ONE HEALTH
ARMENIA

An Assessment of One Health Operations and Capacities

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2 ACRONYMS

AAU	Armenian National Agrarian University
AMR	Antimicrobial Resistance
ASF	African Swine Fever
BNSR	Biosurveillance Network of the Silk Road
CBD	Convention on Biological Diversity
CCHFV	Crimean Congo Hemorrhagic Fever Virus
COVID-19	Coronavirus Disease 2019
DMS	Defense, Military, Security
DTRA	United States Defense Threat Reduction Agency
EHA	EcoHealth Alliance
EID	Emerging Infectious Disease
EIDSS	Electronic Integrated Disease Surveillance System
EPIS	Epidemic Intelligence Information System
EU	European Union
FETP	Field Epidemiology Training Program
FSIB	Food Safety Inspection Body
GIS	Geographic Information System
HFI	Human Footprint Index
HLIB	Health and Labor Inspection Body
HPAI	Highly Pathogenic Avian Influenza
IHR	International Health Regulations
IHISA	Integrated Health Information System of Armenia
JEE	Joint External Evaluation
JRA	Joint risk Assessment
MCM	Multisectoral One Health Coordination Mechanism
MOH	Ministry of Health of the Republic of Armenia
MOU	Memorandum of Understanding
NAPHS	National Action Plan for Health Security
NAS	National Academy of Science
NBSAP	National Biodiversity Strategy and Action Plan
NCDC	National Center for Disease Control and Prevention

NGO	Nongovernmental Organization
VCNA	National Vector Control Needs Assessment
OHHLEP	One Health High Level Expert Panel
OHZDP	One Health Zoonotic Disease Prioritization
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SC-FELTP	South Caucasus Field Epidemiology and Lab Training Program
SNCO	State Non-Commercial Organization
SOP	Standard Operating Procedure
STAR	Strategic Toolkit for Assessing Risks
PPE	Personal Protective Equipment
PVS	Performance of Veterinary Services
RA	Republic of Armenia
RVSPCLS	Republican Veterinary-sanitary and Phytosanitary Center of Laboratory Services
SNCO	State Non-Commercial Organization
TTX	Tabletop Exercise
USAID	United States Agency for International Development
USD	United States Dollar
VCNA	Vector Control Needs Assessment
VL	Visceral Leishmaniasis
WAB-Net	Western Asia Bat Research Network
WHO	World Health Organization
WOAH	World Organisation for Animal Health (formerly OIE)
YSMU	Yerevan State Medical University
YSU	Yerevan State University

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 adopted.

Armenia 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 Armenian 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 Armenia is the Ministry of Health, Ministry of Economy (responsible for agriculture and veterinary services), Ministry of Environment, and Inspectoral Body of Food Safety (FSIB). Other sectors including academia, security, and national science bodies also conduct One Health research and set biosafety and security priorities and policies. These sectors have a history of largely operating independently, but with Armenia 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). Armenia, however, has not yet completed a National Action Plan for Health Security (NAPHS), and has a few other plans and assessments in development that have yet to be completed or renewed.

Historically the country has not always adhered to or fulfilled the recommendations from previous health assessments for a number of reasons, including financial and human resource capacity restraints. Moreover, the communication and dissemination of evaluation results could be made more accessible to One Health stakeholders across other departments or sectors.
By fulfilling recommendations from capacity assessments, and completing a NAPHS, it is expected to result in more cost-

effective approaches as Armenia shifts more toward prevention of health threats instead of a typical reliance on response.

Table 1. Completed assessments and plans

PLAN OR ASSESSMENT	COMPLETED? (YEAR)
JEE	Yes (2016, 2023)
PVS Evaluation	Yes (2007)
PVS Evaluation Follow-Up	Yes (2018)
PVS Gap Analysis	Yes (2009)
PVS Legislation	No
IHR-PVS Bridging Workshop	Yes (2019)
NAPHS	No
STAR	Yes (2019, 2022, 2023)
OHZDP	No
National AMR Action Plan	Yes (2015)
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, notifications of most infectious diseases, including many zoonoses, is a legal requirement in Armenia. The country is currently finalizing the development of an Electronic Integrated Disease Surveillance System (EIDSS), which will be main government tool used for real-time sharing of health information. Currently, limited biosurveillance data is shared between Ministries, except by specific request, but the goal is for the Ministry of Health (MOH), Ministry of Economy (formerly Agriculture), and FSIB to feed into EIDSS where epidemiological, veterinary and vector surveillance data can be stored and accessed by stakeholders. While more than 170 infectious diseases are subject to notification, the Ministry of Health and Ministry of Agriculture (now Economy), in 2014, published a joint decree listing priority zoonoses of greatest public health concern, including anthrax, avian influenza, rabies and five others. MOH and Ministry of Economy collaboration also extends to disease outbreak investigations, which are commonly conducted by multidisciplinary teams. Developing surveillance systems outside of human health, however, is lagging. The Ministry of Environment currently plays a downsized role in One Health activities. 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. The two closest examples are the “Intergovernmental Biosecurity and Biosafety working group” and the “High level inter-ministerial steering committee on IHR implementation, Infectious diseases control, and implementation of Armenia’s overall laboratory network” (it was recently refreshed as the government’s structure changed in 2021-2022). In addition to managing Armenia’s laboratory network, the steering committee is also engaged in zoonoses control and adopting a One Health approach and has balanced

participation from several sectors including Health, Environment, Security, and academia, in addition to a group of rotating guest specialists who participate when their area of expertise is needed. The "Intergovernmental Biosecurity and Biosafety working group", is a multisector group led by the National Security Council and was formed to draft new biosafety regulations. Involvement of the security sector in matters of biosafety, alongside public health and veterinary specialists exemplifies how different sectors can align under a unified One Health agenda. Continued collaboration among these sectors could help form the development of a national One Health committee in the future.

Compared to other parts of the world, Armenia, 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 Armenia include land conversion for agriculture, unregulated ecotourism (especially to caves), improper biosafety measures among some small-scale farmers, livestock going out to pasture and interacting with wildlife, animal movement across migratory routes, lack of regulation for antibiotic use (antimicrobial resistance) among veterinarians, and limited wildlife surveillance.

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 Armenia (Table 2). Additional recommendations are in the full report.

Table 2. Recommended actions for advancing One Health in Armenia

RECOMMENDATIONS	
Coordination and Governance	Formally establish a National One Health Committee that includes representatives from the Ministry of Health, Ministry of Environment, Ministry of Economy (including agriculture), National Security Council, Food Safety Inspection Body, Environmental Protection and Mining Inspection Body, National Academy of Sciences, 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	Increase targeted engagement to vulnerable groups of people, including providing vaccinations and information on zoonotic disease risk reduction methods to farmers and pet owners.
	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, including implementing joint exercise training and shared case definitions.

Overall, Armenia has made substantial growth in developing its human and animal health surveillance capacity, workforce, and infrastructure, especially in the last decade. 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 Armenia.

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[2-5]. 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[6]. 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[7-9].

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[6, 10, 11]. 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[6, 10]. Based on these factors, and its high diversity of poorly studied mammals (particularly bats and rodents), the South Caucasus region – including Armenia – has the potential to be an emerging infectious disease hotspot. Furthermore, as a geographic crossroads between the Middle East, Europe, Russia and Asia, the South 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 [12].

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. Armenia 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.

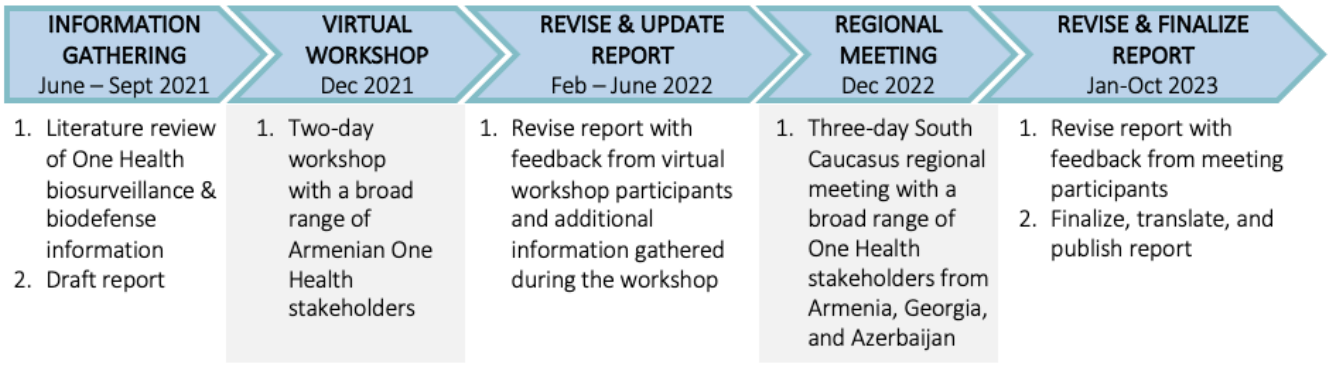
5 PURPOSE OF THIS REPORT

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 Armenia. 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 Armenia.

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 2-3 December 2021 with government and academic experts in Armenia to discuss the One Health, biosurveillance, and biodefense activities being implemented in Armenia. Workshop attendees participated in activities and discussions targeted at understanding gaps and opportunities to enhance multisectoral collaboration. After the workshop, the report was revised with 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 Armenia, Georgia, and Azerbaijan, 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 Armenian, and published in Armenian and English online at the websites for EcoHealth Alliance (https://www.ecohealthalliance.org), Yerevan State University (www.ysu.am) and the Armenian Association of Mammologists (aamngo.org). A shorter, peer-reviewed manuscript summarizing the key findings from our workshop 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 Armenia, Azerbaijan, 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, 23 specifically focused on Armenia. 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 Armenia 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 2-3 December 2021 convening participants from the Ministry of Health, National Academy of Sciences of the Republic of Armenia (NAS RA), Security Council Office, Yerevan State University (YSU), 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 Armenia. A complete list of workshop participants, agenda, and activities can be found in the Annex.

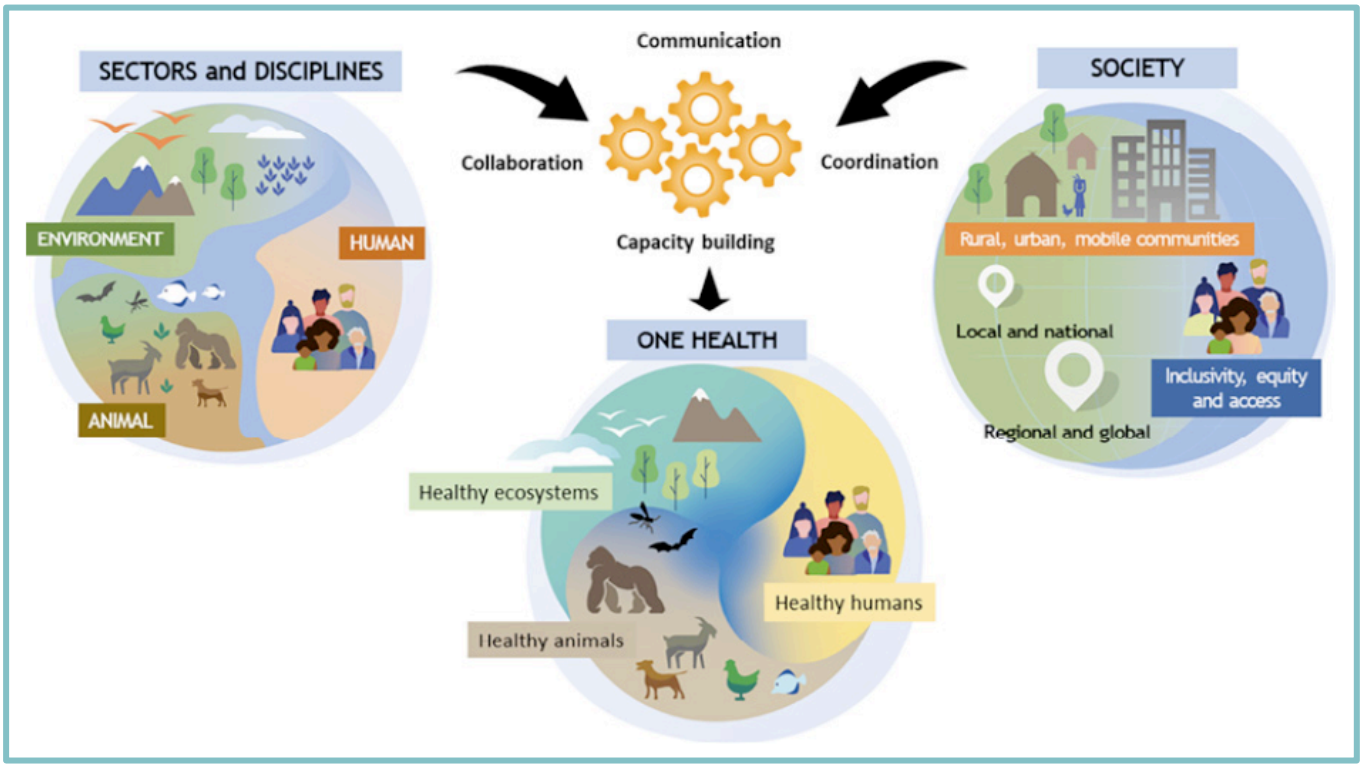
6.3 South Caucasus Regional Meeting on One Health Biosurveillance and Biodefense

