.

The persistent burden of endemic diseases like seasonal influenza, anthrax, rabies, plague, tuberculosis, and antimicrobial resistance and the threat of emerging or re-emerging zoonotic pathogens, including especially dangerous pathogens such as Crimean Congo Hemorrhagic Fever Virus (CCHFV), Tularemia, and others continue to pose challenges to health systems and society – especially when resources are tied up responding to new outbreaks (e.g., COVID-19). Additionally, as the factors that affect outbreaks of both endemic and newly emerging diseases are wide-reaching across populations, environments, and industries, effectively preventing, detecting, and responding to these challenges can be extremely difficult. It requires collaboration at all levels, i.e. a "whole-of-society" approach, to shape and implement policies, risk monitoring and risk reduction practices, maintain coordination, clearly communicate across sectors and with the public.

Therefore, to efficiently address the emergence of new diseases and the burden of endemic ones, a collaborative, One Health approach that integrates strategies and resources from across disciplines and enables cross-sector information sharing, communication, joint surveillance, and response should be adopted. Azerbaijan has made great progress to enhance its biosurveillance and biodefense activities, but there are opportunities to further invest in and generate benefits from a One Health, multi-sector approach.

5 PURPOSE OF THIS REPORT

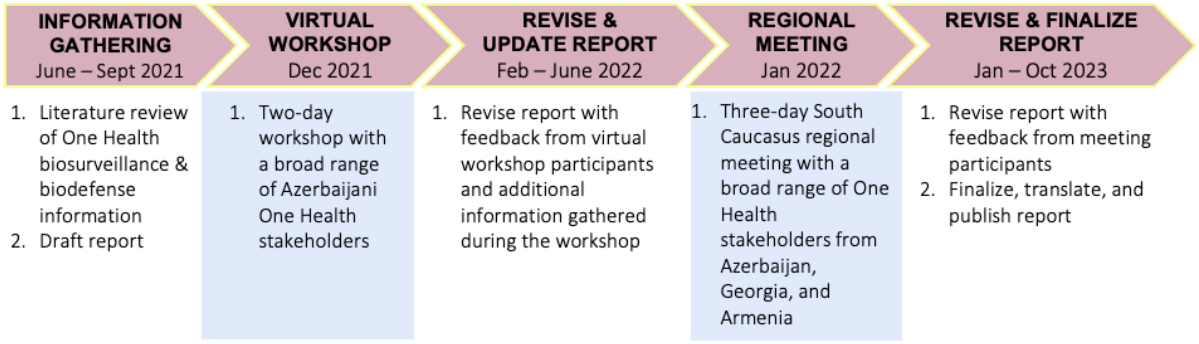
It is important to recognize that applying a One Health approach to enhancing health security is typically hindered by the single-sector approach taken by line ministries. This report provides examples of the application of One Health approaches and outlines the opportunity for incorporating an expanded One Health approach to enhance biosurveillance and biodefense activities in Azerbaijan. The information in this report builds on previous findings from national assessments, plans, workshops, and peer-reviewed literature to provide a comprehensive One Health lens towards planning for, preventing, and responding to health threats in the future. We additionally integrate information and perspectives gained from a two-day virtual workshop with a broad range of representatives from multiple sectors in Azerbaijan.

6 METHODOLOGY

This report was developed using a combination of literature review, stakeholder mapping, and roundtable discussions to identify areas for improved multisectoral collaboration in One Health (Figure 1). The process began with a literature review which provided the structure for the draft report. Following the literature review and initial report development, a two-day virtual workshop was held on 14-15 December 2021 with Azerbaijani experts from government, academia, and nongovernmental organizations (NGO) to discuss the One Health, biosurveillance, and biodefense activities being implemented in Azerbaijan. Workshop attendees participated in activities and discussions targeted at understanding gaps and opportunities to enhance multisectoral collaboration. After the workshop, the report was revised based on input from workshop attendees and additional documents gathered as a result of the workshop. Then, in December 2022, EcoHealth Alliance (EHA) hosted a regional meeting with One Health stakeholders from Azerbaijan, Georgia, and Armenia, to foster cross-country and cross-sector collaboration, which uncovered additional information that is included in this report. After final revisions, the report was translated in to Azerbaijani, and published

in English and Azerbaijani online at EcoHealth Alliance's website (https://www.ecohealthalliance.org). A shorter, peer-reviewed manuscript summarizing the key findings from our workshop, regional meeting, and literature review is also in preparation.

Figure 1. Process to develop this report.



6.1 Literature review

1) To start, a systematic English-language literature search was conducted using Web of Science and PubMed. The search was limited to the period of 2010-2021(June) and included all publications related to biosurveillance, biodefense, One Health, zoonoses, emerging infectious disease, or related search terms in the Caucasus region, or in Azerbaijan, Armenia, or Georgia specifically. The initial search yielded 2,061 records, which after reviewing titles and abstracts, was cut down to a final group of 208 papers for full-text review. Of these papers, 31 specifically focused on Azerbaijan. The final group of papers were reviewed for background information on One Health and biosurveillance/ biodefense as well as examples of multisectoral collaboration between authors, institutions, and sectors. Information from the literature review is weaved throughout this report.

2) A gray literature search was also conducted for documents related to One Health and biosurveillance/ biodefense in Azerbaijan via government websites, general web search, and previously identified sources including World Health Organization (WHO), World Organisation for Animal Health (WOAH, formerly OIE), and World Bank websites. Background information from these documents and tools is incorporated in this report. In particular, multiple tables and figures from the World Bank's *Operational Framework for Strengthening Human, Animal and Environmental Public Health Systems at Their Interface*[13] have been adapted and included as examples in this report.

3) After the virtual workshop (see below), additional scientific publications and gray literature shared by workshop participants was reviewed and included in this report.

6.2 Multisectoral One Health Virtual Workshop

A two-day virtual workshop was held on 14-15 December 2021 convening participants from the Ministry of Health, Ministry of Agriculture, Ministry of Ecology and Natural Resources, Institutes of Zoology and Botany of the Ministry of Science and Education, Food Safety Institute, Baku State University and others to discuss – and participate in – small group activities related to One Health, biosurveillance and biodefense practices and policies, as well as identifying emerging infectious disease risk factors in Azerbaijan. A complete list of workshop participants, agenda, and activities can be found in the Annex.

6.3 South Caucasus Regional Meeting on One Health Biosurveillance and Biodefense

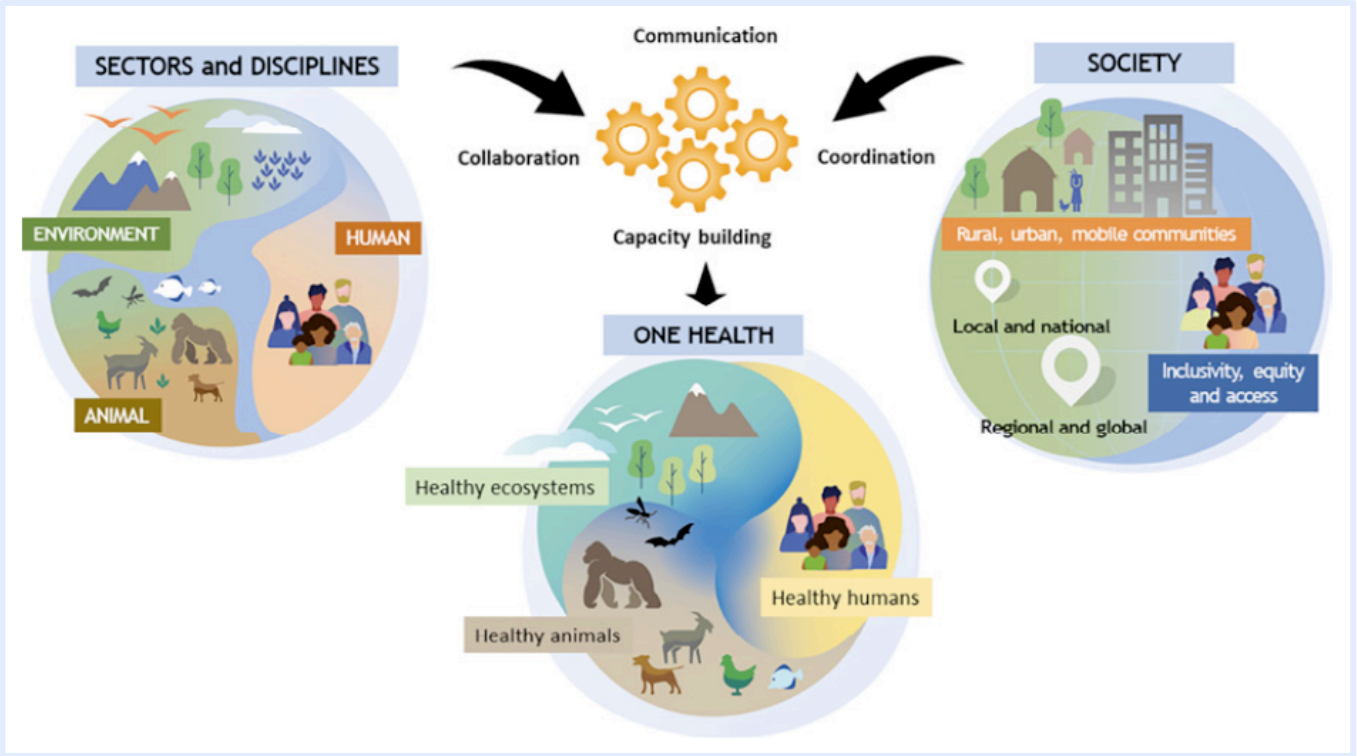
A three-day meeting was held in Tbilisi Georgia on 6-8 December 2022 bringing together 45 participants from Azerbaijan, Georgia, Armenia, and EHA. Stakeholders representing 20 different affiliations, including Ministries of Health, Environment, Agriculture, Science and Education, national security, tourism, revenue service, and NGOs gathered to share insights and expertise on implementing One Health programs and research in the South Caucasus region (Figure 2). Some information generated from the meeting is included in this report.

Figure 2. South Caucasus stakeholders gather to share information and expertise

7 ONE HEALTH FRAMEWORKS

The concept of One Health has been recently defined by the WHO One Health High Level Expert Panel (OHHLEP) as "an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems (Figure 3). It recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent. The approach mobilizes multiple sectors, disciplines and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy and air, safe and nutritious food, taking action on climate change, and contributing to sustainable development"[14].

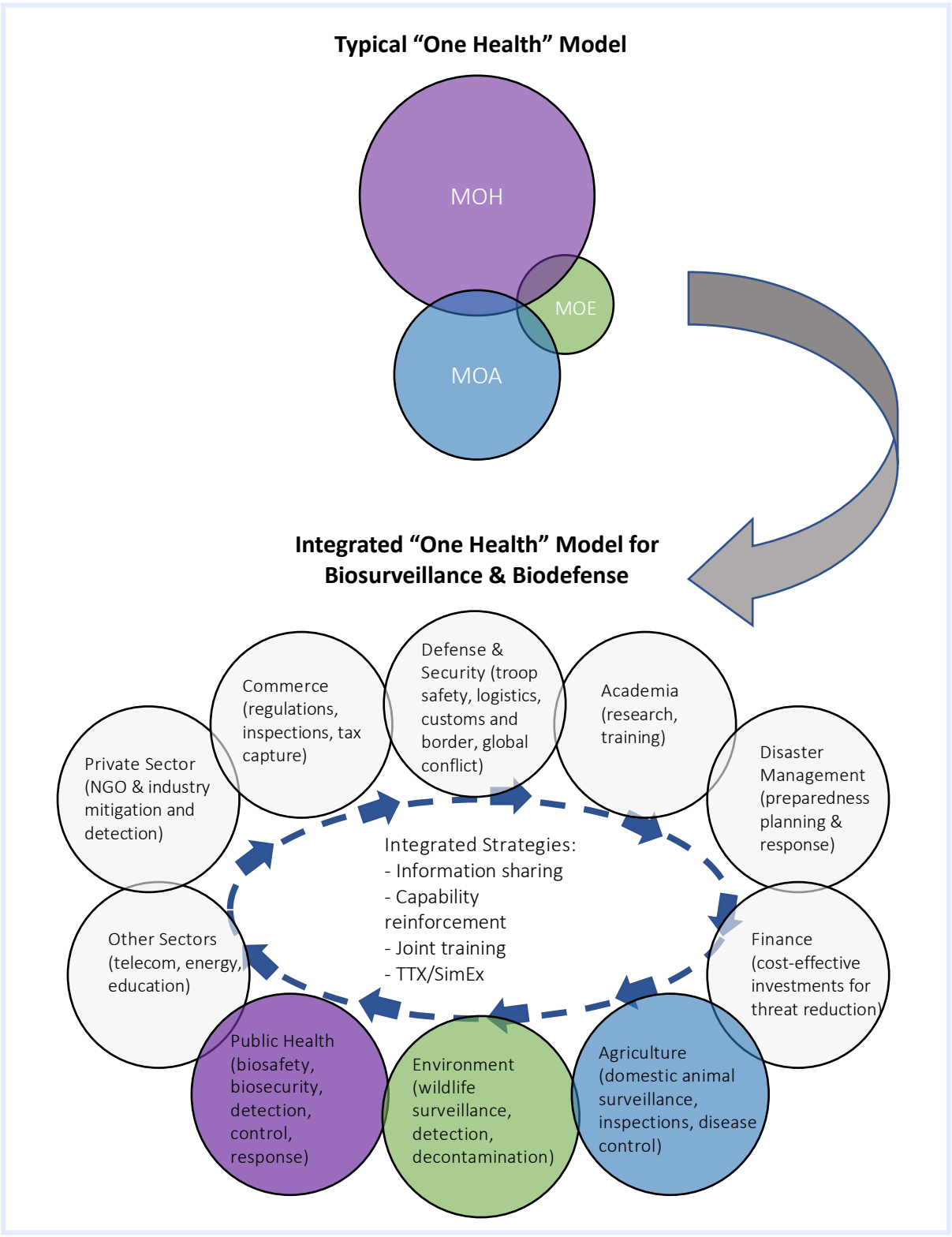
Figure 3. One Health visual definition (OHHLEP)



While holistic by definition, in practice, One Health is often driven by activities in and across a couple of sectors, i.e., Ministries of Health and Agriculture, with the environmental sectors typically involved to a much lesser extent. However, as Figure 4 demonstrates when we move away from a simplified, typical One Health model towards a comprehensive One Health approach, a wide variety of sectors can collaborate and contribute to strategies that enhance biosurveillance and

biodefense. Importantly, not every sector will be involved in all One Health activities. Depending on the scenario, one sector may lead or have an outsized role, but that does not mean that other sectors cannot contribute to enhance response efforts. Further, understanding the actions required from each sector – and their cost – can help inform cost-effectiveness analyses of preventative measures that avert disease outbreaks from occurring.

Figure 4. Comparing One Health biosurveillance and biodefense models



8 ONE HEALTH SECTORS IN AZERBAIJAN

It is expected that not every sector will always play an equal role in One Health activities and responsibilities, but that does not mean that sectors outside of health, agriculture, and environment should be routinely excluded. A true One Health approach to preventing, detecting, responding, and recovering from health challenges includes additional sectors like defense, security, academia, disaster relief, and others, that have a vested interest in improving population health at the local, regional, national, and global levels. Moreover, a clear delineation of responsibilities is essential in both times of emergency and nonemergency for swift action and communication and to reduce duplication of tasks. Specific sectors that play a potential role in implementing comprehensive One Health programs in Azerbaijan are listed in Table 3. Azerbaijan is, however, currently going through a government restructuring both in terms of institutional mandates and name changes so some of the ministries and sub-ministry level directorates may change after the release of this report. Regardless, the need for diverse multisectoral inclusion in One Health operations remains.

