Baseline and Capacity-Building Needs Assessment for the project on Strengthening One Health-Based Prevention, Preparedness, and Response (PPR) in the Greater Virunga Landscape (GVL)

BASELINE ASSESSMENT REPORT



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Acronyms and Abbreviations

AAR	After Action Review
AFENET	African Field Epidemiology Network
AHW	Animal Health Worker

ASSP	Agents de Santé et de Surveillance Primaire (DRC)
BSL	Biosafety Level
BSL-3	Biosafety Level 3
CHW	Community Health Worker
DEO	District Environment Officer
DHIS2	District Health Information Software 2
DIDMAC	District Disaster Management Committee
DHO	District Health Officer
DLFP	District Laboratory Focal Person
DRC	Democratic Republic of the Congo
DVO	District Veterinary Officer
EAC	East African Community
ELISA	Enzyme-Linked Immunosorbent Assay
EMA-i	Event Mobile Application (WOAH animal reporting tool)
ESMP	Environmental and Social Management Plan
ESSF	Environmental and Social Safeguards Framework
FAO	Food and Agriculture Organization of the United Nations
FETP	Field Epidemiology Training Program
FGD	Focus Group Discussion
GD	Gorilla Doctors
GESI	Gender and Social Inclusion
GIS	Geographic Information System
GVL	Greater Virunga Landscape
GVTC	Greater Virunga Transboundary Collaboration
HPAI	Highly Pathogenic Avian Influenza
HRH	Human Resources for Health
ICCN	Institut Congolais pour la Conservation de la Nature (DRC)
IDSR	Integrated Disease Surveillance and Response
IGAD	Intergovernmental Authority on Development
IGCP	International Gorilla Conservation Programme
IHR	International Health Regulations (2005)
INRB	Institut National de Recherche Biomédicale (DRC)
JEE	Joint External Evaluation
KAP	Knowledge, Attitudes, and Practices
KII	Key Informant Interview
LC	Local Council
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MEL	Monitoring, Evaluation, and Learning
MoFPED	Ministry of Finance, Planning and Economic Development
MoH	Ministry of Health
MoWE	Ministry of Water and Environment
NADDEC	National Animal Disease Diagnostics and Epidemiology Centre
NAPHS	National Action Plan for Health Security

NEMA	National Environment Management Authority
NGO	Non-Governmental Organization
NGS	Next Generation Sequencing
NOHP	National One Health Platform
NRL	National Reference Laboratory
OHAT	One Health Assessment Tool
OHCA	One Health Community Assessment
OHTWG	One Technical Health Working Group
PCR	Polymerase Chain Reaction
PHEOC	Public Health Emergency Operations Centre
POC	Point of Care
PoE	Point of Entry
PPR	Prevention, Preparedness, and Response
PVS	Performance of Veterinary Services
PWD	Persons with Disabilities
PZDS	Priority Zoonotic Diseases
QENP	Queen Elizabeth National Park
RAB	Rwanda Agriculture and Animal Resources Board
RBC	Rwanda Biomedical Center
RCA	Root Cause Analysis
RCCE	Risk Communication and Community Engagement
RDB	Rwanda Development Board
RDTs	Rapid Diagnostic Tests
RRT	Rapid Response Team
RRH	Regional Referral Hospital
RVF	Rift Valley Fever
SOPs	Standard Operating Procedures
SPAR	State Party Self-Assessment Annual Reporting
UWA	Uganda Wildlife Authority
UNICEF	United Nations Children's Fund
UVRI	Uganda Virus Research Institute
VHF	Viral Haemorrhagic Fever
VHT	Village Health Team
WOAH	World Organization for Animal Health (formerly OIE)
WHO	World Health Organization
WWF	World Wide Fund for Nature
ZDCO	Zoonotic Diseases Coordination Office

Executive Summary

Background

One Health is a multi-sectoral and multi-disciplinary approach aimed at designing and implementing programs, policies, legislation, and research where multiple sectors communicate and collaborate to achieve better public health outcomes. The World Wide Fund for Nature (WWF) and partners, with funding from the Pandemic Fund, is implementing the Strengthening One Health-based (PPR) in the Greater Virunga Landscape project. This project aims to enhance the capacity for prevention, preparedness, and response (PPR) to zoonotic diseases using a One Health approach, strengthening capacities across the human, animal, and environmental health sectors. The African Field Epidemiology Network (AFENET) was engaged to conduct a comprehensive baseline and capacity-building needs assessment from December 1 2025 to April 10 2026.

Methods

The evaluation employed a mixed-methods approach, combining quantitative and qualitative data collection. It was participatory and community-driven to ensure inclusivity and local ownership. One Health (OH) was defined as joint: surveillance, information sharing, collaboration, budgeting, coordination, planning, financing, and outbreak response to events in humans, animals, wildlife, environment at international, national or local levels. For all ten objectives, we followed the capacity building pyramid as described by Potter and Brough, to identify the tools, skills, staffs and infrastructure, systems, and roles needed to implement One Health in the GVL.

Key Informant Interviews (KIIs) were held at national level, 16 (Uganda), 19 (Rwanda), and 14 (DRC) with OH ministry representatives and partners. A total of 76 district or territory level KIIs were held (15 in DRC, 32 in Uganda and 29 in Rwanda) with stakeholders from human health, animal health, environmental sectors, and community structures. Community level Focus Groups Discussions (FGDs) were held (22 in Uganda, 8 each in Rwanda and DRC) with males, females, local leaders, representatives of persons with disabilities, refugees, youth and the elderly. These aimed to evaluate One Health structures and implementation in communities, gender and social inclusion, perceptions, and zoonotic disease risk. Qualitative data were analyzed using an inductive–deductive thematic approach consistent with NVivo-style coding. Codes were grouped into themes and sub-themes, and frequencies were calculated as the proportion of respondents mentioning each theme. Quantitative surveys at household levels (155 in Uganda, 116 in DRC and 159 in Rwanda) to document community knowledge, attitudes and practices related to zoonoses. Descriptive summaries were computed using SPSS 21.0 to align the baseline indicators for the project. In each country, we obtained institutional review board ethical clearance, all data were anonymized prior to analysis, and we followed the WWF environmental safety standards. No personally identifiable information was included in the dataset. Priority recommendations were generated from the field actions during the validation meeting of subject matter experts through consensus by the Delphi method and 1000minds.com consultative process.

Key findings

Communities around Ugandan parks have a high knowledge score on zoonoses. Up to 89.6% of respondents agreed that collaboration between human, animal and environmental health sectors is essential for controlling zoonotic diseases. Similarly, 92.9% recognized that interactions among wildlife, livestock and humans increase the risk of disease transmission, but only 29.6% of respondents reported having ever reported unusual animal deaths. Communities perceive zoonotic disease risk as linked to livelihood activities (hunting, grazing, firewood collection). While awareness of safe practices exists, poverty and food insecurity drive risky

behaviours. Gender roles shape exposure pathways, with men facing direct risks and women/children indirect ones. High-risk groups identified: 35%, practices around dead animals: 20%, gender roles in exposure: 25%, prevention and control suggestions: 15%, and challenges and impacts: 5%. Uganda has made substantial progress in operationalizing One Health, particularly in building collaborative structures and improving outbreak response systems. These findings align with broader global evidence that post-COVID-19 investments have accelerated One Health institutionalization. However, the persistence of financing constraints (90%) underscores a critical structural weakness. The reliance on donor funding reflects a lack of domestic ownership and integration into national budgeting systems, which threatens sustainability.

Coordination challenges, reported by 65% of informants, highlight a disconnect between formal structures and functional implementation. KIIs focused more on institutional weaknesses than community behaviours. While platforms exist, their effectiveness is limited by weak accountability mechanisms and fragmented data systems. The predominance of reactive approaches (55%) mostly activated during outbreaks, suggests that Uganda's One Health system remains oriented toward downstream response rather than upstream prevention. District Task Force replaces One Health committees with functional DTFs, but dormant OH structures. surveillance is fragmented with human and animal systems not integrated and there are capacity gaps in laboratories where early detection is critical.

This baseline demonstrates that Rwanda has achieved high-level conceptual and policy maturity in One Health, with universal understanding (100%) and strong policy presence (89%). This reflects significant national commitment and alignment with global frameworks. A large majority of respondents (91.0%) reported having heard of zoonotic diseases, demonstrating widespread basic awareness. However, knowledge is concentrated around a limited set of commonly publicized diseases, including COVID-19 (44.4%), rabies (43.1%), influenza (31.4%), Ebola (29.4%), Rift Valley fever (24.2%), and Marburg (17.0%). Recognition of other important zoonoses such as brucellosis (11.1%) and anthrax (3.3%) was substantially lower. The national and district level findings reveal a consistent implementation gap, particularly in coordination (83%), financing (83%), and system capacity (78%). The heavy reliance on external funding mechanisms for coordination, such as the Pandemic Fund, highlights a structural vulnerability. Coordination challenges around data sharing and sectoral silos undermine the effectiveness of surveillance and response systems. This suggests the need for integrated digital platforms and stronger governance mechanisms. Also, the lack of routine simulation exercises and readiness testing limits the system's ability to respond optimally to emerging threats. The country needs to shift from: reactive to proactive systems; fragmented to integrated approaches; and ensuring inclusive participation.

For DRC, Mpox (80–85%), anthrax (60–70%), and Ebola (65%) were the most frequently reported priority zoonoses. While 55% of respondents reported some form of multi-sectoral collaboration, coordination was largely *ad hoc* (70%) and dominated by the human health sector (60%). At community level, handling of bush meat (74.1%), animal bites or scratches were widely recognized (74.1%), consumption of undercooked meat (37.1%) and contact with blood or meat (37.1%) were perceived as important modes of transmission. Practices like consumption of raw milk (4.3%) or sharing water sources with animals (6.0%), and the proportion of people who declared "not knowing" (18.1%) reflects a gap in knowledge that can limit prevention efforts. Preventive measures including handwashing (57.4%) and vaccination of animals (38.3%) were well recognized, while properly cooking meat (27.8%) or using insecticide-treated bed nets (10.4%) remain poorly recognized. Financial constraints (85–90%), lack of logistics (70–80%), and weak governance structures

(60%) were the most cited barriers to OH implementation. Community-level FGDs revealed risks driven by poverty, including consumption of unsafe meat (60%) and wildlife contact (50%). Although gender inclusion was acknowledged (60%), representation of vulnerable groups remained limited. From community level FGDs, five insights emerged: 1) knowledge–practice gap: communities understand risks but continue unsafe practices (especially bush meat consumption); 2) livelihood–health trade-off: economic necessity (food, income) drives risky behaviours; 3) weak One Health operationalization: the concept exists in theory but is not institutionalized locally**;** 4) human–wildlife conflict central to One Health: health risks are deeply tied to ecological and economic pressures; and 5) systemic constraints dominate: lack of funding, coordination, and inclusion limits effective One Health implementation.

Conclusion, this baseline highlights significant gaps in the implementation of the One Health approach in the GVL Despite high awareness of zoonotic threats, systemic barriers like underfunding, weak coordination, and limited integration undermine effective response. The analysis supports a systems-based conceptual framework in which One Health effectiveness is determined by the interaction of five domains: a) governance and coordination; b) financing and resources; c) surveillance and information systems; d) community behaviours and socioeconomic context; and e) human resource capacity and inclusion. Weaknesses across these domains vary by country, and collectively constrain the operationalization of One Health in the GVL. Addressing these challenges requires coordinated investments across institutional, technical, and community levels to transition from reactive to preventive One Health systems. Advancing One Health in the GVL will require a multifaceted approach that addresses behavioural, structural, and institutional barriers. Interventions should prioritise implementing these recommendations so as to improve early detection of zoonotic diseases, strengthen outbreak preparedness, reduce disease transmission at the human–wildlife interface, and enhance community resilience. Other key findings, policy, and practice recommendations are summarized in the table below.

Table 1: Summary of the key findings and baseline data for the project indicators

		Baseline level			
Key finding	**Capacity Area & Indicators**	**Uganda (GVL)**	**DRC (North Kivu)**	**Rwanda**	**Prioritized recommendations**
1. Hotspot Identification and Risk Profiling	Hotspots integrated into digital surveillance (%)	**100%**	**50%**	**100%**	- Establish or strengthen sentinel surveillance sites for RVF, YF in the GVL - Improve critical infrastructure for prevention (wildlife-human interface barriers, access to safe water - Conduct economic evaluation studies on outbreaks, prevention and preparedness cost benefits - Address socioeconomic drivers by promoting alternative livelihoods and sustainable agriculture to reduce dependence on bush-meat and wildlife resources.
More than 30 villages and surrounding communities were hot spots due to human wildlife conflicts, close interface with wildlife, with livestock grazing areas, trade and migration routes, high mobility of humans, livestock and wildlife, and sharing of water resources. The names of villages can change when these dynamics change. Routine surveillance data was collected and reported from these communities.	No. of contingency plans developed	7 Plans. Integrated into NAPHS II	5 Plans. Finalized under ROHSP II	3 Plans. Ebola active; Mpox being updated	
2. One Health Policy and Institutional Frameworks The policy guidance and frameworks existed in the three countries; committees existed at national, and sub-national levels, although there was less structural coordination of One Health at community level. Teams work together mainly when there is a threat or real event, less during the preparedness phase.	Developed policy recommendations on OH PPR	Yes	Yes	Yes	- Strengthening multi-sectoral cross-border coordination, collaboration and data sharing - Fast-track the 2022 Wildlife Compensation Regulations (Uganda) to reduce impact of human wildlife conflicts - Institutional strengthening by activating One Health teams at Sub-county and District levels to develop work plans, jointly implement.
3. Surveillance and Early Warning Systems The systems were both paper based and electronic across human, livestock and wildlife surveillance in the three	Number of decision-making instances based on signals	3, using the 7-1-7 Framework	Not captured	30,728	- Adopt interoperable digital cross-border surveillance platforms for human animal-environmental health data across ministries and cross-border.
	Average time between disease detection and alert issuance	24 – 48 hours	48 hours	24–48 hours	

countries. Early warning and preparedness activities existed with regular reports. There was limited cross-sectoral data sharing per country and no cross-border interoperable system across the GVL. DRC benefits from the Famine Early Warning Surveillance network (FEWSNET) and other reports on health and security.	No. of functional digital surveillance systems established	3 (human), 2 animal, 2 wildlife)	3 (human), 2 animal, 2 wildlife)	3 (human), 2 animal, 2 wildlife)	- Conduct community "sentinel surveillance" training by scaling the Village Health and Conservation Team (VHCT) model. - Identify and train stakeholders at the animal, environment, and human interface to use the One Health approach in surveillance and reporting - Create mandatory monthly data-sharing meetings between Park Wardens (wildlife), DVOs (livestock), and DHOs (human) - Develop, translate, and disseminate case definition on common wildlife zoonoses to the GVL districts - Share laboratory protocols for biobanking and reference testing across countries.
	Digital System Interoperability (%)	0%	0%	0%	
	Average time (days) between detection and alert	1 day	1-2 days	1-2 days	
	Zoonotic spill-over alerts validated by authorities	3 (using the 7-1-7 framework)	3 (investigated and responded to)	15.8% (4855 alerts)	
4. Laboratory Diagnosis & Diagnostic Networks There was a strong laboratory system for human health, moderate capacity for livestock diagnostics in the GVL. Each country had a major laboratory that handles wildlife samples. Cross-country reference testing is not yet in place.	BSL-2 Laboratories Audited	17	1	2	
	BSL-3 Laboratories Audited	3	1	0	
	Standardized lab protocols in use for transboundary testing	0	0	0	
	Samples bio banked according to SOPs (%)	22%	10%	28%	
	Number of biosafety and biosecurity protocols developed	50-80% of laboratories have them	22%	34.5% of laboratories	
	% of samples (Wildlife/Human) bio banked according to SOPs	**Biobanking:** 85% Human, 35% Domestic, 22% Wildlife.	**Biobanking:** 88% Human, 42% Domestic, 28% Wildlife.	**Biobanking:** 45% Human, 15% Domestic, 10% Wildlife.	
5. Human Resource Capacity The public health human resource capacity existed to support zoonotic disease prevention, preparedness and response at varying levels per country. The human health sector was more empowered, followed by livestock and environmental health. Communities had resource persons supporting surveillance and event reporting, prevention activities and risk communication.	No. of frontline staff assessed	35	3	N/A	- Establish cross-border rapid response teams with agreed verification protocols and secure access plans for conflict-affected zones in DRC. - Conduct cross-border simulations to share experiences and trainings of different cadres of staff in human, animal and wildlife settings - Improve veterinary service access by lobbying for deployment of more veterinary officers to underserved
	Trained stakeholders showing improved skills (%)	92%	78%	94%	
	One Health experts per District/Sector adjacent to GVL	3.5/10,000	1.8/10,000	4.2/10,000	
	No. stakeholders trained; % demonstrating improved skills	1,240 Trained. 92% skill improvement (AFENET, 2025).	860 Trained 94% skill improvement (RBC, 2026).	1,520 Trained. 78% skill improvement (Africa CDC, 2026).	

6. Points of Entry (PoE) Capacity All GVL countries had established capacity at official and gazetted PoEs. The designated PoEs were reporting and building IHR capacities as per WHO guidance. Goma International airport was closed. Use of porous borders continues to present risk.	Airports/Border posts assessed via WHO criteria	16	10	12	rural areas and expand livestock vaccination programs. - Organize regular sensitization sessions of communities and VHTs to strengthen joint surveillance. - Continue training and skills enhancement to address knowledge and attitude gaps among OH teams
	Customs/Border personnel trained on OH protocols	77.1%	0	0	
	No. of PoE (Airports/Land) assessed using WHO criteria	**16 Assessed.** 2 Airports, 14 Land Borders;	**10 Assessed.** 2 Airports, 8 Land Borders (World Bank, 2026).	**12 Assessed.** 3 Airports, 9 Land Borders (WHO, 2025).	- Introduce One Health into the training of teams at PoEs. - Support laboratory capacities at PoEs for effective preparedness and timely detection of events.
7. Multi-Sectoral Coordination: GVTC and EAC were coordinating several health related activities of multi-disciplinary nature. Several conservation partners and multi-country international NGOs were operating in the three countries and coordination OH activities across the landscape. The national One Health committees were active and support sub-national coordination of OH. The multi-sectoral committees met regularly in the preparedness phase, *ad hoc* and when needed during public health events.	Established cross-border coordination mechanisms	**2**	**2**	**2**	- Strengthen the district One Health platforms by improving financing, coordination among District Health Offices, Veterinary services, Wildlife Authority and Environmental agencies at district administrative and community implementation levels to reflect One Health in practice. - Establish and institutionalize community-level One Health platforms (define clear, roles, promote inclusion)
	Functional OH Technical Committees established	**0**	**0**	**0**	
	Joint planning and review meetings (MOH and others)	**24**	**8**	**18**	
	No. of functional Technical Committees and Joint Meetings	**6 Committees** 24 Joint meetings; Permanent Secretariat.	**5 Committees** 18 Joint meetings; bi-monthly reviews.	**3 Committees** 8 Joint meetings; provincial focus.	
8. Community Knowledge, Attitudes, and Practices (KAP) - Communities and households had high knowledge levels, but limited prevention and reporting practices. Their attitudes influenced behaviours.	Mean Knowledge (KAP) Score (%)	83.2%	83.9%	89.9%	- Design and deliver One Health focused risk communication and community engagement (RCCE) sessions to communities based on the data (Needs and gaps). - Translate IEC materials into local languages, and target special groups
	Zoonotic Awareness (%)	86.5%	84.5%	88.7%	
	Respondents perceiving benefits to wildlife conservation (%)	55.0%	40.0%	56.0%	
9. Gender and Vulnerability Integration	Proportion of OH activities that are gender-responsive	**20%**	**30%**	**30%**	- Develop targeted messaging for: Women (domestic exposure) Men

- All countries had mainstreamed gender into programming. No clear delineation shown for One Health. - Community alerts were sent without gender details, which are included when investigating, analyzing and reporting; events in livestock and wildlife health did not include gender details of the owners or affected households	Community surveillance programs with gender component	30% (of community HCWs are female and youth),	30%	30%	(occupational risks), Youth (behavioural change) - Strengthen community engagement strategies to work with the "gender" special groups
10. One Health Financing The three countries had developed their National Action Plan for Health Security (NAPHS) based on JEE gaps and included One Health as a core principle. Governments fund the staff, equipment, and infrastructure that facilitate OH implementation. There were no specific funding votes for OH, but the functions of surveillance, laboratory, prevention were enshrined in individual ministry budgets. Coordination and collaboration activities were majorly funded on project basis, using donor funding and government resources. Partners were contributing to One Health implementation at national and district levels. The private sector and civil society role in financing OH activities were indirect in kind and for services, not as stand-alone fund allocations.	Status of the GVL Regional Fund	Not started	Not started	Not started	- Integrate One Health into existing health security plans by embedding financing strategies within (NAPHS) - Conduct cost-effective and impact studies using rigorous economic evaluations and simulations to support policy advocacy and justify increased domestic allocations. Engage private sector in surveillance technologies uptake and community outreach activities - Ring fence minimal recurrent budgets for district One Health functions (surveillance, veterinary outreach) within national budgets to reduce donor dependency. - Establish performance linked blended finance by combining donor catalytic grants with domestic budget commitments tied to measurable One Health indicators (surveillance coverage, joint outbreak drills).