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

7 ONE HEALTH FRAMEWORKS

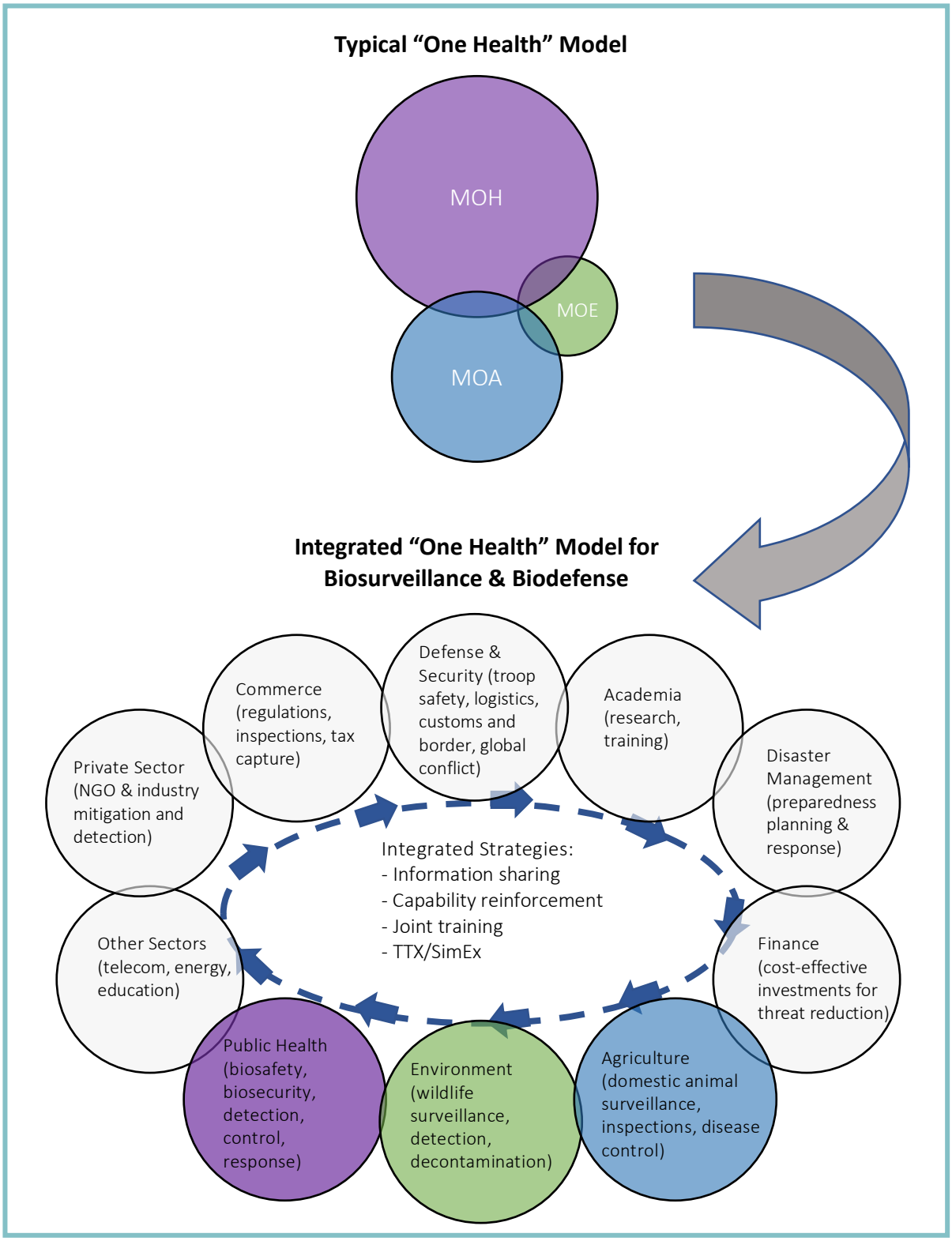
The concept of One Health has been recently defined by the WHO One Health High Level Expert Panel (OHHLEP) as "an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems. It recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent (Figure 2). 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 2. One Health visualization (OHHLEP) Annual Report 2021.



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 3 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 3. Comparing One Health models



8 ONE HEALTH SECTORS IN ARMENIA

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, veterinary medicine, 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 Armenia are listed in Table 3.

Table 3. Potential One Health sectors in Armenia

SECTOR, MINISTRY, OR ORGANIZATION	SUB-MINISTRY OR DIRECTORATE	RELEVANT ONE HEALTH SCOPE	LIMITATIONS OR ASPECTS NEEDING ADDITIONAL ATTENTION
Ministry of Health	• National Center for Disease Control and Prevention (NCDC) • Zoonotic and Parasitic Diseases Epidemiology Department • National Center for Infectious Diseases • Infection hospitals • National institute of Health	• Surveillance, monitoring, treatment, and evaluation of infectious diseases for humans and animals (e.g., zoonotic and parasitic) • Vector control and monitoring • Implementation of IHR regulations • Oversees water safety and outbreaks of communicable diseases • Data analysis and reporting • Biosafety information for researchers doing fieldworks to decrease risk of infection • Risk assessment • Trainings of specialists • Policy making • Antibiotic resistance prevention, control, surveillance, and monitoring • Public awareness • Laboratory diagnosis and pathogen identification	• Coordination between departments and other ministries • Need more biosafety training • Training, cooperation and experience exchange with other stakeholders and countries • Centralized information control • Lack of staff • Gaps of regulation
Ministry of Environment	• Bio-Resources Management • Climate policy department • Hydrometeorology and monitoring center, State Non-Commercial Organization (SNCO) • Department of special protected areas and biodiversity policy	• Develops and implements environmental legislation, regulation, policies and guidelines • Preserves biodiversity and specially protected areas • Promotes effective use of natural resources • Monitoring of target wild animal species • Cooperation and data sharing • Reporting to other ministries	• Verifying information for decision makers • Cooperation with other ministries and international organizations • Gaps in regulation • Biodiversity species information

Ministry of Economy	• Scientific center for risk analysis and assessment in food safety • Border Control Posts Coordination Division • Sampling and laboratory examination organization (reference laboratories) • Department of Veterinary and Livestock • Tourism Committee	• Policy and legislation development related to agriculture, food safety, veterinary standards • Develop human capacity in agriculture sector • Animal/livestock disease surveillance, diagnostics and reporting • Vaccinations to farm animals • Creating protocols • Food safety and animal disease monitoring and control • Genetic control of imported and export products • Risk assessment • Control of food and livestock safety • Promote food security • Public awareness and communication	• Genetic control • Centralized network • Fund and infrastructure • Centralized information system • Relatively narrow range of diagnostic studies
Health and Labor Inspection Body	• Anti-epidemic department	• Ensure compliance with the requirements of the legal acts of the field of health care • Risk management to ensure the sanitary and epidemiological safety of the population • medical care and service • Participation in policy development • Awareness raising of local government • Reporting • Laboratory diagnostics for different pathogens (e.g., viruses, parasites, etc.)	• Cross training with research bodies • Training of specialists • Gap in regulation • exchange of personal data • Involvement of large-scale stakeholders in awareness training programmes
Environmental Protection and Mining Inspection Body		• Ensure compliance with environmental safety requirements and legislation • Monitoring of target species, environmental changes etc.	• Awareness and coordination • Land use change • Monitoring
Food Safety Inspection Body		• Policy and legislation development related to food safety standards etc. • Food safety monitoring and control • Promote food security • Food and farm animal biosafety control	
Security	• National Security Council • Customs and Border Service • Police	• Help and control for transportation of potentially dangerous samples to cooperating centers where they will be analyzed • Policy making • Coordination of the biosurveillance and biosecurity working group	• Coordination and finalization of biosecurity regulation in Armenia
Scientific Bodies	• Armbiotechnology Scientific and Production center • National Academy of Sciences • Scientific Center for Zoology and Hydroecology • Institute of Zoology and Institute of Molecular Biology	• Wide ranging research projects across the One Health spectrum • Laboratory diagnostics • Reporting and recommendations to governmental bodies • Provide expert opinion to government agencies • Publish and communicate research findings • Lab diagnostics	• Increase the staff and involve new specialists • Funding

	• National institute of health		
Universities, Academia, and Education	• Yerevan State University • Yerevan State Medical University • National Agrarian University of Armenia • Scientific center of zoology and Hydroecology • Institute of Physiology after L.A. Orbeli	• Provide graduate level training (e.g., veterinary and medicine) • Biodiversity research ecological and parasitological research • Cooperation with NCDC • Research on a wide range of topics (e.g., biodiversity, ecology, parasitology, virology etc.)	• Need to involve new students in field and prepare new specialists • More communication with decision makers • Law limit for working with pathogens • New courses • Funding
Other Ministries	• Ministry of Emergency Situations • Ministry of Defense • Ministry of Finance • Ministry of Foreign Affairs • Ministry of Internal Affairs	• Involved in emergency situation control and management • Trainings and workshops • Helping in sampling	• Need for more special training • Clearer entry points for working with ministries of health and environment
Private Sector	• Health and veterinary clinics • Diagnostic labs • Food safety labs • Ecotourism agencies	• Control food supplies and certification of materials and food • Raising public awareness	• Awareness raising • Need for additional training courses
Local Government	• Municipalities • Village administrations	• Provide support at the local level e.g., conducting research in hard-to-reach areas • Monitor changes or unusual increases of wild species of animals • Protocol for dealing with animal mortality • Involved in emergency situations and in quarantine	• Data integration and information sharing with national government
Other	• NGO's	• In case of not enough personnel, NGO's can provide help to personnel and volunteers to working groups • Inserting of the mobile application of tracking of target wild animals • Fixing the high mortality case rate among wild or domestic animals	• Wide dissemination of information

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, the Republic of Armenia 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 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 Ministry of Health reported about 26,5 trillion AMD spent on COVID relief efforts in 2020, and like all countries, has faced significant indirect costs as well[18]. Armenia also received 260 million USD in support from the World Bank, USA, and European countries[19]. The COVID-19-induced shutdown in Armenia also led to an estimated 7.6 percent reduction in gross domestic product in 2020[20]. The short-term impacts of COVID-19 could also substantially increase poverty rates, impoverishing an estimated 370,000 Armenians[21]. This means one in four Armenians could suffer downward mobility from the economic shocks of COVID-19[21].

The agricultural sector – a core element of the Armenia's economy – was also affected by the COVID-19 pandemic. For example, an assessment of COVID-19 impacts on agriculture in the Lori and Tavush regions of Armenia found that food and value chains were particularly disrupted with smallholders more exposed to pandemic interruptions and shocks than large holders[22]. Importantly, however, COVID-19, did not create a broad set of new challenges, rather border restrictions and supply chain disruptions, as well as widespread health issues, increased the existing gaps and difficulties in value chains. These pandemic-related shocks to broad systems, such as agriculture, underscores the high cost of emerging disease outbreaks beyond direct human health impacts and the need for increased investment and adoption of One Health approaches.

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. 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 (e.g. 15,000 Armenian farmers received financial compensation for loss of livestock in 2008)[23]. It also affects the broader economy as other countries may ban imports of Armenian meat and consumer prices may rise due to lack of supply. Armenia has recently been on the reverse side of this having temporarily banned the importation of pigs and pork products from seven European countries in September 2021 in order to prevent the introduction and spread of African swine fever (ASF)[24]. 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 may 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[25]. 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[25]. 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 at times 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[26]. 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[26].

10.2 Biodefense and One Health in Armenia

In Armenia, both the security and health sectors contribute to infectious disease identification as the responsibility for identification is spread across laboratories at the NCDC, Republican Veterinary-sanitary and Phytosanitary Center of Laboratory Services (RVSPCLS), Institute of Molecular Biology of NAS RA, Scientific Center for Zoology and Hydroecology (SCZH) of NAS RA, and at Yerevan State University. The Ministry of Defense has a military medical department and a sanitary-epidemiological service, which ensures the implementation of relevant functions in the defense system. The Ministry of Defense then turns to the Ministry of Health for more specialized research, control and prevention measures. Armenia 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 Armenia's capacity to detect, diagnose, and report bioterror attacks and potential pandemics[27].

Additionally, the recently developed National Security Strategy of the Republic of Armenia (2020) specifically mentions promoting public health and biosecurity, as well as rehabilitating, protecting, and improving the environment[28]. While the Strategy does not provide specifics, the inclusion of public health and environmental conservation in the National Security Strategy is an important recognition that security and health are intertwined. Additionally, the Interagency working group on Biosafety and Livelihood Issues – which was established in 2018 under decision N 1320-A and is coordinated by the Security Council Office – recently developed a new draft law on biosafety and livelihood – a first for the country. The law outlines the legal framework for biosafety and livelihood security in Armenia. The creation and collaboration of this intergovernmental group – which includes representatives from 7 different ministries and 10 total organizations – is an important example of the benefits of multisectoral cooperation.