Table 3. Potential relevant One Health sectors in Azerbaijan

SECTOR, MINISTRY, OR ORGANIZATION	SUB-MINISTRY OR DIRECTORATE	RELEVANT ONE HEALTH SCOPE	LIMITATIONS OR ASPECTS NEEDING ADDITIONAL ATTENTION
Ministry of Health	• Special Dangerous Infections Control Center (SDICC) and regional units • Center for Public Health and Reforms (CPHR) • Republican Center of Hygiene and Epidemiology • District Centers for Hygiene and Epidemiology • Department of Informatics and Statistics	• Laboratory work, diagnostic capacity, analysis, methodological development, and support • Pathogen monitoring and disease investigation • Public awareness raising on disease prevention • Monthly and yearly disease reporting with other ministries and international organizations (e.g., WHO) • Monitoring, preparation, and implementation of disease prevention strategies • Collecting information for the statistical committee • Preparation of laws and policy	• Lack of epidemiologists in the country • Developing lab capacity (moving from BSL-2 to BSL-3) • Training and technical workforce development • Funding • Data and reporting transparency and availability
Ministry of Agriculture	• Agrarian Services Agency • Department for working with farmers, associations, and cooperatives • Land use control department • Animal Husbandry Research Institute • Veterinarian Research Institute • Agriculture Training Center	• Provide registration and vaccination for livestock • Raising awareness among public and farmers • Developing capacities of farmers • Monitoring livestock disease and sample collection • Production and processing of agricultural products	• Capacity development • Training on biosecurity and biosafety rules and regulations • Funding • Data and reporting transparency and availability

		• Veterinary and plant protection and quarantine • Conducting studies on zoonotic diseases, including regional distribution of highly pathogenic diseases such as avian influenza	
Ministry of Ecology and Natural Resources	• Department of Environmental Policy • Department of Environment and Natural Resources Regulation • Department of Environmental Awareness and Public Relations • Protection of Biodiversity Service • State Environmental Security Service • Department of Monitoring • Rehabilitation Center • Biodiversity Service • National Parks • State Environmental Expertise Agency • Hazardous Waste LLC • Caspian Ecology Monitoring Service • AzerLab LLC	• Environmental protection, organization of nature use, effective use of mineral resources and surface natural resources • Protection of biodiversity, • Protection of forests and greenery • Preserving ecological balance for the safety and welfare of people, animals, and the environment • Support vaccination of wildlife • Raise public awareness • Preparation of laws and policy	• Funding • Involvement of experts • Lack of labs • Lack of rehabilitation centers
Food Safety Agency	• Animal Health Department • Central Veterinary Laboratory • Azerbaijan Food Safety Institute, including 16 BSL-2 laboratories (food, animal, etc.)	• Diagnostics of dead/slaughtered livestock • Scientific research on diseases • Simulation trainings • Raising public awareness • Preparation of methodologies • Preparation of laws and policy • Oversee businesses, supermarkets, restaurants etc. • Enforces compliance with food safety and veterinary guidelines	• Capacity development • Funding • International experience • Lab improvements e.g., developing a BSL-3 lab
Security	• State Security Service • Commission of Emergency Situations • State Customs Committee	• Respond to emergencies • Respond as a part of action plans and assessments • Coordinate biodefense work	• Closer involvement in emergency situations (ministry of defense) • Trainings on biosafety • Availability of reports • Accessibility during emergency situations

Scientific Bodies	• Ministry of Science and Education (currently being restructured), including Institutes of Zoology, Botany, and Molecular Biology and Biotechnologies	• Provide scientific research on diseases and provide recommendations • Develops a system of higher education that ensures the transfer of scientific innovations to production, • Training highly qualified specialists	• Laboratory capacity • Funding • Capacity development and training • International experience and knowledge exchange • Lack of experienced staff
Universities and Academia	• Azerbaijan State Agricultural University (ADAU) • Azerbaijan Medical University • Azerbaijan State Advanced Training Institute for Doctors • Baku State University • Khazar University	• Veterinarian training facilities • Public health and medicine training • Continual in-service training for professionals • Train the next generation of One Health professionals	• Exchange of information and experiences with other international universities and educational centers • Development of One Health-specific coursework and joint training among veterinary and public health schools
Other Ministries, Private Sector, NGOs, Local Government and Other institutions	• Ministry of Emergency Situations • Ministry of Defense • Ministry of Science and Education • Ministry of Finance • Ministry of Foreign Affairs • Ministry of Internal Affairs • State Statistical Committee • World Wildlife Fund (WWF) Azerbaijan • "EkoSfera" Social-Ecology Center (NGO) • Azerbaijan Management Union of Medical Territorial Units (TABIB)	• Provide technical expertise, training, and support as needed at both the national and local levels	

9 INVESTING IN ONE HEALTH

Given the high cost of new and emerging diseases – like COVID-19 – in addition to the persistent burden of endemic diseases, Azerbaijan would benefit from further investing in a multisectoral, One Health approach to strengthening zoonotic disease biosurveillance and biodefense. Implementing a multisectoral approach to preventing and responding to zoonotic disease outbreaks makes the best use of limited resources, money, and personnel across disciplines, improving the efficiency and effectiveness of zoonotic disease management. It also offers synergies and cross-sectoral coordination which help to expand capacity and efficiency in disease prevention, detection, response, and recovery while avoiding duplication of tasks, ultimately leading to financial savings[13]. Recent research has shown that investing in One Health for disease prevention, even with a moderate

reduction in disease emergence risk, costs just 1/20 of the value of lives lost each year to emerging viral zoonoses and 1/10 of the annualized economic losses[15]. Similar studies have shown that the cost to prevent pandemics (in the form of preventing deforestation, regulating wildlife trade, and expanding early detection systems for disease surveillance) far outweighs the costs incurred from pandemic outbreaks of zoonoses[16, 17].

Moreover, timely control of zoonotic disease is cost-effective and saves lives[13]. The ongoing SARS-CoV-2 outbreak has shown us that when epidemics spread the cost of combatting them also goes up exponentially. There is a wide range of direct and indirect costs that accrue during a disease outbreak (Table 4). The government of Azerbaijan spent 800 million manat (~470 million USD) on COVID relief efforts in 2021, and like all countries, has faced significant indirect costs as well[18].

The COVID-19-induced shutdown in Azerbaijan led to an estimated 4.3 percent reduction in GDP 2020[19]. In 2021, there has already been a 40% increase in unemployment, compared to 2019 with 300,000 people officially registered as unemployed.[20] Lockdowns to control the spread of SARS-CoV-2 in Azerbaijan have resulted in lower trade, tourism and consumer demand, while oil revenue – a key component of the national economy – have declined due to the global economic shutdown[21]. The government of Azerbaijan recently received a USD 250 million loan from the Asian Development Bank to help mitigate the health, social, and economic impacts of COVID-19[21]. The pandemic may impact the economic future of Azerbaijan for years to come.

Livestock disease outbreaks on farms (e.g., African swine fever, foot-and-mouth disease etc.) can also lead to significant financial loss in the agricultural sector. This is critically important in Azerbaijan where agriculture makes up 6% of the national GDP and employs 38% of the workforce[22]. Not only is it time and labor intensive to identify the source of an outbreak, cull affected animals, vaccinate others, and quarantine affected communities, it can be expensive to provide government financial compensation for the loss of livestock. It also affects the broader economy as other countries may ban imports of Azerbaijani meat and consumer prices may rise due to lack of supply. In cases where those livestock diseases have the ability to transmit to wildlife species or humans, additional significant impacts could occur.

Table 4. Examples of direct and indirect costs that result from human or animal disease

COST CATEGORY	EXAMPLES OF COSTS	
	HUMAN	ANIMAL
Direct costs	Costs of medical treatment; contact tracing; vaccination; restricted movement; job loss, long-term adverse health effects (e.g., long COVID)	Costs of veterinary treatment; culling and disposal of animals; vaccination; farm loss, including number of animals, inability to buy/sell animals,
Indirect costs	Reductions in tax revenue and tourism, loss of ecosystem services; interruptions in schooling, reduced childhood vaccination and treatment of other illnesses; increased "burnout" among healthcare workers and reduced focus on other health issues resulting in increased human morbidity and mortality.	Domestic market and export losses; reductions in tax revenue, revenue from food availability; upstream ripple effects on industry (e.g., feed supply, processors, retailers);

Information from the World Bank One Health Operational Framework (Berthe et al. 2018)[13]

10 BIODEFENSE, SECURITY, AND ONE HEALTH

10.1 General Overview

Biodefense consists of both combatting naturally occurring biothreats (e.g., CCHFV, SARS-CoV-2, Ebola, avian influenza) as well as human generated ones (i.e., intentional, or nefarious attacks with biological agents such as anthrax, botulism, and others). Biological weapons can pose a serious threat to economies, militaries, public health and agriculture, and there is growing concern that more accessible and sophisticated biotechnology tools are making it easier to develop and use bio weapons[23]. However, the immense impact of SARS-CoV2 (COVID-19) and escalating frequency of new emerging infectious disease events, remind us, that natural disease emergence events, particularly by high-transmissible viruses, may pose a much larger threat to health and national security than intentional bioweapon attacks[23]. Consequently, enhancing biodefense to include One Health approaches will result in direct gains for national security. Integration of One Health and biodefence can begin with reviewing strategic biodefense documents, such as a National Biodefense Strategy, to ensure that animal, environmental, and public health agencies are aligned and coordinated with biodefense and national security activities.

Like the public health sector, defense, military, and security (DMS) sectors globally are engaged in preventing and mitigating high consequence health threats. Defense ministries are being tasked to develop medical countermeasures such as diagnostics, vaccines, and treatments for biological threats. Military troops are aiding affected populations by building treatment centers, securing checkpoints, and

providing peacekeeping forces to allow aid workers to do their jobs. Law enforcement agencies are protecting healthcare workers and enforcing public health measures such as quarantine. Border control agencies are working to identify infectious agents in goods crossing national borders, while intelligence agencies try to predict where the next infectious disease will emerge, while also tracking nefarious individuals/groups for "manmade" biothreats.

Generally, health sectors globally specialize in functions such as biosurveillance, healthcare and case management, but they are less well suited for logistics and transport or bioweapons disposal functions, which can be supported by DMS sectors[24]. For example, core capabilities of the DMS sector are often aligned with the pillars of handling zoonotic disease outbreaks (prevent, detect, respond, and recover) and can assist in the areas of intelligence, early warning, medical countermeasures, reporting, remains disposition, law enforcement, and capacity-building that supports recovery[24].

10.2 Biodefense and One Health in Azerbaijan

The National Security Concept of the Republic of Azerbaijan (2007) is a key guiding document on security policy in Azerbaijan. In addition to traditional international security topics (protection of military, border security, etc.) the Concept briefly highlights the connection between environmental health and security and the emergence of potentially new health threats[25]. Specifically, pollution, degradation of agricultural soils, and irrational use of natural resources are sighted as serious problems that not only affect security, but also negatively impact economic and social life and public health[25]. While the National Security Concept does not provide specifics on how the security sector is collaborating with the MENR on environmental protection, the inclusion of environmental health is an important recognition that security and One Health are intertwined.

In Azerbaijan, the SDICC primarily leads infectious disease identification, but the Center for Sanitary and Epidemiological Control of the Main Medical Department of the Ministry of Defense also conducts investigations of bacteriological agents and toxic agents in field conditions to preserve military safety. While the MENR and MOH are primarily responsible for biosafety and biodefense in Azerbaijan, collaboration between these sectors and DMS sectors would exemplify an integrated One Health model. Moreover, a coalition approach like this can create cohesion between departments and localities which can help alleviate competing priorities and demands that traditionally push sectors to operate in silos[23].

Azerbaijan also has international collaborations on health and biodefense, including with the U.S. Department of Defense on preventing the proliferation of technology, pathogens and expertise that could be used in the development of bioweapons, and enhancing Azerbaijan's capacity to detect, diagnose, and report bioterror attacks and potential pandemics[26]

Azerbaijan, like all countries, is currently at an inflection point where it can learn from the COVID-19 pandemic and address critical gaps in local, national, and regional biodefense, before the next infectious disease pandemic or biological attack. While some collaboration between health and DMS sectors in Azerbaijan exist, further strengthening of this partnership would be beneficial. Finally, optimizing the roles of all sectors involved with One Health, including DMS will help to reduce disease burden, negative financial impacts, security risks, and wide societal disruption from infectious disease outbreaks[24].

11 RISK REDUCTION AND RISK PROFILING

Risk reduction involves measures to decrease the likelihood of hazards impacting humans, animals, or the environment, or to lessen the intensity or severity (reduce the impact of risk) of such hazards[27]. Risk reduction for zoonotic diseases includes a process of identifying factors that reduce the underlying drivers or factors that determine infection and/or spillover (e.g., joint risk assessment and strategic planning) and then implementing interventions and communication measures to prevent the disease agents from creating health risks at the human-animal-environment interface[27].

Examples of zoonotic disease risk factors include:[27]

- Land use changes, deforestation, habitat loss, and destructive practices such as mining
- Changes to the human-wildlife interface
- Lack of immunization of humans and animals
- Improper food preparation
- Social change such as population growth, density, and migration
- Agricultural practices, including biosecurity and hunting/slaughtering of animals
- Air pollution and climate change
- Chemical contamination in soil and water

Taking these factors into account in a structured and transparent manner using a multisectoral, One Health approach allows better understanding of the transmission pathways and patterns that can lead to zoonotic pathogen spillover and spread of zoonotic disease[27]. It is especially important not to overlook environmental factors as pathogens can spread to people through contaminated soil and water, and as climate change worsens extreme weather events like floods may lead to zoonotic and vector-borne disease outbreaks[27].

11.1 EID Risk Profiling

The process of identifying potential risk factors and risk reduction practices should be conducted jointly by experts from all relevant sectors to maximize efficiency, provide varying perspectives, and avoid unintended consequences from miscommunication that may increase zoonotic disease impact if sectors are not informed and engaged[27].

During both the virtual workshop and regional meeting, participants engaged in the process of identifying EID risk factors specific to Azerbaijan (Table 5). Participants were provided an example risk profile that uses a standard template to identify factors, including country-specific ones, which may affect (decrease or increase) emerging infectious disease risk and impact. The template was used to jumpstart discussion, including to consider the relevance of factors, target gaps in knowledge where further assessment may be needed and identify priorities for emerging zoonoses risk reduction. Using their expert knowledge and the template, this activity aimed to promote a shared understanding across sectors and institutions about potential sources of risk, as well as potential opportunities for risk mitigation. After the workshop, additional factors were added to the table and the final results are presented in Table 5 below.

The four categories of EID risk factors used in this activity are:

Emergence factors: ecological, epidemiological, or socio-economic conditions that could aid in the new appearance or rapid increase in incidence or geographic range of disease

Spread factors: human and animal movement and travel patterns, infrastructure, density dynamics, or access to key disease detection and control measures that could affect the spread of disease

Vulnerability factors: gaps in disease detection and response capacity, infrastructure, workforce readiness, security, and One Health systems that increase susceptibility to disease outbreak and containment

Protective factors: practices, policies or other conditions that may reduce the risk of spillover or lessen the impacts of a disease following emergence.

Table 5. Risk factors for potential emerging infectious diseases (including zoonotic, vector-borne, and food-borne pathogens) in Azerbaijan

EMERGENCE FACTORS	SPREAD FACTORS
• Human wildlife contact e.g., contact with rats and birds (rabies); or contact through hunting (wild birds, foxes, wolves, marmot) leading to tick-borne diseases; or contact with wild boar and Caucasian Tur • Lack of proper food safety (e.g., milk) • Livestock interference with environment (e.g., land conversion to pasture) • Urbanization of new areas e.g., construction of infrastructures near forest belts, water sources, etc. • Contact with anthrax and spores in the environment • Pesticides/herbicide negatively affecting environmental health • Deforestation – happens in general, but is particularly bad from war in Karabakh • Uncontrolled tourism • Contaminated surface water with parasitic diseases, faulty water purification (e.g., with geohelminths) • Introduction of new species e.g., for aquaculture • Ecological changes (including those due to economic development) e.g., agriculture; dams, changes in water ecosystems • Microbial adaptation and change e.g., in response to selection in environment • Widespread use antibiotics	• Transport of animals – uncontrolled cross-border transport of animal products • Natural migration of animals • Transport of contaminated food • Migration of people (e.g., spreading disease) – or moving from rural areas to cities • Use of high-density facilities (Karabakh war) • Changes in food processing and packaging • Uncontrolled sale of meat and dairy products at markets in cities • Wild bird encroachment on farms and settled populations
VULNERABILITY FACTORS	**PROTECTIVE FACTORS**
• Lack of disease detection in wildlife (e.g., understanding causes of mortality of wild boar and Caucasian Tur; Caspian seals) – Limited number of wildlife vets to detect diseases; sometimes limited research to identify etiology. Lack of wildlife vets also means if there is an outbreak among wildlife, there is a need to bring in international vets which takes time and allows for disease to spread • Comprehensive wildlife monitoring on wildlife reserves is limited (e.g., only identifying quantity of animals rather than surveillance and disease detection) • Lack of ecological and environmental education e.g., behavior in the forests, casual contact with animals with the possibility of infection (rabies) • Changing climate (e.g., risk of anthrax re-emergence from buried animals) • Little funding for scientific research – e.g., lack of funding to conduct research e.g., conduct toxicological analysis to find out causes of death. It would be beneficial to attract international organizations and funding • Information flow to the public is restricted to WHO sources and people get info from Facebook. It is difficult to use local Azerbaijani experts for sources of information (media and open public information) • Weak veterinary control, especially in the private sector • Weak regulation on antibiotic usage, veterinary practices	• Livestock vaccination (more prevalent for commercial farming, less so for smallholder farming) • Periodic monitoring for the presence of pathogens among fleas, ticks (plaque, cholerae, tularemia, etc.) (carried out by SDICC) • Information dissemination to increase awareness of disease risk – some process in place but could expand awareness campaigns • Culinary culture – any kind of meat and food preparation goes through heat (no raw meat) • Good infrastructure/understanding of known diseases through the Special Dangerous Control Center • EIDSS provides real-time surveillance data • Risk mapping of bat borne disease

11.2 EID Risk Identification and Hotspot Mapping

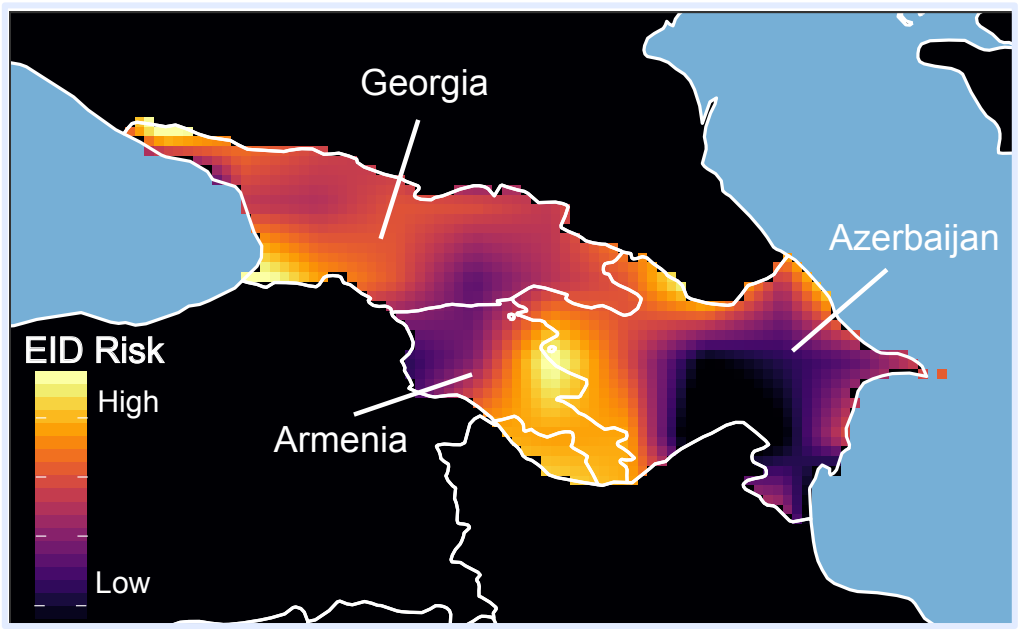
Most novel infectious diseases originate in wildlife and then spill over to humans. Those spillover events follow patterns that make them more likely to occur in some areas than others, creating hotspots of disease emergence. Mapping hotspots can help decision makers optimize surveillance efforts and promote public health interventions that reduce the risk of disease spilling over from wildlife to humans.