1.0 Introduction

1.1 Background

The East African region, particularly the biodiversity-rich Congo basin, faces an increasing incidence of zoonotic diseases such as Ebola, Marburg virus disease, Rift Valley Fever, and anthrax. The Greater Virunga Landscape (GVL) is a critical transboundary area where complex health threats are driven by rapid population growth, climate change, environmental degradation, and socio-political instability. These factors intensify the interactions between humans, livestock, and wildlife, increasing the risk of zoonotic disease emergence. The region's fragile health systems and frequent human displacement further heighten the risk of epidemics. One Health is a multi-sectoral and multi-disciplinary approach aimed at designing and implementing programs, policies, legislation, and research where multiple sectors communicate and collaborate to achieve better public health outcomes.

In response, the World Wide Fund for Nature (WWF), with funding from the Pandemic Fund, is implementing the Strengthening One Health-based (PPR) in the Greater Virunga Landscape project[1]. The Pandemic Fund support to the GVL will increase the region's compliance with International Health Regulations (IHR 2005) and raise the Joint External Evaluation (JEE), State Party Annual Reporting (SPAR), and Performance of Veterinary Services (PVS) scores[2]. This were through several components including strengthening disease surveillance systems; enhancing laboratory capacities; building workforce and community capacity; fostering regional coordination and governance; and catalyzing investments for sustainability. This project aims to enhance the capacity for prevention, preparedness, and response (PPR) to zoonotic diseases using a One Health approach, strengthening capacities across the human, animal, and environmental health sectors. The African Field Epidemiology Network (AFENET) was engaged to conduct a comprehensive baseline and capacity-building needs assessment from December 1 2025 to April 10 2026. This baseline and capacity assessment report outlines the methodology, results and a synthesis of status on the baseline indicators, capacity gaps and prioritized actions.

1.2 Baseline Objectives

The main objective was to conduct a baseline and capacity-building needs assessment across different institutional levels and sectors. This assessment focused on key areas of surveillance and early warning systems, laboratory systems, public and community health, and human resources in the GVL. The information in the report will serve as a cornerstone for tailoring the capacity-building program and assessing the project's future impact.

The specific objectives of this assessment were:

1. **Hotspot Identification:** To identify hotspot areas within the GVL vulnerable to zoonotic disease outbreaks, considering factors like human-wildlife conflict, poaching, and proximity to wildlife habitats.
2. **Policy Assessment:** To identify and assess existing One Health initiatives, policies, and institutional frameworks, identifying gaps and opportunities for strengthening them.

[1] https://www.thepandemicfund.org/projects/fast-tracked-strengthening-one-health-based-ppr-greater-virunga-landscape
[2] www.fao.org/one-health/partners/projects/pf-regional---democratic-republic-of-congo--rwanda--uganda/en

3. **Surveillance and Early Warning:** To assess the capacity of stakeholders to operationalize early warning systems, including event detection, investigation, information sharing, and border health management.
4. **Laboratory Capacity:** To assess the availability of laboratory diagnosis capacity, specimen referral systems, and biosafety/biosecurity across the human, animal, and agriculture sectors.
5. **Workforce Assessment:** To assess the public health and community human resource capacity (knowledge, skills, staffing, technology) for PPR.
6. **Point of Entry (PoE) Assessment:** To assess the capacity of key airports and border points (equipment, human resources, knowledge) to prevent, detect, and respond to zoonotic diseases.
7. **Coordination:** To assess the level of multi-sectoral coordination and stakeholder engagement in One Health activities at local, sub-national, and regional levels.
8. **Community KAP:** To document community knowledge, attitudes, and practices (KAP) related to zoonotic diseases and human-wildlife interactions, disaggregated by demographic groups.
9. **Gender and Social Inclusion (GESI):** To identify gender-related disparities and assess the involvement of women, youth, persons with disabilities, and refugees in One Health approaches.
10. **Financing:** To determine the status of financing for One Health at local, national, and regional levels.
11. **Recommendations:** To generate tailored recommendations for targeted One Health interventions based on the identified gaps and risk profiles.

2.0 Methods

2.1 Study Design and Approach

This assessment employed a mixed-methods approach, combining quantitative and qualitative data collection. The methodologies were founded on a highly participatory and community-driven approach to ensure inclusivity and local ownership. We worked closely with the target communities in the GVL and key local and national stakeholders. We defined One Health activities as joint: surveillance, information sharing, collaboration, budgeting, coordination, planning, financing, and outbreak response to events in humans, animals, wildlife, environment at international, national or local levels. Our methodologies utilized community consultations and mapping, participatory workshops, and storytelling (success stories). As part of the (Environmental social safeguards (ESSF), we trained the project teams and oriented field data collection members, including research assistants, on equity and inclusive principles. These locally led contexts and community-driven approaches were key in enabling inclusivity in participation and consideration of diversity while addressing gender disparities during the assessment.

In Uganda, this study focused on brucellosis, rabies, anthrax, plague, Avian influenza, viral haemorrhagic fevers (VHFs) e.g. Ebola, Marburg, and trypanosomiasis as the Priority Zoonotic Diseases (PZDs). For Rwanda, PZDs are VHFs, highly pathogenic avian influenza (HPAI), Rift Valley Fever, brucellosis, rabies, and trypanosomiasis. In DRC, the PZDs are VHFs, Chikungunya, Non-Typhoidal Salmonellosis, Yellow Fever, rabies, Mpox, West Nile Virus, and Influenzas as shown in the figure below.

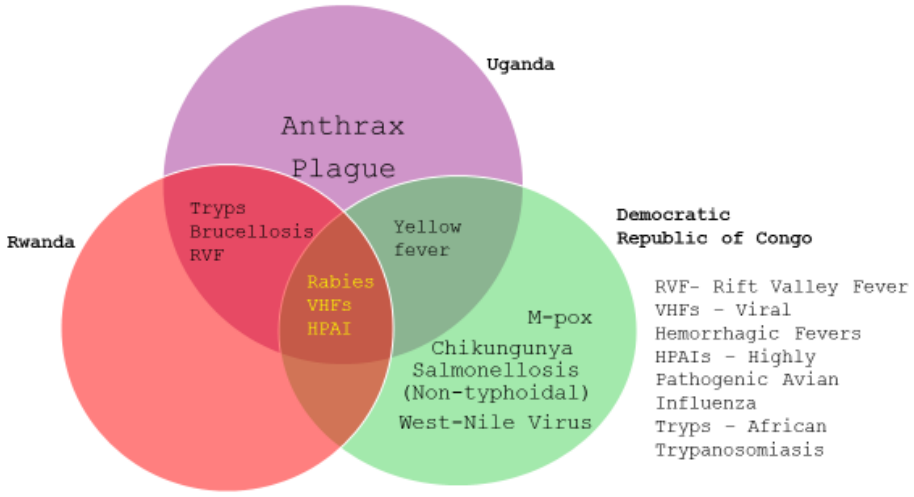


Figure 1: A cross-section of priority zoonotic diseases in Uganda, Rwanda and DRC, 2025

2.1 Conceptual Framework and Theory of Change

For surveillance and early warning systems, laboratory systems, Human resource, One Health financing, we relied on the JEE's and SPAR guidelines or majorly the components in detect, prevent and respond technical areas. We applied selected components of the One Health Assessment Tool (OHAT) and One Health Community Assessment (OHCA) to evaluate other aspects of One Health. This assessment was guided by the "capacity building pyramid" as described by Potter and Brough[3]. This framework allows for a systemic analysis of capacity by evaluating four interdependent levels:

1. **Structures, Systems, and Roles** (the foundation)
2. **Staff and Infrastructure**
3. **Skills**
4. **Tools** (the apex)

The gaps identified at each level were used to design sustainable capacity-building interventions. This framework was integrated with international standards, including IHR Joint External Evaluation (JEE) indicators and FAO/WOAH competency tools.

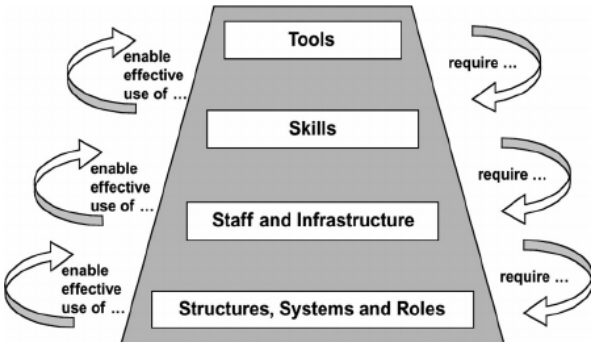


Figure 2: The capacity building pyramid adopted in the baseline assessment

2.2 Study Setting and Population

The assessment was conducted in the transboundary GVL area of the Democratic Republic of the Congo (DRC), the Republic of Rwanda, and the Republic of Uganda. The geographical area covered by the assessment included the following areas:

[3] C. Potter and R. Brough. Systemic capacity building: a hierarchy of need. https://academic.group.com/heapol/article/19/5/336/713594

- **Uganda (11 Districts):** Rubanda, Kabale, Kisoro, Kabarole, Bunyangabo, Ntoroko, Bundibugyo, Kamwenge, Kanungu, Kasese, and Fort Portal.
- **Rwanda (4 Districts):** Burera, Musanze, Nyabihu, and Rubavu.
- **DRC (4 territories):** Rutshuru, Beni, Nyiragongo, and Lubero.
- **Protected Areas (9):** Virunga NP, Mgahinga Gorilla NP, Bwindi Impenetrable NP, Queen Elizabeth NP, Volcanoes NP, Semliki NP, Rwenzori Mountains NP, Kibale NP, and Sarambwe Wildlife Reserve.

Points of Entry (8): Entebbe International Airport and ground-crossing border points namely: Katuna, Cyanika, Goma-Gisenyi, Kasindi, Ishasha, and Bunagana, Bwera/Mpondwe, Busunga (Uganda-DRC), Ntoroko (Lake Albert).

Population: The study population included multi-level stakeholders:

- National level policy makers & technical officers (health, agriculture, environment sectors)
- Sub-national technical officers
- Health, animal and environmental health workers
- Community members in park-adjacent areas, including high-risk livelihood groups

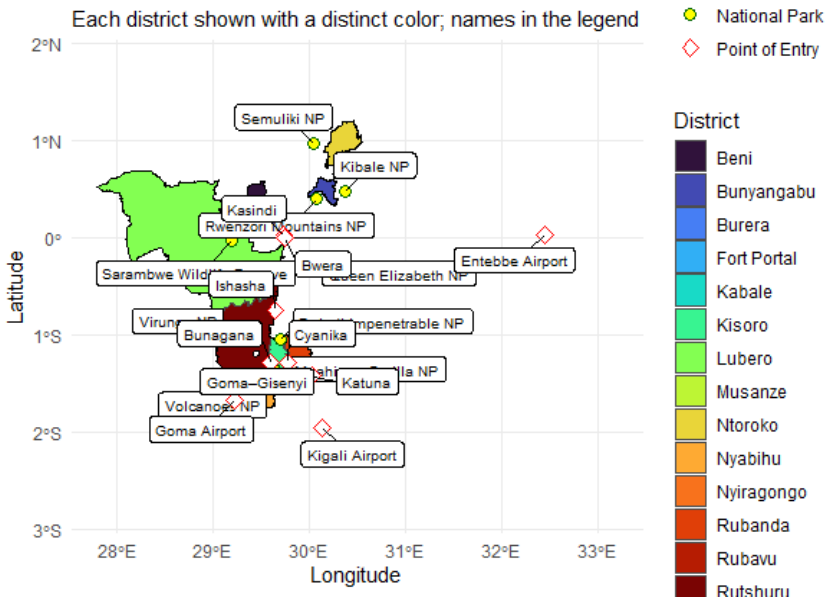


Figure 3: Baseline assessment areas in Uganda, Rwanda and DRC

2.3 Stakeholder Mapping and Engagement

Stakeholders were identified through a structured mapping process based on influence, interest, and role in One Health systems. An Assessment Steering Committee comprising representatives from each key sector and GVTC partners guided the methodology during an inception meeting held at Las Vegas Garden Hotel in Mbarara District, Uganda from 15 to 17 December 2025. These and more stakeholders validated the findings before dissemination. In addition, reconnaissance meetings followed by data collection sessions were held with key government stakeholders in each country including:

- **Uganda:** Ministry of Health (MoH), Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Uganda, OPM, NEMA, EOC, National One health platform, UWA

- **Rwanda:** The One Health Multi-sectoral Coordination Mechanism.
- **DRC:** Ministries of Health, Agriculture, Livestock, Environment, and Higher Education, as well as the l'Université Catholique duGraben participated.

The project partners (FAO, WHO, UNICEF, WWF, GVTC, Gorilla Doctors, IUCN, IGCP etc.), District Health Teams, Village Health Teams (VHTs), and community groups (farmers' cooperatives, traditional healers) were also engaged. A full list of key informants/stakeholders has been provided in **Annex 3**

2.4 Data Collection

A multi-pronged data collection strategy was used, with all tools designed and administered electronically in Kobo Toolbox. Tools were designed in English for Uganda and Rwanda, and translated to French for DRC. These tools and the consent forms were then translated into the commonly spoken local languages (Runyakitara, Kinyarwanda, Lingala etc.). During the interview process, enumerators used local languages in each respective data collection point. The data was back translated to English and French after transcription (for KIIS and FGDs) for further analysis.

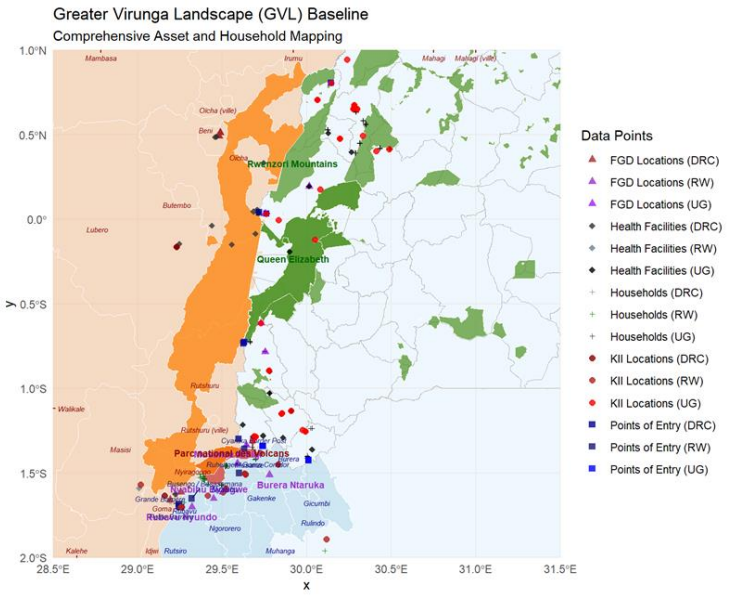


Figure 4: Map of the GVL showing study points reached during the baseline study

Literature and Document Review: A comprehensive review of existing national documents (2019 to 2025) was conducted. These documents and secondary data sources used for reference included: the WWF project document including its M&E Framework, the Joint External Evaluation (JEE) reports, Performance of Veterinary Services (PVS) reports, National Action Plans for Health Security (NAPHS I and II), IHR 2005 benchmarks, and other strategic plans from all three countries as well as other published scholarly and grey literature. Also, performance reports for laboratories and Points of Entries (POEs) were assessed using standard data abstraction tools developed.

Research Team Training and Quality Control: From inception, the team leader (PI) convened meetings with the respective country focal persons to mobilize and form research teams. In country training workshops were conducted to review the data collection tools, ensure coherence in translation (French, English,

Kinyarwanda), and data collection plans, management, and analysis plans. Tools were pretested in Entebbe, Uganda and targeted non sampled facilities and respondents. The tools were then refined based on feedback, before final deployment. We integrated the WWF environment and social safeguards into data collection throughout the process.

Questionn1aire survey: Structured questionnaires were administered by personal interviews to a target sample of health workers, veterinary, laboratories, wild and environmental officers in each country.

KAP survey: Using Kish and Leslie's formula (assuming 10% brucellosis prevalence, p=0.1, 1-p=0.9, at 95% confidence), a sample size of 139 households per country was calculated. Adjusting for 10% non-response, we targeted 152 households per country. These were allocated proportionately into the study districts in each country (e.g., 152/11 districts led to about 14 households per district in Uganda; 152/4 districts or territories was 38 households per district in DRC/Rwanda). Up to 433 household Knowledge, Attitudes, and Practices (KAP) surveys were conducted (159 in Rwanda, 155 in Uganda, and 116 in DRC). Households were randomly selected based on the inclusion criteria i.e. proximity to the protected areas, consent to participate and being in the location for at least one year. We excluded households which were not occupied at sampling time, had no adult at home, or when the household head could not speak the language, the team understood well. A full list of communities that participated in the KAP surveys is attached in **Annex 5.**

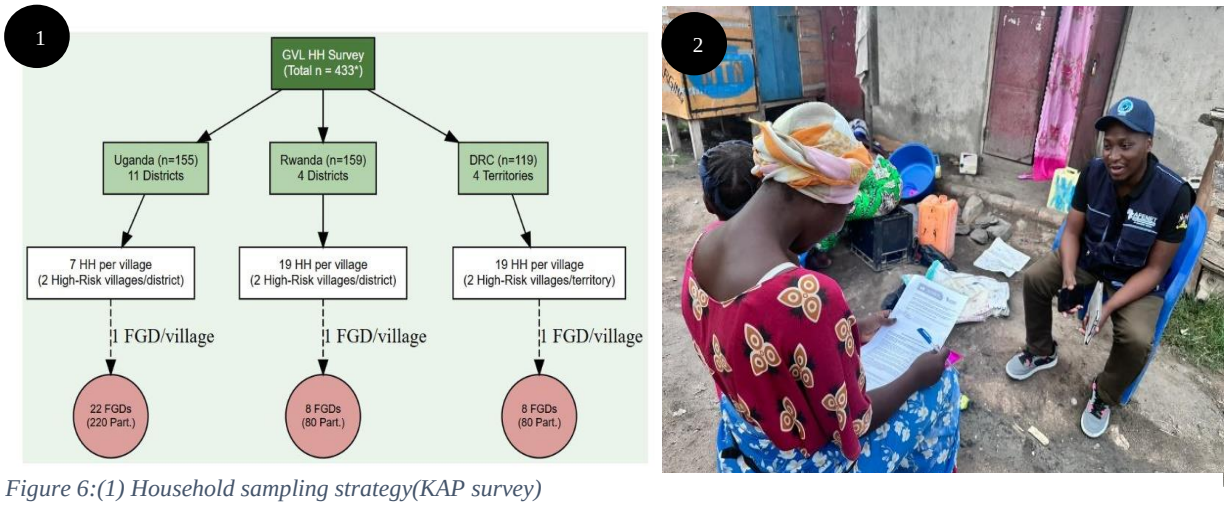


Figure 6:(1) Household sampling strategy(KAP survey)

Figure 5: 1) Selection of households and FGDs per country; (2) Household survey interview in Ntoroko District, Uganda.

Qualitative Interviews

Key Informant Interviews (KIIs): These were held at national level, 16 (Uganda), 19 (Rwanda), and 14 (DRC) with OH ministry representatives and partners. A total of 76 sub national (district or territory level) KIIs were held (15 in DRC, 32 in Uganda and 29 in Rwanda) with stakeholders from human health, animal health, Wildlife, environmental sectors, and community structures. Standardized guides were used for KIIs with District Health Officers, District Veterinary Officers, laboratory managers, hospital administrators, and community leaders.

Focus Group Discussions (FGDs): FGDs (8-10 members each) were held with park-adjacent communities with participants purposively selected. Each FGD included a note taker and moderator. We ensured inclusion

of specific interest groups such as women, youth, Refugees, persons with disabilities etc. (22 in Uganda, 8 in Rwanda, and 8 in DRC). Respondents were predominantly general community members (53%), complemented by community/LC leaders (14%), health actors/VHTs (14%), elderly 14% and vulnerable groups i.e. PWDs and youth 7%).





Photo 1: Participatory epidemiology, FGD, Kibaale NP, Kamwenge District, Uganda
Photo 2: FGD with veterinary personnel and butchers, Nyiragongo Territory, DRC

Participatory Epidemiology (PE): PE methods such as seasonal calendars, mapping, ranking, and causal flow analysis were used to enrich the data collection process in the above methods.

A. **Direct Observations:** Facility walk-throughs were conducted to verify the functionality of equipment, cold-chain, and data-management systems at facilities and points of entry (Tool 7A and 7B). This supplemented the in-person interviews and group discussions.

Table 2: Participants interviewed using different tools at various levels

Tool	Respondents/Sites
1. National level Key Informant Interview Guide	Ministry Officials (Health, Agriculture, Wildlife), GVTC Secretariat, National One Health Platforms, One Health Coordinator and secretariat members, OHTWG co-chairs (Directors MoH, MAAIF, MWE and UWA), PHEOC lead, National IHR Focal Point, MoFPED representative, Key representatives from; WHO, FAO, WOAH, UNEP and donors and partners.
2. District Level KII Guide	District Health Officers (DHO), District Vet Officers (DVO), Laboratory managers, Surveillance Focal Points, District Environmental Officer, Wildlife expert at subnational and regional levels, District One Health Team lead (where different from the DHO or DVO), District Task Force lead, private sector, and NGOs at regional and sub-national level, Kabale and Fort Portal Regional Public Health Emergency Operations Centre (PHEOC), park rangers, provincial officials in Rwanda/DRC, private vets, NGOs, local implementers in GVL regions
3. Community Level FGD & KII Guide	Park Rangers, Community Health Workers, Local Leaders, Women's Groups, community members disaggregated as men, women, youths, people with disabilities, refugees, traders.
4. Household Questionnaire	152 households in each country from areas around the park proportionately allocated per district e.g. 14/district in Uganda; 38/district in Rwanda and DRC.
5. Facility and Points of Entry Observation Checklist	Laboratories, Health Centers, Surveillance Units, Border Points (PoEs)

2.5 Data Management, Analysis, and Prioritization

Data Management: Quantitative data from Kobo Toolbox were exported to Microsoft Excel, SPSS version 22.0 and R software for analysis. GIS coordinates were submitted into a mapping software. Choropleth and spot maps were generated to show the high risk (hot spots), medium and low risk areas. The qualitative data from KIIs and FGDs were transcribed, translated, and analyzed thematically using the N-vivo software. From the thematic analysis, we generated several themes, sub-themes, and quantified proportions (%) based on frequency, emphasis, and recurrence across responses. These percentages reflect relative prominence across all KII responses (i.e., how much each theme dominates the dataset), consistent with qualitative quantification approaches.