BOX 1. Biodefense and scientific research go hand-in-hand.

Proper biosafety is critical for protecting the health and safety of both human researchers and animals. Between 2018-2023 researchers from Yerevan State University (YSU) led a biosurveillance project in Armenia to characterize the diversity of bat coronaviruses in Western Asia, understand risk factors associated with spillover of viruses into humans, and strengthen research capacity to improve biosecurity and bat conservation[1]. In addition to researchers from YSU, the Ministry of Environment provided permits and oversight of wildlife sampling while the National Security Council ensured proper biosafety protocols for sample analysis in regional reference laboratories. Multisectoral collaboration on research, like this, exemplifies how researchers, conservationists, and security experts can cooperate to ensure rigorous academic research and biosafety can be intertwined to fulfill an overall goal of improving our collective understanding and preparedness in preventing zoonotic disease threats.

While the MOH is ultimately responsible for biosafety and biodefense, collaboration between health, security, environment, and defense exemplifies an integrated One Health model for biodefense. 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[25].

Armenia, 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. There are already several examples of collaboration between health and DMS sectors in Armenia and further strengthening of this partnership could lead to improved coordination between the sectors. More specifically, the Office of the Security Council could build on its central role in organizing the Intergovernmental Biosecurity and Biosafety working group and coordination on wildlife sample exportation to lead a multisector group to assess and consider establishing a National One Health committee. In light of the COVID-19 pandemic, there is urgency and momentum for completing the stated public and environmental health objectives in the National Security Strategy, with a particular focus on strengthening biological risk management systems. 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[26].

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[29]. 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[29].

Examples of zoonotic disease risk factors include:[29]

- Land use changes, deforestation, habitat loss, and destructive practices such as mining
- 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
- Changes to the human-wildlife interface
- Chemicals 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[29]. 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[29].

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[29].

During both the virtual workshop and regional meeting, participants engaged in the process of identifying EID risk factors specific to Armenia (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, density, and travel patterns, infrastructure, 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 Armenia.

EMERGENCE FACTORS	SPREAD FACTORS
• Ecotourism (wide range of caves, hiking, camping). Only 1-2 caves have some protections or awareness measures in place to limit human access/wildlife contact • The use of water from random wells for drinking purposes also plays a role in the emergence of leptospirosis, tularemia and a number of other diseases • Vectors (arthropod) may be greater risk than direct mammal contact. Vector biology and distribution is changing due to climate change • Some direct mammal transmission e.g., related to rodent density and human interaction – Leptospirosis and tularemia (natural foci in almost all territory in Armenia), and hantavirus infection • Livestock sometimes spend significant time in mountains (pastures) and are exposed to wildlife. Possible wolf/jackal transmission to livestock via bites • Rich diversity of mammals and vectors (invertebrates) – particularly locally migratory species – as Armenia has dueling "Iranian and European" climates of dry areas and humid colder areas • AMR: Antibiotics widely used among veterinarians, which can also end up in food of animal origin and into humans • Wildlife habit destruction/change due to building new roads and increased mining – bringing wildlife in closer proximity to human villages (shifting seasonal movements i.e., mouflon and bezoar goats) • Agricultural land use by villagers (uncontrolled pesticide and rodenticide usage) – can cause insecticide resistance • Shared water sources – wild animals and livestock	• Seasonal livestock movements (e.g., from Ararat valley to mountainous areas and back) • Widespread rubbish in nature ecosystems (insufficient waste management/biosecurity attracting other wildlife) • Ecological crossroads for migratory species (Armenia sits between the Caspian and Black Sea) • Poor awareness or uptake among farmers and agriculturalists about proper biosafety measures • Geographic/climatic conditions are favorable for arthropod vectors of infectious diseases • Transportation of animals without always following quarantine rules
VULNERABILITY FACTORS	**PROTECTIVE FACTORS**
• Minimal existing regulation on AMR • Minimal education/public awareness for tourist guides for human health, especially caves (some limited informal meeting with tourist guides and wildlife academic/research experts - focused on animal protection not health) - different priorities and need for One Health coordination across sectors • Wild animals sometime kept in captivity without proper biosafety • Not sufficient sampling efforts for vector surveillance • Poor diagnostic capacity in the veterinary lab network; full diagnosis is inly completed at the central veterinary lab • Limited One Health experts to lead research studies • Need for better data and information sharing between hospitals and public health clinics regarding diagnostics • Need for better diagnostic tools and training of clinicians to identify rare diseases e.g., rare diseases like tularemia and leptospirosis are diagnosed late or never (this is especially important when patients are traveling between different regions in Armenia). • Inter-species transmission: Limited follow-up of investigations to determine epidemiology (e.g., sick animal predation) and distribution to inform risk mapping • Land use change (e.g., mining) is not measured • Lack of centralized and widespread information flow	• Opportunity to work with Tourism agencies (awareness raising, e.g., happened with NCDC during Zika). The One Way tourism company is implementing the "Biological hazards of outdoor recreation" course in their guide training program. A poster in front of Areni 1 cave presents information on safety in the cave. • No tradition of using wildlife for food – even hunting is limited in Armenia (some small bird hunting), strict protections • MOH-led workforce training for zoonotic infectious disease diagnoses among medical professionals to avoid nonspecific "fever of unknown origin" diagnoses • NCDC has some capacity for risk assessments via mapping of zoonotic data (e.g., bat-borne disease) to guide surveillance and early detection • Several zoonoses trainings targeted at medical professionals to improve infectious disease diagnoses and avoid "fever of unknown origin" • High number of research projects, particularly in human and animal health sectors

11.2 EID Risk Identification and Hotspot Mapping

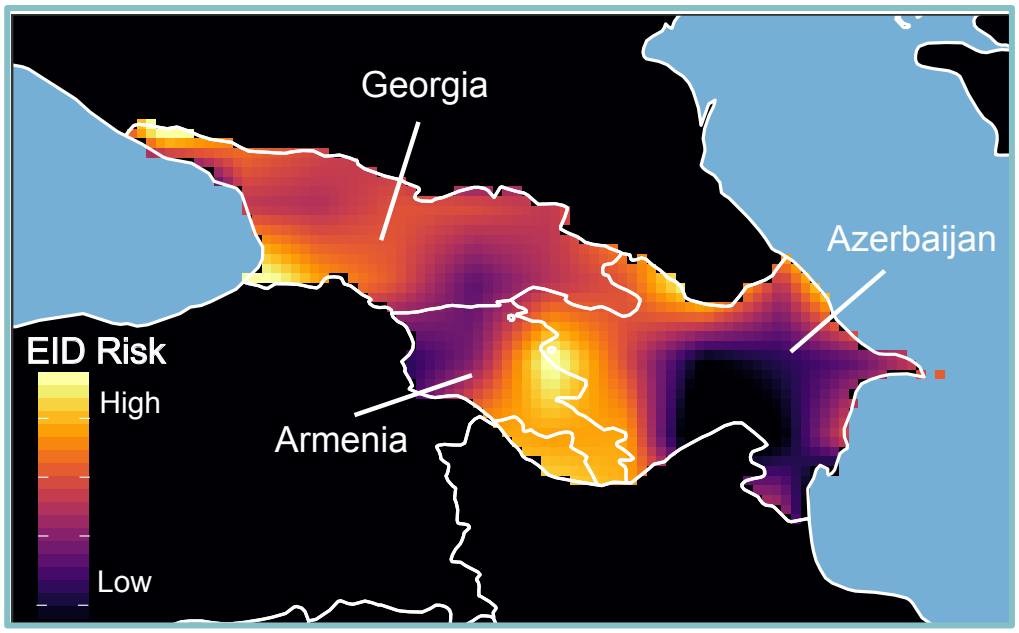
Most novel infectious diseases originate in wildlife and then spill over to humans. Those spillover events follow patterns that make them more likely to occur in some areas than others, creating hotspots of disease emergence. Mapping hotspots can help decision makers optimize surveillance efforts and 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[10], it is important to involve a diversity of sectors in the risk mapping process. The NCDC is primarily responsible for mapping zoonotic disease risk in Armenia, but other organizations including the Institute of Geological Sciences, NAS RA, Armenian National Agrarian University, and faculty of geology and geography at YSU conduct mapping exercises and research. Most of the disease mapping currently being done in Armenia 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[6, 10]. 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[10]. As an example, the risk of wild birds becoming infected with avian influenza and spreading the virus within Armenia, and the Caucasus region, is relatively low, but Armenia, Georgia, and Azerbaijan 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[10] has been downscaled to create a regional zoonotic disease risk model for the Caucasus region (Figure 4).

Figure 4. 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 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. Gathering and analyzing diverse data requires time and collaboration among experts including epidemiologists, entomologists, cartographers from NCDC, and specialists from the scientific center for risk assessment and analysis, food safety sector, and the Ministries of Environment and Economy of the Republic of Armenia. This is a priority area for future research.

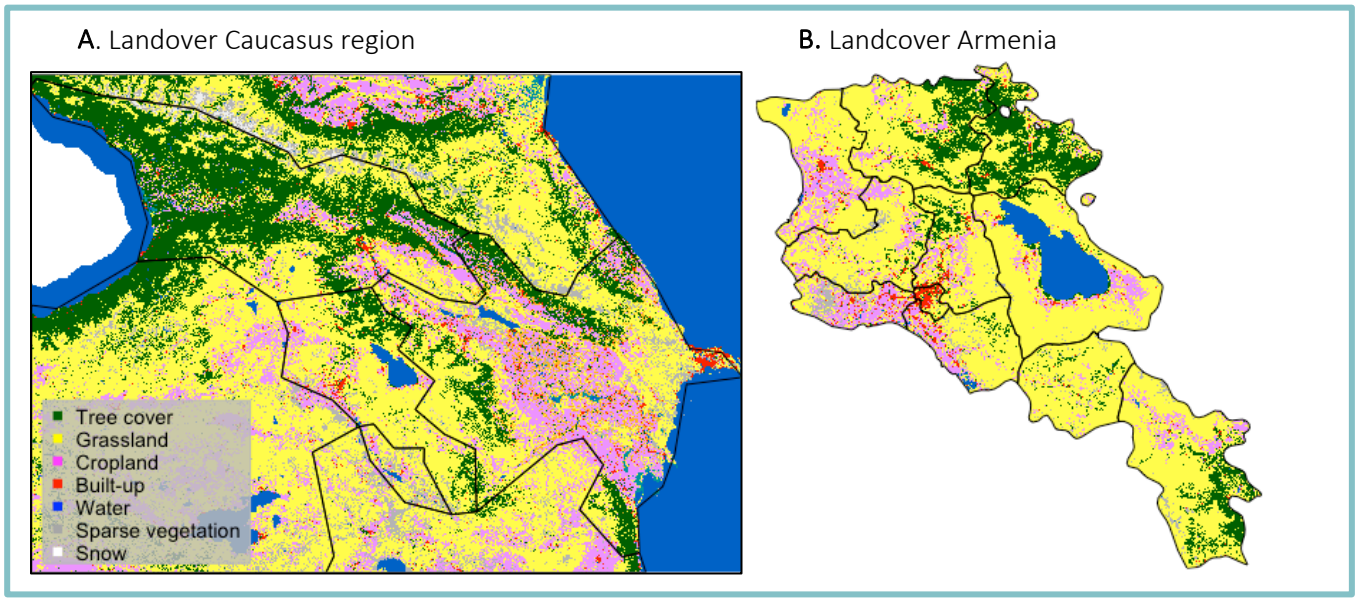
11.2.1 Land used change

Anthropogenic land use change related to agricultural practices is a key driver of EID emergence and spread.[10] 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.[30] 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 Armenia/Azerbaijan border[31]. 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 5). In comparison to its neighboring countries, Armenia has a much larger proportion of tree grasslands, but less tree cover and cropland compared to Georgia and Azerbaijan, respectively. As Armenia continues its economic development, it will be critical for the country to sustainably develop land, conserve its forests – particularly in the northeast – and monitor the human pressure it is putting on the environment.

Figure 5. 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**. Armenia is largely covered in grassland with other areas of tree cover, cropland, and smaller built-up areas (red). In comparison to neighboring countries, Armenia has a higher prevalence of grassland, with relatively lower cropland and 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 Armenia sustainably maintains natural land and monitors rates and location of land conversion.