Cross-sector collaboration is also an essential part of identifying risk factors and hotspots for emerging infectious diseases. As zoonotic EID risk mapping requires not just health-related data, but demographic, environmental, biological, and wildlife data[11], it is important to involve a diversity of sectors in the risk mapping process. The Ministry of Health is primarily responsible for mapping zoonotic disease risk in Azerbaijan, but other organizations including research institutes of the Ministry of Agriculture, Ministry of Science and Education, and Food Safety conduct mapping exercises and research. Most of the disease mapping currently being done in Azerbaijan is descriptive and focuses on visualizing cases and prevalence/incidence of zoonotic disease across the various regions. This is acutely important work, but there is an opportunity to further build mapping capacity to include spatial analyses that bring together risk maps for multiple diseases, and information from other sectors including animal species distribution, land cover, livestock density, climate, and other forms of data.

As a whole, the Caucasus represents a potential EID 'hotspot' region largely due to the confluence of several ecological and demographic risk factors, including high wildlife diversity, growing human population, land-use change, and agricultural and urban expansion[7, 11]. It has not traditionally been considered a high-risk region (e.g., tropical regions along the equator: Brazilian Amazon, Central Africa, Southeast Asia), but many global zoonotic disease models do not include all disease emergence points from the Caucasus region[11]. As an example, the risk of wild birds becoming infected with avian influenza and spreading the virus within Azerbaijan, and the Caucasus region, is relatively low, but Azerbaijan, Georgia, and Armenia are all located along migratory pathways for wild birds, and the "risk landscape" for spillover is not static. Continual changes in land use, population growth and movement, animal husbandry practices, conflict, climate change, human pressure on environments, as well as other factors are dynamic and alter the risk landscape year over year.

To demonstrate an example of zoonotic EID risk mapping, a previously published analysis[11] has been downscaled to create a regional zoonotic disease risk model for the Caucasus region (Figure 5).

Figure 5. Preliminary EID 'hotspot' map for the Caucasus



This preliminary analysis highlights several important findings:

1) the risk of new disease emergence is not uniform across the region.
2) the most vulnerable regions for natural biothreats, are across disputed areas and border regions in Azerbaijan and Armenia where environmental exposure of military personnel may be the greatest.

This preliminary analysis is insightful, but it is hampered by one of the most common challenges in EID risk mapping – a lack of comprehensive, national-level data. In order to improve this model, more granular and country-level data needs to be incorporated. This is a priority area for future research.

11.2.1 Land used change

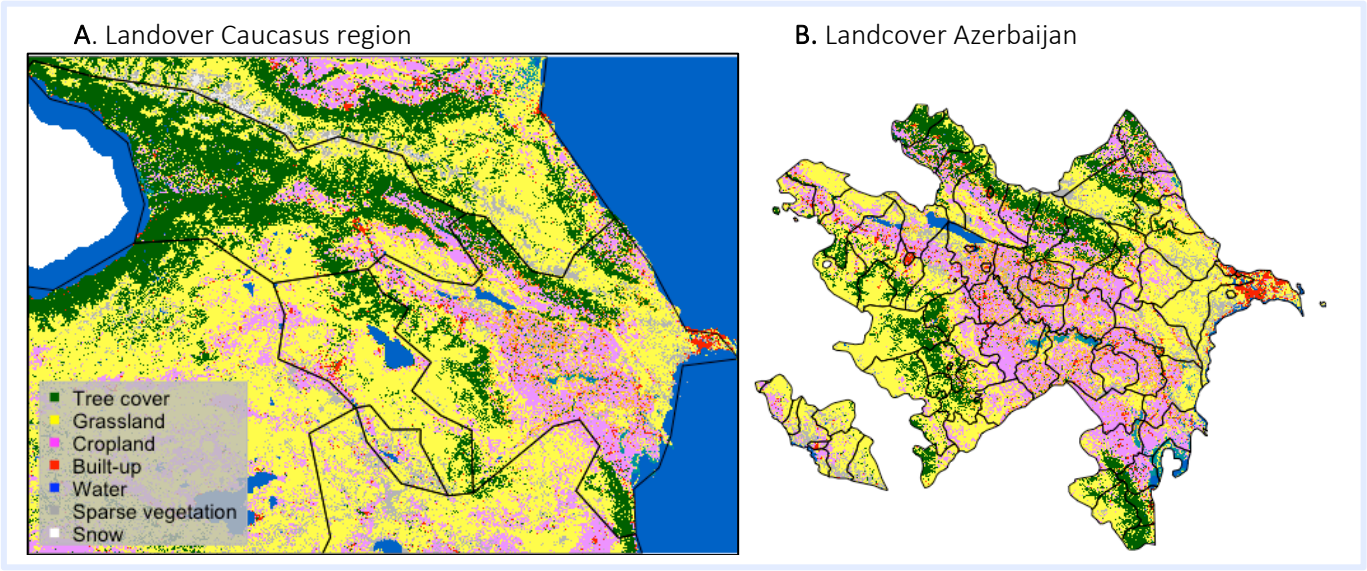
Anthropogenic land use change related to agricultural practices is a key driver of EID emergence and spread.[11] It can increases people's contact with wildlife, and their pathogens, and has been linked to more than 30% of new diseases reported since 1960.[28] As humans continue the process of globalization through land use change, conflict, and migration we need to continuously monitor zoonotic disease risk. For example, socio-economic changes in post-conflict zones have continued to shift the landscape of agricultural production and land abandonment at the Azerbaijan/Armenia border[29]. Changes in land use, like this, can potentially lead to changes in the zoonotic disease risk landscape.

The Caucasus region is predominately made up of grasslands, cropland, and tree cover (Figure 6). In comparison to its neighboring countries, Azerbaijan has a much larger share of cropland, and has undergone more conversion of forested and grasslands to croplands. As Azerbaijan

continues its economic development, it will be critical for the country to sustainably develop land, conserve its forests, and monitor the human pressure it is putting on the environment.

Figure 6. Land cover classifications, Caucasus region. ESA WorldCover project 2021

A. Land cover Caucasus region. The region is predominately grassland (yellow), cropland (purple), and tree cover (green). **B**. Azerbaijan is largely covered in cropland and grassland with other areas of tree cover and smaller built-up areas (red). In comparison to neighboring countries, Azerbaijan has a higher much higher prevalence of cropland, with relatively lower tree cover. Cropland and agricultural land conversion (from forested areas) have been previously associated with higher potential for zoonotic spillover, so it is important that Azerbaijan sustainably maintains natural land and monitors rates and location of land conversion.



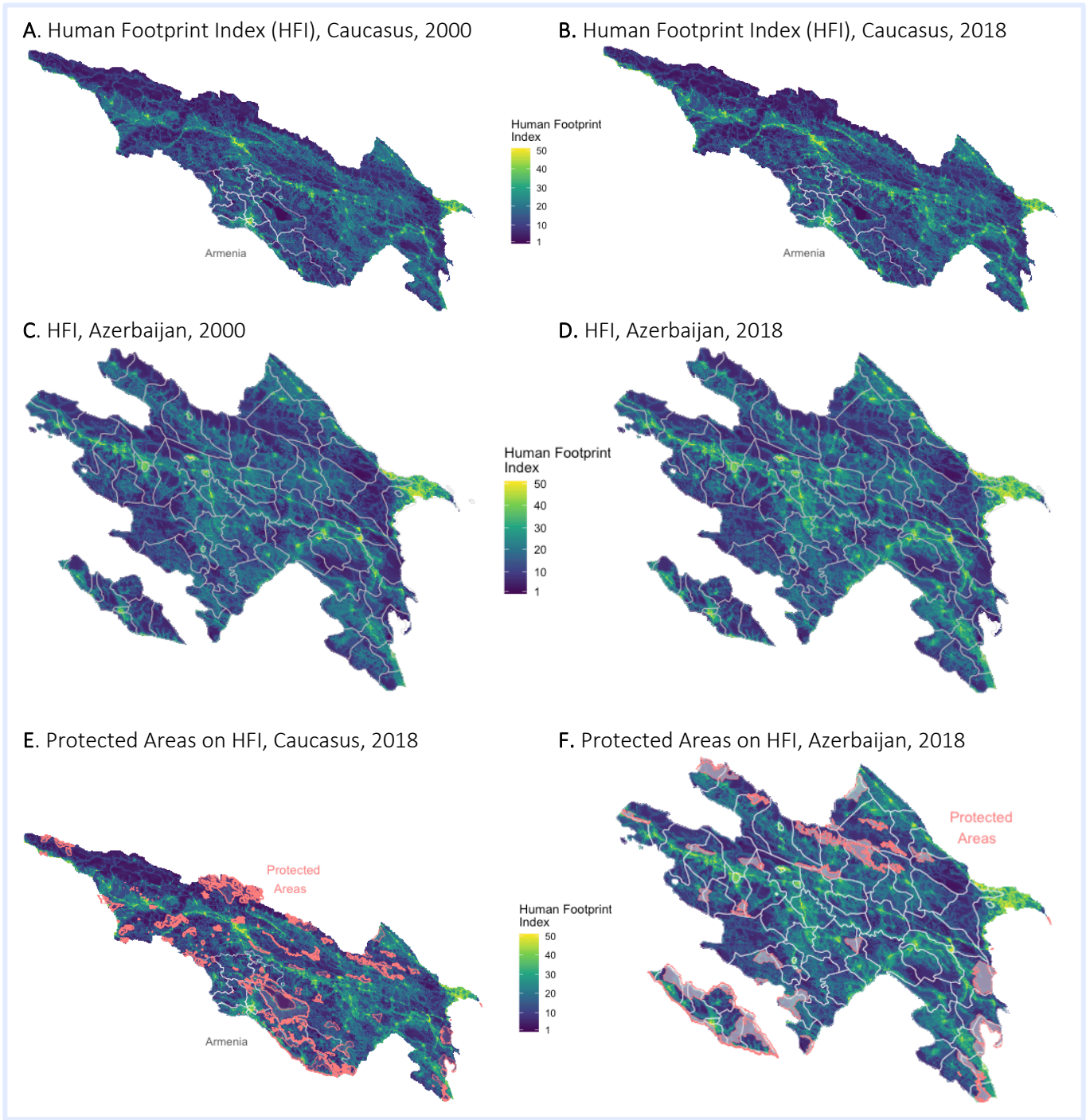
11.2.2 Human Footprint Index

Another measure of human-derived pressure on the natural environment is the Human Footprint Index (HFI). It is a composite metric that details the cumulative human terrestrial pressure put on the environment. Made up of 8 variables (built environment, population density, nighttime lights, cropland, pasture, roads, railways, and navigable waterways), it depicts how humans are changing the environment over time. Like most countries, Azerbaijan has significantly expanded its human footprint during the 21st century (Figure 7)[30]. This expansion means that human populations are better connected than before, which can lead economic growth and improved health outcomes, but it can also lead to more rapid disease spread.

Human-led development can be particularly destructive if it replaces natural habitats, areas of biodiversity, and important wildlife preserves. Azerbaijan has a scattered groups of protected and conserved areas throughout the country, none of which significantly overlap with the most developed areas of Azerbaijan near the capital of Baku.

Figure 7. Human Footprint Index (2000 vs 2018) and protected and conserved areas

The Human Footprint Index provides a map of cumulative human terrestrial pressure put on the environment, from dark blue (low pressure) to bright green (high pressure). Human pressure has increased in both the Caucasus region (A, B) from 2000 to 2018 and in Azerbaijan specifically (C, D). Increasing human pressure is particularly an issue near protected areas (E,F) and areas of high mammalian biodiversity, as it can pose a challenge to environmental preservation and potentially put humans and livestock in contact with wildlife, possibly increasing risk for disease spillover.[30, 31] There are scattered groups of protected and conserved areas throughout Azerbaijan(F), which are a significant distance from the highest areas of human pressure near Baku. conserved areas throughout Azerbaijan(F), which are a significant distance from the highest areas of human pressure near Baku.

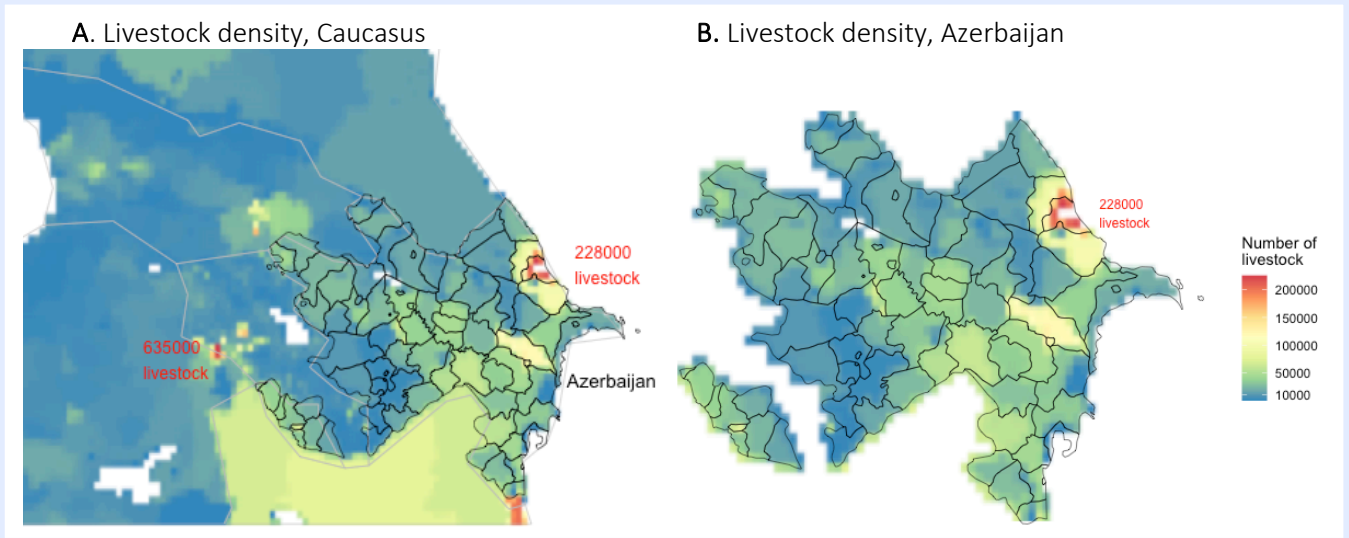


11.2.3 Livestock Density

By concentrating large numbers of animals in small areas, we increase the interactions and opportunities for disease transmission between livestock-to-livestock, livestock-to-human, and livestock-wildlife-human.[32] This is especially true for intensive livestock production, which is not generally an issue in Azerbaijan as approximately 47% of people in Azerbaijan live in rural areas and livestock (predominately chicken, sheep, cattle, and pigs) is generally held among small-scale subsistence farmers (Figure 8). However, there is a high density of livestock in the Siyazan district, which represents the highest density of livestock in Azerbaijan, the second highest in the Caucasus region, and poses a potential risk for animal-to-animal and animal-to-human disease spread. Overall, although the risk of zoonotic disease spillover is relatively low, increasing extensive transportation networks and the sale and transport of live animals can contribute to the emergence and spread of zoonotic pathogens.[32]

Figure 8. Livestock density, Caucasus region 2015

Total sum of chicken, cattle, goat, sheep, horse, pig, buffalo, and duck from blue (lowest number of livestock) to red (highest number of livestock).[33] **A**. Compared to other parts of the region, Azerbaijan has a slightly higher density of livestock per 10km^2 area. **B**. Within Azerbaijan, there is one particularly dense area of livestock (228000 livestock in approximately one 10km^2 area) near Siyazan district, although the rest of the country maintains a relatively low density of livestock.



12 BIODIVERSITY IN AZERBAIJAN

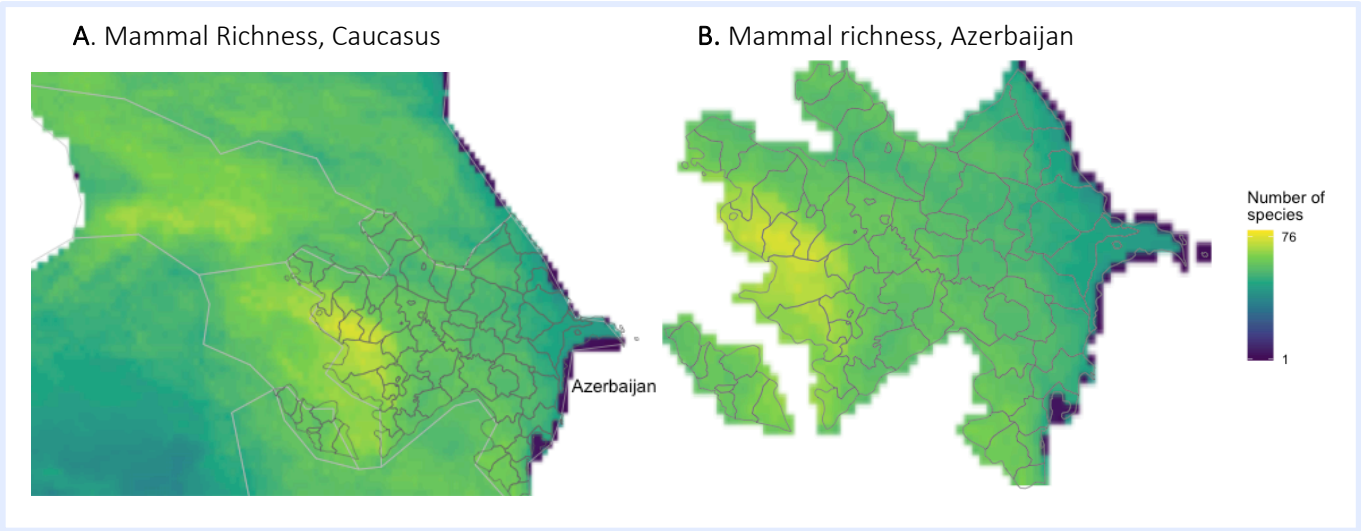
Azerbaijan is a country rich in biodiversity and climactic variability. Its diverse landscapes include mountains, wetlands, semi-arid low-lying plains, and a long stretch of coastline along the Caspian Sea. Its geographic placement between the Caspian, Black, and Mediterranean Seas and juxtaposition between Europe and Asia means both European and Asian species of animals live in Azerbaijan[34]. The country also has a broad range of climactic zones that contribute to high levels of biodiversity, including both humid and dry subtropical conditions and mountain and foothill zones with temperate climates.