Gap Analysis: We compared the collected baseline data against target benchmarks (e.g., from WHO IHR). A Root-Cause Analysis (RCA) was used to map identified gaps to underlying factors (tools, skills, staffing, infrastructure, systems, policy, etc.) and we categorized them according to the capacity building pyramid. This information was triangulated with that from the desk reviews.

Risk stratification: Primary data derived from a cross-sectional household survey, FGDs, KIIs conducted per country across the GVL was combined with secondary data and literature. To quantify household-level vulnerability to zoonotic spill over, we formulated a composite Zoonotic Risk Score grounded in One Health epidemiological principles. This risk metric integrated both geographic exposure and self-reported behavioural practices. Specific human-animal-environment interactions were weighted based on their documented potential for disease transmission. High-risk exposures, including the consumption of bush meat, consumption of meat from animals found dead, and handling of meat from visibly sick animals, were assigned a weight of +3 points each. Moderate-risk exposures, such as consuming food with animal bite markings and sharing primary water sources with domestic or wild animals, were assigned +2 points. Conversely, consistent hygiene practices, specifically handwashing with soap after handling animals or raw meat, served as a protective factor and reduced the total score by 2 points. Finally, household proximity to the wildlife interface was incorporated on a sliding scale: residences located <1 km from a protected area received +3 points, 1–5 km received +2 points, 6–10 km received +1 point, and distances exceeding 10 km contributed 0 points to the baseline risk. Human and livestock population, trade and movement routes were combined to show overlaps of risk.

Geospatial analysis: Geospatial processing and visualization were conducted using the R statistical computing environment. Household coordinates recorded during the survey were cleaned, filtered for missing values, and projected as spatial feature objects using the WGS84 coordinate reference system (EPSG:4326) via the sf package. To contextualize the risk landscape, international borders and sub-national administrative boundaries were integrated using the rnaturalhealth library. Additionally, precise spatial polygons representing national parks and protected areas within the study's bounding box (Longitude: 29.0° to 31.0°, Latitude: -1.5° to 1.5°) were queried and extracted directly from OpenStreetMap utilizing the osmdata package. A choropleth-style overlay was then constructed using ggplot2, mapping individual household nodes scaled by size and color intensity (using a continuous, colorblind-friendly gradient) to visualize the spatial heterogeneity of zoonotic risk across the region.

Action prioritization: We used strong community-led monitoring, evaluation, and learning (MEL) approaches to utilize feedback loops, which ensured that the findings and recommendations reflected the magnitude of community gaps and needs according to the priority matrix. The prioritization criteria demonstrated the feasibility of implementing proposed actions. Additionally, we conducted validation

workshops with key stakeholders to discuss the findings. This allowed all communities, including marginalized or underserved groups, to share their thoughts, ensuring that the results truly reflected their experiences and needs. We then incorporated the feedback and made necessary adjustments before the final dissemination of these results.

Prioritization: A two-step process was used to prioritize interventions:

- **Delphi method:** Key themes and recommendations from qualitative data were presented to a panel of 5-8 subject matter experts representing each country (during validation meetings) to achieve consensus.
- **Multi-criteria decision modelling:** We used the 1000minds.com platform. A panel of 4 criteria were presented to the panel to generate weights for different criteria. This produced a robust, quantitatively ranked list of priorities that are presented in this report.

2.6 Environmental, Social, and GESI Safeguards

- **WWF ESSF:** the team adhered to WWF Environmental and Social Safeguard (ESSF) standards. All activities were screened using the ESSF risk matrix. An Environmental and Social Management Plan (ESMP) was used throughout the process. A culturally appropriate grievance channel for reporting was established in each country, using trusted VHTs, and participants were provided with team lead phone numbers in the consent forms. This created a channel of reporting in case of any violation or need for further information.
- **GESI considerations:** gender equity and social inclusion (GESI) was integrated into the study teams and design. We specifically mapped and engaged marginalized groups (women, youth, PWDs, indigenous groups). All data was disaggregated by sex, age, and other social markers. Questionnaires were adapted to explore gender-specific roles in livestock, wildlife, and caregiving. Specific FGDs were held with women, youth, and disabled persons to capture their unique experiences.

3.10 Ethical Considerations

Administrative and sectoral approvals were obtained in all three countries, In Uganda ethical approval was obtained from Busitema University, Faculty of Health Sciences REC (NO. BUFHS-2026-65) and submitted to UNCST. In Rwanda, University of Rwanda College of Medicine and Health sciences granted the IRB approval (No: 108/CMHSIRB/2026). In the DRC Comité d'Ethique de la Recherche Médicale de l'Université Catholique duGraben gave approval (PRO. 11/25/UCG/CERM). Ethical principles were upheld through written Informed consent from all participants, Voluntary participation Confidentiality and anonymization of responses.

3. Findings

The Greater Virunga Landscape (GVL) spans across Uganda, Rwanda, and the Democratic Republic of Congo (DRC), encompassing ecosystems such as Virunga National Park, Mgahinga Gorilla National Park, Volcanoes National Park, and associated buffer zones. There is exceptional biodiversity, including endangered mountain gorillas, other wildlife, and dense human populations whose livelihoods depend on agriculture, livestock, and natural resource use. Operationalizing One Health approaches in this area critically supports the interdependence of human, animal, and environmental health. Evidence suggests that One

Health can prevent and mitigate emerging and endemic diseases, antimicrobial resistance, food safety risks, and ecosystem degradation.

The document and database reviews focused on the national One Health plans, Pandemic Fund/GVTC project documents, conservation-health program reports, surveillance assessments and field reporting by the United Nations in Rwanda, FAOLEX Database, thepandemicfund.org, Food and Agriculture Organization. The IHR metrics referenced from the electronic State Party Annual Reporting (SPAR) 2024 assessment reports were: C1: Policy, C2: IHR Coordination, C3: Financing, C4: Laboratory, C5: Surveillance, C6: Human resources C11: Points of Entry, and C12: Zoonotic diseases. The average percentages computed indicated the status of a given indicator. The country specific reports were compared to the WHO AFRO regional and the global averages (**Figure 7**). For the JEE, similar metrics for each county indicators were compared.

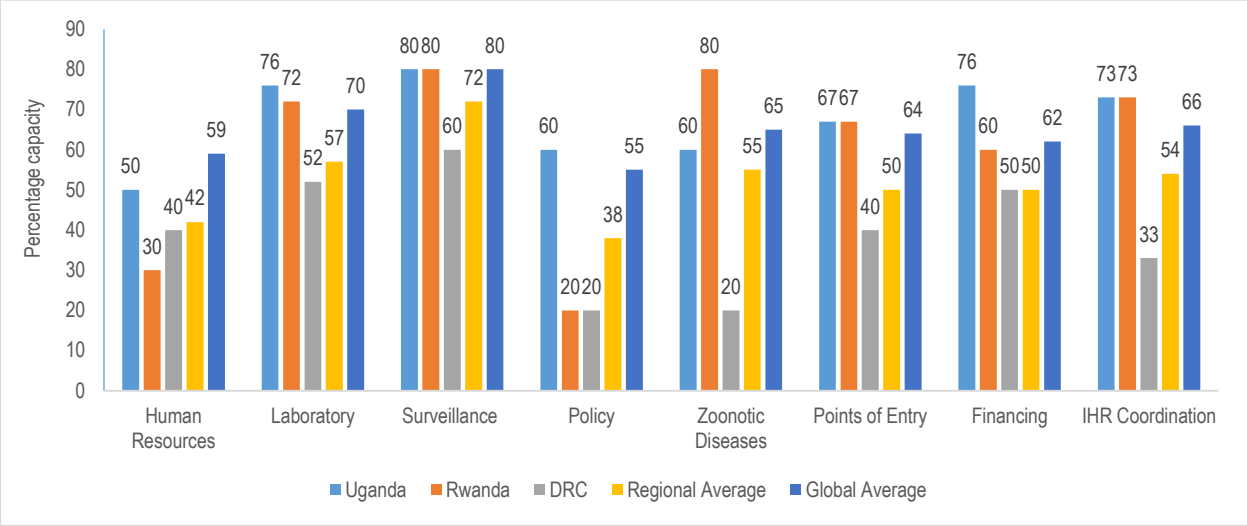


Figure 7: Core capacity in selected technical areas reported in GVL countries

In all capacities, the three countries are below the regional and global average, indicating a need for health security capacity strengthening. Overall, Uganda has an average of 73%, Rwanda 67% and DRC 50% capacity, although with variation across technical areas as showed above.

3.1 Hotspots for zoonotic disease transmission in GVL

This section provides findings based on objective 1: To identify hotspot areas within the GVL vulnerable to zoonotic disease outbreaks, considering factors like human-wildlife conflict, poaching, and proximity to wildlife habitats. Data for this objective was extracted from the literature, document reviews, KIIs with national and district level respondents indulging the representatives of the protected areas in each country. We defined a hotspot village less by name and more by function if it sits at the intersection of wildlife habitat, livestock systems, and human livelihood pressure**.** The geospatial modeling method was used to derive the highest-risk villages or communities. In Uganda these were places where wildlife habitat + livestock systems + human livelihoods + water systems + mobility intersect simultaneously. The occurrence of these risk factors can change over time due to interventions against the risk factors (reduced), or when new practices emerge in a given area (increase). In Rwanda, the most at-risk villages were those where park proximity + livestock density + water sharing + human mobility overlap. In DRC, livestock+ park proximity + livestock density +

water sharing + human mobility + bush meat trade or consumption overlap. Primary data was supported by literature review on these risk factors per country.

Zoonotic disease risk in the GVL

The Greater Virunga Landscape (GVL) constitutes a critical zoonotic interface where the convergence of wildlife movement, intensive livestock production, and expanding human settlements creates high-risk pathways for pathogen spillover. The major zoonotic disease risks in this region were primarily driven by the close proximity between wild herbivores such as buffalo and hippopotamus and domestic cattle, particularly at shared watering points and communal grazing corridors. Several diseases of significant public and veterinary health concern dominated the landscape's risk profile. Brucellosis, caused by *Brucella abortus*, remains a leading zoonotic threat in the GVL. The infection was frequently maintained in domestic herds that interact with wildlife, and transmission to humans occurs predominantly through the consumption of unpasteurized milk and direct contact with infected fetal membranes or tissues during calving. Similarly, bovine tuberculosis, caused by *Mycobacterium bovis*, persists due to the overlap between livestock and wild buffalo populations, exacerbated by informal cattle movement, and the lack of robust dairy-chain biosecurity. Additionally, anthrax outbreaks in the GVL were often tied to environmental persistence and the scavenging of wildlife carcasses, where humans may handle infected materials and risk rapid transmission.

These risks were further compounded by the structure of the animal value chain within Kasese and the surrounding GVL districts. Informal slaughter practices, inadequate veterinary oversight at rural markets, and limited public health awareness regarding zoonotic transmission pathways elevated the danger at every stage from pasture to plate. Addressing these risks requires a multi-sectoral One Health approach, integrating genomic surveillance of both wild and domestic isolates with targeted community education, improved herd biosecurity, and infrastructure development to reduce human-livestock contact in identified transmission hotspots. By prioritizing these specific locations where the density of livestock and the intensity of wildlife interaction are statistically highest, integrated management strategies can effectively safeguard local livelihoods, prevent potential epidemics, and preserve the long-term ecological balance of the Greater Virunga Landscape.

Uganda

A total of 155 households with 861 people were surveyed from 11 administrative units. These were community members comprised of 79 (50.9%) females and 74 (49.1%) males. The majority (75.8%) of the respondents were from male-headed households. The average age of the respondents was 44.9 ± 16.7 years (minimum 18, maximum of 94 years). About two thirds (65.1%) were farmers, majority (85.7%) of whom were engaged in crop farming. Other respondents were involved in businesses such as operating shops, fishing, and transport, restaurant, tourism, and hotel operations. On average, the respondents' experience spanned 20.7 ± 15.7 years (minimum 1 to maximum of 65 years). Household sizes were 5.6 ± 3.1 people (minimum 1 to maximum of 28 people). They were predominantly Bakiga (38.3%), Batooro (19.5%), Bakonjo (13.4%), Bafumbira (10.7%), Batwa (6.7%), among others. Although 92.6% of the households had no members with disability, 2.7% had physical handicap, 2.0% had visual challenges, and 1.3% had hearing impairment. Almost half (49.7%) of the respondents had attained primary level, 25.5% had secondary level, 3.4% had tertiary level, and 20.8% had no formal education. The primary livelihood source for the households

was crop farming (57.0%), businesses (18.8%), livestock keeping (10.7%) fishing or related activity (6.7%), tourism (2.0%) and others (4.8%).

A proportional thematic analysis of community perspectives from FGDs revealed that human–animal interaction (30%), health system and One Health (20%), and socioeconomic drivers (20%) were the most dominant themes, as shown in the figure below:

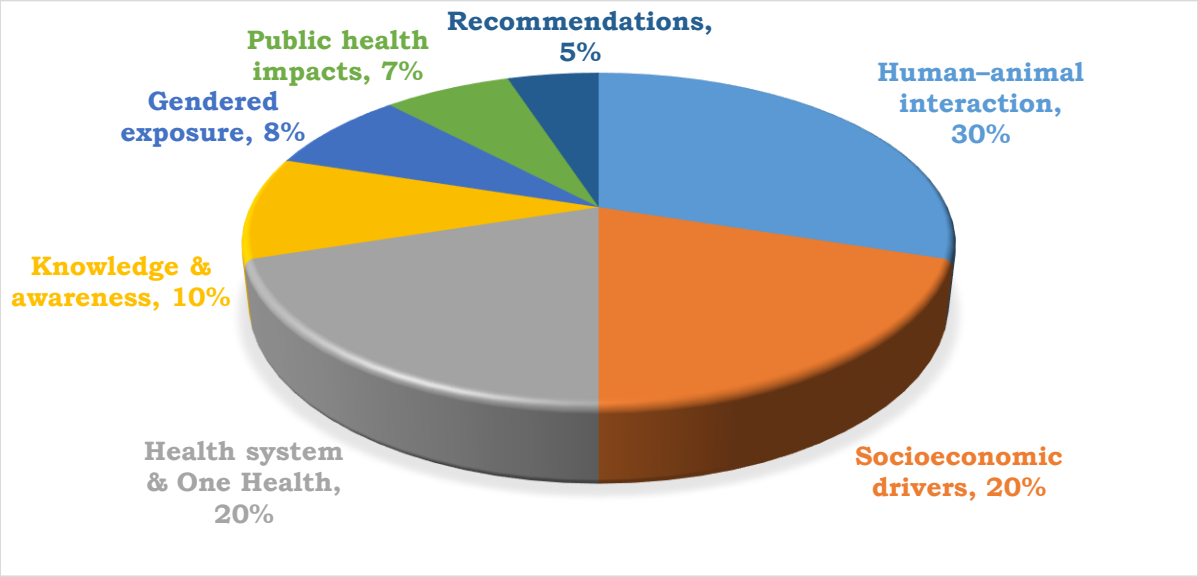


Figure 8: Themes merging from FGD participants on zoonoses and One Health, Uganda (n=)

Human–animal interaction was a major pathway for zoonotic disease exposure. FGD participants consistently highlighted frequent interaction between humans, domestic animals, and wildlife as a key factor influencing zoonotic disease transmission. These interactions were primarily driven by livelihood activities and proximity to protected areas.

Occupational and livelihood exposure: community members engaged in activities such as hunting, livestock grazing, fishing, and collection of forest resources reported increased contact with wildlife and their environments. Hunters and individuals involved in bush-meat handling were considered particularly vulnerable due to direct contact with animal blood and tissues. Participants explained that:

> *"Hunters and illegal poachers have direct contact with wild animals during hunting, slaughtering and handling of bush-meat. If the animals are infected the risk of disease transmission is very high."* FGD Kirembe, Kasese District.

Similarly, livestock keepers reported that grazing animals near park boundaries increases interaction between domestic animals and wildlife, creating opportunities for pathogen transmission. Environmental exposure: participants also described indirect exposure pathways through environmental contamination such as trespassing animals into gardens or entering homesteads and leaving parasites or faecal materials. Shared water sources, and consumption of fruits bitten by wild animals were cited as potential sources of infection. Communities reported that wildlife frequently enter residential areas, contaminating household environments and water sources used by both animals and humans.

Proximity to wildlife habitats: the distance from the surveyed households to protected areas varied from less than 1 kilometre (36.9%), one to five kilometers (43.0%), six to ten kilometres (2.7%), 11 kilometers or more (10.7%). Some households (6.7%) had no close linkage with the protected areas.



Figure 9: Observation of Human-wildlife interaction, Ntoroko District, Semuliki National Park

Photo 3: Wildlife (baboons) interacting around a shared water source in Rwanda
Photo 4: Wildlife (baboons and domestic animals (goats) interfacing along a drainage and dumping site in Kanara Town Council, near Semuliki National Park, Ntoroko District, Uganda.

Human-wildlife conflict (HWC): FGD findings highlighted this as one of the most common challenges with animals destroying food, death of people, livestock and spread of diseases. From FGDs, public health impacts of the protected areas varied. Human–wildlife conflict emerged as a significant issue affecting both livelihoods and health outcomes in communities bordering protected areas.

Crop destruction and food insecurity: participants reported widespread crop destruction by wildlife, particularly elephants, baboons, and wild pigs. These losses contribute to poverty, hunger, and school dropouts among children.

> One participant stated: *"These wild animals destroy our gardens and because of that we remain poor and our children cannot go to school."*

Injuries and disease risks: community members also described incidents of wildlife attacks causing injuries and sometimes deaths. In addition, interactions between wildlife and domestic animals were perceived to increase the risk of disease transmission. The psychological burden of living near wildlife was also highlighted, with participants describing fear, sleepless nights, and stress caused by guarding crops from animal raids.

"It is risky to stay near the park because we live in fear. For example, you might be doing some farming work in your garden, and these elephants attack you. You have to run, and in the process, you might end up having an accident. Or the elephant itself might injure you or kill you." FGD Women, Kamwenge District.

"Living near the park is quite a challenge to me because I am disabled. So, when baboons or maybe elephants or monkeys come to raid my crops, I cannot run to chase them away. Unfortunately, even the wife is old, and does not have support." Male FGD Respondent, Kanungu District.

"We don't sleep. Every night, we guard our gardens against invasion by the wild animals. Neither children nor adult get enough rest. There is always noise in the place with people banging jerrycans to scare these wild animals away. As a result, our children have stunted growth because we cannot provide enough nutritionally for them. FGD respondent, Bundibugyo District.

Socio-economic drivers of zoonotic disease risk: in Uganda, poverty and limited livelihood opportunities emerged as key drivers influencing risky behaviours such as bush-meat consumption and dependence on forest resources.

Consumption of bush-meat and dead animals: several respondents reported that some community members consume meat from animals that died of unknown causes. This behaviour was largely attributed to poverty and the lower cost of such meat compared to market prices. Participants noted that although some individuals understand the health risks, economic hardship often overrides these concerns. Bush meat consumption practices were reported around communities living along the Semliki National Park in Ntoroko, Bundibugyo, Kibaale National Park in Bunyangabu, Kamwenge, and Rwenzori NP in Kasese district. The most consumed wild animals included baboons, monkeys, warthogs/wild pigs respectively. Others include antelopes, kobs, and snakes. These were not sold in open butchers but secret referrals (had to detect those who sell) for those looking for bush meat. One participant explained:

"When people find dead animals, they feel blessed; they slaughter and share because the meat is cheaper than normal meat." FGD respondent, Uganda.

Poverty and food insecurity: crop destruction by wildlife was reported to significantly reduce household food supply and income. This situation was linked to increased reliance on natural resources from the park and other potentially risky coping mechanisms. Community members in 8 of the 11 districts surrounding protected areas explained that elephants, baboons, and other wildlife frequently destroy crops such as bananas, maize, and cocoa, leading to hunger and financial stress.

Spatial distribution of zoonotic risk: spatial analysis of the composite Zoonotic Risk Scores revealed pronounced geographic clustering of high-risk households across the Greater Virunga Landscape. Hotspots of elevated zoonotic spill-over risk were predominantly concentrated along the immediate peripheries of major protected areas. The most significant clustering occurred along the boundaries of Semuliki National Park, spanning the Bundibugyo and Ntoroko districts, as well as along the edges of Kibaale National Park. The spatial distribution demonstrated a strong proximity effect, with the highest-scoring nodes tightly aggregated within the less than 1 kilometre buffer zones of these wildlife interfaces, confirming that communities situated directly at the forest edge bore a disproportionate baseline risk for spill-over events.