11.2.2 Human Footprint Index

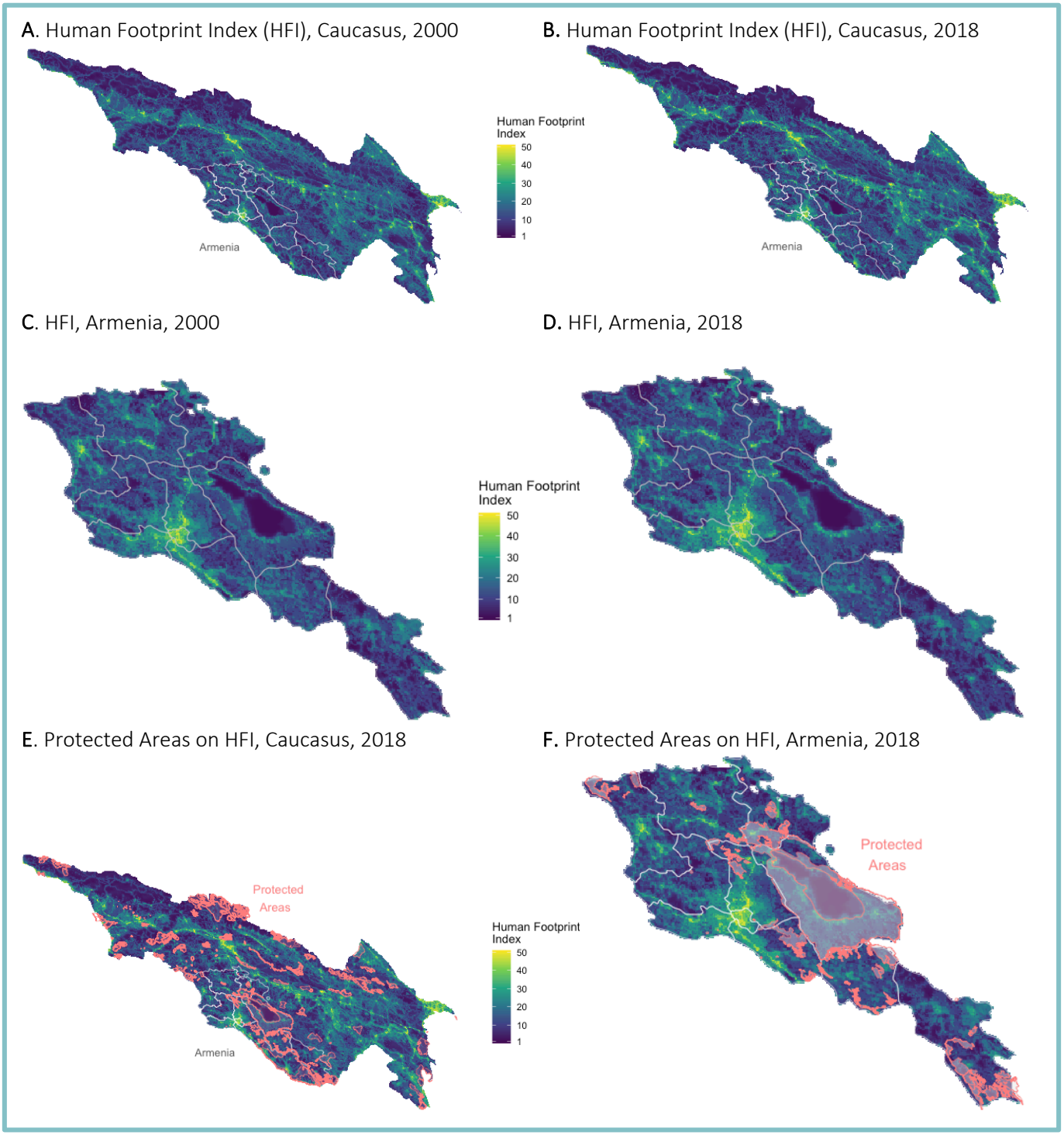
Another measure of human-derived pressure on the natural environment is the Human Footprint Index (HFI). It is a composite metric that details the cumulative human terrestrial pressure put on the environment. Made up of 8 variables (built environment, population density, nighttime lights, cropland, pasture, roads, railways, and navigable waterways), it depicts how humans are changing the environment over time. Like most countries, Armenia has significantly expanded its human footprint during the 21st century (Figure 6)[32]. 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. Fortunately, Armenia has a large swath of protected and conserved areas, particularly around Lake Sevan, which is approximately 60 kilometers from the most developed areas of Armenia near the capital of Yerevan.

Figure 6. Human Footprint Index (2000 vs 2018) and protected and conserved areas, Caucasus.

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 Armenia 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.[32, 33] There are substantial protected areas in Armenia, especially around Lake Sevan (**F**), which are a significant distance from the highest areas of human pressure near Yerevan.



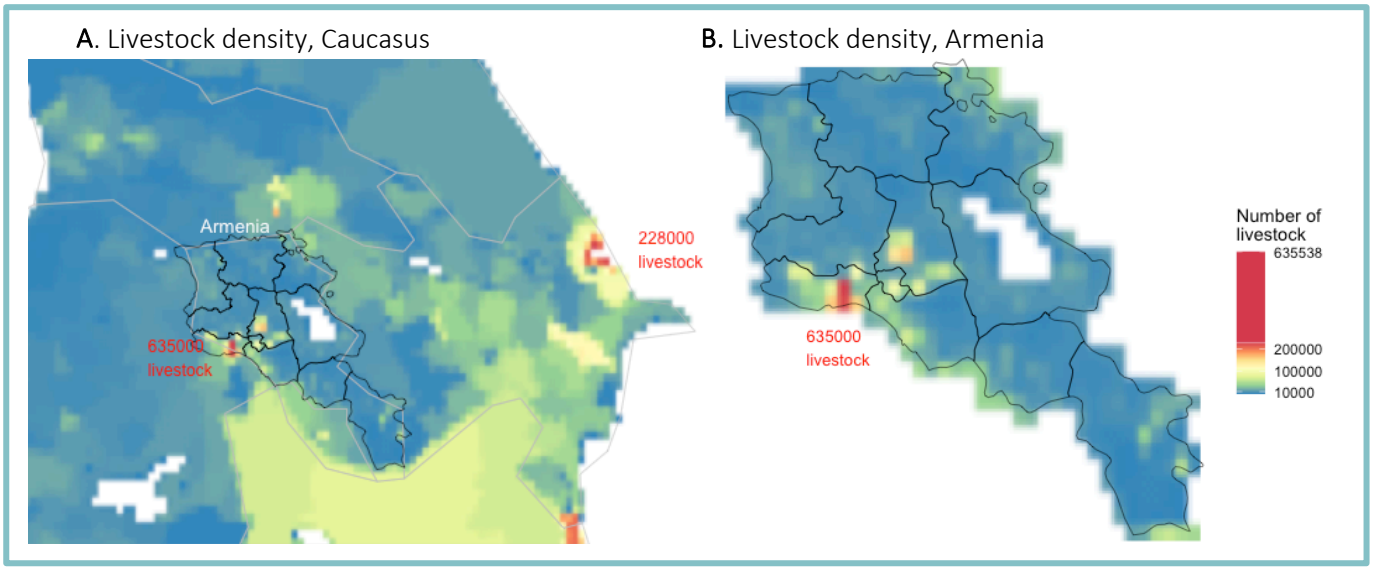
11.2.3 Livestock Density

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.[34] This is especially true for intensive livestock production, which is not generally an issue in Armenia, compared to other parts of the region, as approximately 36% of people in Armenia live in rural areas and livestock

(predominately chicken, sheep, cattle, and pigs) is generally held among small-scale subsistence farmers (Figure 7). However, there is a high density of livestock just outside of Yerevan, near Armavir, which represents the highest density of livestock in the Caucasus region and poses a potential risk to 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.[34]

Figure 7. 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).[35] **A**. Compared to other parts of the region, especially Azerbaijan and Iran, Armenia has a lower density of livestock per 10km^2 area. **B**. Within Armenia, there is one very dense area of livestock (635000 livestock in approximately one 10km^2 area) just west of Yerevan, although the rest of the country maintains a relatively low density of livestock.



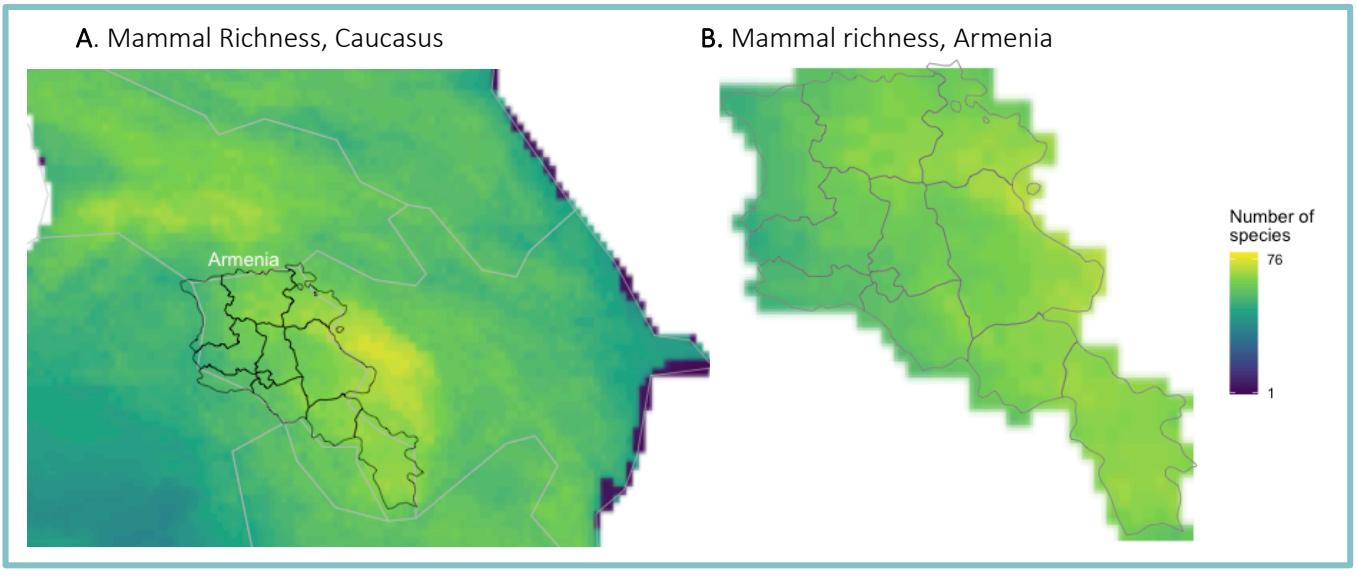
12 BIODIVERSITY IN ARMENIA

Armenia is a country rich in biodiversity and climactic variability. It is a mountainous country filled with diverse ecosystems including mountain ranges, deep river valleys, volcanic plateaus, and the Ararat Plain. Its climate is generally dry but contains >3,000 plant species across 5 altitudinal vegetation zones: semidesert, steppe, forest, alpine meadow, and high-elevation tundra. Steppe is the most common vegetation zone and consists of drought-resistant grasses, thorny bushes, and juniper. The alpine zone (above 6,600 ft) contains stunted grass, which is good for pasture and contains rich fauna including mountain turkey, horned lark, bearded vulture, bezoar goat and mountain sheep (mouflon). The forest zone, which occupies ~10% of the country is mostly stunted grass, which is good for pasture, and contains rich fauna including mountain turkey, horned lark, bearded vulture, bezoar goat and mountain sheep (mouflon).

There are over 12000 animal species (though the great majority are insects), including 307 birds and 102 mammals, including 28 species of bats and 34 species of rodents, which are known to carry the most viruses with zoonotic disease potential.[11, 36, 37] Among terrestrial mammal species, there is a relatively even distribution across the country and region (Figure 8). 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 8. Terrestrial mammal species richness, Caucasus region, 2022.

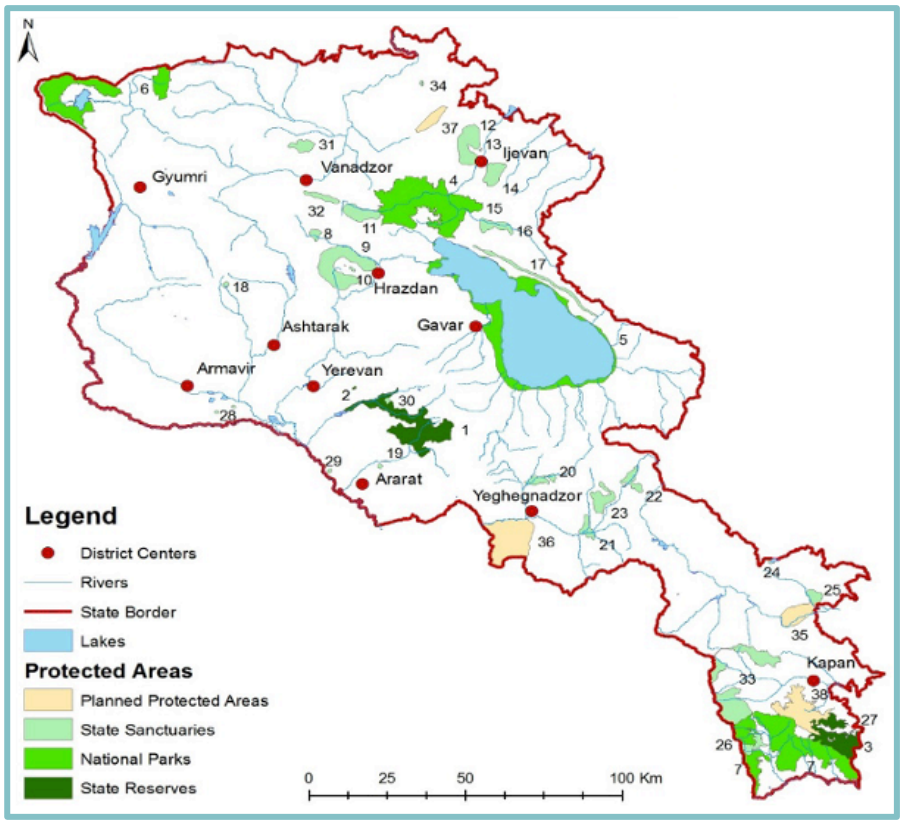
This figure shows the sum of terrestrial mammal species from blue (lowest number of mammal species) to yellow (highest number of mammal species).[38] Areas of greater wildlife diversity are often areas where viral diversity is the highest, thus increasing the potential for EID spillover if interactions between wildlife and humans or livestock occur.[6, 10] **A**. Mammal richness is relatively constant across the region with the riches areas just east of Lake Sevan. **B**. Within Armenia, 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).