There is a rich diversity of wildlife in Azerbaijan. There are 106 species of mammals (three of which are unique species: Caucasus goats and west-Caucasus moufflons), 97 species of fish, 363 species of birds, 10 species of amphibians, and 52 species of reptiles that have been recorded and classified in Azerbaijan[35]. Among the mammals, there are 31 species of bats and 38 species of rodents, which are known to carry the most viruses with zoonotic disease potential.[12, 36] The Red Data Book of Azerbaijan (2nd edition), which details endangered species, includes 108 species of animals: 14 species of mammals, 36 species of birds, 13 species of reptiles and amphibians, and 40 species of insects[37].

Further, among terrestrial mammal species, there is a relatively even distribution across the country and region (Figure 9). While the number of mammal species is fairly constant there are, however, slight differences in the specific species of animals in different parts of the country (specific species distribution maps not shown).

Figure 9. Terrestrial mammal species richness, Caucasus region, 2022

This figure shows the sum of terrestrial mammal species from blue (lowest number of mammal species) to yellow (highest number of mammal species).[38] Areas of greater wildlife diversity are often areas where viral diversity is the highest, thus increasing the potential for EID spillover if interactions between wildlife and humans or livestock occur.[7, 11] **A**. Mammal richness is relatively constant across the region with the richest areas in Gadabay, Dashkasan, and Kalbajar districts, Azerbaijan. **B**. Within Azerbaijan, there is little difference in the number of terrestrial mammal species per 10km^2 area across the country (although different species of mammals reside in different parts of the country).



Approximately 10% of Azerbaijan is considered a Specially Protected Area[34], an area that has doubled in the last 10 years. This includes 37 Protected Areas (land: 10.16% and marine 0.44%) with 7 providing management effectiveness evaluations[39]. There are also 9 national parks, 8 state reserves, and 18 state nature sanctuaries[39]. Furthermore, the country has approximately 12-16% forest cover, most of which is broadleaf[34, 40] (Table 6).

Table 6. Overview of forest and biodiversity in Azerbaijan

GEOGRAPHIC REGION	FOREST COVER	SHARE OF FOREST AREA DESIGNATED FOR PROTECTIVE FUNCTIONS	SHARE OF FOREST AREA CONSERVED FOR BIODIVERSITY	SHARE OF RURAL POPULATION
Azerbaijan	13%	77%	10%	47%
Caucasus Average (AZE, GEO, ARM)	NA	77%	11%	44%

Information from FAO/UNECE State of Forests of the Caucasus and Central Asia[40]

Additionally, despite its richness, there are several threats to biodiversity in Azerbaijan. They include over-grazing, illegal and unregulated fishing, hunting, and logging, climate change, deforestation to build infrastructure, and several others (Table 7)[34, 40, 41]. Factors that are driving the loss of biodiversity include a lack of institutional capacity and financing mechanisms for biodiversity and conservation, poverty in rural areas, lack of reliable data and others. Furthermore, economic incentives underpin many of these threats to biodiversity. For example, the high profitability and lack of alternate income sources for rural populations makes illegal logging enticing. Additionally, ecotourism is on the rise putting pressure on forested regions[34, 40]. According to one report, this issue is in part enhanced by low education levels and knowledge of conservation among tourists and those involved in the tourism industry[42].

Table 7. Threats to biodiversity in Azerbaijan and their associated drivers

THREATS TO BIODIVERSITY	DRIVERS OF BIODIVERSITY THREATS
• Over-grazing • Forest and water management practices • Illegal and unregulated fishing, hunting, and logging • Pollution • Fire (burning of maize fields in winter and grass in summer) • Invasive and non-native species • Climate change • Mining • Deforestation to plant crops and build roads • Destruction of arable lands through soil erosion, salinization, fertilizers, pesticides, and herbicides • Construction of dams and rivers fragmenting land	• Corruption • Poverty in rural areas • Lack of political will • Lack of institutional capacity in biodiversity and conservation efforts • Lack of accessible and reliable data • Low level of awareness of the importance of biodiversity • Lack of sustainable biodiversity financing mechanisms

Information from USAID/Azerbaijan Foreign Assistance Act 119 Biodiversity Analysis[34]; FAO/UNECE State of Forests of the Caucasus and Central Asia[40]; and the Azerbaijan Sixth National Report to the Convention on Biological Diversity[41]

The threats to biodiversity and deforestation are significant issues, in part, because of their role in the emergence and spread of infectious disease. For example, much of the territory of the Republic of Azerbaijan a is considered susceptible to especially dangerous pathogens[43]. Species associated with elevated risk of harboring or transmitting high consequence pathogens include many species of birds and mammals, both domestic and wild, such as rodents, bats, raptors, and ungulates.

The responsibility of forming and managing environmental policy and projects is the Ministry of Ecology and Natural Resources, however the ministry lacks adequate staff and capacity to be as effective as possible[34]. The World Wide Fund for Nature (WWF) also works closely with MENR on matters of biodiversity and conservation, but due to

government restrictions, few other NGOs can work on biodiversity conservation in the country[34]. In terms of regulation and policy, environmental conservation is briefly, but explicitly mentioned in the Constitution of the Azerbaijan Republic, and there are several laws on biodiversity with the main ones being the Law on Specially Protected Areas and Objects Law on Environmental Protection (1999) and the Law on Ecological Safety (1999)[34].

Azerbaijan is also a member of the Convention on Biological Diversity (CBD) and most recently completed its Sixth National Report to the Convention on Biological Diversity in 2019 (Table 8).

Table 8. Biodiversity-related conventions

COUNTRY	THE RIO CONVENTIONS			BIODIVERSITY- RELATED CONVENTIONS				
	UNCBD	UNFCCC	UNCCD	CMS	CITES	RAMSAR	WHC	BERN
Azerbaijan	2000 Approval	1995 Ratification	1998 Accession	-----	1998 Accession	2001	1993 Ratification	2000 Accession

UNCBD = United Nations Convention on Biological Diversity,
UNFCC = United Nations Framework Convention on Climate Change
UNCCD = United Nations Convention on Combatting Desertification, CMS – Convention on Conservation of Migratory Species of Wildlife Animals, Cites = Convention on International Trade in Endangered Species of Wild Fauna and Flora,
RAMASAR = Convention on Wetlands pf International Importance, especially as waterfowl habitat
WHC = Convention concerning the protection of the world cultural and natural heritage,
BERN = Convention on conservation of European wildlife and Natural habitats

Coinciding with its obligations to the CBD, Azerbaijan published its most recent "National Strategy of the Republic of Azerbaijan on Conservation and Sustainable Use of Biodiversity for 2019-2020", which aims to improve conservation and sustain biological diversity[41]. An evaluation of the progress to achieving the objectives laid out in the National Strategy on Conservation and Sustainable Use of Biodiversity shows that Azerbaijan has made "fair/reasonable progress" to "good progress" on most of the objectives. There are no objectives with "limited progress" and one objective with "excellent progress", which is the expansion of protected areas[41].

13 PUTTING ONE HEALTH INTO ACTION

In the following sections we outline seven specific processes for putting One Health into action, or "operationalizing a One Health approach" in Azerbaijan. Operationalizing a multi-sector, One Health approach can take multiple forms and is context dependent, however these broad components, borrowed from previous One Health evaluation and operational frameworks[13, 27, 44, 45], are key in establishing an effective One Health response. They include:

1. Existing national infrastructure, capacity, tools, and resources
2. Multisectoral, One Health, coordination mechanism(s)
3. Cross-sectoral biosurveillance system for disease reporting and data sharing
4. Joint priority setting and preparedness planning, including the identification of disease risk factors or geographic disease hotspots
5. Effective and coordinated risk communication
6. One Health workforce development
7. Monitoring, evaluating, and reporting on One Health activities

13.1 Existing national infrastructure, capacity, tools and resources for addressing zoonotic diseases for collaboration across sectors and disciplines

Operationalizing One Health first requires a thorough understanding of the existing national landscape, including what policies, assessments, plans, funding, implementing projects, data sharing and communication systems, and expert networks are in place. Effective coordination and alignment between these elements is critical but is often a major challenge. Taking inventory of these, whether at a global, regional, national, or sub-national level can help provide potential pathway for synergy at various entry points of a system. For example, in a coordinated system, regulatory frameworks will inform national capacity assessments, which lead to planning tools, which are then funded and implemented jointly between relevant sectors with support from expert networks and shared data and information systems. Most of the time, however, this flow of action is not as linear as just described, and elements often feed into and inform one another. Notably, these components will vary from context-to-context and country-to-country to reflect changes in risk factors, needs, resources, and governance. Examples of these components specifically for Azerbaijan are depicted below in Table 9.

Table 9. One Health relevant regulatory frameworks, assessments, tools, implementation resources, information systems, and expert networks in Azerbaijan, with year of establishment/latest update

CATEGORY	INVENTORY
Regulatory Frameworks	• Veterinary Law of Azerbaijan (about veterinary medicine) • Law on Protection of public health (1997) • Law on Sanitary and Epidemiological Safety (1992) • Law on immunoprevention of infectious diseases • Law on protecting the health of the population (No 360-IQ) • The biological security rules on Labs (2010, Decree 15) • Order No. 63 of the Ministry of Health (Regulations on the control of especially dangerous infections) • Regulations and standards under Food Safety Agency (AFSA) • Rules for the implementation of aquaculture • Several laws on biodiversity including the Law on Environmental Protection (1999) and Law on Ecological Safety (1999) • MOH/ MOA Joint Decree on Priority Zoonoses (2014) • Convention on Biological Diversity
Capacity Assessments	• Performance of Veterinary Services (PVS) • PVS Evaluation Follow up Mission • PVS Gap Analysis Mission • Joint External Evaluation of IHR Core Capacities (in progress) • WHO Strategic Tool for Assessing Risks (2019) • WHO Simulation Exercise (2019) • WHO After-action Review (2019) • Simulation exercises on Foot and Mouth Disease (FMD) and Avian Influenza • AMR Self-Assessment (2019-2020)
Planning Tools	• National AMR Action Plan • National Action Plan for Zoonotic Disease • Comprehensive Action Plan Against Bird Flu • FMD Contingency Plan • Contingency Plan on Pest Petite Ruminant (under development) • National Bridging Workshop on IHR and PVS (2013) • National Strategy of the Republic of Azerbaijan on Conservation and Sustainable Use of Biodiversity for 2019-2020 • US CDC One Health Zoonotic Disease Prioritization Workshop (2015)
Implementation Resources	• Central Veterinary Laboratory of AFSI • Regional labs (6 BSL2), including the Special Dangerous Infection Control Centre • MOH/ MOA Reference Lab • Research capacity: MS&E/ MOA/ ADAU have institutional capacity • Government financing for animal health control measures (vaccines) • WWF works with Food Safety Agency on animal tests and vaccinations • Cooperation with veterinary services and conservation organizations on wildlife reintroduction • Creation of Disease-Free Zones • WHO-MOH collaboration on COVID-19 testing and capacity building with lab staff • REACT-C19 project • Regional biosurveillance projects (e.g., Biosurveillance Network of the Silk Road, Western Asia Bat Research Network, EUROBAT) • Several DTRA-funded human and animal health projects

Information and Reporting Systems	• Electronic Integrated Disease Surveillance System (EIDSS) • Pathogen Asset Control System (PACS) for sample tracking • Electronic database for AFSI (AQTIS) • Electronic Observation System for Infectious Diseases • National Veterinary Information System (NVIS) • Animal Identification and Registration System (AIRS) • İGAS (İnventory and Gap analysis system) • Laboratory networks specific to each ministry • Veterinary Services informs on disease circulating in animals
Expert Networks	• Commission on emergency situations • Commission against epizootic situations • National Immunization Technical Advisory Group (NITAG) • Several Informal technical working groups, including working groups on infection prevention and control and medical waste management

Assuring effective health governance, legislation, financing, and institutional structures are in place is critical for Azerbaijan to expand its biosurveillance and biodefense capacities. Azerbaijan has several key laws in place, including the Veterinary Law of Azerbaijan, Regulations on the control of especially dangerous infections (Order No. 63 of the MOH), Law on Environmental Protection (1999), Law on Ecological Safety (1999), Rules for Identification of Animals, the State Program for 2019-2025 for Ensuring Food Safety in Azerbaijan Republic[46], and many others. Yet, there are areas for improvement in One Health policy, specifically regarding wildlife health in relation to biodiversity preservation and protection.

There is also political will to support IHR implementation with national legislation covering human, animal, and environmental health. The designated IHR focal point is based within the Public Health and Disease Control Division of ARSN and coordinates legal and regulatory frameworks for IHR implementation. During the COVID-19 pandemic, several new legal documents and guidelines came into force, including COVID-19 national strategy, a national decree from the Cabinet of Ministers to prevent and mitigate the disease, and rules and regulations for quarantine and other measures to slow the spread of disease.

In terms of capacity assessments and planning tools, Azerbaijan has put significant effort into the areas of animal and human health by completing the Performance of Veterinary Services Evaluation, Follow up Mission, and Gap Analysis; Strategic Tool for Assessing Risks; multiple disease-specific simulation exercises; and is in progress on completing a Joint External Evaluation of IHR Core Capacities. There are also several Standard Operating Procedures for outbreaks of zoonotic diseases, establishing a rapid response team, and others. In terms of environmental health and biodiversity, there are national plans in place that are in accordance with the CBD (discussed previously in this report). While these efforts show a clear dedication to improving animal and human health, they have not always covered a full multisectoral scope as they are often conducted solely by one ministry or sector, or without input from other ministries or academic experts.

Additionally, there is room for increased transparency in Azerbaijan as many

capacity assessments and planning tools are not publicly available or are only published in print and are not easily available online. This hinders cross-sector information sharing of lessons learned and best practices and makes it harder to identify opportunities for collaboration. There are, of course, legitimate security or privacy concerns with distributing sensitive information regarding vulnerabilities in health security, but more often than not, health information does not meet this criterion and should be made more easily accessible to experts within other government ministries and in academia.

Regarding implementation resources, there are several laboratories with diagnostic capabilities, including the Central Veterinary Laboratory of the Azerbaijani Food Safety Institute (AFSI) and several regional labs. There is also strong research capacity within the Ministries of Health, Science and Technology, and Agriculture, and with research institutions such as Azerbaijan State Agricultural University (ADAU), Baku State University and Azerbaijan Medical University. The government of Azerbaijan also finances several animal health control measures, including vaccinations for foot and mouth disease, anthrax, brucellosis, classical swine fever, Newcastle disease, equine influenza, rabies and others.[46] WWF also works closely with AFSI on animal testing and vaccinations based on feedback from Veterinary Services.

The government has several capacity building and research projects in partnership with WHO and FAO that support a range of topics including COVID-19 laboratory diagnostic capacity, universal health care expansion, and agricultural health[47-49]. Finally, Azerbaijan is an active participant in multiple regional surveillance projects including the Western Asia Bat Research Network. More information on these research networks can be found further in the report.

Azerbaijan utilizes several electronic information systems across the human-animal-environmental health spectrum, including an Electronic Integrated Disease Surveillance Network (EIDSS), National Veterinary Information System (NVIS), Pathogen Asset Control System (PACS), and others. More information on these systems can be found further in this report. While these systems are effective in capturing epidemiologic and biologic data, information sharing about ongoing One Health projects and progress could be improved. Additionally, improved metadata standards and criteria for the minimum necessary data needed for sharing One Health or biosurveillance data across platforms are needed.

Finally, with respect to expert networks there are multiple working groups, including the Commission on emergency situations, Commission against epizootic situations, and the National Immunization Technical Advisory Group (NITAG), but there is no dedicated One Health expert group. Fortunately, Azerbaijan is a relatively small country, so informal communication is often common and effective, but the country would benefit from further institutionalizing additional expert groups related to One Health. Azerbaijan is also a member of the Global Health Security Agenda.

13.1.1 Common Challenge to One Health Implementation and Funding

For longevity and sustainability of One Health systems and programs, regulatory frameworks and policies need to be established in law with dedicated, consistent funding streams. Not having official, institutionally established policies and funding can hinder multisectoral collaboration as priorities can shift every few years depending on which political party and officials are in office. With limited resources and competing priorities, sustained funding is often the biggest challenge to implementing One Health programs. This is true for all countries, from Azerbaijan to the United States and all countries in between. The existence of a national plan, health information system, or central coordination body is an excellent start, but it is not enough. Funding is needed to implement plans and build data sharing systems where sectors can collaborate with one another to jointly tackle health challenges. Importantly, however, One Health is, and should be context-specific, and funding needs to be allocated to where it can make a difference – which will inevitably look very different in each country. Global funding mechanisms are beginning to launch or expand, including the Pandemic Fund, Nature4Health, and World Bank One Health project funding, and countries including Azerbaijan could be well placed to receive funding if they continue to show a high-level government commitment to One Health.

Like most countries, Azerbaijan faces a consistent challenge in securing sustained One Health funding. Core surveillance detection and response capacities are partially funded through state programs, but there is minimal funding for trainings. Azerbaijan also faces other common barriers to implementing One Health, including a lack of awareness, and understanding for why a One Health approach can be helpful, unclear mechanisms of communication between sectors, and a lack of human resources to implement a multisectoral, One Health approach. In rural areas in particular, a lack of trust and communication between human and animal health sectors further plays into the challenge of implementing One Health programs.

13.2 Multisectoral, One Health, coordination mechanism(s)

A multisectoral One Health coordination mechanism (MCM) refers to any formalized, standing, group that acts to strengthen or develop collaboration, communication, and coordination across the sectors responsible for addressing zoonotic diseases and other health concerns at the human-animal-environment interface[27]. The multisectoral coordination mechanism can be tailored to focus on priority zoonotic diseases or health threats in Azerbaijan including AMR, food safety etc.