Impact of Wildlife on Communities

Tourism revenue provides economic opportunities for local communities through employment, business activities, and revenue-sharing initiatives. Despite existing challenges, many community members recognize wildlife as an important asset for environmental protection and socioeconomic development.

Behavioural drivers and risk profiles: the observed spatial heterogeneity was largely driven by the compounding effects of geographic vulnerability and high-risk human-animal interactions. For example, the elevated risk clusters identified in areas such as Ntandi (Bundibugyo) reflected a critical convergence of close park proximity with high-risk behavioural practices, notably bush-meat consumption, the handling of deceased wildlife, and the sharing of water resources with animals. Conversely, moderate to low-risk nodes were more widely dispersed. These lower scores were characteristic of households located in districts further from dense protected boundaries or in communities where geographic risk was effectively mitigated by strong protective behaviours, such as consistent hygiene practices and abstention from wildlife consumption. Ultimately, the geospatial mapping illustrates that zoonotic risk within the landscape was highly localized, dictated by the intricate socio-ecological interactions occurring at the household level (**Figure 7 A**). This dynamic zoonotic connectivity map visualizes the complex pathways of pathogen transmission risk across the Greater Virunga Landscape. The map presents the critical epidemiological nodes, uniquely categorized into protected National Parks, official Points of Entry, active livestock markets, and recognized human-wildlife conflict hotspots. Directional trajectories connect these nodes to illustrate the primary drivers of animal mobility, capturing cross-border livestock trade routes, wildlife migration corridors, and zones of informal grazing overlap. The map explicitly highlights the "Virunga Nexus," demonstrating how contiguous protected areas form a continuous, transnational ecological reservoir. Furthermore, markets and official border crossings are mapped as critical mixing points where human and animal populations densely converge. Specific conflict zones are also pinpointed to reveal the exact geographical pressure points most vulnerable to initial zoonotic spillover events. Ultimately, this spatial model upgrades static risk assessments into a dynamic early-warning tool, enabling policymakers to strategically deploy targeted One Health surveillance along active pathogen highways.

Key hotspots include Bwindi, Queen Elizabeth, Virunga, and Volcanoes National Parks, where past outbreaks of Ebola, Marburg, anthrax, Rift Valley fever, and Mpox had been recorded. As a risk factor, human-wildlife conflict (HWC) in Uganda increased from 16 cases in 2013 to 862 cases in 2020 and 845 cases in 2021[4]. Of the reported HWC cases, crop damage (89.5%), livestock predation (4.8%), human injury (4.1%) and human death (1.6%) were the consequences. Animals mostly reported in these conflicts are African elephant (*Loxodonta africana),* buffalo (*Syncerus caffer caffer*), hippopotamus (*Hippopotamus amphibious*), lion (*Pathera leo*), leopard (*Pathera pardus*) and crocodile (*Crocodylus niloticus*). There was variation in risks due to human activity and biodiversity richness[5] as shown in the table below. Hotspot: Kanara T/council (Kanara and Rwenyange Villages). The characteristics were fishing communities, point of entry, transit Centre for refugees or immigrants, observed frequent Human-animal interaction, proximity to

[4] https://africa.awsassets.panda.org/downloads/hwc-report
[5] https://greatervirunga.org/what-threatens-biodiversity-conservation-in-the-greater-virunga-landscape

protected areas (homesteads just a few meters from the park). In the past, several zoonotic disease outbreaks occurred in the landscape, resulting from spillovers from animals to humans and vice versa.

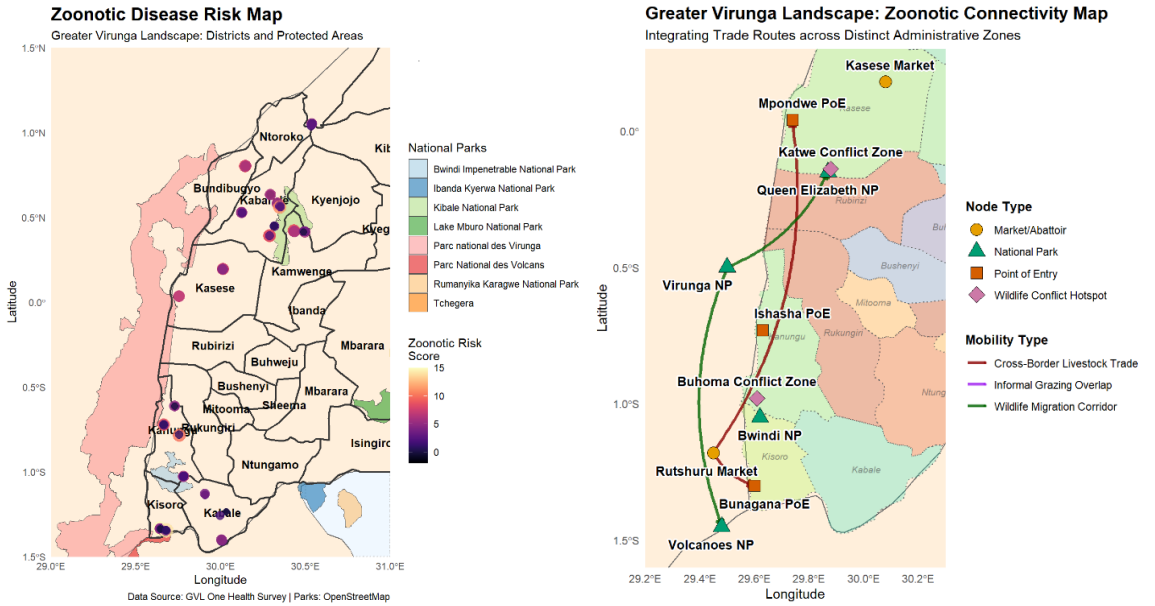


Figure 10: Map of Uganda hotspots for zoonoses (A), environmental and human related risk factors (B)

Major diseases recorded were Ebola, Marburg, anthrax, Rift Valley fever, Mpox, respiratory infections in gorillas. Data from the past two decades indicates that Uganda had Anthrax multiple outbreaks in western districts near Queen Elizabeth NP, linked to livestock and wildlife carcasses from 2017 to 2024[6]. In western Uganda bordering GVL, Rift Valley Fever was reported in livestock from 2013 to 2022[7]. There had been sporadic outbreaks of Marburg Virus in western Uganda caves near Semuliki NP. Recently, there were COVID-19 transmission risks heightened by gorilla tourism in Bwindi NP[8].

Rwanda

A total of 28 key informants from 4 districts Burera (7), Musanze (7), Nyabihu (7) and Rubavu (8) were interviewed. Of these, 25 (86.2%) were males and 4 (13.8%) were females. On average, district KIs had 10.2 years of experience, range (1-20), and a median 10 years. District KIs were drawn from the one health sectors (Health, Agriculture, Water and Environment, Wildlife). They included Directors of Public Health, Animal resource officers, Laboratory managers, IDSR focal persons and disaster management.

The accompanying choropleth map illustrates the aggregated zoonotic disease risk across northwestern Rwanda, derived directly from community FGDs. By quantitatively scoring qualitative transcripts for local mentions of priority pathogens such as Brucellosis, Rift Valley Fever, and Ebola alongside high-risk community behaviours like handling animal carcasses and consuming uninspected meat, the spatial model translated localized vulnerabilities into a regional heat map. The analysis explicitly highlights the districts bordering the Greater Virunga Landscape, with Musanze emerging as the most critical hotspot for zoonotic

[6] https://uniph.go.ug/trends-and-spatial-distribution-of-human-anthrax-outbreaks-uganda-2017-2024/
[7] https://link.springer.com/article/10.1186/s12917-025-04825-6
[8] https://www.monitor.co.ug/uganda/news/national/tayebwa-warns-human-activity-sparks-new-disease-threats-5196948

pressure based on community testimony. The strategic overlay of key ecological nodes, notably Volcanoes National Park, underscores the intense human-wildlife-livestock interface in this region. Ultimately, this district-level aggregation provides a vital, community-grounded tool for policymakers to geographically target One Health interventions, public sensitization campaigns, and early-warning surveillance resources exactly where exposure risks were most acutely experienced by the residents themselves.

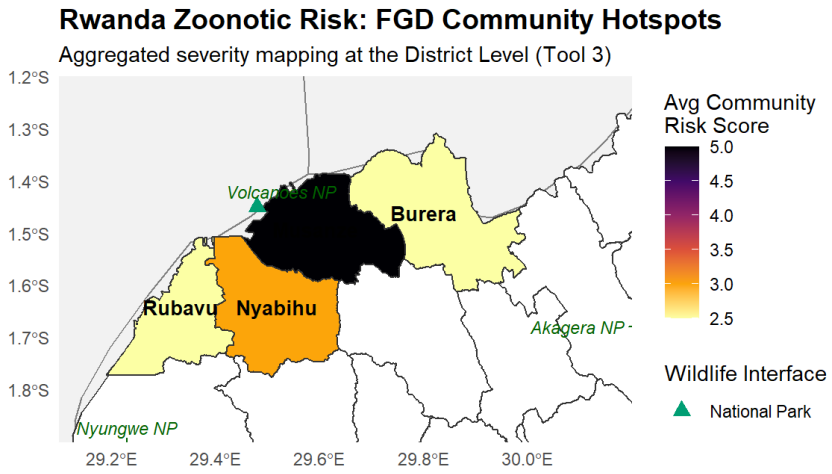


Figure 11: Community level mapping of zoonotic risk in the assessed districts, Rwanda

Zoonotic disease hotspots & trends: Rabies (dog bites) and brucellosis and were consistently identified as priority zoonoses by the informants. Other zoonoses that were highlighted include VHFs (Marburg and Rift Valley Fever), Anthrax, Mpox and Tuberculosis. Zoonotic hotspots are concentrated in border districts and protected area interfaces with increased disease incidence linked to cross-border animal movement and human-wildlife interaction.

> *"Most cases come from areas near national parks and borders where animals mix…"* KII respondent, Rwanda

High exposure to zoonotic risk driven by human–wildlife interaction: All 88 FGD respondents (100%) in Rwanda described intense human–wildlife interaction, particularly in communities bordering Volcanoes National Park. Vulnerable groups included children, women, elderly, and farmers. Exposure pathways included crop contamination, contact with animal faeces, handling livestock and wildlife, and consumption of unsafe food. Human–wildlife conflict was a central risk determinant. All respondents emphasized severe human–wildlife conflict, including crop destruction, injury and death, poverty and food insecurity.

> *"People living near the park face high risks… wild animals enter villages, contaminate water and crops. Buffaloes, baboons, monkeys, and elephants destroy crops, kill people… cause poverty and hunger."* FGD respondent, Rwanda.

Previously, Rwanda reported Rift Valley Fever (2022), an epizootic among livestock, especially in the Eastern Province[9]. In Volcanoes NP, there were concerns about respiratory disease transmission between humans and gorillas. We focused on documented outbreaks with clear epidemiological data. The country experienced Rift Valley Fever (RVF) outbreaks in 2012, 2018, and 2022 among livestock with human spillover. The *Rift*

[9] https://wwwnc.cdc.gov/eid/article/30/10/24-0264_article

Valley fever virus (RVFV) is a zoonotic, mosquito-borne virus affecting animals and humans. From March to October 2022, RVF led to a countrywide epizootic[10] causing 3,112 infections (1,342 confirmed) among cattle, goats, sheep; 1,254 abortions, especially in cattle and 516 deaths[11]. Among human, about 170 infections and 22 human deaths were reported[12], though human data varies by source and reporting framework.

Marburg Virus Disease (MVD) outbreak was first registered among 67 humans with 15 confirmed deaths (CFR 24%) from 27 September to 20 December 2024[13]. This was likely by Egyptian fruit bats**,** *Rousettus aegyptiacus* linked to the index case in a mining cave. Early cases among healthcare workers highlighted gaps in infection control. Rabies is endemic with sporadic human exposures and occasional fatality. For example, in 2016, the human health system documented 413 dog bite incidents and one human death due to rabies[14]. Mpox was first reported in 2024 in rural areas, following increased human–animal interaction, indicating emerging zoonotic spill-over. Other zoonoses were *known to occur* although not systematically documented. Brucellosis: Prevalence among livestock and humans documented, but not classified as a discrete outbreak event within 2010 to 2025. Bovine tuberculosis: Present in livestock with low prevalence; zoonotic potential but sporadic. Leptospirosis: High sero-prevalence was reported, suggesting exposure risk; not clearly tied to a specific outbreak. Anthrax presence was recognized in livestock, but outbreak data in humans was limited.

DRC

From the KIIs and data review, Mpox emerged as the most frequently cited zoonotic disease, followed by anthrax and viral hemorrhagic fevers, indicating a strong influence of recent outbreaks on risk perception.

> *"In 2025, we experienced 36 suspected cases of anthrax, 18 cases of rabies, and 54 cases of Mpox… including one death."* Mentioned one respondent.

> *"The region has experienced anthrax outbreaks… as well as Mpox outbreaks. Although I cannot provide trends because these zoonotic diseases are new and not widely known."* said another respondent.

Analysis of data on surveyed households highlighted a strong male predominance in the management of households 78 (68.4%). The level of education remained low, marked by a significant proportion of households with no education or only primary schooling (33.3% each). Economically, farming was the main source of income (69.8%), confirming the dependence on subsistence agriculture. Finally, almost all respondents had no disability (94.78%), reflecting a generally able-bodied population. Finally, the ethnic structure was dominated by the Nande, who constituted more than half (56.03%) of the sample (**Table 3**).

Table 3: Sociodemographic characteristics of households surveyed in Rutshuru, Nyiragongo, Beni and Lubero of North Kivu Provinces, 2026

Variables	Frequency	Proportion (%)

[10] https://wwwnc.cdc.gov/eid/article/30/10/24-0264
[11] https://www.sciencedirect.com/science/article/pii/S2352771424001800
[12] https://www.mdpi.com/2076-2607/13/1/91
[13] https://www.who.int/emergencies/disease-outbreak-news/item/2024-DON548
[14] https://pmc.ncbi.nlm.nih.gov/articles/PMC12043602

Respondent's sex (n=116)	Female	59	50.9
	Male	57	49.1
Age of respondent	18-24 years	18	15.8
(n=114)	25-34 years	30	26.3
	35-44 years	37	32.5
	45-54 years	12	10.5
	≥ 55 years	17	14.9
Education level (n=114)	None	38	33.3
	Primary	38	33.3
	Secondary	34	29.8
	Superior	4	3.5
Marital status (n=114)	Single	17	14.9
	Married/In a relationship	85	74.6
	Widow/Widower	12	10.5
Household size (n=110)	> 6	40	36.4
	≤ 6	70	63.6
Tribe (n=116)	Lendu	1	0.9
	Nande	65	56.0
	Tutsi	2	1.7
	Other	48	41.4
Main source of income (n=116)	Livestock farming	5	4.3
	Crop farming	81	69.8
	Other	30	25.9
Disability status	None	109	94.8
	Physical	5	4.4
	Visual	1	0.9

Three dominant sub-themes emerged from district level KIIs: a) perceived increase in outbreaks (65%), b) limited knowledge of trends (25%), and c) improved response capacity (20%). Respondents frequently described recurring outbreaks of Mpox and anthrax, although a subset reported insufficient knowledge to assess trends. The community risk behaviours generated from the FGDs were: low awareness (70%), consumption of dead or unsafe meat (60%), poverty-driven exposure (60%) such as eating undercooked bush meat, and wildlife contact including poaching (50%). These behaviours reflect structural vulnerabilities rather than individual-level risk alone.

> *"Poverty causes the population to frequently visit the park for farming and hunting."* FGD Respondent, DRC

Previously, DRC responded to several Ebola Virus Disease outbreaks in North Kivu and Ituri provinces, often linked to bush meat and forest encroachment. At the same time, from 2022 to 2025, Mpox caused large outbreaks in South and North Kivu, with new variants emerging due to human-to-human transmission[15].

[15] https://www.who.int/emergencies/disease-outbreak-news/item/2024-DON522

There are historical spill overs of Marburg and other Filoviruses in forested regions. The high-risk zones are Virunga NP and surrounding communities due to poaching and deforestation[16]. These factors and consumption of dead animal meat in the GVL requires a mix of physical barriers, biological deterrents, and economic incentives. For each country, the hotspots are presented in **Table 4** below. Livestock included cattle, goats and sheep. Figures are based on national censuses. DRC has arbitrary figures due to displacement of human and animal populations.

Table 4: Hotspot areas in Uganda, Rwanda and DRC with risk factors

Area, District	Sub county/Village	Protected Area, PoE	Human Population	Livestock Population	Key Characteristics of the Hotspot	Major zoonotic disease risk
Uganda: Bundibugyo	Bubandi, Bubukwanga	Queen Elizabeth NP	250,000	45,000	Mountain slope villages + forest edge settlements	Ebola, Marburg, Anthrax, TB
	Busaru, Harugali, Kasitu, Nduguto	Busunga			Hunting of bats, monkeys, birds, Encroachment into Semuliki forest, Human mobility, Disease importation, Cross border trade	
Kasese	Kamukumbi, Kabiriizi, Kadeya, Kahendero, Kanyampara, Kanyangeya, Katojo, Kidodo, Katunguru, Kiteso, Nyamatunga, Rwehingo	Queen Elizabeth NP, Mpondwe, Bwera	800,000	180,000	Bush meat consumption and trade	Mpox, Ebola, Anthrax - HIGH
Kabale	Lake Bunyonyi basin communities Abattoir-linked villages Peri-urban livestock villages	Bwindi NP	240,000	95,000	Livestock slaughter exposure, Dense human populations near wildlife corridors, Human mobility, Disease importation, Animal contact (trade, care), Slaughter practices	Rift Valley Fever - HIGH
						Anthrax outbreaks in cattle, Rift Valley fever in livestock[17]
Kisoro	Nyarusiza, Nyakinama	Mgahinga Gorilla NP, Bwindi NP	300,000	70,000	Gorilla tourism	Respiratory pathogens - V. HIGH
	Muramba (village clusters)	Cyanika, Bunagana, Katuna			Illegal hunting & Habitat encroachment, Crop raiding → wildlife contact, Bush meat consumption and trade, Human mobility, Disease importation	Viral spill overs – HIGH (bat/primate reservoirs)
Ntoroko	Kanara Town council (Kanara,Rwenyange)	Semuliki NP,Ntoroko (Lake Albert)	80,000	55,000	Shared water, Carcass exposure, Fishing communities, point of	Anthrax - HIGH

[16] https://link.springer.com/article/10.1186/s40249-025-01278-9
[17] https://uniph.go.ug/trends-and-spatial-distribution-of-human-anthrax-outbreaks-uganda-2017-2024/

	Livestock-dense agro-pastoral villages, Kanara TC				entry, transit centre for refugees or immigrants, Animal contact, Slaughter practices	
Rwanda: **Musanze**	Kinigi sectors, villages around: Kinigi, Nyabigoma, Bisate	Volcanoes NP	476,522	51,565	Gorilla tourism, human–primate contact, Crop raiding (buffalo, monkeys), Occasional bush meat handling, Rift Valley fever epizootic (2022), poor zoonotic awareness among farmers[18], [19]. High population density about 500 people/km²	Respiratory zoonoses (primate) → HIGH
	Gataraga sector (livestock + forest interface)				High livestock density	Brucellosis - VERY HIGH
	Villages supplying Gataraga abattoir, Nyange and Muhoza peri-urban villages				Slaughter exposure (blood, tissues), Milk consumption practices, Informal slaughter, Urban–rural livestock interface, High population density	RVF → MODERATE
Burera	L. Burera and Ruhondo basin villages, All lakeshore communities, Cyanika border sector, Cross-border villages	Volcanoes NP Cyanika	387,729	66,221	Shared water: Humans, Livestock, Wildlife (birds, small mammals), Livestock movement, Informal trade, Disease importation	Brucellosis - VERY HIGH
	Rugarama and Butaro (agro-pastoral villages)				High cattle and goat density, grazing overlap, Raw milk consumption.	Brucellosis - HIGH
Nyabihu	Bigogwe and Jenda sectors (forest-edge villages) Mukamira livestock corridor, Dairy belt		319,047	41,663	Wildlife encroachment, Bush meat exposure (small mammals, rodents), Intensive cattle production, Shared grazing zones	Brucellosis → VERY HIGH RVF → HIGH Anthrax → MODERATE
	Karago highland villages, High rainfall + runoff				Free grazing & proximity to wildlife increases zoonotic transmission, Water contamination, Soil–livestock–human interface	
Rubavu	Gisenyi & Rubavu town, Lake Kivu shoreline villages, High-density settlements	Volcanoes NP	546,683	32,245	Slaughterhouse exposure, Informal meat handling	Brucellosis → VERY HIGH
					Shared water use	RVF → HIGH

[18] https://www.frontiersin.org/journals/public-health/articles/10.3389/fpubh.2025.1569682/full
[19] https://wwwnc.cdc.gov/eid/article/30/10/24-0264_article

	Fishing and lakeside communities				Fish + livestock interface	Ebola spill over risk → MODERATE
	Busasamana and Nyamyumba (park-edge villages), Goma–Gisenyi border corridor				Wildlife incursion, High mobility, Human–animal contact, Cross-border disease flow (DRC)	Rabies → MODERATE
DRC: Beni	Villages near Mbau, Oicha, and forest edge	Virunga NP	1,000,890	1,130,000	- High bush meat trade (duikers, primates)	Ebola - HIGH
	Mabalako, Bashu	Mountain gorillas, elephants, hippos; Maiko is rich in okapi and primates			- Shared water sources with wildlife, - Livestock grazing near forest	
Nyiragongo	Villages around Kibati, Munigi, Buhene	Virunga NP	338,966	136,750	- Dense peri-urban livestock (goats, poultry). Poaching, deforestation, bush meat trade, Ebola spill overs, Mpox outbreaks (2022–2025)[20], [21]	Ebola, anthrax - HIGH
	Kibumba, Rugari	Gorillas, chimpanzees, diverse birdlife			- Human–wildlife contact - Informal bush meat markets	
Rutshuru	Villages near Kiwanja, Bunagana, Bwisha				- Cross-border bush meat trade with Uganda	Rift Valley Fever, Ebola
	Binza, Nyamilima, Ishasha	Gorillas, savannah ecosystems, Cross-border wildlife corridors with Uganda	620,700	1,555,000	- High livestock density (cattle corridor), - Shared rivers and ponds with wildlife, - Informal bush meat markets	
Lubero	Villages near Kanyabayonga, Miriki, Kayna, Kyondo, Kirumba	Bat caves, gorilla and monkeys	1,703,102	1,297,000	- Subsistence hunting and bush meat consumption, - Shared water sources in mountainous terrain, - Livestock grazing in forest margins	Marburg virus, anthrax

Zoonotic disease risk at household level in the GVL

The household-level risk assessments across the Greater Virunga Landscape (GVL) revealed distinct profiles of zoonotic vulnerability, influenced by proximity to protected areas, socio-economic activities, and variations in community awareness. By analyzing knowledge, attitudes, and practices (KAP) data from surveys conducted across Uganda, Rwanda, and the DRC, we characterized the areas of highest risk where a

[20] https://link.springer.com/article/10.1186/s40249-025-01278-9
[21] https://www.who.int/emergencies/disease-outbreak-news/item/2024-DON522

combination of frequent human-wildlife contact and limited preventative measures created an environment conducive to pathogen spillover.