In terms of land use, more than 60% of Armenia is under active agriculture, and in semi-desert and mountainous steppe zones the figure reaches up to 80-90%[39]. However, only 18% of the country is under intense development, where approximately 88% of the total population resides, and 38% of the country is considered minimally developed with a low population density[39].

Armenia has 38 Protected Areas (land: 24.68% and marine 0%) with 29 providing management effectiveness evaluations[40] (Figure 9).

Figure 9. Specially protected areas of Armenia[41]



There are 3 national parks, 3 state reserves, and 27 protected areas[40]. Armenia has approximately 11% forest cover, most of which is designated for protective functions[42] (Table 6). Furthermore, in 2018 Armenia pledged to restore 260,000 hectare of forested land by 2030 (although the government is revising this number and has yet to release a new pledge)[42].

Table 6. Overview of forest and biodiversity in Armenia

GEOGRAPHIC REGION	FOREST COVER	SHARE OF FOREST AREA DESIGNATED FOR PROTECTIVE FUNCTIONS	SHARE OF FOREST AREA CONSERVED FOR BIODIVERSITY	SHARE OF RURAL POPULATION
Armenia	11%	67%	33%	36%
Caucasus Average (ARM, AZE, GEO)	NA	77%	11%	44%

Information from FAO/UNECE State of Forests of the Caucasus and Central Asia[42]

Additionally, despite its richness, there are several threats to biodiversity in Armenia – nearly all of which are human caused and driven by economic and social desires. They include illegal/unregulated logging, agricultural practices, including overgrazing and conversion of wild land to agricultural land, and several others (Table 7). Factors that are driving the loss of biodiversity include poor economic conditions with a high demand of limited resources leading to unregulated logging, and insufficient financial resources and institutional capacity within the Ministry of Nature Protection[42]. Overexploitation of nature also goes beyond biodiversity loss and has broader impacts on ecosystem health, habitat loss, pollution, climate change, and ecosystem services overall.

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

THREATS TO BIODIVERSITY	DRIVERS OF BIODIVERSITY THREATS
• Mining, including mining waste • Excessive water extraction and use • Untreated/poorly treated wastewater • Illegal/unregulated logging • Climate change • Infrastructure development, including hydropower, railways, highways and water lines • Deterioration of water quality in Lake Sevan • Agricultural practices, including grazing • Pests, diseases, and invasive species • Illegal/unregulated/poorly regulated hunting and fishing • Overgrazing, leading to decrease in natural regeneration	• Poor social and economic conditions • Lack of institutional capacity and prioritization and a legacy of corruption • Poor management of energy supply and consumption • Lack of public environmental awareness • Lack of environmental data and monitoring • Limited capacity to secure resources for environmental investments • Legislative gaps and lack of transparency • Weak coordination between government and other environmental actors

Information from USAID/Armenia Foreign Assistance Act 119 Biodiversity Analysis[43]; FAO/UNECE State of Forests of the Caucasus and Central Asia[42]; and the Armenia Sixth National Report to the Convention on Biological Diversity[39]

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, 95% of the territory of the Republic of Armenia is considered susceptible to especially dangerous pathogens[44]. Species associated with elevated risk of harboring or transmitting high consequence pathogens include bats and rodents.

The responsibility of forming and managing environmental policy and projects is the Ministry of Nature Protection, with the Department of Forest Policy and Biodiversity playing a particularly important role. Armenia is a member of the Convention on Biological Diversity (CBD) and its primary policies and plan on biodiversity "'Strategy and National Action Plan of the Republic of Armenia on Conservation, Protection, Reproduction and Use of Biological Diversity (2015)'' is consistent with, and based on, the goals set out by the 2010-2020 Strategic Plan of the Convention on Biological Diversity[39]. In addition to delivering on the country's obligations under CBD, the government adopted the "Strategy and State Program of Conservation and Use of Specially Protected Nature Areas of the Republic of Armenia" in 2014[39]. Armenia is also a signatory on international conservation agreements, including the Convention on Migratory Species (Table 8).

Table 8. Biodiversity-related conventions

THE RIO CONVENTIONS			BIODIVERSITY- RELATED CONVENTIONS				
UNCBD	UNFCCC	UNCCD	CMS	CITES	RAMSAR	WHC	BERN
1993 Acceptance	1993 Acceptance	1997 Ratification	2011 Party	2008 Accession	1993	1993 Notification of succession	2008 Ratification

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

The political will to preserve biodiversity is important, but there are challenges ahead. The government is in an intensive process to review and update the National Forest Policy and Strategy, which is not yet completed, but aims to be finalized by the end of 2023. A need for the adoption and implementation of the Landscape Restoration Strategy and Action Plan 2022–2032 has also been previously recommended, but not yet implemented as a critical step in conserving Armenia's forests and biodiversity[45]. Furthermore, as Armenia develops its next National Biodiversity Strategy and Action Plan (NBSAP), there is an opportunity to align it with important one health targets. NBSAPs typically drives countries' ecosystem and

biodiversity management priorities and operations, so the development of a new plan offers a chance to build in disease risk reduction, creating synergies between Armenia's NBSAP and eventual National Action Plan for Health Security.

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 Armenia. 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, 29, 46, 47], 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 One Health 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 Armenia are depicted below in Table 9.

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

Regulatory Frameworks	• Law on Food Safety • Law on Biosafety and Livelihoods (established under Prime Minister decision N 1320-A) • Republic of Armenia (RA) law on Medical Care and Service of the Population • RA law on ensuring sanitary and epidemiological security of the RA population • RA MOH order 17.12.10 "Real-time electronic epidemiological control of infectious diseases" • Chemical agreements • Convention on Biological Diversity • Convention on the Conservation of Migratory Species of Wild Animals
Capacity Assessments	• Performance of Veterinary Services (PVS) • PVS Evaluation Follow up Mission (2018) • PVS Gap Analysis Mission • Joint External Evaluation of IHR Core Capacities (2016) • Self-assessment of Essential Public Health Operations • National Vector Control Needs Assessment (VCNA) in Armenia • Strategic Risk Analysis and Profiling for Health Emergencies • AMR Self-Assessment (2019-2020)
Planning Tools	• National Bridging Workshop on IHR and PVS • Public Health Emergency Preparedness and Response Plan • National Action Plan for Health Security (initiated, but not yet completed) • Strategy and National Action Plan of the Republic of Armenia on Conservation, Protection, Reproduction and Use of Biological Diversity • Strategy and State Program of Conservation and Use of Specially Protected Nature Areas of the Republic of Armenia • National Action Plan on Antimicrobial Resistance (2015)
Implementation Resources	• Laboratory at YSU for genetic studies of parasites/pathogens • Laboratory of molecular parasitology at the Institute of Zoology • Member of MediLabSecure • Member of VectorNet • Member of Western Asia Bat Research Network (WAB-Net) • Several DTRA-funded human and animal health projects
Information and Reporting Systems	• Electronic Integrated Disease Surveillance System (EIDSS) • ArMed national digital health system (for human health and hospitals) • Integrated Health Information System of Armenia (IHISA) • WhatsApp, Viber, other forms of digital and social media communications • Academic journals for science reporting (e.g., Armenian Journal of Health and Medical Sciences)
Expert Networks	• Intergovernmental Biosecurity and Biosafety working group under security council office • National Immunization Technical Advisory Group (NITAG) • Inter-ministerial working group on One Health issues • Society of parasitologists of RA • Expert group on Zoonotic diseases under the MOH • Several Informal technical working groups

Armenia has several key laws and institutional structures in place to support the governance and expansion of its biosurveillance and biodefense capacities. These include a law on food safety, chemical hazards, sanitary and epidemiological security and is in the process of developing a new "Public Health Act"[12], a new environmental policy and environmental system[48], and the new law on biosafety and livelihoods. There is also pronounced political will to support IHR implementation with extensive national legislation (>400 legal texts) covering human, animal, and environmental health[44]. The designated IHR focal point is based within the MOH and coordinates legal and regulatory frameworks for IHR implementation[44]. Yet, there are areas for improvement regarding One Health implementation, specifically regarding Civil law, exportation of wildlife sampling, and guidance on technology transfer and biosafety research in universities. Armenia also lacks a permanent national water management board and has an aging legal framework, which has hampered cross-sectoral cooperation on clean water initiatives[49]. This could also leave the country vulnerable to water supply disruptions, i.e. from intentional or natural contamination via water-borne pathogens.

In terms of capacity assessments and planning tools, Armenia 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; Joint External Evaluation of IHR Core Capacities; Self-assessment of Essential Public Health Operations; and National Security Strategy. In 2022, Armenia also completed a workshop on implementing the Tripartite Zoonoses Guide to bolster multisectoral understanding of zoonotic disease prevention and control. There are also several Standard Operating Procedures (SOP) for outbreaks of zoonotic diseases, cattle burials, establishing a rapid response team, and others. In terms of environmental health and biodiversity, there are several national plans 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, when continued follow up assessments are conducted without appropriately addressing gaps identified in the first assessment, the duplicative assessments will point to the same challenges, but actual steps to implement the recommendations and address gaps have not always been taken.

Regarding implementation resources, there are several laboratories with diagnostic capabilities, multiple DTRA-funded capacity development and research projects. Armenia continues to participate in regional surveillance projects including the Western Asia Bat Research Network, MediLab Secure and others. The COVID-19 pandemic was also a driving factor in improving information sharing within the human health sector with improved diagnostic testing and reporting from health clinics, hospitals, and labs. More information on these resources can be found further in the report. There are, however, areas for improvement, such as

weak mechanisms for multisectoral revision of strategies, including challenges in integrating research results into ongoing national surveillance programs and policies. Public-private partnerships can also be challenging to implement as strict laws sometimes hinder the business sector from partnering with government on health issues. Therefore, there is an opportunity for enhanced cooperation between the private sector and the Ministry of Foreign Affairs to aid in developing public-private partnerships.

This challenge of integrating new research into programs is in part due to information sharing systems that are often siloed or not available for easy dissemination. For example, information sharing is usually sector-specific and is sometimes published only in print versions that are not easily accessible online. Furthermore, academic journals in Armenia usually only publish information in-print and are not readily available online, preventing widespread dissemination of scientific findings. There are, of course, legitimate security or privacy concerns with distributing sensitive information regarding vulnerabilities in health security at times, 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. The main form of real-time information sharing of health information in Armenia is via the Electronic Integrated Disease Surveillance System (EIDSS), which will be discussed in depth later in this report. Further, improved metadata standards and criteria for the minimum necessary data needed for sharing One Health or biosurveillance data across platforms are needed.

Finally, with reference to expert networks, there are multiple working groups, including the National Immunization Technical Advisory Group, an intersectoral task force for zoonotic diseases (within the MOH), an inter-ministerial working group on One Health issues, and the Interagency working group on Biosafety and Livelihood under the Security Council Office who developed and are implementing a new national law on biosafety and biosecurity. While there is no one high level One Health committee, fortunately, Armenia 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. Additionally, Armenia stands to benefit from participating in global or regional expert networks, including the Global Health Security Agenda (Armenia is not currently a member).

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 Armenia 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 Armenia could be well placed to receive funding if they continue to show a high-level government commitment to One Health.

Like most countries, Armenia faces a consistent battle for sustained One Health funding. Core surveillance detection and response capacities are partially funded through state programs, but there is minimal funding for trainings. Armenia 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.

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[29]. The multisectoral coordination mechanism can be tailored to focus on priority zoonotic diseases or health threats in Armenia including AMR, food safety etc.

Armenia does not have a National MCM or National One Health committee yet. There is interest among technical One Health stakeholders, but legally formalizing a national multi-ministerial committee will be challenging without high level political support. 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 Economy (including Agriculture), Ministry of Nature Protection for Wildlife Animals, Food Safety Inspection Body, and Office of the Security Council are also involved, but to a lesser extent.[12] MOH also recognizes the value of collaborating with other institutions and is in the process of formalizing Memorandums of Understanding (MOU) with the Scientific Center of Zoology and Hydroecology, Institute of Molecular Biology of the National Academy of Science (NAS) RA, Research Institute of Biology, and the Yerevan State University (YSU).