Currently, Azerbaijan does not have a National MCM or National One Health committee. There is interest among some technical One Health stakeholders, but legally formalizing a national multi-ministerial committee will be challenging without high level political support. In March 2023, the government of Azerbaijan and WHO, FAO, WOAH, and FAO hosted a meeting on strengthening One Health Coordination Mechanisms in Azerbaijan introducing the MCM Operational Toolkit. The meeting aimed to introduce colleagues from relevant technical sectors and to begin to raise political support for developing an MCM and implementing the Tripartite Zoonoses Guide.

The main sector responsible for handling One Health related issues (e.g., preventing, detecting, and responding to zoonotic diseases) is the Ministry of Health, but other sectors including the Ministry of Agriculture and Ministry of Ecology and Natural Resources are also involved. In particular, there is strong core of collaboration between four agencies: Ministry of Science and Technology, MOA MENR, and AFSI. These institutions are often in contact and provide a breadth of expertise on human and animal (and environment to a lesser extent) disease research and health projects conducted throughout the country. If a MCM is to be formed, these four agencies would provide a strong foundation to build around.

Additionally, although there is not a national-level One Health body, there are lower-level coordination groups, including the Commission against epizootic situations which includes representatives from MENR, MOA, AFSI, MOH, Ministry of Emergency Situations, and local administrative bodies and is tasked with developing recommendations about livestock health (Table 10). There are also several smaller scale working groups (formal and informal) that create action plans and recommendations for different ministries. These working groups, sometimes lack clear roles and responsibilities, however, and could be enhanced by adding additional relevant experts and by clarifying each organizations responsibility. In addition to working groups, there are several informal groups among scientists and experts (e.g., on WhatsApp) that are able to instantly communicate and share knowledge but lack decision making power or influence. Other non-national-level collaborative projects include a joint effort between MOH, Agrarian services, and food safety on reporting especially dangerous pathogens in a timely manner.

Table 10. Multisectoral coordination groups present in Azerbaijan

NAME OF MULTISECTOR COMMITTEE/GROUP	REPRESENTATIVES	COMMITTEE MANDATE OR RESPONSIBILITIES	FORMALLY ESTABLISHED THROUGH POLICY, MINISTERIAL DECREE, OR LAW?
Commission on emergency situations	All ministry representatives	Lead and control all emergency situations, i.e., action plans, coordination, response etc.	Formally established under decision from the Cabinet of Ministers
Commission against epizootic situations	Ministry of Agriculture, Ministry of Health, Food Safety Agency, Ministry of Emergency Situations, Ministry of Ecology and Natural Resources, local administrative bodies	Surveillance, establish expert groups, develop recommendations about livestock of animals	Formally established under decision from the Cabinet of Ministers
Several small working groups	Representation from different ministries depending on the working group	Create action plans and provide recommendations	Established based on commissions
Medical Waste Management group	MOH MENR Ministry of Economy State Agency on Mandatory Health Insurance Administration of the Regional Medical Divisions Open Joint Stock Company	Carrying out evaluations, preparing proposals; Improvement of the legislative base around medical waste management	Joint command of MOH and MENR
Coronavirus Operational Headquarters	Cabinet of Ministers consisting of authorized representatives of various state institutions.	Prevent the threat of the coronavirus epidemic in the territory of Azerbaijan	Formally established by order of the President (No. 1861)
Informal groups (often on WhatsApp)	Scientists and government workers	Share experiences and knowledge. It is often easier to share information in this informal capacity with international colleagues rather than going through formal communication channels	No

In a sign of interest and dedication to improving multisectoral collaboration in health, in 2013, Azerbaijan hosted one of the first ever National Bridging Workshop on the International Health Regulations (IHR) and the Performance of Veterinary Services (PVS) organized by MOH, MENR, WHO and WOAH. During the event, attendees ranked the areas in highest need of collaboration (information not public). The National Bridging workshop also included objectives and actions for each priority area of collaboration, but it is not clear what progress has been made towards each objective.

Overall, it is clear that there is a growing interest in One Health in Azerbaijan with a handful of dedicated champions in government, academia and NGOs but formally institutionalizing One Health remains a challenge. We urge Azerbaijan to continue its effort to establish a national One Health MCM or similar National One Health committee with broad representation across ministries, including MOH, MENR, MOA, Ministry of Defense, Food Safety Institute, Ministry of Science and Technology, and non-governmental experts including academic researchers or non-profit stakeholders. Once established it will be crucial for the MCM to receive designated financial and human resources so it can fulfill its mandate and coordinate One Health programs and policies across sectors.

13.3 Cross-sectoral biosurveillance systems for disease reporting and data sharing

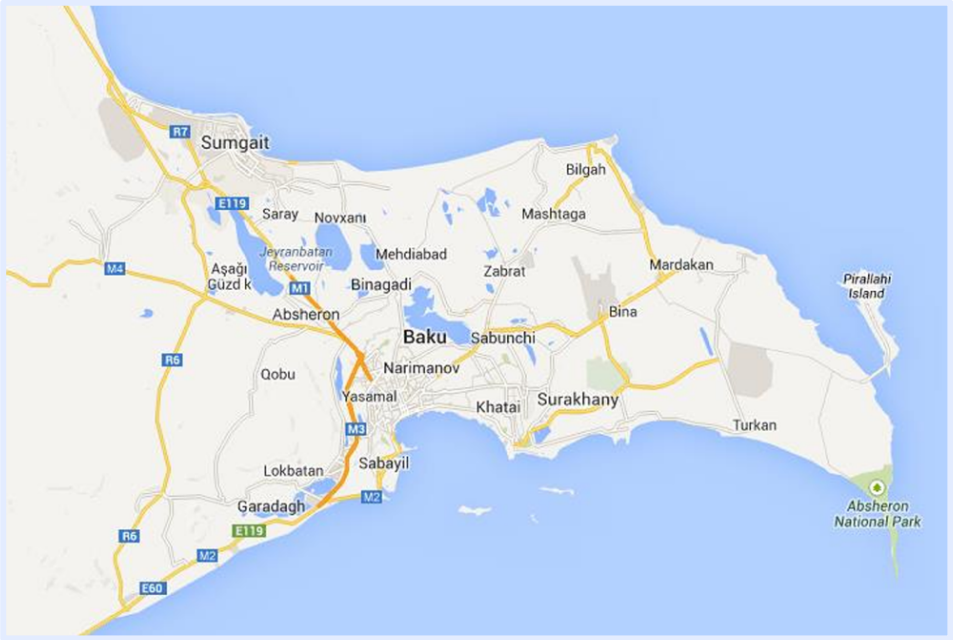
Biosurveillance is a process that includes active data gathering, analysis, and interpretation of information relating to disease activity and threats to human, animal, or environmental health, regardless of intentional or natural origin. In addition to detecting potential disease outbreaks it also includes a responsibility to provide decision-makers and the public with accurate and timely information related to disease prevention, mitigation, response, and recovery[50]. Information sharing and collaboration between sectors is critical for sentinel surveillance, early detection, and rapid response because zoonotic diseases can be can be transmitted between people and animals, or via the environment they share[27].

Surveillance systems for zoonotic diseases are in place in both the human and animal health sectors in Azerbaijan, and they each contribute to a shared national Electronic Integrated Disease Surveillance System (EIDSS) which provides patient-specific information, real-time disease reporting, integration with other electronic health systems, and information exchange between different agencies.[51] EIDSS is designed with a One Health approach to conduct real-time exchange of information between veterinary and healthcare sectors and facilitates compliance with the International Health Regulations (IHR) 2005. EIDSS includes 7 key modules, including human disease cases, vector surveillance, and laboratory modules, which summarize data across sectors[52]. EIDSS contains data on 50 notifiable diseases which are entered by all District Centers of Hygiene and Epidemiology and medical facilities.[51]

The government also conducts active surveillance on several animal diseases, including brucellosis, foot and mouth disease, glanders and highly pathogenic avian influenza (HPAI).[46] The MOH, Veterinary Services, and AFSA use EIDSS, but shared visibility of veterinary and human data has not been established to conduct joint zoonotic disease investigation.[46, 51] Developing a shared connection between veterinary and human services for integrated surveillance and collaborative investigation of zoonotic infections could help streamline response and create efficiencies.[51]

In 2021, in order to improve food security, the government created an Animal Identification and Registration System (AIRS) to track every animal and livestock product 'from farm to table' and ensure food safety.[46] AIRS, and its complement, the National Veterinary Information System (NVIS), use and store information to monitor infectious disease outbreaks, and NVIS also tracks exchanges and sales of animals.[46] Furthermore, a pilot "Animal Disease Free Zone" on the Absheron peninsula is being established where importation of animals and animal products will be monitored and registered under special guidance to enhance animal and zoonotic disease safety (Figure 10).[46] If successful, the lessons and experience from the Animal Disease Free Zone will be expanded throughout the country.

Figure 10. Animal disease free zone



In terms of laboratory capacity, each main health institution has its own laboratory network. This includes the AFSI's Central Veterinary Laboratory (CVL), one mobile Biosafety Level-3 (BSL-3) AFSI lab, six regional Biosafety Level-2 (BSL-2) labs and the Special Dangerous Infection Control Center (SDICC) reference lab. Launched in September 2020, the CVL and regional diagnostics labs began using the Pathogen Asset Control System (PACS) to cover daily laboratory operations[53]. The PACS system includes a central database located within the CVL and all data is monitored by AFSI-CVL. Both the CVL and regional labs conduct food testing on meat for human

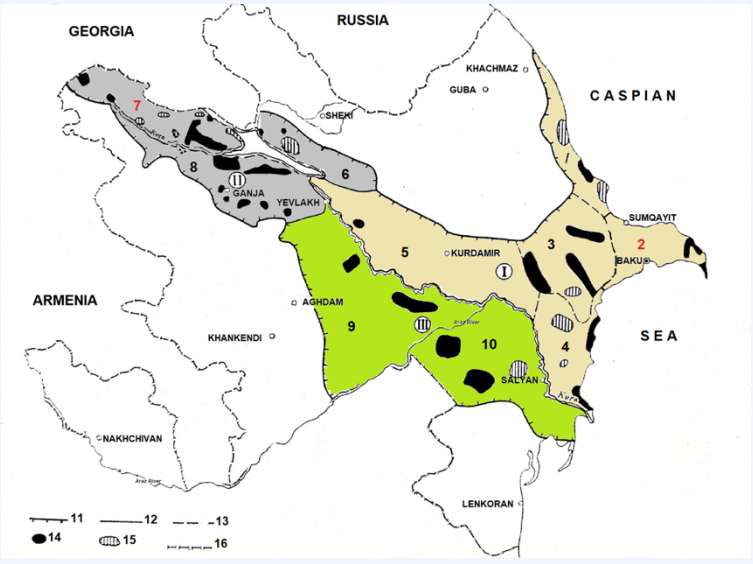
consumption, fish, honey, and other types of food and enter all information into PACS. In addition to PACS, AFSI also utilizes an electronic database for food safety (AQTIS) to monitor food imports and exports, pesticides, veterinary products and agro-chemicals.

Developing surveillance systems that incorporate environmental and wildlife components are also critical to detect and swiftly respond to zoonotic disease outbreaks and other health threats. Environmental and wildlife data can help authorities recognize specific geographic areas where disease outbreaks may be more likely to occur, which can cut down on outbreak response time and help better target resources. With few wildlife veterinarians in Azerbaijan, wildlife biosurveillance is currently limited and mainly focuses on counting species abundance rather than pathogen sampling and detection. Although there is not official surveillance programme for zoonotic diseases in wildlife, there are numerous biosurveillance projects active in Azerbaijan. Further developing wildlife surveillance capacity could be an effective mechanism to further integrate One Health processes and cross-sector data sharing into human and animal health surveillance.

Moreover, a 2015 study conducted by researchers at the Republican Veterinary Laboratory and the Barda Zonal Laboratory found that environmental testing for viral diseases at live bird markets could be an effective testing strategy that merits further consideration in national surveillance planning [54]. In particular, environmental sampling can be beneficial as it is not invasive so it may be more acceptable by market vendors who are concerned about adverse effects that sampling could have on their birds, and it may also be safer for veterinary health officers, since it avoids the need to directly handle and sample live birds [54].

BOX 1.
Rodent foci plague in Azerbaijan

The Libyan jirds, a widespread and numerous rodent species in Azerbaijan, are carrier of numerous infectious diseases. This species is considered the key carrier in the natural foci of plague in the foothills and lowlands of the Eastern Transcaucasia. There are three isolated geographical populations of this species in Azerbaijan, noted in green, gray, and yellow (Gazakh-Ajinohur, Karabakh-Mil, Shirvan-Absheron).[1]



13.3.1 Regional collaboration for Biosurveillance and Data Sharing

Azerbaijan is an active participant in several collaborative biosurveillance projects in the Caucasus region. These partnerships provide Azerbaijan and neighboring countries an opportunity to share information and skills when it comes to disease outbreaks, One Health workforce development and training, professional connections, and more. Examples of regional biosurveillance collaborations include:

- Biosurveillance Network of the Silk Road – BNSR is multinational partnership aimed at improving regional disease surveillance, detection, and communication. It hosts annual cross-border meetings and regular teleconferences between veterinarians and epidemiologists. Through the BNSR, a cross-border surveillance mechanism with Azerbaijan and Armenia and has been set up, providing urgent and monthly notifications for disease outbreaks.
- There is also regional cooperation in the field of chemical, biological, radiological, and nuclear defense (CBRN) between Azerbaijan, Armenia, and Georgia
- TESSy/The European Surveillance System
- VectorNet – European network for sharing data on the geographic distribution of arthropod vectors, transmitting human and animal disease agents
- EUROBATS – An agreement among 38 European member states on the Conservation of Populations of European Bats. The aim is to provide member nations with a framework to conserve bat populations and health.
- Western Asia Bat Research Network (WAB-Net) – regional initiative establishing the first bat research network in Western Asia with the aim of integrating ecological research on bats with virus surveillance to promote bat conservation and safeguard public and animal health.

BOX 2.
Western Asia Bat Research Network

The Western Asia Bat Research Network (WAB-Net) is a regional initiative to establish the first bat research network in Western Asia with the aim of integrating ecological research on bats with virus surveillance and to promote bat conservation and safeguard public and animal health. Led by scientists at the Institute of Zoology (ETN), researchers in Azerbaijan are characterizing the diversity of bats and bat-borne coronaviruses (CoVs) in Azerbaijan while training in best practices for bat sampling and biosafety to improve field sampling efforts and our understanding of bat species native to Azerbaijan.[2]

13.4 Joint priority setting and preparedness planning, including the identification of disease factors or geographic disease hot spots

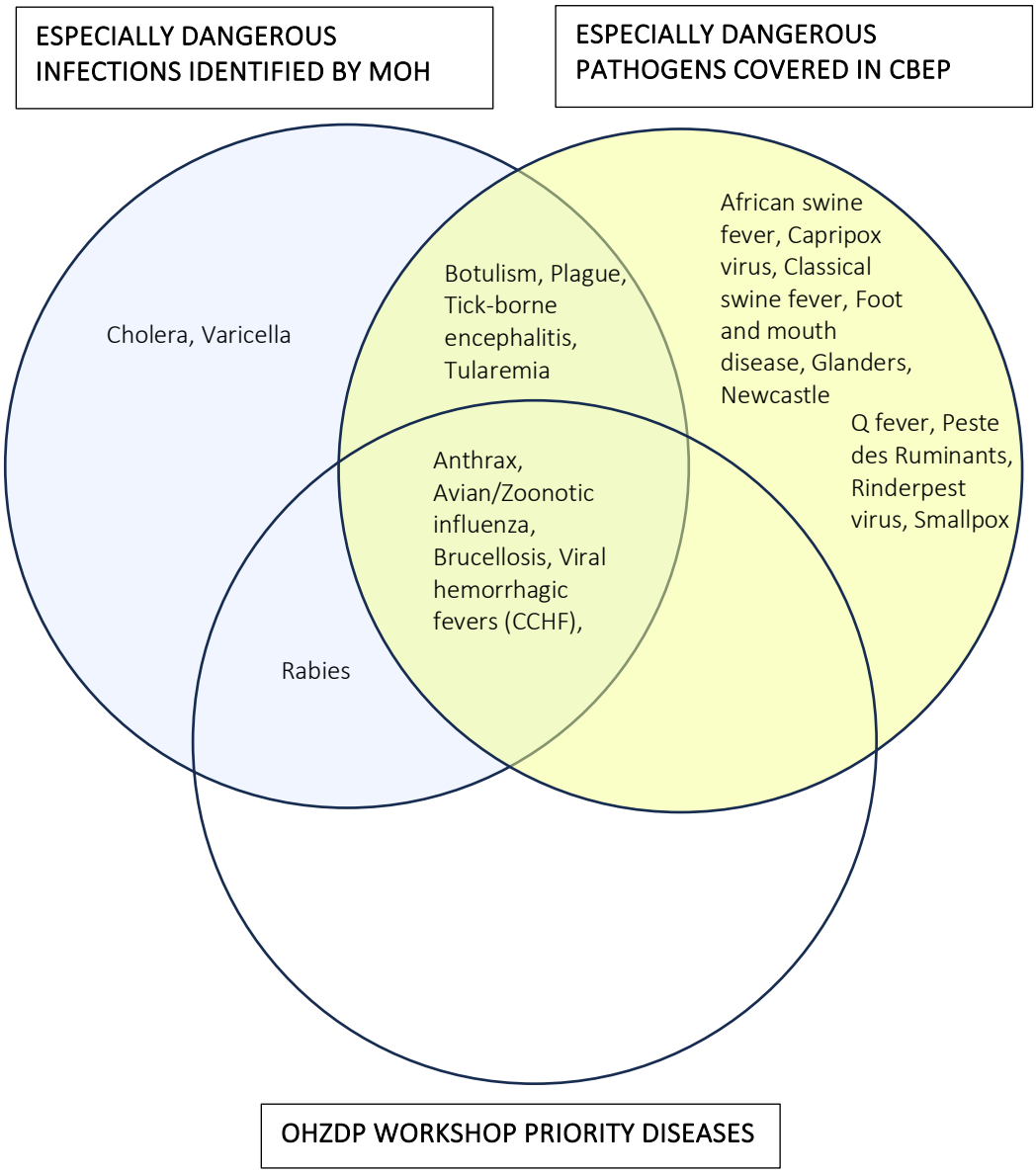
Joint, cross-sector planning provides an opportunity for experts from different disciplines to contribute to, and 'buy-into' One Health activities from the onset of a project. In doing so, different perspectives are brought forward to enhance projects by sharing knowledge and experiences and preventing duplication of efforts.