Overall, the districts that exhibited the highest household-level risk scores were consistently those where the combination of high geographic proximity to protected areas and heavy reliance on subsistence pastoralism occurred. In the DRC, specifically in districts bordering the Virunga National Park such as Rutshuru, households situated within a 1–5 km buffer demonstrated significantly elevated risk scores. These communities frequently engaged in agricultural activities that necessitate regular entry into protected wildlife corridors. Because these households often report high levels of direct interaction with livestock and occasional opportunistic contact with wildlife, they serve as primary interfaces for potential pathogen transmission. The risk in these sectors is further compounded by a lower prevalence of robust zoonotic disease literacy, which delays the recognition of clinical signs in both animals and humans.

In Rwanda, districts such as Nyabihu exhibited localized high-risk profiles characterized by high livestock densities and fragmented grazing lands near protected borders. Household data indicated that where distance to the national park was less than 1 km, the frequency of "shared resource" interaction such as livestock utilizing the same water points as wild herbivores was at its peak. These households often lacked advanced biosecurity infrastructure, meaning that waste management and animal housing practices are frequently insufficient to prevent the environmental persistence of pathogens. This lack of physical barriers between domestic herds and the wildlife perimeter elevated the vulnerability of these districts to zoonotic agents like *Brucella.*

Within the Ugandan sector of the GVL, specifically in Kasese and neighboring districts, the highest risk scores were associated with high-traffic agricultural corridors and livestock market zones. Frontline staff data suggested that while awareness of zoonotic diseases exists, the operational implementation of preventative measures such as consistent PPE use and systematic waste segregation were inconsistent. Households in these districts that combine pastoralist lifestyles with close proximity to the Queen Elizabeth Conservation Area showed the highest risk scores, as these areas act as hubs for animal movement. Deficits in livestock vaccination and the informal nature of the local meat value chain in these high-score districts further amplified the risk of zoonotic transmission, making them focal points for targeted interventions.

Synthesizing these findings, the districts with the highest household risk scores were defined by four converging factors: proximity to national parks (≤ 5 km), a primary economic reliance on pastoralism or subsistence farming that requires encroachment into wildlife zones, significant knowledge gaps regarding zoonotic disease symptoms, and inadequate on-farm biosecurity practices. Mitigating these risks requires a localized One Health approach that prioritizes these high-score districts for infrastructure development, such as improved livestock enclosures, and community-led surveillance training. By transforming these vulnerable hotspots through targeted resource allocation and improved disease literacy, it is possible to safeguard both the livelihoods of the local population and the long-term ecological integrity of the Greater Virunga Landscape.

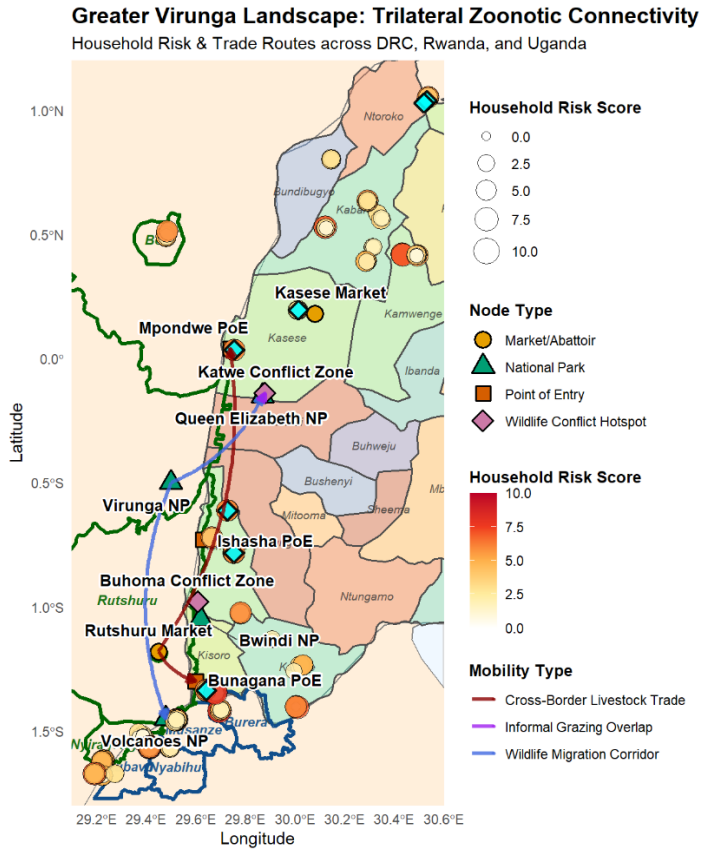


Figure 12: Hotspots in the Greater Virunga Landscape with mobility, trade, and household risk score

Human-wildlife conflict in the GVL

The GVL represents one of the most complex human-wildlife conflict (HWC) zones in Africa. The landscape was characterized by high human population densities directly adjacent to critical wildlife corridors, creating constant pressure on land use. As communities expanded their agricultural activities, encroachment into these corridors disrupted historical wildlife migration routes, leading to frequent and often destructive encounters between farmers and wild species. Conflict was primarily driven by crop damage, water point competition, and livestock predation, which pose a significant threat to local livelihoods and regional food security. Because many of these communities were highly dependent on subsistence agriculture and pastoralism, the economic impact of HWC is immediate and severe, often fostering negative attitudes toward conservation efforts.

Furthermore, the GVL interface acts as a high-stakes transmission zone for zoonotic diseases. The high density of livestock, combined with seasonal wildlife movements, creates a persistent "bridge" for pathogen spillover. Effectively managing HWC in the GVL requires moving beyond reactive measures toward integrated, landscape-level strategies that prioritize sustainable land-use planning, secure community-based mitigation, and robust One Health surveillance to safeguard both local socio-economic stability and the long-term integrity of the landscape's biodiversity.

In Rwanda, the accompanying faceted map below isolates and visualizes three critical drivers of human-wildlife conflict: physical danger, crop destruction, poverty, and water contamination as identified by local

communities during FGDs. By transforming qualitative community testimonies into quantifiable thematic heat maps, this visualization revealed that vulnerability was not uniform. Burera and Nyabihu districts emerged as the primary epicenters for severe agricultural losses and direct physical threats, driven largely by wildlife (such as buffalo) breaching park boundaries and destroying livelihoods. Conversely, water contamination was highlighted as a distinct, highly localized zoonotic pathway in Nyabihu, where unprotected water sources flowing from the volcanoes intersect with daily household chores.

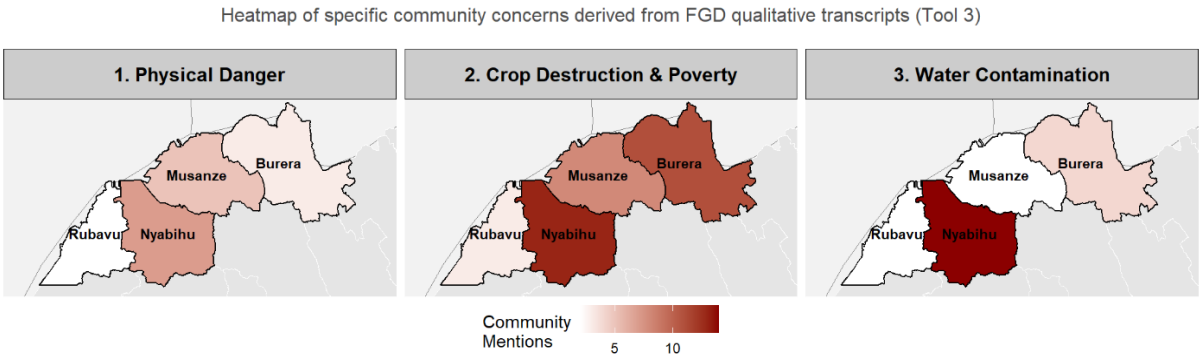


Figure 13: Primary drivers of human-wildlife conflict near Volcanoes National Park, Rwanda

Case study 1: Human-wildlife conflict in Kasese district, Uganda

By isolating this specific geographic and temporal window, the data offers a high-resolution view of the conflict landscape, revealing the specific wildlife species such as elephants and hippopotami that pose the greatest impact on local agricultural and household security. This localized approach was essential for identifying the precise hotspots where the wildlife-livestock interface is most active, thereby allowing for the development of targeted, community-level mitigation interventions. These are both ecologically sustainable and directly responsive to the needs of the affected populations in Kasese. For example, between Feb 2021 and November 2022, the most number of incidents were reported in July of each year. During this period, the majority of the cases were caused by elephants and involved crop raiding and damages (**Figure 14 below**).

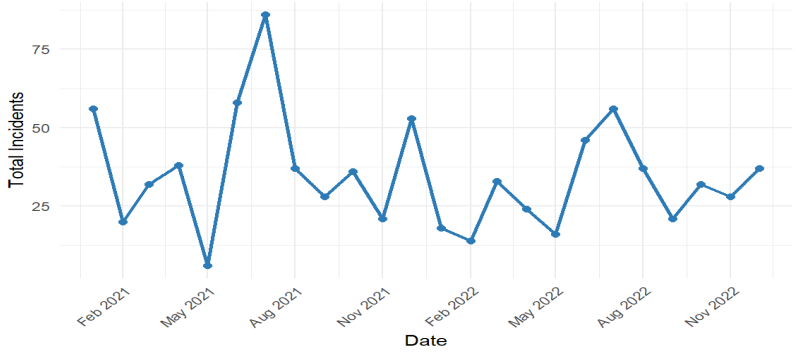


Figure 14: Temporal trend of human wildlife conflict in Kasese District, Uganda (Feb 2021 – Dec 2022)

From February 2021 to December 2022, the trend shows two peaks over, coinciding with the crop harvest time, and elephants caused the most damage. Kabiriizi, Kadeya, Kahendero, Kanyampara, Kanyangeya, Katojo, Kidodo, Katunguru, Kiteso, Nyamatunga, Rwehingo were the most affected and at risk areas.

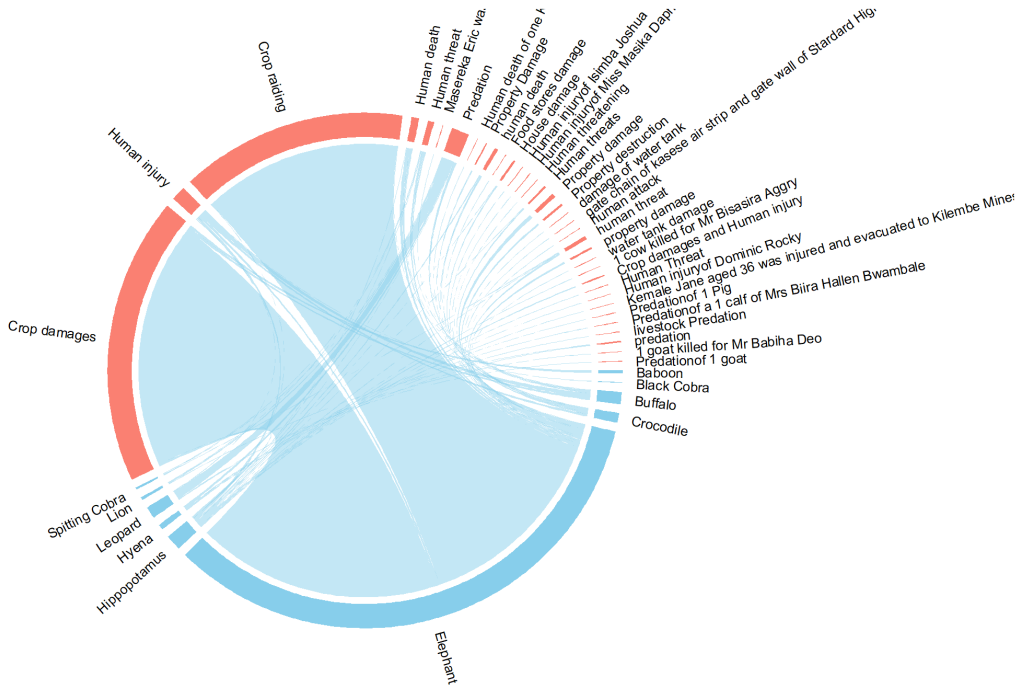


Figure 15: Wildlife species and type of damage caused in human-wildlife conflicts in Kasese District, 2021 to 2022

Wildlife corridors and livestock trade routes in the GVL

Both wildlife corridors and livestock trade routes are important drivers of zoonotic risk across the Greater Virunga Landscape by linking protected ecosystems with densely settled border districts. The blue dashed wildlife corridors connect Virunga National Park, Volcanoes National Park, and Queen Elizabeth National Park, indicating ecological pathways through which wild animals may move across national boundaries. These corridors can facilitate the natural spread of pathogens carried by wildlife and increase opportunities for spillover where wildlife interfaces with livestock grazing lands and nearby human communities. Several moderate-to-high risk points were located close to these corridors, particularly in the Virunga–Queen Elizabeth and Virunga–Volcanoes linkages, suggesting that wildlife movement may contribute to transboundary disease circulation.

Similarly, the livestock trade routes (red) highlight areas where domestic animals are transported through border markets and trading centers, especially around Rutshuru, Musanze, Kisoro, and surrounding frontier districts. Movement of cattle, goats, pigs, and poultry along these routes can rapidly disseminate infectious diseases such as brucellosis, anthrax, Rift Valley fever, and respiratory pathogens between communities and across countries. Where livestock routes intersect wildlife corridors or park-adjacent districts, the risk may be amplified through indirect contact at shared water points, grazing zones, and informal markets. Overall, **Figure (16) below** suggests that zoonotic threats in the Greater Virunga Landscape are strongly shaped by the combined influence of ecological connectivity and commercial livestock movement. This underscores the need for coordinated cross-border surveillance, animal health controls, and One Health risk management.

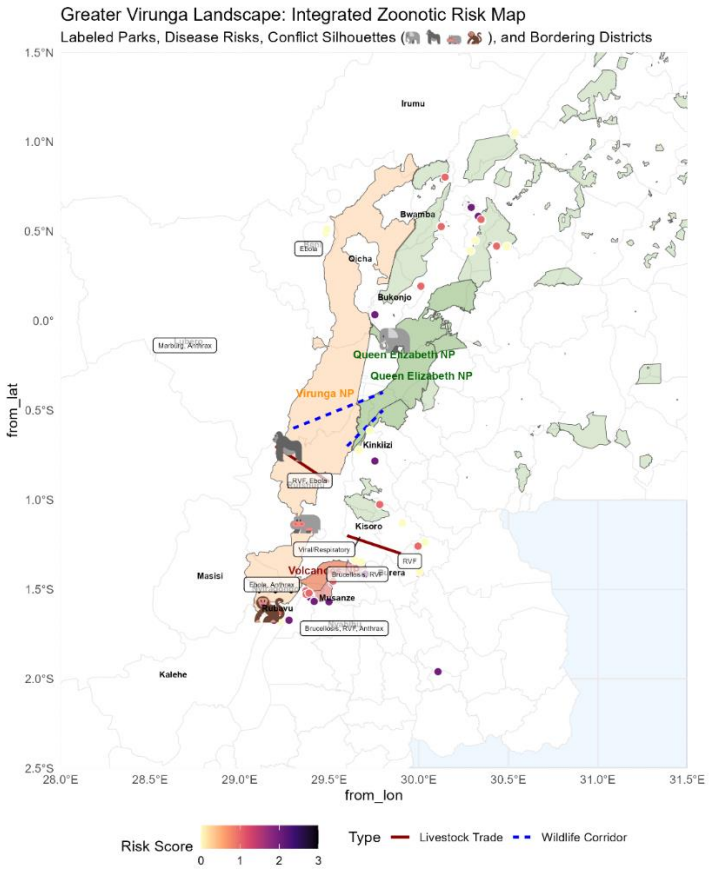


Figure 16: Wildlife corridors, livestock trade routes, zoonoses, and predominant risky species in the GVL protected areas

Human populations and Points of Entry

Overall, areas of higher human population density and major Points of Entry (PoEs) within the Greater Virunga Landscape were closely associated with increased zoonotic risk, emphasizing the role of human mobility and settlement concentration in disease transmission. Highly populated districts in southwestern Uganda and northern Rwanda, particularly around Kisoro, Musanze, Burera, Rubavu, and Nyabihu, were shaded in darker blue tones and coincided with multiple medium-to-high zoonotic risk points. Dense human populations can increase exposure through close contact with livestock, wildlife products, informal food markets, and crowded living conditions that facilitate pathogen spread. In addition, the clustering of official border crossings such as Cyanika, Katuna, Ishasha, Kasindi, and Busunga further amplifies risk by enabling frequent movement of people, animals, and goods across Uganda, Rwanda, and eastern DRC. These PoEs act as critical connectivity nodes where cross-border trade, labor migration, tourism, and livestock transport may accelerate the introduction and dissemination of infectious diseases. Our findings suggest that densely populated border districts and their associated PoEs should be prioritized for strengthened surveillance, screening, sanitation, and coordinated One Health preparedness measures to reduce zoonotic threats in the region (**Figure 17**).

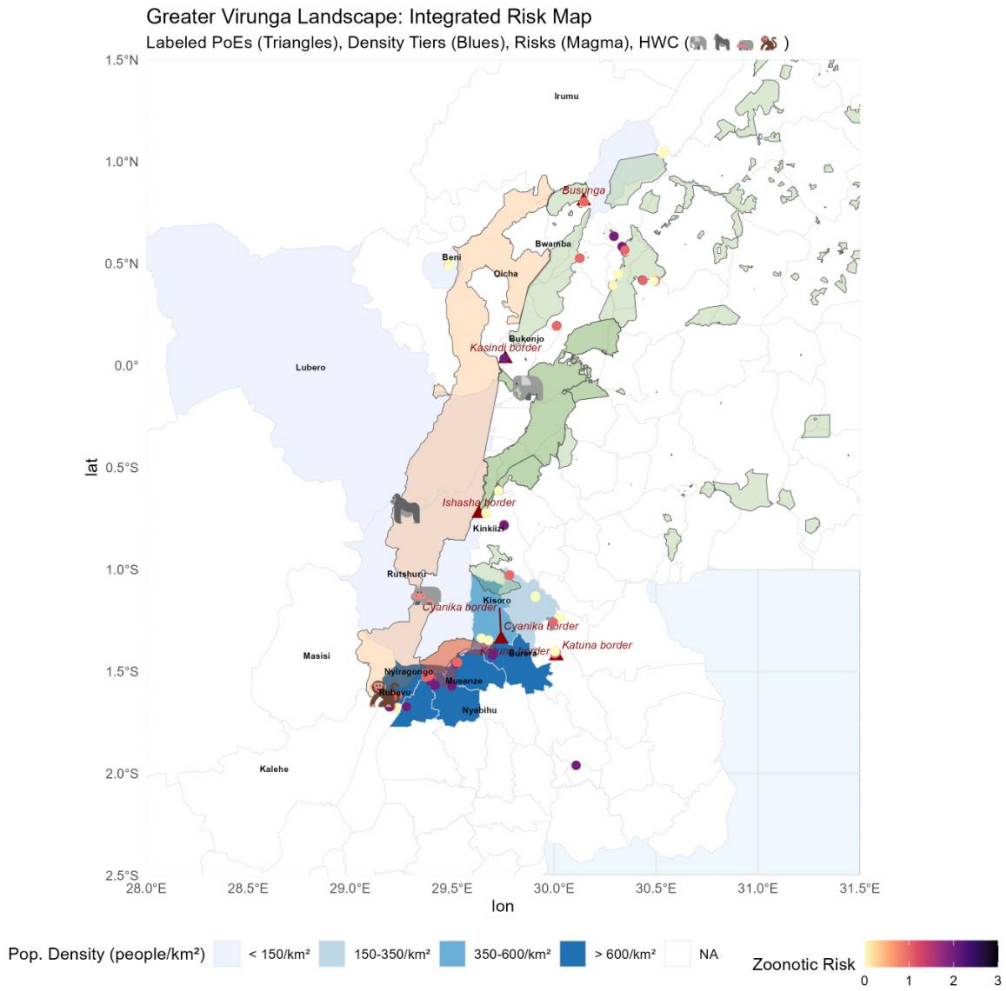


Figure 17: Zoonotic risk profiles based on PoEs, human population density, and human-wildlife conflicts in the GVL

Effect of varying livestock population

Zones in the Greater Virunga Landscape with larger livestock populations tend to coincide with elevated zoonotic risk, highlighting the important role of domestic animals in disease emergence and transmission. Districts such as Rutshuru, Lubero, and Ntoroko, which are shaded in darker orange-brown tones indicating high livestock densities, also contained several medium-to-high household zoonotic risk points. High concentrations of cattle, goats, sheep, pigs, and poultry can amplify opportunities for pathogen circulation within herds and increase contact between animals and humans through farming, markets, slaughter, and household husbandry. In this transboundary landscape, where livestock frequently move across borders for trade and grazing, dense animal populations may further facilitate the spread of infectious agents between Uganda, Rwanda, and eastern DRC. The overlap of high livestock numbers with wildlife-adjacent districts additionally raises the risk of spillover at shared water sources, grazing areas, and park boundaries. Overall, our findings suggest that livestock-rich districts should be prioritized for integrated One Health surveillance, vaccination, and biosecurity interventions to reduce zoonotic threats (**Figure 18 below**).