In 2022, however, with WHO support, a workshop focused on implementing the WHO/FAO/WOAH Multisectoral Coordination Mechanism Operational Tool and Tripartite Zoonoses Guide was organized. During the workshop participants highlighted common human and animal diseases in Armenia and outlined steps to localize and implement the Tripartite Zoonoses Guide. The workshop was followed by a second workshop organized by CH2N/Jacobs, where participants identified gaps in legal acts regulating zoonoses and implementation of One Health approaches. The results of both workshops were summarized in the draft of the RA government's decision "On approving the 2023-2027 program for the fight against and prevention of zoonotic diseases", which will be submitted for government review and ratification (planned after the adoption of the Law on Biosafety and Livelihood).

While a national One Health coordination group is still being developed, there are lower level multisectoral groups, including the Interagency working group on Biosecurity and Livelihood (under the Security Council Office) which developed and are implementing the new Law on Biosafety and Livelihood is responsible for importing and exporting biological samples, amongst other things (Table 10). There is also an Inter-ministerial working group on One Health issues that is newly formed and is working on developing a One Health strategy for Armenia. This group is made up of representatives from MOH and Ministry of Economy as well as other researchers and experts. This is a clear example of growing national interest in adopting more One Health approaches, but officially

formalizing and providing funding and resources for One Health groups is still a challenge. Other non-national-level collaborations include a joint effort between NCDC and veterinary services on Leishmaniasis control, and a partnership between NCDC and meteorological services to provide weather information which are used for climate-sensitive diseases.

Table 10. Multisectoral coordination groups present in Armenia

NAME OF MULTISECTOR COMMITTEE/GROUP	REPRESENTATIVES	COMMITTEE MANDATE OR RESPONSIBILITIES	FORMALLY ESTABLISHED THROUGH POLICY, MINISTERIAL DECREE, OR LAW?
Interagency working group on Biosafety and Livelihood under security council office (est. 2018)	MOH Min. Economy Min. Environment Min. Emergency Min. Foreign affairs Min. Justice Min. Defense Food Safety Inspection Body National Security Service Police	Develop law on biosafety, monitor import/export of biological samples, discuss One Health and biosurveillance projects coming into Armenia.	Prime minister decree (decision N 1320-A)
Inter-Ministerial working group on One health issue	MOH Min. Economy Nongovernmental researchers and experts	One health strategy development, other issues connected with One health	Established under MOH and Min. Economy jointly

While these examples mark clear progress in strengthening One Health collaboration, there remains a culture of working through vertical programs,[12] and intersectoral decision-making in public health is recognized as essential, yet, putting it in place has proven challenging[50]. Furthermore, in many public health areas, the collaboration mechanisms (interim committees and/or working groups), though formally applied, are still largely neglected in practice, such as in routine data sharing, joint risk assessment, and multi-sectoral decision making[50]. Therefore, the challenge is mainly one of implementation[50]. "Intersectoral action is hampered globally, and in Armenia, by a prevailing view of health as the responsibility of the health sector. Strict demarcations between sectors hamper the view of health as a collective goal of high priority"[50].

In a sign of interest and dedication to improving multisectoral collaboration in health, in 2019, Armenia hosted a National Bridging Workshop on the International Health Regulations (IHR) and the

Performance of Veterinary Services (PVS) organized by the Ministry of Health, Ministry of Agriculture, Food Safety Inspection Body, WHO and WOAH. Coming out of the event, attendees concluded that collaboration gaps between the human and animal health sectors were mostly systemic, not disease specific[51]. The participants ranked the areas in highest need of collaboration as: 1) communication on priority zoonoses 2) joint field investigation and response 3) coordination at local and regional levels for registering zoonoses in a One Health framework 4) development of laboratory system 5) ensure functional surveillance system for priority diseases 6) and institutionalize a system of regular joint risk assessments[51]. 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. Similar joint workshops were held in 2022 and 2023 to discuss priority diseases and health challenges, including influenza, rabies, leishmaniasis, and other zoonoses, but additional information about those meetings is not readily available.

Successfully completing the National Bridging Workshop demonstrates the Armenian government's commitment to improve cross-sector collaboration, yet there are opportunities to involve additional sectors to enhance the country's One Health capabilities. For example, participation in the workshop heavily skewed towards the public health (55% of attendees) and animal health (37%) sectors. While these two sectors are expected to play significant roles in leading Armenia's efforts to prevent, detect, and respond to zoonotic diseases, there is an opportunity to involve other sectors, including Ministries of Environment, Nature Protection, Defense, Finance, and National Security Services, among others, to further enhance One Health systems and cross-sector collaboration. The development of a National Action Plan for Health Security will present an important chance for integration of these and other sectors and stakeholders for a more comprehensive approach.

Overall, it is clear that there is a growing interest in One Health in Armenia with a handful of dedicated champions in both government and academia, but formally institutionalizing One Health remains to be done. We urge Armenia to continue its effort to establish a national One Health MCM with broad representation across ministries. While institutions such as MOH and Ministry of Economy are justly poised to lead One Health initiatives, other sectors including Ministry of Environment, Food Safety Inspection Body, National Security Service, and non-governmental experts including university researchers and the private sector would be valuable additions. 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.

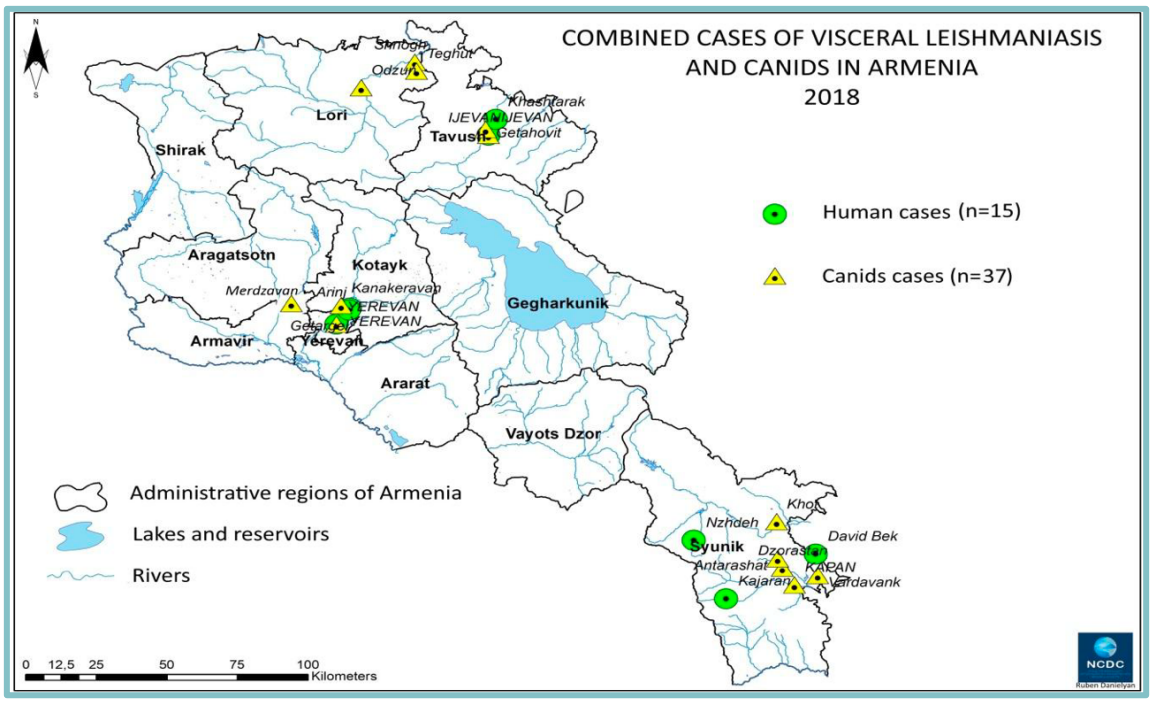
13.3 Cross-sectoral biosurveillance systems for disease reporting and data sharing

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[52]. 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[29].

Armenia is in the process of rolling out a new national Electronic Integrated Disease Surveillance System (EIDSS) , which when completed will provide near real-time surveillance and information sharing across the human and animal health sectors (including zoonotic diseases). The purpose of EIDSS is to integrate epidemiological, veterinary, food safety, and vector surveillance data with a laboratory component and joint data analysis capabilities[53]. 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.

Laboratory research is also monitored in a joint database at the Ministries' Central Facility. There is also a plan for notifications from the primary medical institutions to be received electronically by connecting them with the Integrated Health Information System of Armenia (IHISA) electronic medical record system. An example of shared human and animal health data used jointly to map cases of Visceral Leishmaniasis can be found in Figure 10.

Figure 10. Shared biosurveillance data from both humans and canids are used to map out cases of Visceral Leishmaniasis in Armenia, 2018



Moreover, notification of infectious diseases is a legal requirement in Armenia.[44] In the case of zoonoses, both NCDC and the Food Safety Inspection Body (SATM) will be notified. And there are standard case definitions that are regularly reviewed in accordance with IHR and EU directives. Veterinary services also uses standard case definitions and reports notifiable diseases to the World Organization for Animal Health (formerly OIE). Any medical practitioner with a patient diagnosed with a disease on the official 'list of notifiable diseases' is required to notify NCDC. There are 41 nosocomial diseases and unexpected/unusual public health events that require immediate notification and 144 other communicable diseases that require notification within 24 hours[44] (Table 11). Despite these legal requirements, not all private laboratories report all their cases of infectious disease[44]. This is an area where public and private sector collaboration could be improved. Additionally, disease outbreaks are investigated by multidisciplinary rapid response teams consisting of Food Safety Inspectorate experts and public health experts from NCDC/MOH.

Table 11. Example priority notifiable diseases, Armenia

HUMAN DISEASES	ANIMAL DISEASES	ZOONOSES
• All vector-borne diseases	• African Swine Fever • Classical Swine Fever • Lumpy Skin Disease • Newcastle disease	• Anthrax • Brucellosis • Foot-and-mouth disease • Rabies

In terms of vector surveillance, NCDC conducts routine entomological and ectoparisitological surveillance all over the country as part of the national vector-borne disease control programming. There is, however, a specific mention of the need to apply a One Health approach to strengthen intrasectoral and intersectoral collaboration – particularly with the private sector and NGOs – involved in vector control planning, implementation, monitoring, and evaluation in the National Vector Control Needs Assessment[44].

In terms of wildlife biosurveillance, there are several research projects aimed at studying zoonoses, including among bats, rodents, and birds. Wildlife biosurveillance research is usually conducted by the National Academy of Sciences of the Republic of Armenia, YSU, and the National Academy of Sciences of Ukraine. Other NGOs also partner on zoonoses research in the country.

13.3.1 Laboratory Data Sharing

In terms of laboratory capacity, NCDC is responsible for coordination of the overall laboratory network. There is a main NCDC reference laboratory (designed for biological agents of risk group 1&2) with 10 specialized laboratories, including the laboratory of particularly dangerous, natural foci and zoonotic infections, and the laboratory of epizootology, ectoparisitology, and entomology[44] (Figure 11).

Figure 11. NCDC reference Laboratory branches

- Department of medical immunobiological preparations
- Bacteriological laboratory
- Laboratory of virology
- Laboratory of parasitic disease
- Laboratory of particularly dangerous, natural foci and zoonotic infections
- Sanitary-chemical laboratory
- Toxicology laboratory
- Laboratory of radiology
- Prion laboratory
- Laboratory of epizootology, ectoparasitology, and entomology

Developing surveillance systems in sectors outside of human health is also critical to detect and swiftly respond to zoonotic disease outbreaks and other health threats. Environmental data, for instance, can help authorities recognize specific areas where disease outbreaks may be more likely to occur. For example, a geospatial analysis of all Tularemia cases in Armenia between 1996-2012 showed that the majority of cases were associated with the steppe vegetation zone, elevations between 1,400 and 2,300m, and the climate zone associated with dry, warm summers, and cold winters[54]. Characterization of these environmental factors can be used to improve Tularemia surveillance and outbreak response. Despite this, Armenia still lacks adequate monitoring of other environmental indicators (e.g., food, workplace, soil, and housing) and data collection and surveillance of behavioral and biological factors are dependent on external funding[50].

There is also a veterinary epidemiological surveillance system in Armenia. There are regional epidemiologists of the Center for Veterinary Sanitary and Phytosanitary Services of the SNOC, who carry out primary veterinary epidemiological control, as well as inspectors of the Ministry of Health and Welfare, who carry out case investigation, outbreak surveillance.

Additionally, in the laboratories of general parasitology and helminthology and molecular parasitology of the National Academy of Sciences of RA, parasitological studies of pathogenic material taken from wild animals, including parasitic zoonoses, are regularly carried out, but the institutions do not have the authority to conduct studies related to infectious diseases.

It is common for there to be an imbalance in capacity and capability of different sectors to conduct information sharing[29], nonetheless it is important for each sector to understand their role in contributing to biosurveillance as each sector brings in different expertise and perspectives. Integration of environmental and agricultural surveillance data with EIDSS provides a natural opportunity to improve multisectoral collaboration on biosurveillance through data sharing, risk identification and zoonotic disease monitoring in humans, animals, and the environment.