For example, In May 2019, representatives from the Ministry of Health, Emergency Situations, Internal Affairs, Defense, Food Safety Agency (AFSA), the Poison Control Centre, and WHO gathered to participate in a workshop to develop a public health risk profile for Azerbaijan.[55] Workshop participants developed a data-informed ranked listing of imminent and/or recurrent risks in the country and a set of recommendations for priority actions to manage threats based on parameters such as the likelihood, health consequences, magnitude, exposure, frequency, and seasonality of disease.[55] While predominately focused on public health, this workshop exemplifies the multi-sectoral collaboration required to develop comprehensive risk assessments for One Health issues.

In addition to joint preparedness planning, joint identification, and prioritization of diseases can be useful, particularly for zoonotic diseases that span the human-animal-environmental interface. The Ministry of Health publishes a list of especially dangerous infections, as well as instructions on disease control, which serves as the primary disease prioritization tool (Table 10). Disease research in Azerbaijan has often focused on these pathogens and diseases, many of which are of great importance to the Caucasus region wholly, in addition to Azerbaijan. Pathogens with a significant body of research from Caucasus countries includes, anthrax (Bacillus anthracis), avian influenza virus, Brucellosis (Brucella), plague (Yersinia pestis), and tularemia (Francisella tularensis).[26]

Other projects have also identified priority pathogens for Azerbaijan, including a multiyear Cooperative Biological Engagement Program (CBEP) collaboration between the U.S. Department of Threat Reduction Agency (DTRA) and the Government of Azerbaijan. This collaboration aimed to strengthen biosafety and biosecurity by focusing on several especially dangerous pathogens (Table 10). Furthermore, in 2015, Azerbaijan completed a One Health Zoonotic Disease Prioritization (OHZDP) workshop in collaboration with U.S. CDC and found overlapping results to both the MOH-identified list of especially dangerous infections and the CBEP findings (Figure 11)[56].

Figure 11. Priority diseases and especially dangerous pathogens in Azerbaijan as identified by the MOH, CBEP and OHZDP



13.5 Effective and coordinated risk communication

Effective risk communication relies on all relevant sectors and disciplines working together with technical and policy experts within the multisectoral coordination mechanism sharing information, advice and opinions, and working with affected populations to identify risk factors and potential risk reduction practices[27]. Incorrect information may have inadvertent economic (e.g., trade or travel impacts), environmental (e.g., culling), social (e.g., stigma) or other consequences that can potentially worsen the situation. Moreover, failure to effectively communicate during a health crisis can lead to panic, insufficient public knowledge and

erosion of faith in public health authorities. Thus, effective messaging must be in place for accurate, transparent, and coordinated information flow to the public, ensuring credibility to counter potential misinformation[13].

Additionally, compared to other health objectives, improving risk communication is seen as more attainable and less-resource intensive. Outside of hiring additional experts in multiple sectors, which can be costly and not financially possible, there is an opportunity to further develop joint communication strategies and public outreach campaigns around priority zoonoses. For example, a 2018 survey found that with effective communication a simple public awareness campaign can be successful in getting people to vaccinate their pets against rabies.[57] The study found that people exposed to their rabies information and education campaign were 1.4 times more likely to report having vaccinated their dogs against rabies, an essential component of human rabies prevention[57].

Aside from public-facing communication, internal cross-sector communication is essential, but could be improved. Information silos can sometimes prevent important information and research from reaching all relevant One Health actors. For example, many government reports are not publicly available online nor are they disseminated to departments and ministries outside the ones who produced the information. This hinders potential collaboration between academia, NGOs, and government because each sector may not know the types of research each sector is working on.

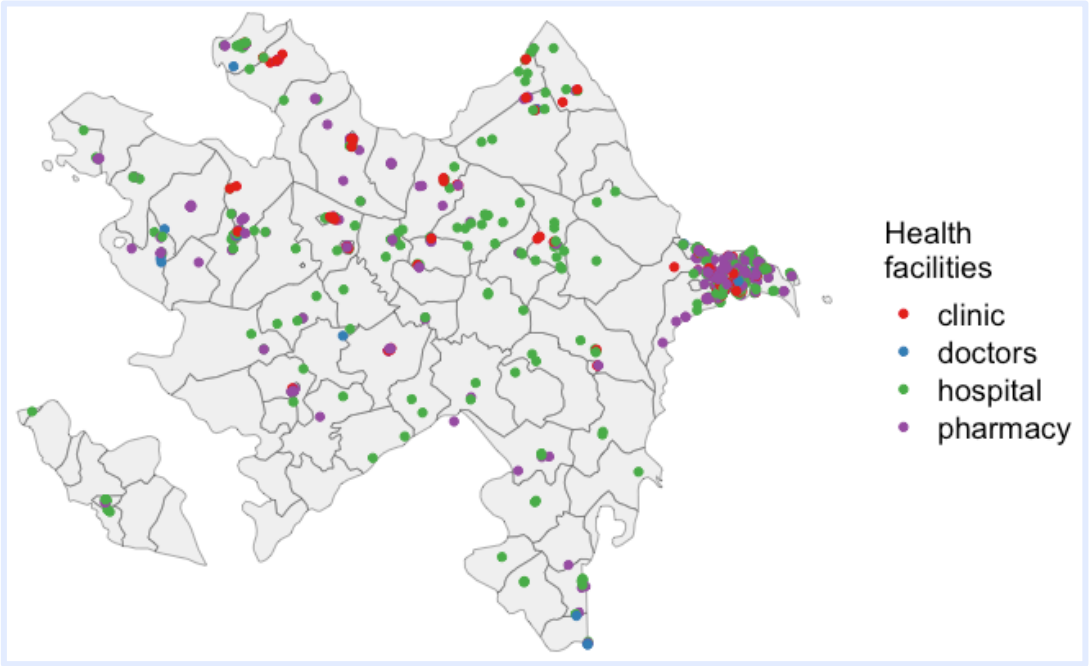
It is important to note, however, that routinely publishing peer-reviewed research papers is not always a government mandate and is not necessarily required for effective One Health operations. Ministries may collaborate, but not jointly publish. The MoH and MOA routinely conduct disease research and share it publicly with the media, mainly through each ministry's public relations department. Each ministry, and many subagencies, also maintain websites with key information on disease prevention and control for a wide range of pathogens that affect humans, animals, and plants. Furthermore, Azerbaijan is a relatively small country so informal communication, including using WhatsApp, is common and can be effective. That being said, additional emphasis on strengthening the scientific communication pipeline could help research be more easily disseminated to policymakers and the public.

13.6 One Health workforce development

One Health workforce development includes the continual process of developing education and training programmes which give individuals the knowledge, skills and abilities they need to meet national and international workforce demand and stay up-to-date on research and best practices in their field[27]. This workforce includes physicians, veterinarians, biostatisticians, scientists, laboratory technicians, farmers, customs and border agents, communication and security experts, and others who can systematically cooperate to meet relevant IHR and PVS core competencies. Workforce development is critical in cultivating and maintaining a highly qualified health labor force with appropriate training, scientific skills, and subject-matter expertise to sustain health systems over time. Effective training should be at both the "pre-service" level prior to a person getting a degree or job, as well as "in-service" training which provides continual training for employed people. For reference, the threshold for achieving the Sustainable Development Goals is 4.45 health workers per 1,000 people[58]. Access and proximity to healthcare is also essential to healthy societies. There are approximately 563 hospitals, 352 health clinics, 38 doctors' offices, and 596 pharmacies in Azerbaijan (Figure 12).

Figure 12. Location of health facilities within Azerbaijan, 2020.[59]

A large proportion of health clinics (red), doctors' offices (blue), hospitals (green), and pharmacies (purple) are located in and around Baku, while some districts have zero or only a few health facilities.



The number of medical doctors has remained largely unchanged over the past few decades, taking back to 1990[60], but the number of medical doctors per 10,000 people has declined since 2007 as Azerbaijan's population has increased[60]. It is unclear as to what the number of environmental and occupational health professionals is in Azerbaijan, as data is not as readily available.

Azerbaijan has adequate public and animal health staffing but faces some challenges replenishing veterinary staff. For example, there were 2,901 veterinarians in Azerbaijani in 2019, which is a marked decreased from 3,848 in 2016[61] (Table 11). The number of public animal health professionals has also dropped from 1,505 in 2016 to 923 in 2019[61]. It is not clear what the has caused these declines. While the number of veterinarians has declined, veterinary staff continue to provide essential services. In 2020 the Agency for Agricultural Services, Department of Animal Health and Veterinary Services had a chief veterinary officer and about 40 administrative staff, a research institute, 65 regional offices with a director and field staff, plus 47 diagnostic cabinets solely for Rose Bengal Serum Agglutination testing for brucellosis[22]. On-farm services were delivered by 798 veterinary field units staffed by 1624 veterinarians and veterinary technicians. Most field staff live in villages and each veterinarian or technician is responsible for providing animal health services to their own and one to two neighboring villages and their widespread distribution throughout communities facilitates early detection of outbreaks of endemic and exotic disease. Delivery of veterinary services is challenging in the Azerbaijan rural setting of about 740,000 small holdings with livestock and about 4300 villages[22].

In terms of veterinary workforce training, the Government of Azerbaijan previously implemented a joint workforce initiative in partnership with the U.S. CDC to bolster the SVCS. Unfortunately the longevity of improvements in SVCS staff training remains uncertain because of a limited pool of qualified trainers, a lack of post-graduate training for SVCS staff, and an aging workforce.[62] For example, all doctors within the MOH must receive job training every five years via the Institute for the Improvement of Doctors, but in the animal health sector veterinary epidemiologists mostly receive on-the-job training and do not receive formal continuing education, meaning they are not receiving refresher trainings to keep up with new advancements in their field.[62] In the wake of COVID-19, Azerbaijan has also partnered with WHO on a project to strengthen human resources in the field of public health, especially in rural areas.

To improve knowledge and skills across One Health-related professions, Azerbaijan, could adapt joint One Health training for multiple disciplines at the same time. This includes pre-service training on One Health through academic institutions like Khazar University, which provides One Health coursework and hosts an international conference on One Health[63]. Alternatively in-service training could occur through mechanisms like the One Health Workforce Academies, which provides training on the fundamentals of One Health practice, outbreak investigation and response, risk communication, grant writing and much more.[64]

Table 11 One Health workforce country-level indicators

INDICATOR	VALUE	YEAR	SOURCE
Veterinarians (number)	2,901	2019	WOAH-WAHIS
Public animal health professionals (number)	923	2019	WOAH-WAHIS
Community animal health workers (number)	Data not available	Data not available	WOAH-WAHIS
Medical doctors (number)	31,829	2019	The National health Workforce Accounts database, World Health Organization, Geneva
Medical doctors (per 10,000 people)	31.68	2019	The National health Workforce Accounts database, World Health Organization, Geneva
Nursing personnel (total)	56,148	2014	The National health Workforce Accounts database, World Health Organization, Geneva
Environmental and Occupational Health and Hygiene Professionals (number)	Data not available	Data not available	The National health Workforce Accounts database, World Health Organization, Geneva
Medical and Pathology Laboratory Scientists (number)	Data not available	Data not available	The National health Workforce Accounts database, World Health Organization, Geneva
Human Resources (IHR SPAR) (0-100)	100	2020	IHR SPAR
Field Epidemiology Training Program (FETP)	Yes (including intermediate and advanced)	Since 2019	South Caucasus Field Epidemiology Training Program
Up to date multisectoral workforce strategy (1-5)	Data not available	2023	JEE

13.6.1 South Caucasus Field Epidemiology and Laboratory Training Program

One notable component of Azerbaijan's public health workforce is its participation in the South Caucasus Field Epidemiology and Laboratory Training Program (SC-FELTP). This joint, One Health training program trains epidemiologists, clinicians, laboratory technicians and veterinarians in surveillance, sample collection, lab testing, and other skills.

Between 2009-2018, more than 20 specialists participated in the SC-FLETP advance regional (Azerbaijan, Georgia, Armenia) training program held in Georgia within the framework of One Health. Representatives of 5 countries have already participated in the 2022 FETP intermediate educational program (held in Tbilisi), and 2 doctors and 3 veterinarians from Azerbaijan joined this program. In December 2023, 4 more people (2 veterinarians + 2 doctors) will complete this training. In Azerbaijan, there are regional and republican epidemiological centers. That is, not all employees in all centers are FETP trained, although epidemiologists are involved in other training workshops.

In addition to the SC-FELTP, we urge Azerbaijan to consider conducting joint, One Health training for professionals within the MOH and SVCS for enhanced coordination and information sharing. This type of training does not yet exist in Azerbaijan, but it can help improve professional workforce development, cross-sector collaboration and understanding of the linkages between human and animal health.

13.7 Monitoring, evaluating and reporting on One Health activities

Monitoring, evaluating, and reporting is expected in public health, with an extensive list of common qualitative and quantitative metrics including quality- and disability-adjusted life years to name a few. Animal health metrics are also prevalent, but are often focused on absence of disease or population prevalence, rather than overall state of physical and mental wellbeing because of the ties between domestic animals and economic productivity[65]. Environmental health metrics are less well-defined within the human-animal-environmental triad[65], and are regularly tied to their effect on human health like climate change, pollution, land coverage, and unsafe water and food. Altogether, there is a lack of universally accepted metrics and methods to evaluate issues and interventions across the human-animal-environment interface, making quantifying the value of One Health challenging[13, 65]. Specific methods of measuring, evaluating, and reporting One Health is beyond the scope of this report, but several examples can be found in the reference section of this report for more information[13, 27, 65-68].

While each One Health program will have different objectives, effective programs should include multi-sectoral indicators that, for example, evaluate systems, coordination, planning, and training, and be based on a sound theory of change within a defined context[13, 65]. One Health programs can, and often do, still include disease-specific targets which can be useful in

providing concrete examples and providing specificity to discussions[13].

The World Bank One Health Operational Framework proposes several high-level national indicators that provide a starting point for evaluating national One Health capability.

1. Core assessments evaluating human, animal, and environmental health e.g., IHR annual self-assessments, JEE and PVS assessments, and assessment of essential public health operations are up to date.
2. Progress toward establishing a national or regional active, functional One Health platform e.g., national MCM on One Health
3. National response plans developed, implemented, and up to date e.g., national action plan for health security, national biodiversity action plan, public health emergency preparedness, performance of veterinary services gap analyses etc.
4. Applied epidemiology training program in place e.g., Field Epidemiology and Laboratory Training Program that includes human disease epidemiologists as well as domestic and wildlife veterinarians
5. Disease-specific targets (e.g., brucellosis, rabies, tuberculosis etc.)

Azerbaijan has completed several of the high-level national indicators mentioned above, including developing assessments, national action plans, and participating in the SC-FELTP.

14 ONE HEALTH CASE STUDY

14.1 Brucellosis surveillance and risk reduction

Information from Khatibi et al. 2021 *Research in Veterinary Science*

Brucellosis, caused by *Brucella abortus* and *Brucella melitensis,* is endemic in Azerbaijan. Despite low human and animal health resources, between 2009-2020 Azerbaijan was able to establish a national brucellosis control programme, conduct brucellosis research and greatly expand SVCS capacity, under the guidance and financial backing of Agricultural Program Implementation Unit.

During this period the national brucellosis control programme was able to conduct and scale up multiple brucella seroprevalence studies in livestock, expanding from a pilot study in 4 administrative districts (rayons) to two national studies conducted in 51 (out of 59) districts. Furthermore, the national brucellosis control programme was also able to lead a case control study to identify management factors associated with brucellosis infection as well as two cross-sectional human seroprevalence studies and a Knowledge, Attitudes, and Practices study among groups of people at high-risk

for brucellosis infection, including farmers, farm workers and veterinarians.

Not only were these studies able to provide important national-level data on trends in brucellosis infections in livestock and small ruminants (Figures 13-14), but they were also able to identify actionable information about farming practices that could be altered to reduce disease risk.