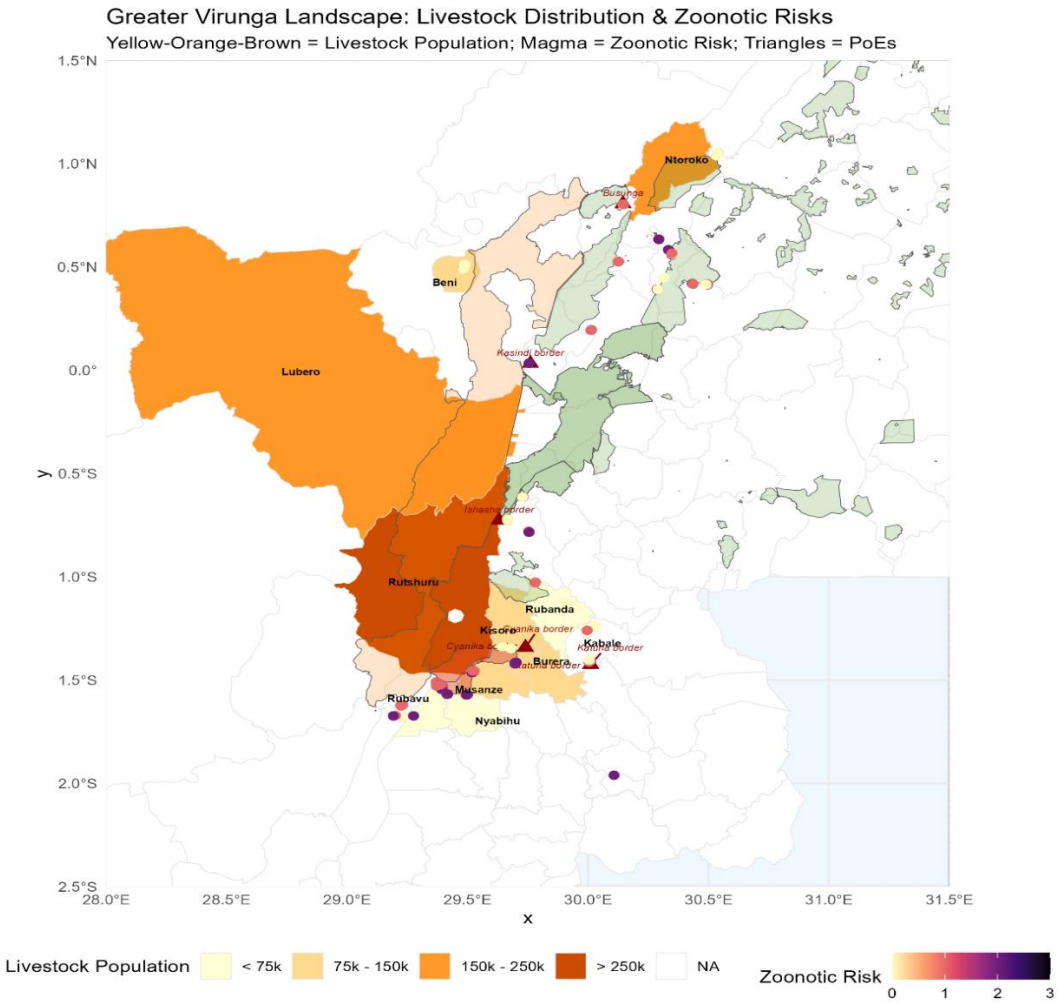


Figure 18: Zoonotic risk map based on livestock population, PoEs and protected areas in the GVL

Several gaps and recommendations generated from this analysis are presented in the table below for consideration. The final priority actions selected during the validation meeting are presented in objective 11.

Table 5: Summary of gaps and recommended actions on managing hotspots

Category	Primary Gap	Priority Actions
Tools and technology	- Limited entomological surveillance despite high abundance of mosquito vectors linked to rainfall patterns - Inadequate physical infrastructure for risk prevention (park fencing) - Unsafe water sources (shared with wildlife) - Economic losses due to animal deaths and abortions need quantification.	- Ecological mapping of areas with varying rainfall patterns and vector changes - Establish or strengthen sentinel surveillance sites for RVF, YF in the GVL - Promote low-cost, community-owned methods like chili-briquettes and beehives to empower locals. - Improve critical infrastructure for prevention (wildlife-human interface barriers, access to safe water - Innovatively expand the use of SMS-early warning systems before elephants leave the park. - Reinforce the existing stone walls with low-voltage electric wires (Rwanda) - Hybrid fencing in hotspots like QENP, KNP by integrating beehive fences alongside electric fences

		- Conduct economic evaluation studies on outbreaks, prevention and preparedness cost benefits
	- No licensed Marburg vaccine or treatment	- Support investigational vaccine use and antivirals prior to outbreaks
Skills	- Limited prior experience in managing filovirus outbreaks, especially in the healthcare setting.	- Conduct cross-border simulations to share experiences - Conduct trainings of different cadres of staff in human, animal and wildlife settings - Strengthen the Ranger-Community dialogue toward collaborative monitoring - For land use, continue the "Buffer Zone" policy for regenerative agriculture (e.g., Pyrethrum)
	- Low community knowledge about zoonotic transmission risks increases spill-over potential.	- Establish and deepen community awareness systems involving VHTs, community and district One Health teams - Conduct medical camps in areas closest to parks
Staffing and infrastructure	- Limited wildlife reservoir monitoring reduces early detection.	- Support surveillance and early warning efforts in animals, wildlife - Lobby for increased technical workforce
Systems	- High incidence of HW conflicts and impact	- Hybrid (beehive and electric) fencing in hotspots - SMS-early warning systems by trained community scouts to use GPS warning of communities - Fast-track the 2022 Wildlife Compensation Regulations (Uganda)
	- No sustained dog vaccination and post-exposure prophylaxis to prevent human cases.	- Support community vaccination programs to protect sylvatic cycle spill overs - Link tourism revenue sharing to HWC insurance premiums for farmers less than 1 km from the PA.
	- High risk of human to human transmission of VHFs in care settings without robust infection prevention and control (IPC).	- Support IPC programs implementation roll out in all health facilities in the GVL - Strengthen community IPC through communal hand washing facilities - Integrate HWC mitigation into IDP support programs.

3.2 One Health Policy Assessment in Uganda, Rwanda and DRC

The section below focuses on objective 2: To identify and assess existing One Health initiatives, policies, and institutional frameworks, identifying gaps and opportunities for strengthening them. We assessed the status through literature and document review, as well as key informant interviews with the national and district level subject matter experts and partners.

Conceptually, there are several foundations for integrated health approaches in biodiversity-rich landscapes. For example, *Zinsstag et al. (2011)*[22] and *Lerner & Berg (2015)*[23] highlight the value of One Health for managing zoonotic diseases in complex ecosystems. Also, *Destoumieux-Garzón et al. (2018)* argue for ecological resilience as an element of One Health, especially in regions where human–wildlife interfaces are intense, such as GVL (**Figure 17** below).

[22] J Zinsstag, E Schelling, D Waltner-Toews, M Tanner. **From "one medicine" to "one health" and systemic approaches to health and well-being.** Prev Vet Med. 2011 Sep 1;101(3-4):148-56 https://pubmed.ncbi.nlm.nih.gov/20832879/

[23] Henrik Lerner, Charlotte Berg, 2015. **The concept of health in One Health and some practical implications for research and education: what is One Health?** Infect Ecol Epidemiol. **https://pubmed.ncbi.nlm.nih.gov/25660757/**

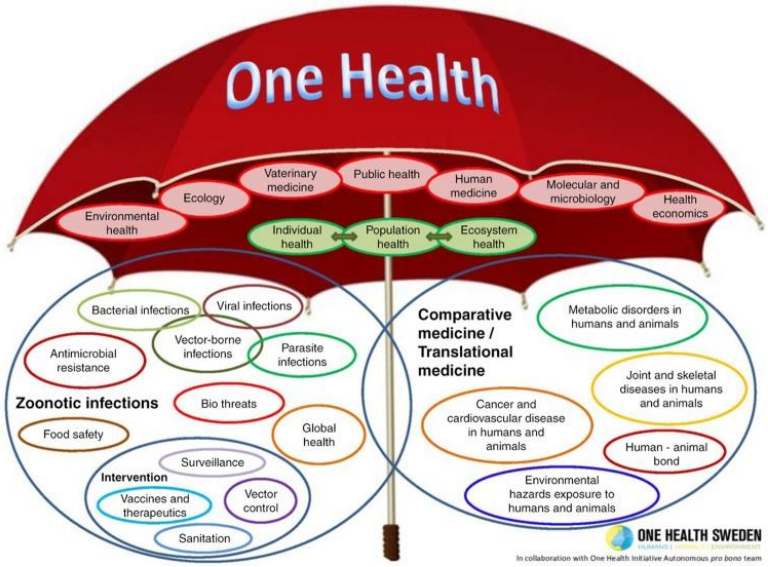


Figure 19: One Health definition and application to research and education (Source Lerner & Berg (2015)

3.2.1 Global and Regional Policy Frameworks Influencing One Health

There are various global and regional frameworks collectively that inform One Health practices in the GVL including the Global Health Security Agenda (GHSA), which supports multi-sectoral collaboration to prevent, detect, and respond to infectious threats. All three countries subscribed and had developed health security capacity based on this agenda. Additionally, all three countries signed the International Health Regulations (IHR, 2005) which mandates development of surveillance and reporting capacities for human health relevant to zoonotic threats. The global quadripartite joint plan of action by (FAO–WOAH–WHO and UNEP) has been a cornerstone in One Health engagement across animal, human, and environmental sectors in Uganda, Rwanda and DRC. As such, the African Union Framework for One Health Practice supports operationalization at country and regional levels, thus a lever for the GVL countries to develop policy direction. At baseline (2025/2026), there had been establishment of a Greater Virunga Transboundary Collaboration (GVTC) with representation from the three countries. The aim was to harmonize policies and protocols, facilitate routine information exchange, coordinate joint preparedness exercises and mobilize pooled resources. There was no signed resolution or treaty amendment that explicitly granted a "One Health" mandate to the GVTC's operations.

> *"Currently funding is from the Pandemic Fund Secretariat. To ensure better funding for management for priority zoonotic diseases, we are fostering regular consultations and engagement at all levels. We need to set up basket fund with contributions from different sources, including also governments and private sector."* KII respondent, GVTC

In concert, the advancements in One Health implementation in the GVL had been a result of all the above frameworks guiding country level capacity development. Regional Technical Committee (RTC) is part of the GVTC efforts to have a panel of representation from Rwanda, DRC, and Uganda. The national level KII respondents proposed that the RTC should play the role of supporting the interoperability of surveillance systems across sectors and among countries. Some (45%) of the national KII respondents in Uganda

mentioned policy, cross-border, and regional coordination challenges. While frameworks exist, implementation remained incomplete. Cross-border collaboration was particularly weak despite high-risk ecological interfaces.

Other transboundary initiatives included ADAPT, operating in DRC and Uganda to strengthen health security and health systems. In addition, the Tackling Deadly Diseases in Africa Project phase 2 (TDDAP-2) was supporting Uganda and DRC to strengthen health security capacities in line with the NAPHS. Directly, the project supported four outputs namely: planning, financing, and coordination; surveillance; workforce development; and community engagement.

3.2.2 National and district One Health initiatives in GVL Countries

Uganda

The country has a national One Health framework 2016, which was recently reviewed in 2023. This established the National One Health Platform (NOHP) with members from Ministry of Health (MoH), Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Ministry of Water and Environment (MoWE) and Ministry of Tourism, Wildlife and Antiquities (MoTWA) represented by the Uganda Wildlife Authority (UWA). Others stakeholders were co-opted to the platform depending on the need. The NOHP members met twice a year, whereas the technical working group (OHTWG) met quarterly. The nominated OH Focal Persons formed the four line ministries and met monthly to run the secretariat. In addition, the National One Health Strategic Plan (2018–2022) and recently reviewed plan 2024 – 2029, enabled multi-sectoral coordination[24]. It outlined zoonotic disease surveillance, multi-sectoral coordination among MOH, MAAIF, MWE, UWA. There was a guiding memorandum of understanding (MoU), and a coordination mechanism existed between the platform ministries and partners such as WHO, FAO, UNICEF. These operated through the National Task Force meetings that took place weekly during preparedness and response phases. During outbreaks of PHTs, the meetings were daily and were attended by the Partners. Notably, the budget allocated specifically for coordination meetings was donor dependent.

The Office of the Prime Minister oversees general coordination of One Health in the country and had advanced the various activities. To decentralize One Health, the country had District One Health Teams (DOHTs) in other parts of the country prior to the OH project. Several joint activities have been implemented by these structures, facilitated outbreak support such as Ebola preparedness and response. However, some gaps persist in sustained institutional financing and integration with environmental sectors. While national platforms exist, local coordination often relies on *ad-hoc* funding from conservation partners like WWF or Gorilla Doctors.

Uganda is developing the national One Health policy. The national framework was not yet fully implemented at the district level in each of the project districts. The GVL districts in Uganda had contingency plans, District Preparedness Plans, District Rapid Response Teams each with a focal person, district ambulances, community health workers and VHTs as well as sample referral systems. There were ongoing efforts to support planning and train members. Some of the stakeholders included security systems, private sector, religious, traditional, and political leaders, technical personnel, Civil Society Organizations (CSOs) and the

[24] United Nations in Rwanda. https://rwanda.un.org/en/3061-rwanda-gets-new-one-health-strategic-plan

community[25]. Several stakeholders including health and development partners, academia, industry, private sector and civil society organizations participated in implementation. At national level, there is a One Health Coordination Office (OHCO) and secretariat with ample representation. Previous joint assessment of OH operationalization showed varied achievement. When asked about the extent to which a sector addressing all One Health indicators and priority areas, the results varied as below:

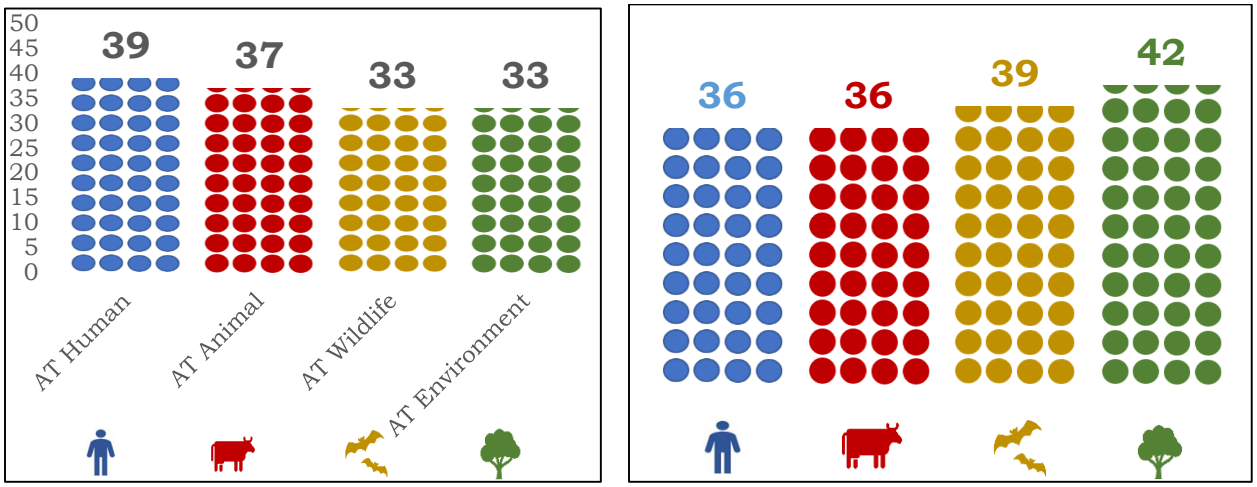


Figure 20A: Sector-specific results on Action Track alignment with OH Indicators (60 possible yes answers) B: Sector Specific Priority Track Alignment with OH Indicators (80 possible yes answers)

During the field assessment (February 2026), key informants from government, NGOs, UN agencies, and conservation organizations contributed to the baseline analysis. The findings revealed a multi-sectoral but unevenly operationalized One Health system, characterized by strong collaboration gains alongside persistent structural, financial, and coordination challenges. Up to six themes and 14 sub-themes emerged, and have been reported in the respective objectives.

Strengthening of One Health collaboration and capacity: A majority of respondents (85%) reported significant improvements in multi-sectoral collaboration and workforce capacity particularly after COVID-19. Institutional structures such as the National One Health Platform and district-level teams were widely recognized. Joint training initiatives and community engagement strategies emerged as key enablers of this progress across disciplines. These have led to improved laboratory and surveillance capacity.

> *"We have been establishing District One Health Teams since 2019 and training them in core capacities … a total of 62 to date, and 11 of these were recently commissioned in the GVL."* KII respondent, Uganda.

At sub-national level, a total of 60 key informant interviews were conducted in 11 districts, with varied participants from 3 (Ntoroko), 4 (Kisoro, Kabale, Kabarole), 5 (Kanungu, Kasese), 6 (Kamwenge, Bunyangabo), 7 (Rubanda) and 8 (Bundibugyo, Fort Portal). These represented various institutions including MoH (60.6%), MAAIF (18.1%), Ministry of Water and Environment (3.3%), UWA (6.6%), local government (6.4%), and NGOs (3.3%). They had on average 11 ± 7.6 years of experience (minimum 1 and maximum 30 years). District-level respondents showed that governance and coordination issues (30%) and health system

[25] Stakeholder meeting on One Health for GVL districts in Uganda, Kasese, 2025

capacity constraints (25%) were the most dominant themes, highlighting systemic barriers to effective One Health implementation.

One Health governance and multi-sectoral coordination (30%): the districts in Uganda mainly practiced outbreak-driven coordination (12%). Collaboration was mainly activated during outbreaks of zoonotic diseases without regular sharing of surveillance data or integration of activities. The routine One Health activities were largely inactive in the 11 districts assessed.

> *"Joint activities are not regular… mostly done when there is an outbreak"* said one respondent, while another noted that *"We collaborate… only when there is an outbreak".* KII district respondent, Uganda.

District Task Force (DTF) as *de facto* One Health platform (10%): despite previous meetings convened by WWF and partners in 2025, respondents noted that DTFs were more functional than formal One Health committees. The latter were still in formative stages including political, health, veterinary, and security actors, with some trainings commenced, yet to start full throttle operations.

> *"Our One Health team is more of District Task Force now."* KII district Respondent Uganda

Leadership and coordination structures (8%): key actors were District Health Officer (DHO), District Veterinary Officer (DVO), Chief Administrative Officer (CAO), and Resident District Commissioner (RDC). Most districts mentioned that coordination is between the DVO and DHO while oversight is by CAO and RDC. The environment officers and natural resources officer were not yet fully on board.

Health system capacity and infrastructure (25%): for effective implementation of One Health, districts need support from the national level and local governments in order to decentralize operations to community level. However, they noted funding and resource constraints (12%). This was a critical sub-theme, highlighting notable lack of funding for meetings, surveillance, response activities. In addition, the participants mentioned that there was heavy dependence on donors to fund activities. The district budgets were already constrained, and thus funded independent departmental activities.

> *"There is no funding currently, we depend on partners. If donors pull out, we may not be functional"* noted one KII respondent. *We have One Health teams that were trained by MoH sometime back even at sub-county levels, but our teams are too inactive. This is mainly due to lack of funding. If we had money to operationalize teams at district level, then we can even revitalize teams at sub-county and parish levels."*

Logistics and infrastructure challenges (6%): respondents highlighted lack of transport (motorcycles), poor laboratory systems and data infrastructure. This affected the sample transportation network for referral of samples within the districts and to national level laboratories.