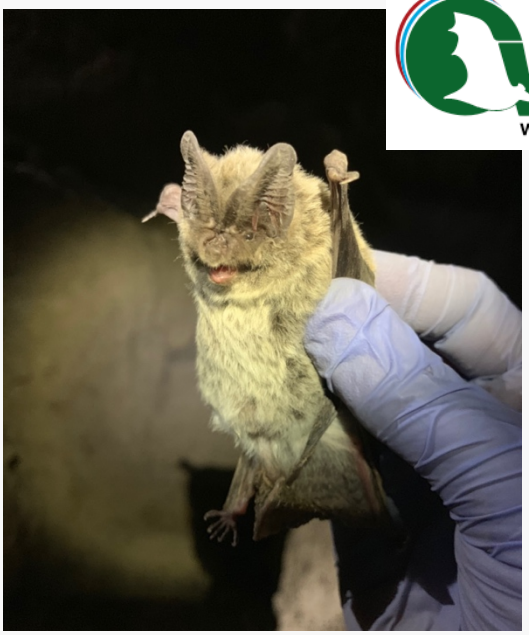
13.3.2 Regional collaboration for biosurveillance and data sharing

Armenia is an active participant in several collaborative biosurveillance projects in the Caucasus region. These partnerships provide Armenia 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:

- Expanding Multidisciplinary Collaboration within BNSR: Biosurveillance Network of the Silk Road (2015 – ongoing) – BNSR is a NGO aimed at developing a functional disease surveillance network in Eastern Europe. It hosts annual cross-border meetings and regular teleconferences between veterinarians and epidemiologists. Through the BNSR, a cross-border surveillance mechanism with Armenia and Azerbaijan has been set up, providing urgent and monthly notifications for disease outbreaks.
- "One Health Network for the Prevention of Arboviral Diseases Around the Mediterranean and Sahel Regions (MediLabSecure)" (2014 – ongoing) – network of regional public and animal health experts from the EU and neighboring countries. In Armenia there is work with human and animal virology labs, medical entomology lab, and public health and veterinary services.
- There is also regional cooperation in the field of chemical, biological, radiological, and nuclear defense (CBRN) between Armenia, Azerbaijan, and Georgia
- Epidemic Intelligence Information System (EPIS)
- European network of Legionnaires disease surveillance
- TESSY/The European Surveillance System
- VectorNet – European network for sharing data on the geographic
- distribution of arthropod vectors, transmitting human and animal disease agents
- 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 Yerevan State University, researchers in Armenia are characterizing the diversity of bats and bat-borne coronaviruses (CoVs) in Armenia while training in best practices for bat sampling and biosafety to improve field sampling efforts and our understanding of bat species native to Armenia, and the region.



WABNet
Western Asia Bat Research Network

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 2014, a joint decree of the Ministries of Health and Agriculture defined a list of eight priority zoonotic diseases of greatest public health concern (Table 12). They are anthrax, avian influenza, brucellosis, glanders, leptospirosis, rabies, and tuberculosis. Guidelines with SOPs for joint approach in the detection and control of all priority zoonotic diseases have also been developed[12]. Independent to that list, in 2012, researchers from GeoHealth Hub conducted a health needs assessment in Armenia and found that following zoonotic diseases to be significant problems: anthrax, brucellosis, leishmaniasis, and tularemia[49].

Table 12. Priority zoonoses in Armenia

PRIORITY ZOONOTIC DISEASES OF GREATEST PUBLIC HEALTH CONCERN	ADDITIONAL ZOONOSES IN ARMENIA
• Anthrax • Avian influenza • Brucellosis • Glanders • Leptospirosis • Rabies • Tuberculosis	• Tularemia • Q-fever • Lyme disease • Leishmaniasis • Echinococcosis • Tenidoses • Listeriosis • Arboviral infections • Plague

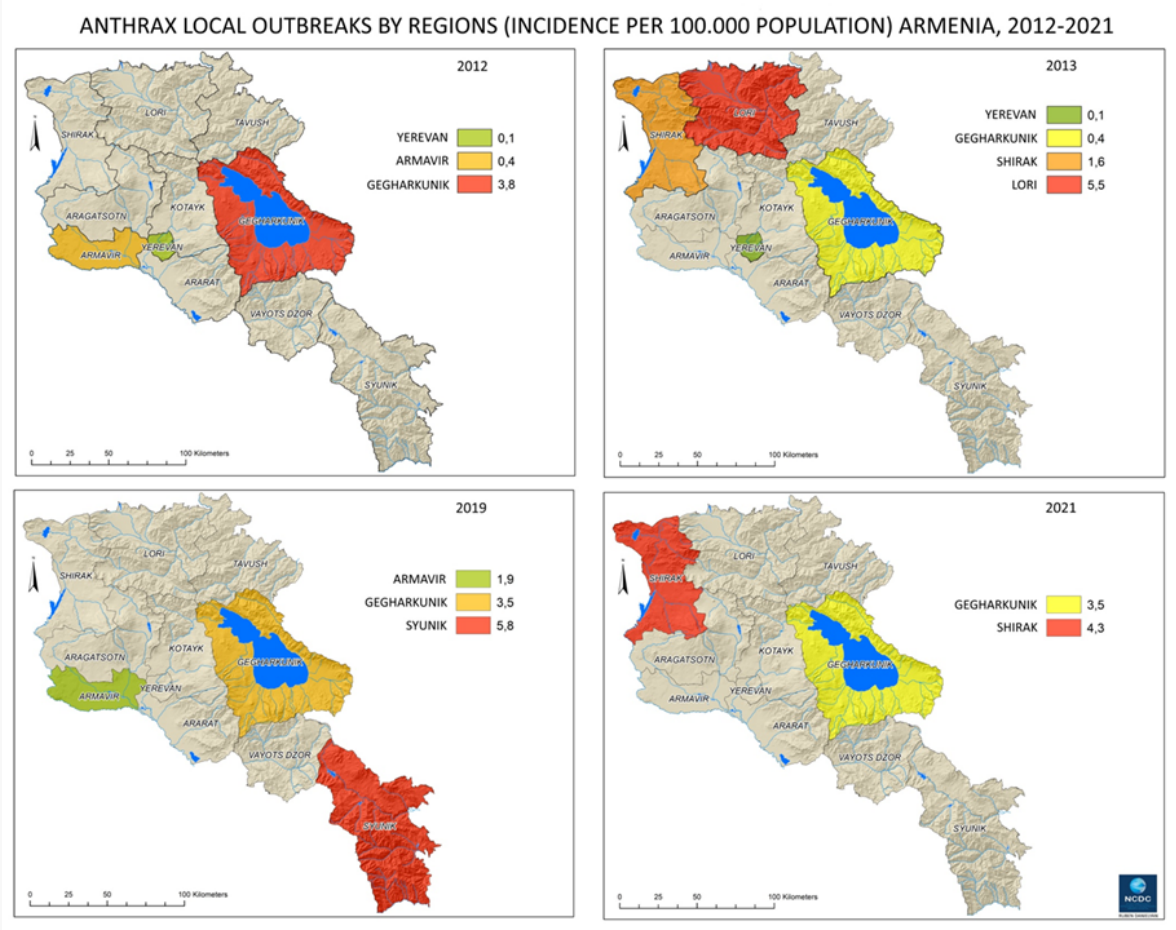
Priority zoonoses based on 2014 joint decree between the Ministries of Health and Agriculture

In addition to publishing a joint list of priority zoonotic diseases, joint preparedness planning can also improve multisectoral coordination and efficiency. For example, Armenia has a public health emergency response plan, but there is a need for continuous joint training between the different sectors, including law enforcement and security[12]. More information on public health and One Health roles and responsibilities can be found in Table 3.

BOX 3.

Joint outbreak response to save lives in Gegharquniq and Shirak

In 2021, an outbreak of anthrax was deducted in the Gegharquniq and Shirak regions of Armenia. A full-scale, multisectoral response was quickly launched with coordination between the Food Safety Inspection Body, Ministry of Economy, Ministry of Health, National Security Service, police, regional administrations and medical facilities. To prevent further disease spread, large scale risk communication and public awareness raising activities were organized, as well as laboratory examination of suspicious meat/products, vaccination of animals, proper destruction of infected meat, and human isolation were enacted. Thanks to this whole-of-government cooperation the outbreak was quickly ended.



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[29]. 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[55]. Thus, effective messaging must be in place for accurate, transparent, and coordinated information flow to the public, ensuring credibility to counter potential misinformation[13].

In the National Bridging Workshop on the International Health Regulations the participants voted that improvement of communication on priority zoonoses was the highest priority objective to strengthen intersectoral collaboration for the country[51]. Compared to other 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. An example of the challenges of effective risk communication and success of cross-sector coordination is presented in Table 13.

Table 13. Challenges and success in combatting highly pathogenic avian influenza

CHALLENGES IN COMMUNICATION	SUCCESS IN COORDINATION
Highly pathogenic avian influenza (HPAI) has pandemic potential. To minimize the threat to humans, it is important to prevent disease outbreaks among domestic poultry. Previous projects, including the World Bank's Avian Influenza Preparedness project[55], have targeted information raising campaigns to people in closest contact with these animals with mixed success. These campaigns often target backyard and commercial farmers, their employees and families with messages hoping to prompt behavior change in the management of poultry through TV and radio spots, leaflets, training programs and children's puppet shows. At times these have shown to be effective in strengthening biosecurity measures but competing local and international media can also cause confusion, misinformation, and panic, particularly among backyard farmers. For example, during a previous HPAI scare that occurred during the project period of the World Bank's Avian Influenza Preparedness project[55], one community veterinary officer estimated that some 60 percent of backyard farmers had slaughtered all their poultry, while other interviews indicated the percentage could be higher[55]. This example epitomizes the challenge that public and animal health experts face. Even with well-developed risk reduction messaging and media, breakthroughs in behavior change can be very difficult or even lead to counterproductive behavior due to misinformation.	Several years ago, in the face of reported outbreaks of H5N1 HPAI in neighboring countries and human deaths from avian influenza in Turkey and Azerbaijan, Armenia in did not have any confirmed cases of HPAI. This was largely due to a quick government response that included an inter-ministerial task force to coordinate between various government agencies[56]. The task force was effective in implementing bans on poultry imports, surveillance at the border posts and communication with the public. The veterinary services was also able to utilize the semi-private community veterinarians and state inspectors for timely surveillance. This success was also, in part, due to Armenia's ability to quickly secure international funding for its HPAI program by designing a national HPAI program under the Global Program for Avian Influenzas' framework in just a few months[56]. By the end of this HPAI scare, with additional support from USAID and the World Bank, Armenia significantly enhanced its veterinary services capacity to prepare and respond to avian influenza outbreaks, while strengthening the veterinary system as a whole.

Health communication in Armenia appears to be revolved around emergency communication and disease outbreaks, rather than day-to-day health communication and dissemination of scientific findings. Every ministry in Armenia has a public relations department with trained spokes people, but there is a need for more proactive communication with communities to strengthen the risk communication system and enhance community trust[12]. While vertical communication within a ministry generally works well, prior simulation exercises have shown that cross-communication between regions and departments is less developed[12].

This siloed communication often shows up in the form of information dissemination.

For example, many government reports are not publicly available online, or only exist in physical print and are not disseminated to departments and ministries outside the ones who produced the information. Moreover, academic journals in Armenia usually only publish information in-print and are not readily available online, preventing widespread dissemination of scientific findings. This hinders potential collaboration between academia 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. Additionally, Armenia 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.

Recently, due to COVID-19, television has begun to pay more attention to scientific life and scientific research in general. Some programs are also devoted to zoonoses and scientific groups involved in the study of zoonoses. However, information is often presented by unprofessional journalists, which has led to misinformation, confusion, and can pose challenges for health communication and risk reduction in the country.

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[29]. 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[12]. 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[12]. 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[57].

The number of veterinarians in Armenia has dropped significantly over the last few years. Between 2015-2017, there were an estimated 1,323 veterinarians, which has since declined to 853 in 2018 and 590 in 2019[58] (Table 14). This is in part, due to the fact that veterinary medicine is not attractive to some young people because of harsh working conditions, long hours, and

low wages. The number of veterinarians in Armenia is now just below a sufficient level based on the Joint External Evaluation threshold of at least 600 veterinarians needed in the country. The number of community animal health workers has also drastically declined from 635 in 2018 to 240 in 2019[59]. Conversely, the number of animal health personnel in the public sector has steadily risen over the past few years from 87 in 2015 to 163 in 2018[58]. It is unclear what specifically has caused these trends, and these mixed results suggest that there is a pipeline for training animal health and para-veterinary professionals, but an in-depth look at the animal health workforce and strategy could be beneficial to help revamp the veterinary workforce.

In terms of human health, the number of medical doctors has risen going from 29 per 10,000 population in 2015 to 44 per 10,000 population in 2019[59]. It is unclear as to what the number of environmental and occupational health professionals is in Armenia, as data is not as readily available. In terms of vector management staff, there are clear roles and responsibilities, but there is a need for a human resources development plan[44]. Furthermore, national level staff, specialists, and regional level staff all are trained in vector monitoring and control activities, but capacity building and training on vector identification, molecular biology, and Geographic Information System (GIS) mapping is needed[44].