Figure 13. Prevalence of brucellosis test-positive cattle in 2009 and 2015 in four pilot study districts (rayons)

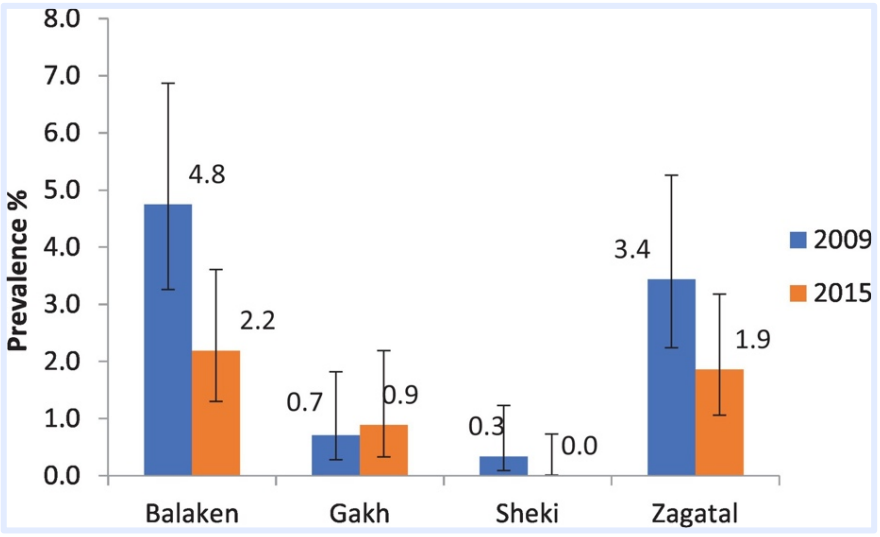
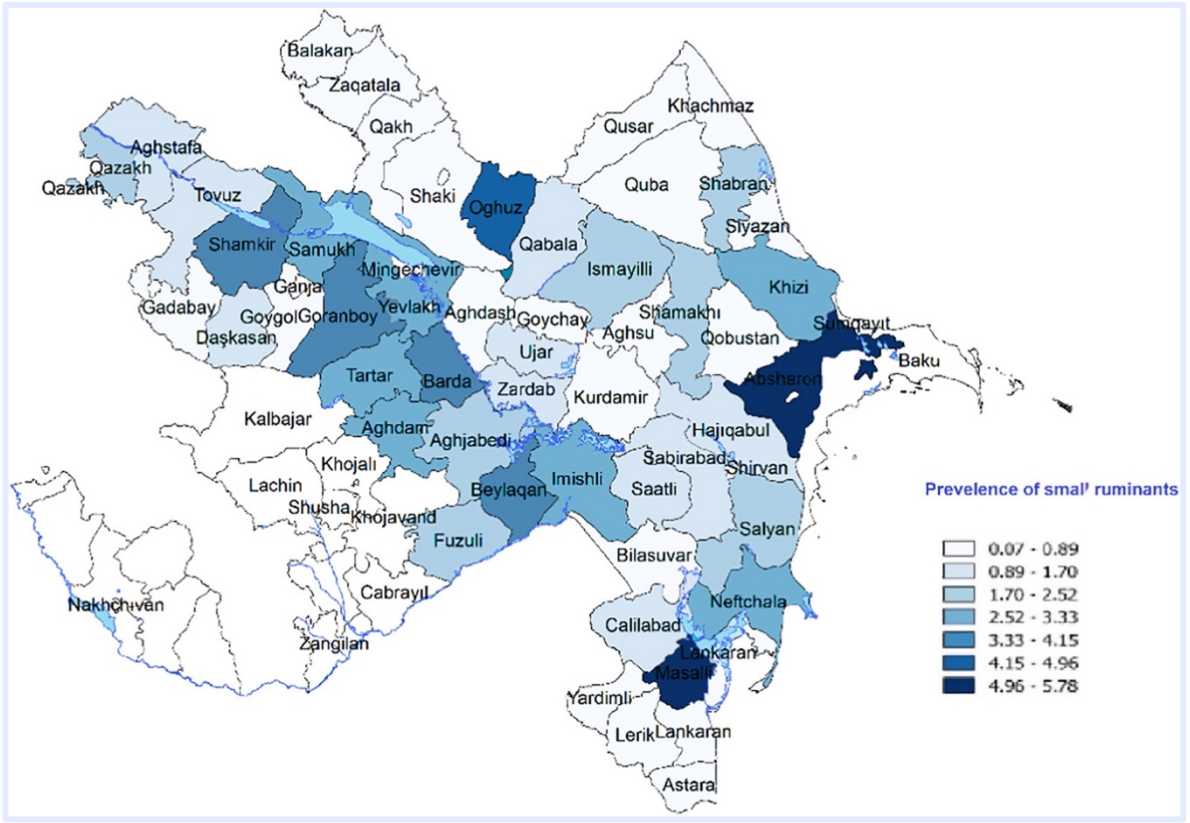


Figure 14. Spatial distribution of the prevalence of test-positive small ruminants among 51 districts sampled in Azerbaijan in 2015



For example, the case control study found that livestock in flocks which went to winter pastures were less likely to be infected than livestock in flocks which stayed at home, farmers who changed breeds of sheep were more likely to be infected than farmers who had not changed breeds, farmers who had brucellosis in their flocks were less likely than farmers with no infection to think that brucellosis is a problem.

Importantly, following these studies the national brucellosis control programme has been incorporating these epidemiological findings into both public awareness and vaccination campaigns to achieve steady progress in controlling brucellosis. Designing and implementing this series of epidemiologic studies has also coincided with expanded Animal Health and Veterinary Service programmes, including hiring additional research and field staff and expanding diagnostic and laboratory capacity in Azerbaijan. Overall, this series of One Health research projects underpins how epidemiologic research, one health workforce development and public risk reduction communication can go hand-in-hand to reduce zoonotic disease risk.

15 RECOMMENDATIONS – Next Steps to Advance One Health in Azerbaijan

Table 12. Recommendations to advance One Health in Azerbaijan

RECOMMENDATION	JUSTIFICATION
Consider establishing a National One Health Committee. Once established, designate financial and human resources so the committee can fulfill its mandated programs	The foundation for a national multisectoral One Health body is already in place. There are several agencies that already focus on One Health-related issues, and the partnership between the MOH, MENR, AFSI, and MS&E is strong.
	There is government interest at the technical level, including within the MOH, MS&E, academia, exemplified by the 2023 meeting on strengthening One Health coordination mechanisms co-hosted between the government of Azerbaijan and WHO, FAO, and WOAH
	Establishing a national, multisectoral One Health committee would create cohesion between ministries as they align under a common goal, improve inter-departmental communication, and reduce duplicative projects.
	A National One Health Committee would help dismantle the common viewpoint that health is the sole responsibility of the Ministry of Health, and it would help shift people's mindset from *"What am I responsible for?" to "What needs to be done to improve our collective health?",* to expand entry points for contributions for effective and efficient efforts for disease prevention through recovery.
	For it to be a true multisectoral body, the National One Health Committee should have representation from the Ministry of Health, Ministry of Ecology and Natural Resources, Ministry of Agriculture, Food Safety Sector, Ministry of Science and Technology, DMS sectors, Academia, and potentially other institutions (e.g., Ministry of Education, WWF, NGOs).
Complete a NAPHS and JEE with a multisectoral group of government experts	The process to complete both the NAPHS and JEE presents an important opportunity for multi-sectoral engagement in prevention, detection, and response. Taking stock of zoonotic disease emergence and spread factors in particular can help to make relevance to multiple sectors clear and facilitate precise entry points for relevant sectors in the development and implementation of the Plan.
	The NAPHS results in a costed action plan, so ensuring a multi-sectoral approach from the onset can ensure the necessary resources for each sector are appropriately identified. This is expected to result in more cost-effective approaches, by shifting more toward prevention instead of a typical reliance on response.
	Tools, such as capacity assessments and national plans that are developed jointly among diverse sectors and stakeholders results in a stronger outputs, improved coordination, collaboration and trust between sectors, and a stronger One Health system overall[44]
	The burden of assessments is often noted, at times reflecting that gap identified in prior assessments have not been addressed. Improved coordination and stakeholder mapping allows for clear attention to areas in need of attention, including relevant roles, responsibilities, and

	resources, to promote progressive system strengthening and preparedness.
Develop a renewed NBSAP in line with the new COP 15 framework	The most recent NBSAP was for the period of 2017-2020 and has since expired, and a new one has yet to be developed
	NBSAP's typically drive countries' ecosystem and biodiversity management priorities and operations, the development of a new plan offers a chance to build in disease risk reduction, creating synergies between Azerbaijan's NBSAP and yet to be completed NAPHS
Enhance public communication about the importance of biodiversity preservation, and safe practices regarding interactions with wildlife from a zoonotic disease perspective	The importance of preserving environmental health and preventing the emergence of potentially new health threats is mentioned in the National Security Concept of Azerbaijan (2007), providing an opportunity to make progress on both environmental health and national security under a One Health umbrella.
	Ecotourism is on the rise in Azerbaijan, putting pressure on forested regions. This may, in part, be due to low knowledge of conservation among tourists and people involved in the tourism industry.
	There are few protective measures to prevent human/wildlife contact at ecotourism sites – some of which harbor high risk specie, e.g., bats that could transmit zoonoses
	Zoonoses-related public awareness raising efforts have succeed before. While not specific to ecotourism, the MOH and MOA have previously led successful zoonoses education and vaccination campaigns related to brucellosis and rabies.
	A public-private partnership between tourism agencies and the government of Azerbaijan could help advertise for private tourism business by promoting safe ecotourism.
	Azerbaijanis rich in biodiversity and improving public awareness about this biodiversity could appeal to people interested in preserving their own health (e.g., prevent diseases from transferring from animals to humans), people interested in climate change (biodiversity and environmental preservation are key to mitigating the negative effects of climate change), and still allows for people to enjoy the natural beauty of Azerbaijan via ecotourism, just in a safer manner.
Improve the transparency and timeliness of health-related information dissemination to additional sectors, departments, and academicians	Improved metadata standards and criteria for the minimum necessary data needed for sharing One Health or biosurveillance data across platforms
	By ensuring that national plans, capacity assessments and tools, research publications and related documents are publicly available and accessible online, not just in print, it promotes transparency and accountability of work.
	Although Azerbaijan is a relatively small country and informal communication can be useful, enhancing formal communication mechanisms across ministries, and with academia, would help to better connect a larger network of expert stakeholders to link research activities to ongoing monitoring and risk analysis processes as relevant.

	Ensuring the timely, transparent, and wide release of results from One Health research and assessments would maximize Azerbaijan's ability to share its success stories, lessons learned, and best practices both domestically and with other countries. An improvement in information flow and awareness would also enhance Azerbaijan's ability to drive change and strengthen One Health processes[44].
Expand zoonotic disease monitoring and surveillance in wildlife using nonlethal methods.	An expansion of wildlife disease monitoring includes developing a functional reporting system and information flow with relevant authorities for wildlife disease events in/around protected and conserved area.
	There are only a small number of wildlife vets in Azerbaijan, which means if there is a disease outbreak among wildlife, international veterinarians need to be flown in which takes time and allows for disease to spread.
	Although SDICC does conduct some surveillance and disease detection for certain species of birds and mammals (mainly rodents), it typically involves killing rodents through trapping and destroying burrows. Conversely, nonlethal wildlife surveillance can be just as effective for disease surveillance, is a more humane method, and preserves natural biodiversity.
	Data on wildlife habitats and species richness can help authorities recognize specific geographic areas or species where disease outbreaks may be more likely to occur, which can cut down on outbreak response time and help better target resources.
	Developing wildlife surveillance capacity could be an effective mechanism to further integrate One Health processes and cross-sector data sharing into human and animal health surveillance via EIDSS or other existing information sharing systems.
Strengthen One Health workforce development and increase cross-discipline training	Conduct workforce planning and benchmarking to support a workforce development strategy that supports multi-sectoral assessment and action across the country's core risks and vulnerabilities
	Expand joint work-training with veterinarians, environmental health specialists, epidemiologists, and other professionals across the human-animal-environmental health landscape (e.g., FSC-ELTP) – including training veterinarians on the public health aspects of One Health and environmental health experts on conservation and its role in zoonotic disease emergence. This could include a collaboration between SVCS and MOH.
	Need for human resources development plan for environmental health, food safety, and veterinary services.
Conduct subnational disease risk assessment and mapping	Increasing understanding of the sources of risk and advancing risk reduction measures will have generate co-benefits within the agriculture and health sectors as well as broader sustainable development
	Prioritize planning at the subnational level to support One Health coordination, including to align diagnostics, screening, awareness, standard operating procedures, and workforce.

16 Conclusions

Azerbaijan has made notable progress in adopting and implementing One Health strategies, even if efforts have been informal to date or focused on specific disease priorities. With a keen interest in further strengthening multisectoral One Health approaches – particularly at the technical level – there is an opportunity for Azerbaijan to be a One Health leader in the Caucasus region. By formalizing a national One Health body expanding sectors and stakeholders involved in routine and emergency operations, Azerbaijan will bolster communication, coordination, collaboration and capacity strengthening across sectors, leading to more efficient human, animal, and environmental health systems. There is also growing interest from international partners and donor organizations for the operationalization of One Health as part of COVID-19 recovery and overall pandemic prevention and readiness. Support for One Health initiatives in Azerbaijan has gained significant traction over the last several years and added expansion of One Health approaches into biosurveillance and biodefense practice, assessment, regulation and coordination will bolster the country's health and security going forward.

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18 ADDITIONAL ONE HEALTH RESOURCES, ARTICLES, & REPORTS

This is by no means an exhaustive list of One Health-related resources but is meant to provide examples of several resources for further education as desired.

18.1 One Health

1. One health joint plan of action (2022–2026): working together for the health of humans, animals, plants and the environment
    a. https://www.who.int/publications/i/item/9789240059139
2. One Health Operational Framework for Strengthening Human, Animal, and Environmental Public Health Systems at Their Interface
    a. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/703711517234402168/operational-framework-for-strengthening-human-animal-and-environmental-public-health-systems-at-their-interface
3. WHO-OIE Operational Framework for Good governance at the human-animal interface
    a. https://www.who.int/publications/i/item/who-oie-operational-framework-for-good-governance-at-the-human-animal-interface
4. Handbook for the assessment of capacities at the human-animal interface
    a. https://www.who.int/publications/i/item/handbook-for-the-assessment-of-capacities-at-the-human-animal-interface-2nd-ed
5. Integrated approaches to health: A handbook for the evaluation of One Health
    a. https://www.wageningenacademic.com/doi/book/10.3920/978-90-8686-875-9
6. One Health Toolkits (several different toolkits, including, stakeholder mapping, policy and advocacy, gender integration, and others)
    a. https://www.onehealthapp.org/resources
7. A systematic review on integration mechanisms in human and animal health surveillance systems with a view to addressing global health security threats
    a. https://onehealthoutlook.biomedcentral.com/articles/10.1186/s42522-020-00017-4
8. One Health: Reducing Disease Risk
    a. https://www.iucn.org/resources/policy-brief/one-health-reducing-disease-risk
9. The Lancet Series on One Health and Global Health Security (a series of several papers, including lessons in One Health collaborations, governance, and ecological equity)
    a. https://www.thelancet.com/series/one-health-and-global-health-security
10. Factors that enable effective One Health collaborations - A scoping review of the literature
    a. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6892547/
11. Institutionalizing One Health: From Assessment to Action
    a. https://pubmed.ncbi.nlm.nih.gov/30480500/
12. A system dynamics approach to understanding the One Health concept
    a. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5587294/
13. Strengthening multisectoral coordination on antimicrobial resistance: a landscape analysis of efforts in 11 countries
    a. https://joppp.biomedcentral.com/articles/10.1186/s40545-021-00309-8
14. One health-based conceptual frameworks for comprehensive and coordinated prevention

a. https://www.g20-insights.org/policy_briefs/one-health-based-conceptual-frameworks-for-comprehensive-and-coordinated-prevention/

18.2 Zoonoses

15. Preventing the Next Pandemic- Zoonotic diseases and how to break the chain of transmission
    a. https://www.unep.org/resources/report/preventing-future-zoonotic-disease-outbreaks-protecting-environment-animals-and
16. A Tripartite Guide to Addressing Zoonotic Diseases in Countries
    a. https://www.who.int/initiatives/tripartite-zoonosis-guide
17. Multisectoral coordination mechanisms operational tool: an operational tool of the tripartite zoonoses guide
    a. https://www.who.int/publications/i/item/9789240053236
18. Joint risk assessment operational tool (JRA OT): an operational tool of the tripartite zoonoses guide
    a. https://www.who.int/publications/i/item/9789240015142
19. Surveillance and information sharing operational tool: an operational tool of the tripartite zoonoses guide
    a. https://www.who.int/publications/i/item/9789240053250
20. The three Ts of virulence evolution during zoonotic emergence
    a. https://royalsocietypublishing.org/doi/10.1098/rspb.2021.0900
21. Want to prevent pandemics? Stop spillovers
    a. https://www.nature.com/articles/d41586-022-01312-y
22. Interventions to Reduce Risk for Pathogen Spillover and Early Disease Spread to Prevent Outbreaks, Epidemics, and Pandemics
    a. https://wwwnc.cdc.gov/eid/article/29/3/22-1079_article

18.3 Environment

23. Country Assessment for the Environment Sector in Health
    a. https://www.ecohealthalliance.org/country-assessment-for-the-environment-sector-in-health
24. Land reversion and zoonotic spillover risk
    a. https://royalsocietypublishing.org/doi/10.1098/rsos.220582

18.4 Biodiversity and Conservation

25. IPBES Workshop on Biodiversity and Pandemics
    a. https://ipbes.net/sites/default/files/2020-12/IPBES%20Workshop%20on%20Biodiversity%20and%20Pandemics%20Report_0.pdf
26. Biodiversity data supports research on human infectious diseases: Global trends, challenges, and opportunities
    a. https://www.sciencedirect.com/science/article/pii/S2352771423000046?via%3Dihub
27. Healthy people and wildlife through nature protection
    a. https://portals.iucn.org/library/node/50682
28. Report on monitoring schemes and data collection on biodiversity for food and agriculture in Eastern Europe and Central Asia
    a. https://www.fao.org/documents/card/en/c/cb6959en
29. The direct drivers of recent global anthropogenic biodiversity loss
    a. https://www.science.org/doi/10.1126/sciadv.abm9982

18.5 Biodefense

30. Building Resilience to Biothreats
    a. www.ecohealthalliance.org/wp-content/uploads/2019/04/Building-Resilience-to-Biothreats.pdf
31. Opportunities for Enhanced Defense, Military, and Security Sector Engagement in Global Health Security
    a. https://www.ecohealthalliance.org/engagement-in-global-health-security/opportunities-for-enhanced-defense-military-and-security-sector-engagement-in-global-health-security-2
32. Biodefense in Crisis
    a. https://biodefensecommission.org/reports/biodefense-in-crisis-immediate-action-needed-to-address-national-vulnerabilities/
33. Establishing a Multilateral Biodefense & Biosecurity Network
    a. https://www.g20-insights.org/policy_briefs/establishing-a-multilateral-biodefense-biosecurity-network/

19 ANNEX: ACTIVITIES FROM VIRTUAL AND REGIONAL WORKSHOPS

19.1 Virtual Workshop Participants

The EHA-organized virtual workshop (14-15 December 2021) had ~60 people with representatives from:

- Ministry of Ecology and Natural Resources
- Ministry of Health / Special Dangerous Infection Control Center
- Ministry of Agriculture
- Ministry of Education
- Ministry of Science and Education (Institute of Zoology)
- Azerbaijan Institute of Food Safety
- Baku State University
- Scientific Research Institute of Medical Prevention
- WWF Azerbaijan
- "AzerEkov" LLC
- “EkoSfera” Social-Ecology Center (NGO)
- EcoHealth Alliance

19.2 Regional Meeting Participants

The EHA and Georgian National Center for Disease Control and Public Health (NCDC)-organized meeting (6-8 December 2022) had ~12 Azerbaijani representatives from:

- MENR
- MOH
- AFSI
- SDICC
- MS&E (Institutes of Zoology and Botany)
- WWF Azerbaijan
- AzerEkov LLC
- Baku State University

19.3 Activity – Putting One Health into Action

In small groups, workshop participants were tasked with identifying the most important existing national infrastructure, capacity, tools, assessments, and resources for addressing zoonotic diseases by filling out an "Operationalizing One Health Framework" for Azerbaijan. Based on the World Bank's *Operational Framework for Strengthening Human, Animal, and Environmental Public Health Systems at their Interface,* this framework is a systematic look at operational tools, strategies and capacity strengthening needs for implementing One Health projects in a given country. The goals of the activity were to:

1.) Get all participants on the same page in terms of understanding what resources are currently in place in Azerbaijan
2.) Understand where strengths lie, and gaps may exist in terms of implementing a One Health structure

Prior to sending participants into groups to complete this activity, participants were led through a global example, with definitions, of what each component encompasses (Figure 15). Finally, for ease of editing the framework was adapted to a table format so everyone could more easily simultaneously add to the framework without disrupting the formatting (Table 12).