> *"Hub coordinators lack motorcycles, and yet internally there are tests we cannot do with our limited laboratory systems."*

Information sharing and surveillance systems (15%): this theme came strongly from KIIs. One of the big areas in One Health is joint information sharing, communication and surveillance in human and animal health. Communication platforms (8%) were predominantly WhatsApp groups (dominant), radio talk shows, and community structures (VHTs, churches). Some of these platforms were shared as the DTF during zoonotic disease outbreaks to communicate with communities. Noted are fragmented surveillance systems (4%) with

separate human and animal surveillance by each department. Despite having electronic systems, there was limited integration. Notably, even in outbreak scenarios, there was no joint surveillance between human and animal side. The latter two were also used for sharing information on animal health events in Uganda.

> *We need to improve our data entry systems so that surveillance and laboratory signals from remote health centers, like Hima or Nyakatonzi, can be entered and accessed in real-time. This will trigger rapid responses, so that affected individuals like the abattoir workers do not avoid reporting symptoms like anthrax or Crimean-Congo due to fear of stigma or discrimination."* KII Respondent, Uganda.

There are key analytical insights drawn from the baseline assessment in Uganda. 1) System-level issues dominate including governance and capacity formed the majority of responses. KIIs focused more on institutional weaknesses than community behaviours. 2) One Health is reactive, not proactive; mostly activated during outbreaks, which indicates weak preparedness systems. 3) District Task Force replaces One Health committees with functional DTFs, but dormant OH structures; important for policy discussion. 4) Funding is the central bottleneck across coordination, training, surveillance, and response. 5) Surveillance is fragmented with human and animal systems not integrated, which is a main One Health failure point.

Rwanda

The country had a strong conceptual understanding of One Health. All national level key informants (100%) demonstrated a clear understanding of One Health, consistently described it as an integrated, multi-sectoral approach linking human, animal, and environmental health. This reflects strong conceptual alignment across stakeholders, indicating successful dissemination of the One Health paradigm at policy and technical levels.

> *"An integrated, collaborative framework that recognizes the health of people is closely connected to the health of animals and our shared environment. We have the One Health Policy, Strategic Plan and Road Map in Rwanda."* KII respondents, Uganda.

There were well developed policy frameworks but implementation challenges. A majority (89%) referenced existing policy frameworks, including strategic plans, operational plans, and international guidelines. For example, the One Health policy and strategic plan, Rwanda Epidemic and Pandemic Preparedness Plan (2026–2040) are available, and operate a One Health Frontline Epidemiology course. In addition, there is the Africa CDC Framework for One Health Practice in National Public Health Institutes and One Health Transboundary Assessment for Priority Zoonoses for guidance. However, 72% highlighted implementation challenges, including fragmented governance, regulatory overlaps, limited translation into action, and ministries often operate in silos.

Rwanda had a National One Health Policy and Strategic Plan (2021-2026) which guided the systems and operations at lower levels. In addition, there was a One Health platform comprised of the Ministry of Health, Ministry of Agriculture and Animal Resources, Ministry of Environment, Rwanda Veterinary Council, Rwanda Medical and Dental Council, Sight and Life Foundation, Rwanda Development Board, Rwanda Food and Drug Authority, the University of Rwanda[26]. The Policy establishes collaboration between MoH, RAB, REMA for data sharing and joint response. There are advanced institutional mechanisms such as the One Health Multi-sectoral Coordination Mechanism (OHMCM) which coordinated Ministries of Health, Agriculture,

[26] https://rwanda.un.org/en/3061-rwanda-gets-new-one-health-strategic-plan

Environment, and Wildlife authorities. Once a year there is a multi-sectoral coordination meeting. During policy reviews and OH implementation, other partners are: University of Global Health Equity (UGHE), World Food Programme, USAID-PREDICT or equivalent USAID project, World Health Organization, US Centers for Disease Control and Prevention (CDC), and Africa One Health Universities Network (AFROHUN).

Members of the OHMCM met quarterly, while the TWGs had quarterly and *ad hoc* meetings during outbreaks or emergencies. Several ministries and institutions including Rwanda Biomedical Centre (RBC), MINAGRI, Rwanda Agriculture Board (RAB), MoH/Rwanda, FDA/RMS were coordinated. MOH was in the lead for One Health Coordination with MoE/REMA/Meteo Rwanda, and the. RDB/ RSA. The RBC One Health Unit has representation from MINEDUC, RDF/ RNP/ NISS, Ministry in charge of Finance and Economic Planning and Ministry in charge of ICT and Innovation. Developmental partners represented are WHO, FAO, UNICEF, US CDC, Africa CDC, COHESA, AFROHUN, ECSA HC, and GVTC. From the academia, University of Rwanda, UGHE, ITM, Helsinki University, SOHIC, and Students' Association are part of OH implementation.

The local NGOs contributing to One Health implementation were Gorilla Doctors, RWCA, WAG, RAWO, SOHIC, New Vision veterinary hospital, AMR Initiative, and OAZIS Health. The national ministries and partners such as WHO, FAO, UNICEF were all part of different TWGs to ease information sharing and collaboration. In terms of funding, coordination meetings were donor dependent. District and community level coordination was through the multi-sectoral Rapid Response Teams (RRTs) during outbreaks. In some districts like Nyamagabe and Burera, there were district and community One Health teams. The meeting times for these teams were not yet set, making them *ad hoc.* Currently, the National OH Teams and departments are in process of establishing a mechanism to monitor performance and progress of the district and community level OH teams. The communication channel between the district OH committee and the national platform were very effective in preparedness and response to outbreaks.

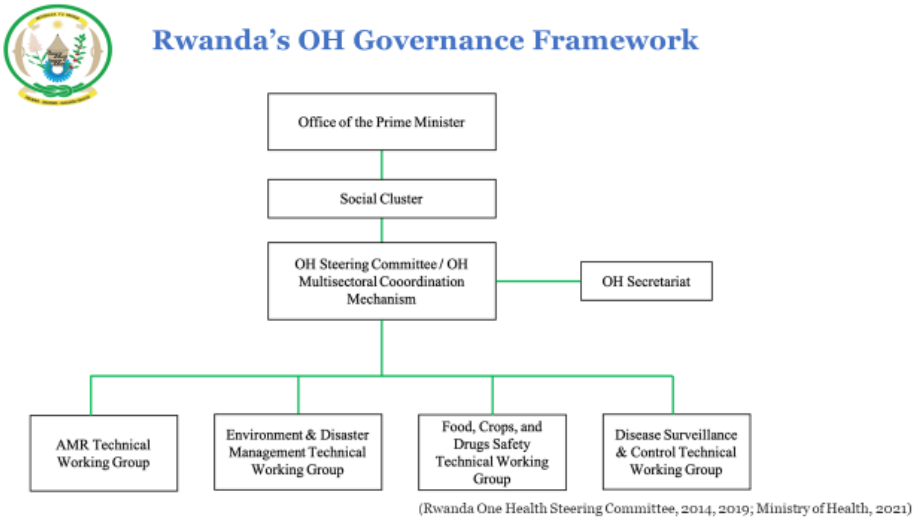


Figure 21: One Health governance framework for Rwanda, 2025

The KI respondents in Rwanda noted that early warning systems existed at sub-national levels. However, they were fragmented, with heavy reliance on informal communication channels. Sharing of One Health data occurred through informal channels- via WhatsApp and verbal reporting alongside formal systems such as (DHIS2). However, lack of standardized SOPs undermined efficiency and interoperability.

"*We don't have a shared system; we just call each other when something happens."* KII respondent, Rwanda.

There were mandatory cross-sectoral zoonotic disease reporting systems linked to community health workers. Rwanda's strength lay in strong governance and data systems, but had not mainstreamed fully the environmental health actions linked to land-use and wildlife conservation.

DRC

The country's One Health landscape is advancing with establishment of multi-sectoral committees and One Health platform. With FAO support under the pandemic project, there is a formal National One Health Strategy and Plan which are operational. This was an important milestone in governance[27, 28,] but implementation was still in infancy. Several partners (WHO, FAO, NGOs) support outbreak response (e.g., Ebola, measles), and collaboration occurs at provincial levels. There was a National One Health Commission with member from the Ministries of Higher Education, University and Research; Public Health and Social Welfare; Environment, Sustainable Development and Climate Economy, Fisheries and Livestock; Communication; Agriculture and Food Security; Rural Development; and the Interior, Security and Customary Affairs. The Commission met once every two months (bi-monthly).

There was a coordination mechanism between national ministries and partners such as WHO, FAO, UNICEF. The One Health Coordination Commission operated in clusters and held annual planning meetings; monitors and evaluates planned activities; and produces reports after each evaluation. A One Health preliminary legislation was under consideration in Parliament. To support these efforts further, in 2025, the national Pandemic Fund project supported the revision of the SIMAR guide, SOPs, and the development of the community-based surveillance manual. There were 17 provincial coordinations, whereby North and South Kivu were under one territorial coordination. However, there is institutional fragmentation and limited surveillance capacity outside urban centers. The security and logistical barriers affect service delivery in GVL-adjacent provinces (e.g., North Kivu and South Kivu). There was no budget specifically allocated to coordination meetings, and currently, funding for activities came from donors.

Reactive rather than preventive systems were noted in DRC. Collaboration was largely triggered during outbreaks, indicating a reactive system. Preventive and preparedness-oriented coordination remained weak, which limited early detection and rapid response capabilities. Reporting tools and systems (3%) for human health reports included IDSR, mTrac, SMS (6767), and situation reports in case of an event. In DRC, there was fragmented One Health implementation. The district level KII findings revealed a partially operational but fragmented One Health system. Four themes emerged indicating that joint meetings and collaboration existed (55%), there was *ad hoc* or weak coordination (40%), community-based surveillance existed (35%), but there was no participation or lack of awareness by some members (30%). While over half (65%) of respondents reported some multi-sectoral engagement, the absence of formal coordination structures and reliance on inconsistent mechanisms indicated limited institutionalization. This aligns with broader evidence from low- and middle-income countries, where One Health approaches often remain conceptual rather than operational.

"Weekly meetings of the epidemiology unit with the animal sector occur… community-based surveillance." KII Respondent 1. *"Joint meetings with other sectors and joint investigations happen*

[27] Food and Agriculture Organization. https://www.fao.org/one-health/partners/projects/pf-regional---democratic-republic-of-congo--rwanda--uganda/en

[28] FAOLEX Database. https://faolex.fao.org/docs/pdf/rwa210403.pdf

when an alert is reported." KII Respondent 2, while KII Respondent 3 mentioned that: *"No, I have not participated in any joint One Health activities."*

Leadership and coordination structures: The Chief Medical Officer of the zone leads coordination. Health sector-led coordination (60%), absence of formal OH structures (50%), and weak governance frameworks (45%) were the main observations by the KIIs.

One respondent noted that: *"Territorial coordination has not yet been established."* While another said, *"There is no multi-sectoral coordination at this level, everyone is in their own office."*

The Chief Medical Officer was frequently identified as the central coordinating authority, reflecting sectoral imbalance. Coordination was predominantly led by the human health sector, with limited integration of animal and environmental actors. This imbalance has been widely documented in global One Health literature and undermines the effectiveness of zoonotic disease control.

In DRC, implementation gaps in One Health (12%) as a theme demonstrated that the One Health structures (6%) were inactive. OH, teams existed but were not functional due to facilitation and funding challenges. At the same time, this led to limited routine activities (4%) like few trainings and irregular meetings. As such, some departments and sectors like environment noted weak inclusion and participation (2%), with limited involvement of women, refugees, and community groups during implementation. Despite these gains, several respondents noted variability in functionality, particularly at sub-national levels.

Challenges in multi-sectoral Collaboration (7%) included teams operating in sectoral silos and a feeling of competition (4%). Despite high awareness of the need to implement, departments operate independently and there was poor information sharing.

"Some departments believe they should handle diseases alone, despite regular Monday meetings as the district administration."

An example of One Health across the borders: several measures were undertaken to safeguard against the risks of anthrax (from hippos) and avian influenza (birds) by communities in Uganda and the DRC around Lake Edward. These include mapping the areas (block off infected field), risk communication and community engagement (RCCE) to raise awareness about the risks of disease transmission, and destruction of carcasses. Funding was secured from the national budget by sector. There were no specific Memoranda of Understanding (MoUs) signed for surveillance or outbreak disease data sharing among the key sectors. Neither was there any for cross-border data sharing across the GVL countries.

3.2.3 One Health Initiatives and Programs in the GVL

These initiatives focus on zoonotic disease prevention, surveillance, laboratory strengthening, coordination, and workforce development with funding from the governments, supported by various partners. Despite the presence of health structures at community level, participants reported limited implementation of integrated One Health approaches.

Table 6: Regional and project-based initiatives contributing to One Health outcomes

Initiative	Scope	Lead Partners	Key Focus
Strengthening One Health-Based PPR **in the GVL** (Pandemic Fund/ World Bank)	Uganda, Rwanda, DRC	GVTC; FAO, WHO, UNICEF, WWF, Gorilla Doctors, IUCN	Surveillance, Laboratory, Workforce & Community Capacity, Cross-Border Coordination & Governance
Tackling Deadly Diseases in Africa Project phase 2 (TDDAP-2) and ADAPT	DRC, Uganda	UK Aid, FCDO, IDI, Resolve to Save Lives	Health security improvement through NAPHS
Global Health Security Projects - **STRIDES**	Regional, Uganda	US govt, local ministries	Zoonotic pathogen surveillance and lab capacity
FAO-ECTAD One Health Support	Uganda	FAO, MAAIF	Surveillance and laboratory support to 11 high risk districts, rapid response support for outbreaks.
Mountain Gorilla Veterinary Programs	GVL	Conservation NGOs (e.g., Dian Fossey Gorilla Fund, ICCN, UWA, ORTPN)	Gorilla health & disease prevention
Advanced Laboratory & Surveillance Expansion	Rwanda	WHO	High-containment lab (BSL-3) under One Health program
Cross-Border Surveillance Pilots	GVL	Ministries + Partners	Shared disease reporting

Gaps and challenges

These initiatives have strengthened collaboration, surveillance, early detection, and cross-border communication but often operated as project silos, thus had limited long-term integration into national systems. Human and animal health sectors are increasingly aligned, but environmental health and ecosystem management are less systematically incorporated into national One Health instruments, creating a gap. This has made land-use planning, wildlife corridors, water and sanitation planning lack formal linkages to disease surveillance systems. Overall, One Health institutionalization and implementation has advanced and accelerated implementation of IHR capacities in the three countries. There are notable gaps that the project can address as shown in Table 7 below.

Table 7: Gaps and challenges to One Health policies and implementation in GVL

Dimension	Key Gaps	Recommended actions
Policy and Governance	Insufficient environment sector integration; no shared cross-border One Health policy.	- Explicitly include environment and wildlife ministries and departments at district level in One Health governance. - Integrate the environment sector, division, departments in OH implementation with a budget line and planned activities - Map existing country level policies for joint implementation of intersecting areas. - Facilitate the districts to develop One Health strategic plans
Hotspot focus	Strengthen identification and zoonotic surveillance	- Map and prioritize high-risk districts (hot spots) - Deploy integrated surveillance systems - Strengthening cross-border coordination
Institutional Capacity	Inadequate trained One Health workforce at sub-national levels.	- Capacity building (3%) by training across sectors and increasing workforce. - Institutional strengthening (4%) by activating One Health teams at Sub-county and District levels to develop work plans, jointly implement.
Financing	Lack of sustained public funding;	- Resource mobilization (2%) to secure dedicated budgets and government funding. - Conduct capacity strengthening engagements and lobby for a budget line direct from Ministry of Finance (Uganda and DRC)

	overdependence on donor projects.	- Work with donor projects to build technical capacity to generate internal revenue. - Negotiate (multi-country level) and manage (at country level) project revenue from the parks and protected areas in GVL.
Data and Surveillance	Fragmented systems; poor interoperability; limited wildlife health monitoring.	- Design and facilitate an interoperable cross-border surveillance system in the GVL - Invest in eco-epidemiological research, develop land-use and ecosystem health indicators tied to disease risk. - Strengthen the wildlife surveillance system including laboratory sample collection, transportation, processing and results dispatch - Develop, translate, and disseminate case definition on common wildlife zoonoses to the GVL districts - Procure a vehicle for coordination, and motorcycles for surveillance in health, production, natural resources and community based surveillance - Establish cross-border rapid response teams with agreed verification protocols and secure access plans for conflict-affected zones in DRC.
Laboratory systems	Address electricity, logistics and HR capacity gaps	- Investing in laboratories and transport - Strengthening workforce capacity - Improving logistics systems
Community Engagement	Variable community-level integration in surveillance and preventive actions.	- Organize regular sensitization sessions of communities and VHTs to strengthen joint surveillance. - Involve communities id design and dissemination of health messages on prevention of zoonoses
Cross-border Coordination	No formal joint outbreak response protocols or shared surveillance platforms.	- Develop and share protocols on outbreak response and surveillance platforms. - Translate the protocols into major languages spoken in the GVL e.g. Kinyarwanda, French, Runyakitara, etc.
District OH Teams	Lack of management plan and financial resources; mindset and perception only reactive; knowledge gaps; insufficient transport for coordination and surveillance; sustainability challenges of community sensitization.	- Continue training and skills enhancement to address knowledge and attitude gaps among OH teams - Support financial inclusion and access - Review the transportation access guidelines, availability and facilitation - Review community sensitization guidelines and messages to be disseminated during human animal and environmental health sessions (integration)

3.3 Surveillance and Early Warning

This section reports findings from objective 3: To assess the capacity of stakeholders to operationalize early warning systems, including event detection, investigation, information sharing, and border health management.

The countries in the GVL show uneven operational capacity for early warning for priority zoonotic diseases. Uganda and Rwanda had relatively stronger primary health reporting and structured animal health posts. The surveillance systems, event detection and verification were stronger compared to DRC. On the other hand, DRC had a high disease burden, but surveillance was uneven and under-resourced. Generally, across the GVL, wildlife disease surveillance was largely reactive, triggered by notable events (e.g., gorilla or wildlife mortality), rather than as routine surveillance.

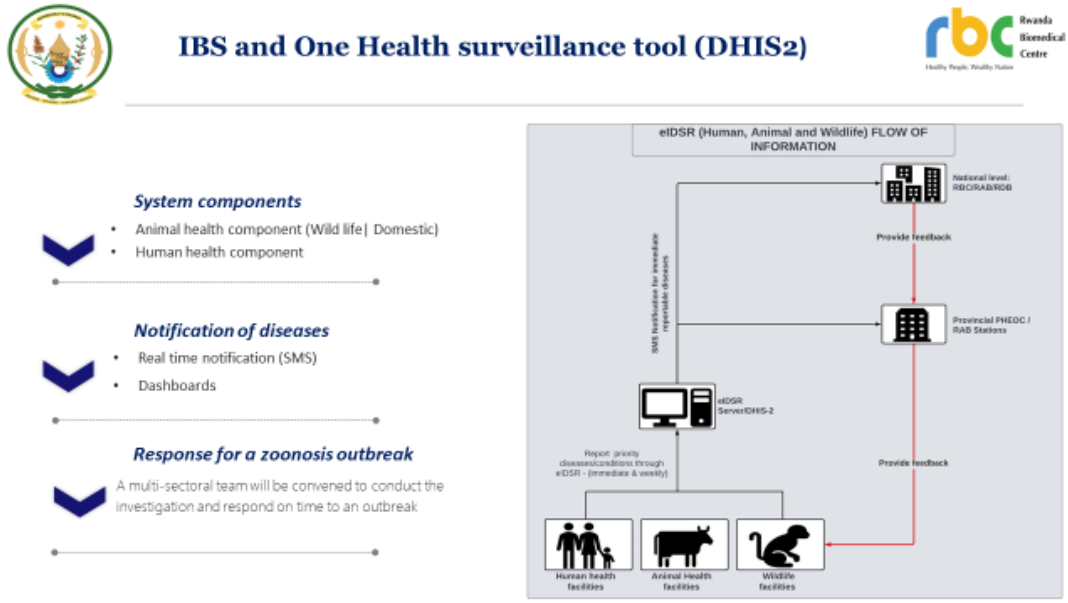
3.3.1 Event detection and community surveillance



Uganda has adopted regional public health operations centre (RPHEOC), two of which are in GVL: Kabale and Fort Portal. These among other diseases conduct surveillance and early warning interventions on priority zoonoses. There were system capacity gaps mentioned by the national KII respondents. Half of them (50%) identified laboratory and surveillance capacity limitations, including delayed reporting and low diagnostic capability. Frontline challenges such as low index of suspicion and infrastructure gaps were highlighted as barriers to early detection.

There are Village Health and Conservation Teams (VHCTs) and district surveillance teams in Uganda (Bwindi)[29] which provide strong community-level detection models. Knowledge gaps at the community and frontline levels were the primary barrier to early detection and investigation of suspected cases in humans, livestock and wildlife.

Conversely, Rwanda has structured district reporting[30]. However, inclusion of privately practicing veterinarians remains a challenge. Private veterinarians handle 80% of livestock production and management systems in Rwanda, but their formal reporting into the national One Health system remains at roughly 15%. The reporting system is as shown in Figure 20 below.



[29] MOH Knowledge Management Portal
[30] ctph.org. https://ctph.org/one-health-program/

Figure 22: Linkages among the system components of surveillance for zoonoses in Rwanda

The Standard Operating Procedures of the surveillance system were well structured. Rwanda used the Integrated Disease Surveillance and Response (IDSR) with electronic IDSR (e-IDSR) platform. Digital system: DHIS2-based e-IDSR for human health; veterinary reporting through Rwanda Agricultural Board (RAB) and Rwanda Development Board (RDB) system with integration pathways established. SOPs for unusual events exist: immediate reporting to district veterinary/health officers/ park vet/ CHW → sector health → district health → RBC/ RAB/RDB→ field investigation within 24 to 48 hours.