Regarding training and professional development, veterinarians regularly participate in the South Caucasus Field and Epidemiology Laboratory Training Program (SC-FELTP), but it is not clear what percentage of veterinarians receive One Health training on the public health aspects of animal health[12]. There are also graduate level university level programs at Armenian National Agrarian University (AAU) and Yerevan State University (YSU) on epidemiology and infectious diseases (including for animals) that offer professional training before people enter the formal workforce. The Department of Zoology at YSU operates a master's program "Zoology and Parasitology", where a number of subjects related to One Health are taught. Also, in the 2024-2025 school year, a new master's program at the Faculty of Biology of YSU is planned to open which will include an educational block dedicated to One Health.

Doctors, epidemiologists, and other human health professionals would also benefit from One Health training – particularly on the animal health side of things – therefore increasing training for doctors, veterinarians, and community animal health workers– particularly in rural areas – would be beneficial and could provide an opportunity to enhance coordination and joint educational training through a One Health approach. For example, Armenia could adapt learning materials from 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.[60]

Table 14. One Health workforce country-level indicators

INDICATOR	VALUE	YEAR	SOURCE
Veterinarians (number)	590	2019	WOAH-WAHIS
Public animal health professionals (number)	163	2018	WOAH-WAHIS
Community animal health workers (number)	240	2019	WOAH-WAHIS
Medical doctors (number)	12964	2017	The National health Workforce Accounts database, World Health Organization, Geneva
Medical doctors (per 10,000 people)	44.02	2017	The National health Workforce Accounts database, World Health Organization, Geneva
Nursing personnel (total)	Data not available	Data not available	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	Since 2009; intermediate since 2023	South Caucasus Field Epidemiology Training Program
Up-to-date multisectoral workforce strategy (1-5)	NA	NA	JEE

Another key indicator of a strong One Health workforce is a well-functioning human and animal laboratory system. A well-functioning system is able to reliably support outbreak and surveillance activities including running diagnostics for animal, food, water and environmental samples. A recent laboratory improvement project aimed at enhancing quality management systems in both human and animal labs found marked improvements in organizational structure, human resources, equipment management, supply chain, and data management between 2017-2020[61].

The biggest deterrent to laboratory improvement was the lack of quality and biosafety managers and appropriate mentorship from central laboratory expertise down to Marz level laboratories[61]. While laboratory capacity is improving in Armenia, continual management training and knowledge sharing between human and veterinary lab specialists should be considered.

13.6.1 Field Epidemiology and Laboratory Training Programs

One notable component of Armenia's 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. Armenia has now graduated to the FETP-frontline and EE FETP intermediate programs.

In addition to the SC-FELTP, Armenia now has its own Armenia Field Epidemiology Training Program (FETP), which was established in 2021 by graduates of the SC-FELTP. The Armenian FETP is a collaboration between the NCDC and National Institute of Health of the Ministry of Health of the Republic of Armenia and the Ministry of Economy and Food Safety Inspection Body[62]. The purpose of this FETP is similar to the SC-FELTP in that it trains national, regional, and district field epidemiologists to strengthen Armenia's epidemic surveillance, preparedness, and response. The first cohort of FETP graduates (~40 people) completed their training in 2022.

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[63]. Environmental health metrics are less well-defined within the human-animal-environmental triad[63], 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, 63]. 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, 29, 63-66].

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, 63]. 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 (FELTP) that includes human disease epidemiologists as well as domestic and wildlife veterinarians
5. Disease-specific targets (e.g., brucellosis, ASF, tuberculosis etc.)

Armenia has completed several of the high-level national indicators mentioned above, including developing assessments, national action plans, and participating in the South Caucasus Field Epidemiology and Laboratory Training Program. There is, however, no specific system in place to systematically monitor and evaluate responses to zoonotic events, nor community mobilization and communication, thus developing a system could be beneficial for future response efforts[12, 44].

14 ONE HEALTH CASE STUDY

14.1 Implementing a multisectoral approach to Visceral Leishmaniasis surveillance

In 2018, a collaboration between private veterinarians and dog-lovers clubs in Yerevan began to form because of a Visceral Leishmaniasis (VL) outbreak. The veterinarians found 11 (20.8%) VL-positive domestic dogs out of 52 investigated dogs with clinical signs (weight loss, hair loss, nose bleeding, etc.). At the same time, the general population as well as scientists from the Institute of Zoology of the Scientific Centre of Zoology and Hydroecology (National Academy of Science of Armenia) noticed an increase in the population of wild jackals in the same area where the incidence of VL was the highest in recent years (regions of Syunik, Lori, and Tavush). To better understand the transmission dynamics – including hosts/reservoirs between wild and domestic canids – Leishmania ecology and develop effective disease control strategies a comparative investigation was launched.

Fieldwork was conducted to find infected jackals and compare biologic samples to those of domestic dogs. The "Republican veterinary-sanitary and phytosanitary centre of laboratory services" SNCO led the investigation of 90 jackals and, for comparison, 90 dogs in three regions of Armenia most affected by VL. Jackals were hunted in presence of veterinarians and were sampled on spot. Domestic dogs were sampled and tested with rK39 tests. Ninety (90) jackals were investigated by rK39 tests, from them, 15 (16.7%) tested positive for VL. Ninety (90) domestic dogs were investigated by rK39 tests, from them, 10 (11,1%) were VL-positive. The study showed that both domestic dogs and wild canids can be reservoirs for VL, and highlights the multidisciplinary approach to disease detection and zoonoses research by involving private veterinarians, government institutes of zoology and science, and the general public in identifying a One Health issue.

Despite this research, continual prevention of VL remains challenging in Armenia as culling of sick dogs is not a legal requirement and it is up to people to care for their own dogs. For the last seven years an ongoing communication campaign has been implemented, however, that is raising public awareness and educating people, especially veterinarians and medical staff about the prevention and treatment of VL. Additional measures that could be taken to reduce the spread of VL, include expanding testing capacity to investigate suspected cases, cull confirmed dogs, and provide educational materials for early detection and case management to private veterinarians in all marzes (administrative districts).

15 RECOMENDATIONS – Next Steps to Advance One Health in Armenia

Table 15. Recommendations to advance One Health in Armenia

RECOMMENDATION	JUSTIFICATION
Finalize 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 technical working groups that already focus on One Health-related issues, including the Intergovernmental Biosecurity and Biosafety working group (under the Security Council Office) working group developing the new national biosafety regulation, and the National Inter-Ministerial Steering Committee for Zoonoses.
	Having recently completed workshops on implementing the WHO/FAO/WOAH Multisectoral Coordination Mechanism Operational Tool and Tripartite Zoonosis Guide, there is clearly government interest at the technical level, including within the MOH, Ministry of Economy, Food Safety Inspection Body, Research centers of NAS, and universities/academia.
	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 Environment, Ministry of Economy, National Security Council, Food Safety Inspection Body, Environmental Protection and Mining Inspection Body, National Academy of Sciences, Academia, and potentially other institutions (e.g. Ministry of Education, Economy).
Complete a NAPHS with a multisectoral group of government experts	The process to complete a NAPHS 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[47]
	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 2016-2020 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 Armenia'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	Ecotourism, particularly cave exploration, is a problem in Armenia and currently there are few protective measures to prevent human/wildlife contact at these sites – some of which harbor high risk specie, e.g., bats that could transmit zoonoses
	"Instilling an environmental mindset" and expanding environmental education is a stated objective of the National Security Strategy, providing an opportunity to make progress on both environmental health and national security under a One Health umbrella[28]
	Public awareness raising efforts have succeed before e.g., NCDC previously partnered with tourism agencies to provide information about Zika virus
	A public-private partnership between tourism agencies and the government of Armenia could help advertise for private tourism business by promoting safe ecotourism.
	Armenia is 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 Armenia via ecotourism, just in a safer manner.
	Currently, there is limited education for tourist guides (e.g., a few informal meetings with guides and academic/research experts) that are narrowly focused on animal health and do not provide adequate information about the risk of zoonotic disease or environmental conservation.
Improve the transparency and timeliness of health-related information dissemination to additional sectors, departments, and academicians	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 Armenia 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 Armenia'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 Armenia's ability to drive change and strengthen One Health processes[47]

	It is crucial to finish the development and implementation of EIDSS to provide real-time surveillance and information sharing between human and animal health sectors, especially for zoonoses. Once finalized, EIDSS can provide the basis for wildlife disease data management.
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.
	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 Workforce development, including professional training on One Health	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., FELTP) – including training veterinarians on the public health aspects of One Health and environmental health experts on conservation and its role in zoonotic disease emergence.
	It could be beneficial to develop specific One Health training courses or modules at higher education institutions, including at YSU, AAU, and the National Institute of Health. For example, zoology is not currently part of the veterinary curriculum of AAU, which hinders veterinarians understanding of the connection between zoonoses and wildlife.
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.
	Improve metadata standards and criteria for the minimum necessary data needed for sharing One Health or biosurveillance data across platforms

16 CONCLUSIONS

The Republic of Armenia 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 Armenia to be a One Health leader in the Caucasus region. By formalizing a national One Health body and expanding sectors and stakeholders involved in routine and emergency operations, Armenia 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 Armenia 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
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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
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5. Integrated approaches to health: A handbook for the evaluation of One Health
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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

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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 (2-3 December 2021) had ~18 people with representatives from:

- Ministry of Health (National Center for Disease Control and Prevention)
- Ministry of Environment
- National Academy of Sciences, RA
- Security Council Office
- National Bureau of Expertise
- Health and Labor Inspection Body
- Yerevan State University
- Armenian National Agrarian University
- 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 ~13 Armenian representatives from:

- Ministry of Environment
- NCDC
- Security Council Office
- Health and Labor Inspection Body
- Yerevan State University
- National Academy of Sciences
- Hydrometeorology and Monitoring Center

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 Armenia. 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 Armenia
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 12). 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 16).

Figure 12. Example Operationalizing One Health Framework with definitions

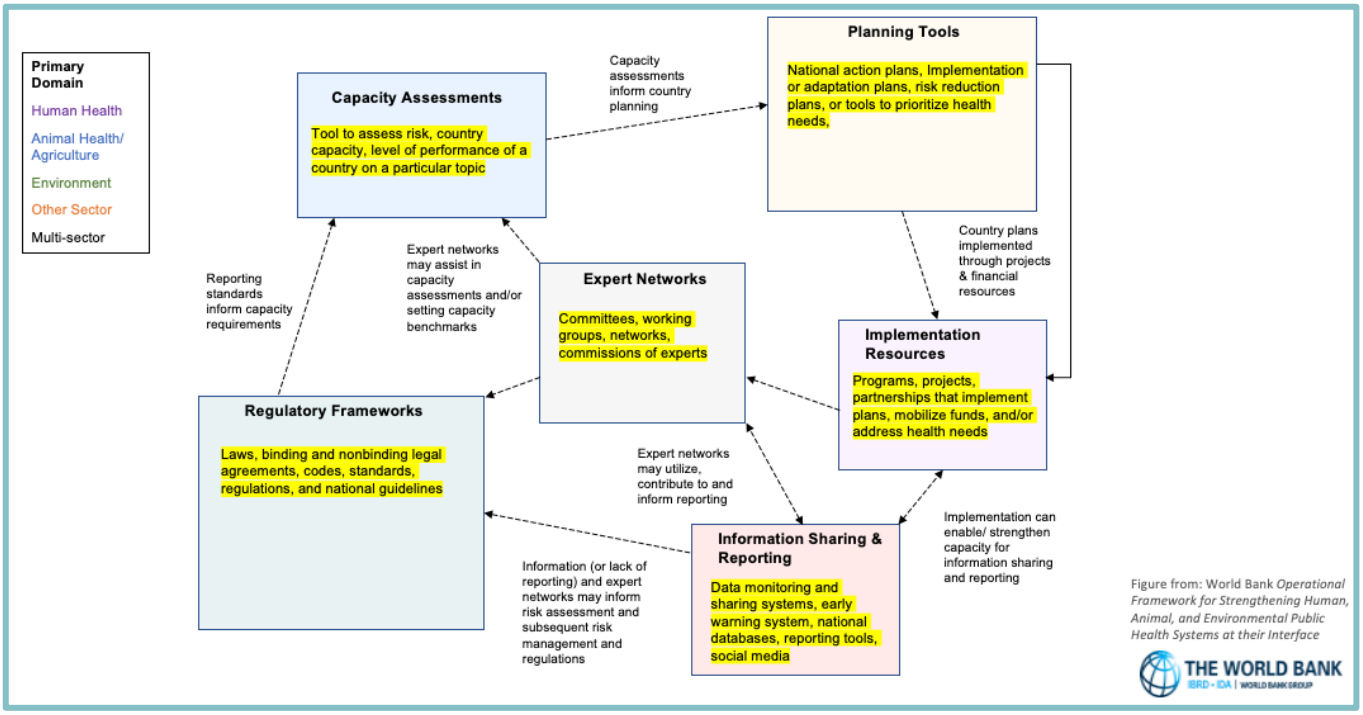

Table 16. Operationalizing One Health framework reformatted to a table for editing

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 Armenia

Participants were provided with an example template (Table 17) 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 Armenia. Both the example template and blank template (Table 18) given to participants are provided below.

Table 17. 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 18. 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 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 Areni-1 Cave (Vayots Dzor province) 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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