Figure 15. Example operationalizing One Health framework with definitions

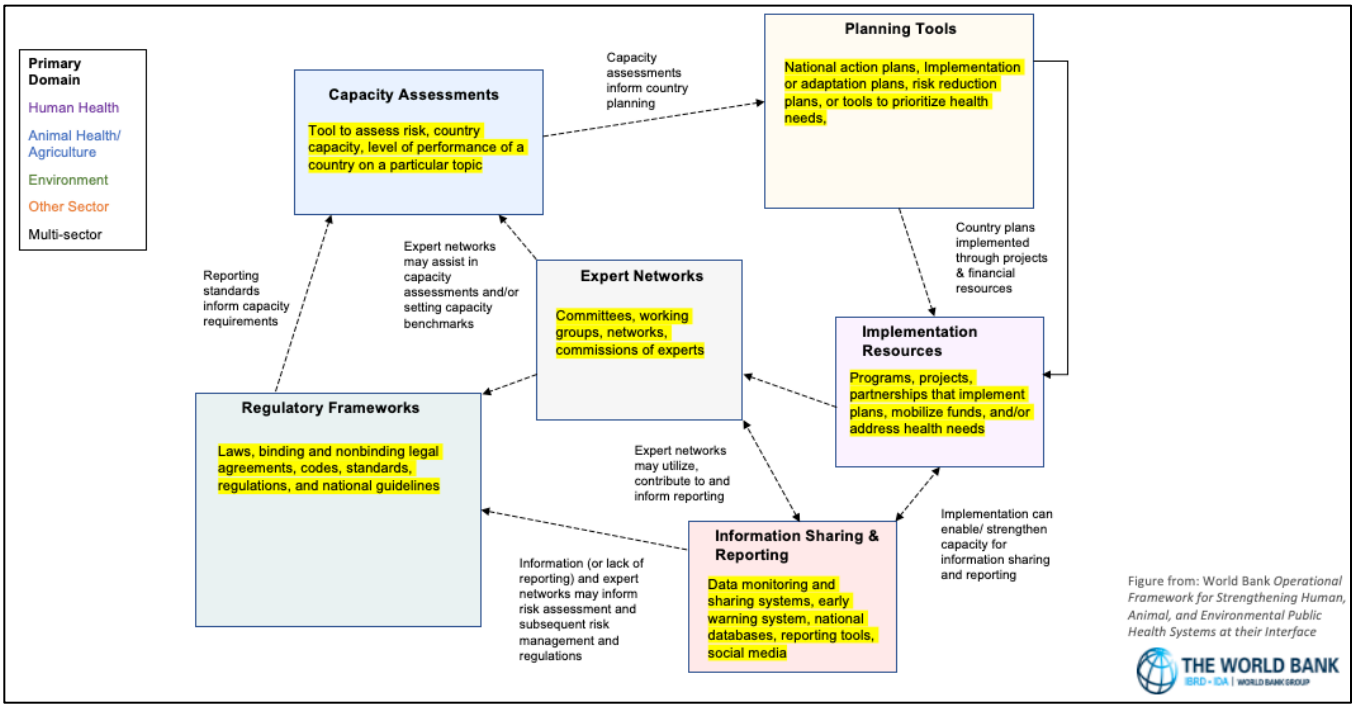

Table 12. Operationalizing One Health framework reformatted to a table for ease of editing

REGULATORY FRAMEWORKS	CAPACITY ASSESSMENTS	PLANNING TOOLS	IMPLEMENTATION RESOURCES	INFORMATION SHARING & REPORTING	EXPERT NETWORKS
Laws, binding and nonbinding legal agreements, codes, standards, regulations, and national guidelines *e.g., National One Health Decree, Public health law, Other National Policies etc.*	Tool to assess risk, country capacity, level of performance of a country on a particular topic *e.g., Other PVS evaluations, self-assessments, capacity audits, OH-SMART, WHO STAR etc.*	National action plans, Implementation or adaptation plans, risk reduction plans, or tools to prioritize health needs *e.g., Zoonotic Prioritization tool, National Biodiversity strategies, Action Plans on AMR, Public Health, Environmental health, Vet Services, Biosecurity Emergencies etc.*	Programs, projects, partnerships that implement plans, mobilize funds, and/or address health needs *e.g., Nationally determined funding, human & financial resources, Bilateral agreements, Global funding, International collaborations etc.*	Data monitoring and sharing systems, early warning system, national databases, reporting tools, social media *e.g., Information systems, DHIS2, WhatsApp/Mobile apps, Academic journals, other surveillance or communication systems etc.*	Committees, working groups, networks, commissions of experts *e.g., Working groups, or commissions on AMR, IHR, Biodiversity, biodefense etc.*

19.4 Activity – Creating an Emerging Infectious Disease (EID) Risk Profile

In small groups, workshop participants were tasked with identifying risk factors that may affect (increase or decrease) EID risk and impact. The goals of the activity were to:

1.) Create a shared understanding across sectors about potential sources of risk and opportunities for risk mitigation
2.) Begin to outline priority risk reduction measures that could be enacted in Azerbaijan

Participants were provided with an example template (Table 13) previously developed by EcoHealth Alliance and completed with the University of Ghana with the support of the UK Animal and Plant Health Agency – to guide them in filling out the EID risk profile for Azerbaijan. Both the example template and blank template (Table 14) given to participants are provided below.

Table 13. Example EID risk profile template

EMERGENCE FACTORS	SPREAD FACTORS
Key interfaces for wildlife-human contact Key interfaces for wildlife-livestock contact Presence of species associated with elevated. Risk of harboring or transmitting high-consequence pathogens Presence of potentially high-consequence pathogens Changing practices (e.g., land use, agriculture, wildlife trade)	Key human movement and animal trade patterns (e.g., rural-urban, cross-border) Key density dynamics (e.g., urban slums, refugee camps, large-scale social gatherings) Key detection or control factors (e.g., limited interaction with formal health system, access to IPC measures) Biosafety and Biosecurity
VULNERABILITY FACTORS	**PROTECTIVE FACTORS**
Disease detection gaps (e.g., known and novel diseases) Workforce gaps (e.g., limited veterinary personnel) Infrastructure gaps (e.g., limited healthcare facilities, unreliable electricity coverage) Limited health security coordination or consideration of environmental factors Instability and fragility	Early warning systems Access to safe water, sanitation, and immunizations Consistent risk messaging and reliable communication channels Multisectoral coordination and harmonization

Table 14. Blank EID risk profile template for workshop participants to fill out

EMERGENCE FACTORS	SPREAD FACTORS
• *Key interfaces for wildlife-human or wildlife-livestock contact* • *Presence of species associated with risk of harboring / transmitting high-consequence pathogens* • *Presence of potentially high-consequence pathogens* • *Changing practices (e.g., land use, agriculture, wildlife trade)*	• *Key human movement and animal trade patterns (e.g., rural-urban, cross-border)* • *Key density dynamics (e.g., urban slums, refugee camps, large social gathering)* • *Detection or control factors (e.g., limited interaction with health system, access to IPC measures)* • *Biosafety and Biosecurity*
VULNERABILITY FACTORS	**PROTECTIVE FACTORS**
• *Disease detection gaps (e.g., known and novel diseases)* • *Workforce gaps (e.g., limited personnel) or training* • *Infrastructure gaps (e.g., limited health facilities, unreliable electricity coverage)* • *Limited health security coordination or consideration of environmental factors* • *Instability and fragility*	• *Early warning systems* • *Cultural practices* • *Access to safe water, sanitation, and immunizations* • *Consistent risk messaging and reliable communication channels* • *Multisectoral coordination and harmonization*

19.5 Meeting Activity – Zoonotic Disease Tabletop Exercise

Schedule

Initial Scenario

- Small group (country) discussion – 45 minutes
- Whole group (regional) discussion – 30 minutes

Coffee Break – 15 minutes

Scenario Update #1

- Small group (country) discussion – 45 minutes
- Whole group (regional) discussion – 30 minutes

Scenario Update #2

- Small group (country) discussion – 30 minutes
- Whole group (regional) discussion – 30 minutes

Lunch Break – 1 hour

Scenario Update #3

- Small group (country) discussion – 30 minutes
- Whole group (regional) discussion – 30 minutes

Scenario Update #4

- Small group (country) discussion – 30 minutes
- Whole group (regional) discussion – 30 minutes

Coffee Break – 15 minutes

Debrief

- Whole group (regional) discussion – 30 minutes

19.5.1 Initial Scenario

One morning, two tourists visiting Jangi Gobustan Cave (Absheron region) discovered a large number of dead bats (approximately 300) on the ground of the cave. Most of the bats appeared to be freshly dead, although some bats were in various states of decomposition. There were still bats alive in the bat colony (about 300 remaining, i.e., half of the population appeared to be dead). Thinking this was odd, the visitors informed the local tourism operator who managed the cave of what they saw. The tourism operator took down the names and phone numbers of the visitors and was quite concerned about this situation. The tourism operator was concerned about their revenue from cave tourism being affected, but also the health of the bat population and health of people who may visit the cave. The tourism operator did not know who to notify or how to proceed.

Discussion Questions

Initial outbreak investigation

1. First, who should the tourism operator notify to help with an investigation of this wildlife die-off event? What department, ministry, or other sectors would be *responsible* for investigating this event?
2. Are there any protocols or policies in place for investigating a wildlife mortality event?
3. Is there a specific surveillance and reporting system in place for investigation of unusual mortality events in wildlife species?
4. What would investigators do when they arrived at the field site? e.g., Specifically, how would they collect samples and data?

Testing and diagnosis

1. What laboratory will test the samples? Is there a dedicated wildlife lab?
2. What tests should the laboratory run?
3. Who will analyze the data from the laboratory and analyze the "risk" of any pathogens identified?

Communication and follow-up response

1. Will details of the bat die-off investigation be shared within the government (across sectors)?
2. Will there be any public outreach and communication, e.g., with the media, about the event?
3. Would any risk mitigation measures be put in place at this stage?

Based on the discussion questions, please fill in the "Action & Coordination Table" by writing down the actions your group would take. Then, put an "X" in the box to mark which sectors would be involved in carrying out that action.

---------- *Pause for Whole Group Discussion* ----------

Share your plan of action and any questions or challenges that arose during your discussion. [We will use this time to address differences and similarities in response plans between the 3 countries.]

19.5.2 Scenario Update #1

While visiting the cave, the investigative team collected diagnostic samples from 30 dead bats that seemed the freshest. Various organ and tissue samples were collected from necropsied bats, stored in viral transport media, and shipped to the relevant laboratory in-country on ice to attempt to identify the pathogen that caused the mass mortality event. Bacterial assays were run first, and *Bartonella* spp. bacteria were found samples from 2/30 bats, but these seemed inconclusive and possibly not the etiological agent that may have caused the die-off. Additional molecular panels using conserved, viral family level PCR assays were run. Panels for 7 different viral families were run, all samples were negative for 6 of the 7-virus family-level tests. However, liver and spleen samples from 18/30 bats (60% percent of bats sampled) were found positive for Lloviu virus (LLOV) infection. LLOV is a member of the Filoviridae family (in the genus *Cuevavirus*) which has been previously detected in bat populations from other European countries, including Spain, Hungary. In previous studies LLOV was found to be associated with bat die-offs. Several filoviruses have previously been shown to jump between hosts, thus posing a possible risk of zoonotic spillover.

Discussion Questions

1. How should the laboratory and investigative team proceed after identifying LLOV as the likely causative agent?
2. What data information system is used to store the lab results? Who has access to this information?
3. What ministries/departments will be informed of the lab results?
4. Will there be any public outreach and communication now that results are known?
5. What are the reporting and notification requirements for a disease outbreak like this?

Based on the discussion questions, please continue adding to the "Action & Coordination Table" by writing down the actions your group would take. Then, put an "X" in the box to mark which sectors would be involved in carrying out that action.

---------- *Pause for Whole Group Discussion* ----------

Share your plan of action and any questions or challenges that arose during your discussion. [We will use this time to address differences and similarities in response plans between the 3 countries.]

19.5.3 Action & Coordination Chart (Example)

1. Write what actions you would take.
2. Write what ministries, sub ministries, departments, NGOs, private sector organizations etc., would be involved carrying out those actions.

		Sectors (sub ministries, departments, organizations etc.)							
		NCDC	Laboratory Ministry of Agriculture	Ministry Environment Wildlife Dept.	Tourism Operator				
Actions	Field Investigation	X							
	Laboratory testing		X						
	Communication	X		X	X				

Action & Coordination Chart

1. Write what actions you would take.
2. Write what ministries, sub ministries, departments, NGOs, private sector organizations etc., would be involved carrying out those actions.

		Sectors (sub ministries, departments, organizations etc.)							
Actions									

19.5.4 Scenario Update #2

A few days after the discovery of the large group of dead bats, cows on a nearby farm begin to get sick. Two cows died and three others were symptomatic (elevated temperature, nasal discharge, and rapid breathing). The farmer contacts their private veterinarian to ask for assistance. After visiting the farm and speaking to the farmer, the veterinarian decides it is necessary to collect diagnostic samples and send them to a laboratory to identify the pathogen that is causing the cows to be sick. Diagnostic tests for common cow diseases (enzootic bovine leukosis, bluetongue, infectious bovine rhinotracheitis, bovine viral diarrhea and anthrax) were all negative. However, just like in the bats, the three symptomatic cows tested positive for LLOV infection (dead cows were not tested) using molecular assays.

Discussion Questions

1. How should the local veterinary office proceed after identifying LLOV as the likely causative agent?
2. What is the normal procedure for handling a disease outbreak on a farm? Is there an action plan for handling situations like this? Is anything different knowing about the nearby bat die-off?
3. What data information system is used to store the livestock lab results? What biosecurity disease prevention and mitigation actions will be put in place given these preliminary results?
4. Will there be any public outreach and communication? Will information be shared with the farmer?
5. What are the reporting and notification requirements for a disease outbreak like this?
6. What additional actions should be taken (from any organization) after getting the lab results?

Based on the discussion questions, please continue adding to the "Action & Coordination Table" by writing down the actions your group would take. Then, put an "X" in the box to mark which sectors would be involved in carrying out that action.

---------- *Pause for Whole Group Discussion* ----------

Share your plan of action and any questions or challenges that arose during your discussion. [We will use this time to address differences and similarities in response plans between the 3 countries.]

19.5.5 Scenario Update #3

Several weeks after identifying that LLOV appeared to cause the die-off in the bat population and that spillover between bats and cows had taken place, the investigative team decided to conduct serological tests on humans within the area. The investigative team leads a communication outreach campaign to recruit consenting people to provide samples for LLOV serologic testing. The investigative team was able to enroll 103 people in the study, who provided blood samples. The sampled population included 3 farmers who worked with the sick cows, and 100 other people who lived in the town closest to the cave where the dead bats were found. The serum samples were then sent off to a laboratory for testing. The test results showed that 10% of the human serum samples, including 2 of the 3 farmers, came back LLOV seropositive. None of the people who provided samples remember showing symptoms of being sick recently.

Discussion Questions

1. How should the laboratory and investigative team proceed after identifying cases of likely human spillover of LLOV?
2. What laboratory would have tested these samples? Since these were human samples, is it a different lab than used in Scenarios One and Two? If so, how is information shared between the two entities?
3. What data information system is used to store the lab results? Who has access to this information?
4. What ministries/departments will be informed of the lab results?
5. In addition to collecting blood samples for serological screening, participants were asked questions to understand how they may have been exposed to LLOV. What questions would you ask the participants?
6. What types of public health outreach and communication would be implemented? How would you ensure that the messaging doesn't lead to retaliation against bats?
7. Are there any interministerial or intergovernmental One Health committees that would be involved?

Based on the discussion questions, please continue adding to the "Action & Coordination Table" by writing down the actions your group would take. Then, put an "X" in the box to mark which sectors would be involved in carrying out that action.

---------- *Pause for Whole Group Discussion* ----------

Share your plan of action and any questions or challenges that arose during your discussion. [We will use this time to address differences and similarities in response plans between the 3 countries.]

19.5.6 Scenario Update #4

One week has now passed since the completion of human serologic testing. No additional cows have shown symptoms of being sick and the previously sick cows appear to have fully recovered. Moreover, no additional dead bats have been found.

Discussion Questions

1. What concluding actions should occur?
2. How will the disease investigation findings be shared across the government?
3. Will disease investigation reports be published (peer-reviewed literature) or made public in another way?
4. Do you recommend the development of any new action plans, policies, risk assessments, or further research?
5. Will there be any additional training or workforce development after this situation?

Based on the discussion questions, please continue adding to the "Action & Coordination Table" by writing down the actions your group would take. Then, put an "X" in the box to mark which sectors would be involved in carrying out that action.

---------- *Pause for Whole Group Discussion* ----------

Share your plan of action and any questions or challenges that arose during your discussion. [We will use this time to address differences and similarities in response plans between the 3 countries.]


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