National KII respondents in Rwanda reported to have strong preparedness efforts but limited simulation and testing. Preparedness systems were reported (67%), including: training and contingency plans. However, full One Health readiness simulation exercises were inconsistent or absent.

3.3.2 Information systems and tools

The surveillance systems were transitioning to the Transboundary Digital Disease Surveillance System which will integrate mHealth tools where VHCTs (Village Health and Conservation Teams) use mobile apps to report animal/human "unusual health events" in real-time. Uganda uses a digital system called DHIS-2 for human health surveillance and EMA-i-+ for animal health. Regular epidemiological bulletins are shared weekly for human health and monthly for animal health[31]. The surveillance system for human health in DRC also uses DHIS-2, EMA-i-+ and the Integrated Analysis Unit (IAU) for immediate alerts. Notably, the IAU is integrated in 10 out of 34 health zones. On the environmental side, there are several applications that operate independently (such as SMART, Earth Range, Ebola+COVID and Mpox Outbreak reporting systems, etc.). The main challenge to interoperability of data reporting across sectors is lack of harmonization of surveillance indicators. The standard operating procedure (SOP) when a "strange or rare event" (e.g., multiple animal deaths) is reported is activation of the multi-sectoral Incident Management System (IMS). The average time (in days) between an alert and a field investigation varies. It's immediate for alerts by the CAI or EMA-i-+, and reporting is integrated in the 7-1-7 approach at the provincial level.

In Rwanda, event detection and investigations followed an average response time of 24 to 48 hours from alert to field investigation. Wildlife unusual events were reported through Rwanda Development Board (RDB). The recent JEE evaluation (2024) showed improved early warning capacity to Level 4. There were cross-border protocols harmonized through East African Community (EAC) mechanisms for events at Lake Kivu and other border regions. In terms of policy engagement and planning, Rwanda had developed comprehensive contingency plans. These included COVID-19 (National Preparedness and Response Plan), Ebola and Marburg (Preparedness and Response Plan for VHFs), Mpox (National Preparedness and Response Strategy), and other priority zoonotic diseases like Rabies, Brucellosis, RVF, Avian Influenza, VHFs.

In DRC, KIIs found that data sharing remained fragmented, with limited interoperability across sectors. The information sharing systems were phone or WhatsApp (70-80%), paper-based reporting (50-60%), digital tools (EWARS, DHIS2, Kobo) at 40%, while others reported no formal system (30%). Some participants

[31] **The quarterly animal health epi-lab bulletin. 2022.**
https://www.agriculture.go.ug/wp-content/uploads/2022/06/Quarterly-Animal-Health-Bulletin.pdf

noted that *"No tools… only via a WhatsApp platform, phone and paper."* While another noted that: *"We use EWARS and Kobocollect."*

Surveillance and data integration was weak with siloed sectoral systems. Although digital tools such as EWARS and DHIS-2 are present, their limited use and lack of interoperability constrain effective surveillance. The heavy reliance on informal communication platforms further underscores systemic weaknesses. Similar challenges exist in Uganda and Rwanda.

Community surveillance was inconsistent in Kivu provinces due to limited access and workforce shortages. The "unusual events" observed in wildlife currently reported to public health authorities through EMA-i-+ and a WhatsApp group called "Message with photo". There is immediate action from alert to investigation. There harmonized protocols for verifying events across borders. Zoonotic surveillance is still sector-specific, thus a need for interoperability of surveillance systems within *UNE SANTE* and implementation of information flow within *UNE SANTE*. Since the last WHO assessment, DRC noted an improvement in early warning system taking into account the recommendations of JEE and PVS. Post-outbreak review practices were conducted (55%) for some events, while others AARs were not conducted (45%). In such instances, AARs were often limited to awareness and surveillance activities. This indicates inconsistent institutional learning following outbreaks.

Training needs in Surveillance

ISAVET (Field Epidemiologist), support for agricultural and veterinary schools (strengthening their skills in disease ecology), environmental health.

In Uganda, tools and technology for surveillance were predominantly paper-based at the community level, although the DHIS-2 system was used for human health data reporting weekly, monthly and quarterly. The data quality in DHIS-2 reporting rate for GVL districts in Uganda was above 80%, although timeliness fluctuated between 75 – 85% due to reporting inconsistencies in some districts. The key metrics for preparedness included the recently adopted 7-1-7 Framework as its primary performance metric: 7 days to detect an outbreak, 1 day to notify authorities, and 7 days to complete early response actions. The performance of the three countries according to the timeliness (7-1-7) varies.

In Rwanda, FGD participants reported strong outbreak response but unequal service coverage. Most respondents (81%) reported effective outbreak response, particularly during COVID-19. Strengths included rapid response, community sensitization, and multi-sector involvement. However, inequities in distribution of the logistics during response were noted.

Event verification and investigation capacity: Rapid response teams existed in Uganda, DRC and Rwanda. However, cross-border teams had not been set up or tested, and joint investigation protocols were limited. Simulation exercises had been conducted before with Mpox and Ebola virus disease scenarios. However, there was no sustained tri-national data-sharing mechanism and the data for the human, livestock, and wildlife systems were stored on different platforms (e.g., DHIS-2, animal health bulletins). Lastly, the workforce shortages affected field epidemiology and veterinary investigation especially in DRC, contributing to a low "suspicion index" at community level.

Table 8: Surveillance and laboratory capacity table and metrics

Capacity area	Rwanda	Uganda	DRC
Policy/platform presence	High	High	Moderate
Community detection (VHCTs)	Moderate-High	High	Low
Rapid verification teams	Moderate	Moderate	Low
Laboratory turnaround time (regional)	Moderate	Moderate	Low
Cross-border data sharing	Low	Low	Low
Border health /quarantine SOPs	Moderate	Moderate	Low

Trends in zoonotic disease occurrence in DRC came from three dominant sub-themes: perceived increase in outbreaks (65%), limited knowledge of trends (25%) and notable improved response capacity (20%) due to the experiences. For example, in the past one year, the data showed 36 suspected cases of anthrax, 18 cases of rabies, and 54 cases of Mpox, including one death. Respondents frequently described recurring outbreaks of Mpox and anthrax, although a subset reported insufficient knowledge to assess trends.

Table 9: Key gaps and priority actions to strengthen surveillance in the GVL

Category	Primary Gap	Priority Action
Tools and technology	- Lack of interoperability	- Digitalize from the Rwandan model throughout the region to ease coordinated, effective information sharing - Share standardized as well as community case definitions for the PZDs - Share cross-border risk mapping and early warning systems. - Adopt interoperable digital platforms for human-animal-environmental health data across ministries and cross-border.
Skills	- Low public awareness of other zoonotic diseases thus low reporting by communities	- Identify and train stakeholders at the animal, environmental and human interface (One Health approach) - Train One Health agents (INOA: National Institute of One Health/UNIKIN); veterinary technicians and field personnel - Conduct "Joint table top, drill, and functional simulation exercises" (SimEx) specifically for cross-border zoonotic spill-overs - Popularize the different definitions of standard cases of zoonoses under surveillance in the DRC, translated into local languages, in all four territories bordering Virunga Park. - Conduct "Joint table top, drill, and functional simulation exercises" (SimEx) specifically for cross-border zoonotic spill-overs. - Conduct community "sentinel surveillance" training by scaling the Village Health and Conservation Team (VHCT) model.
Staffing and infrastructure	Inadequate staff in human, animal, wildlife and environment surveillance	- Scale VHCT community surveillance into two cross-border pilot clusters - Integrate routine wildlife health monitoring with community reporting - Create mandatory monthly data-sharing meetings between Park Wardens (wildlife), DVOs (livestock), and DHOs (human)
Systems		- Operationalize the planned GVTC One Health Secretariat to host a tri-national early warning hub – Support integrated surveillance systems

3.4 Laboratory Capacity in the GVL

This part reports findings for objective 4: To assess the availability of laboratory diagnosis capacity, specimen referral systems, and biosafety/biosecurity across the human, animal, and agriculture sectors. Each country assessment team visited selected human, animal and wildlife laboratories in the respective districts. All human health laboratories were located in a health facility (also assessed for human capacity, equipment, systems, tools, and reporting capabilities). Laboratory checklists and health facility interviews (31) were held. In Uganda, 11 districts had slightly varying representation; three each in Bundibugyo, Bunyangabo, Kabarole, Kasese, Kisoro, Rubanda; four each in Fort Portal, and Kabale; two each in Kamwenge and Ntoroko districts, while one was in Kanungu District. In DRC, 11 laboratories while 8 were evaluated in Rwanda. The wildlife laboratories in Kasese, Musenze and Goma were evaluated. In the GVL, laboratory services are largely integrated into the human and animal health care facilities. The GVL is currently undergoing a "digital leap" to connect remote field sites to national laboratories. Information sharing occurs internally in the respective ministries through the national platforms for key indicators. Cross and tri-national data sharing protocols are weak, hindering timely cross-border alerts[32, 33].

3.4.1 Laboratory performance in GVL, Uganda

The Ugandan side of the GVL features the most formalized wildlife diagnostic infrastructure in the region, with a BSL II laboratory in QENP. However, the diagnostic delays in community-level detection is an area for improvement. There is a low suspicion index among frontline workers, who often treat zoonotic symptoms as common infections (e.g., malaria or "routine" skin infections) until a cluster of deaths occurs. For example, a review of the 2024 Anthrax outbreak in Kanungu District, Uganda, showed that detection took 85 days in animals and 77 days in humans. However, it only took 3 days for laboratory confirmation once samples reached the district. Uganda's Regional Referral Hospitals (like Kabale RRH and Kabarole RRH) have seen capacity scores rise from 58% to 79% (2022–2024). However, many "last-mile" health centers still lack the cold chain and biosafety equipment needed to handle zoonotic samples safely. In terms of biosafety scores, Uganda's Regional Referral Laboratories score was 46% (Fair) on bio risk audits, while the District Health Center IV laboratories score was 21% (Poor), indicating high risk for laboratory-acquired infections at both levels. The testing coverage during the 2025 Mpox response and confirmatory testing access for suspected cases in border regions fluctuated between 20% and 50%.

Of the 31 respondents, 28 were males (90.3%) and 3 (9.7%) females; average age of 35±7.2 years (minimum 24 and maximum 46 years). The health facilities included ten hospitals (seven public, two private and one referral hospital), nine health centre IVs, eight health centre IIIs, two veterinary clinics and one wildlife reference laboratory in Queen Elizabeth National Park. Ownership was largely government (87.1%), private not for profit (6.5%) and private (6.4%). The majority (83.9%) of the laboratories assessed handled human samples, 12.9% handled livestock samples and wildlife. One laboratory also handled environmental samples. The facilities had an integrated digital reporting system for zoonotic diseases called eIDSR short messaging platform called 6767, in addition to DHIS-2, mTrac, Laboratory Information Management Systems (LIMS).

About a third (32.3%) of the laboratory facilities were accredited to international standards such as ISO 15189 or ISO 17025, or enrolled in a quality improvement process like SLIPTA. Accreditation dated as far back as

[32] https://www.thepandemicfund.org/projects/fast-tracked-strengthening-one-health-based-ppr-greater-virunga-landscape
[33] https://www.fao.org/one-health/partners/projects/pf-regional---democratic-republic-of-congo--rwanda--uganda/en

2017 to 2025, while one laboratory was part of the 5th cohort of SLIPTA. Similarly, 32.3% of the laboratories participated in external quality assurance schemes for priority zoonotic pathogens, and conducted various tests as illustrated in the figure below.

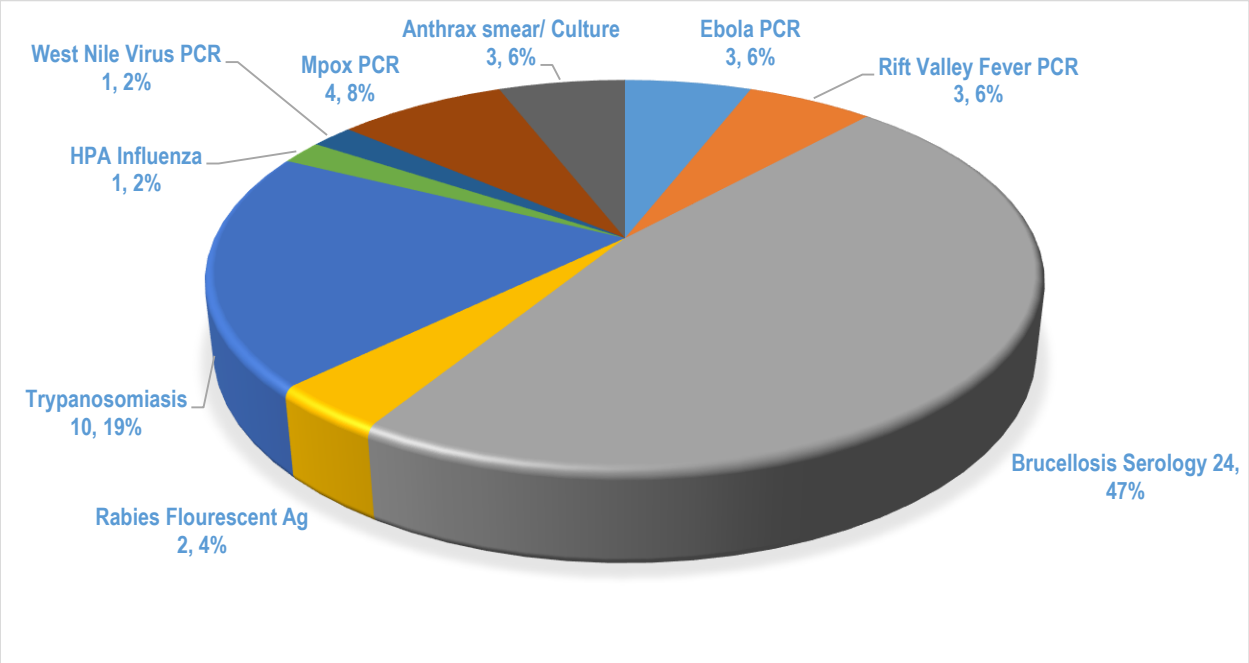


Figure 23: Sampled laboratories (n=31) testing for various priority zoonotic pathogens in GVL, Uganda, 2026

Brucella serology was the most common test carried out by 24 sampled laboratories, followed by trypanosomiasis (10 laboratories), Mpox (4 laboratories), Ebola and Rift Valley Fever (3 laboratories each). The majority (more than 70%) of the laboratories had cold chain, centrifuges and sample transportation carriers, which enabled them to collect and refer samples, if the required tests were not on their test menus (figure below).

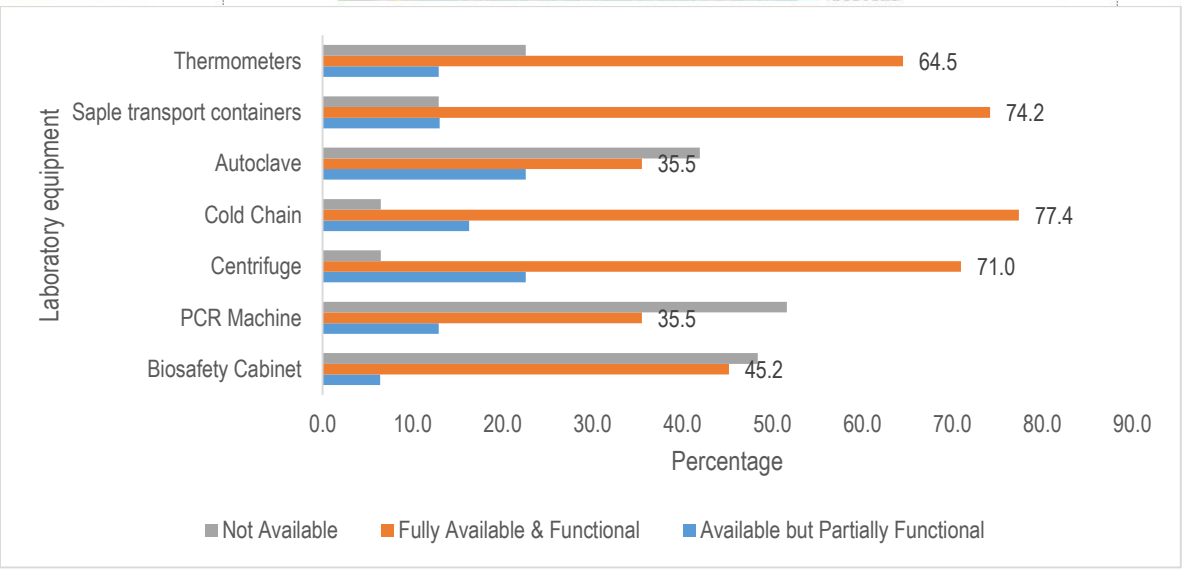


Figure 24: Availability of laboratory equipment in 31 assessed laboratories in Uganda

The equipment or lack of supported their capability to refer samples to laboratories within the region that can support a given pathogen test. On average, the laboratories reported receipt or dispatch of 18±22 (maximum 80) samples over the past six months. More than half (58.1%) of the laboratories had staff consistently trained in bio risk management related to priority zoonotic diseases. Relatedly, 83.9% of the laboratories had a functional specimen referral mechanism from remote hotspots to the central laboratory. Hamurwa HC IV, Maziba HC IV, Rubanga HC III, Bundibugyo District Veterinary Laboratory, and Uganda Wildlife Diagnostic and Research Laboratory did not have a referral mechanism to central laboratories. For example, in the previous six months, different laboratories had referred samples for various tests and had varying turn-around times (TAT). Up to 12 laboratories had sent VHF suspect samples (TAT 24 hours to 2 weeks); Yellow Fever by 4 laboratories (TAT 72 hours to 3 weeks); brucellosis by 5 laboratories (TAT 24 hours to 14 days); trypanosomiasis by 3 laboratories (TAT 7 days); HPAI by 4 laboratories (TAT 24 hours to 3 weeks); anthrax by 7 laboratories (TAT 1 week to 3 weeks); salmonellosis by 4 laboratories (TAT 72 hours to one week). None of the laboratories had sent requests for West Nile virus, plague, or rabies.

Several biosafety and biosecurity protocols existed for protection of laboratory staff and the environment at varying levels in the different laboratories (**Figure 23**). All the laboratories had requisite personal protective equipment (PPEs). Notably, emergency protocols such as availability of ambulances, facility phones, regular drills were noted and yet, in other facilities extinguishers and fire blankets had expired. Please integrate simple histograms, not 3-dimensional ones. Also, include the percentage (%) for the numbers in the histogram.

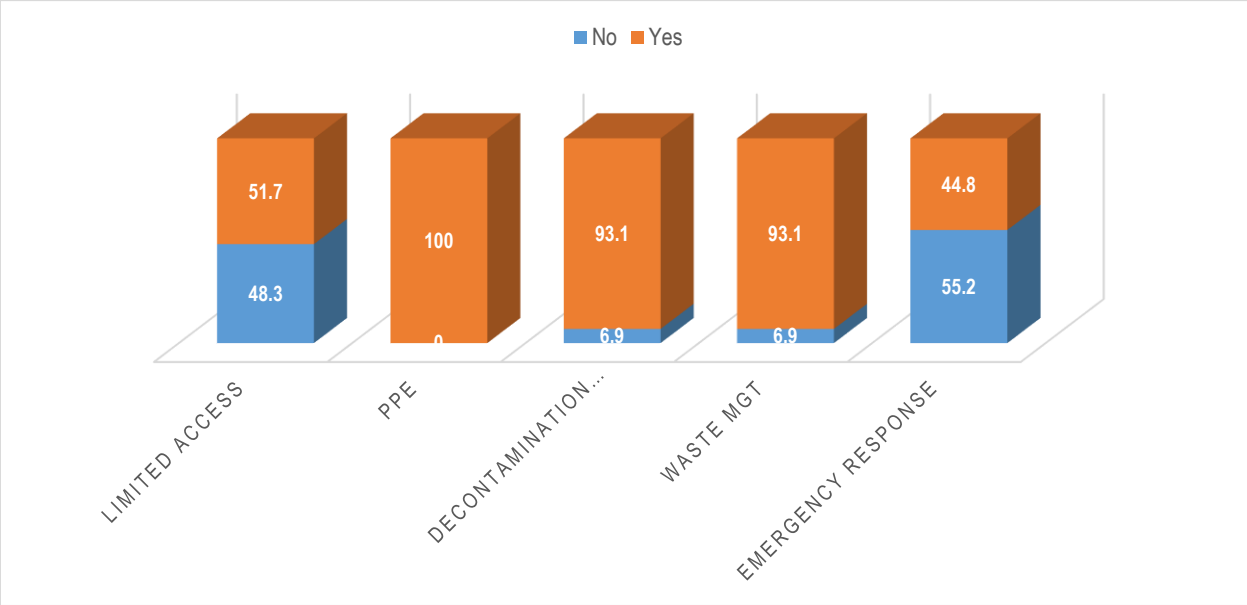


Figure 25: Percentage of laboratories with selected biosafety and biosecurity protocols

Several challenges were mentioned by the participants (Figure 24) including delayed procurement of supplies (64.3%), poor staffing levels (64.3%) and thus work overload (60.7%).

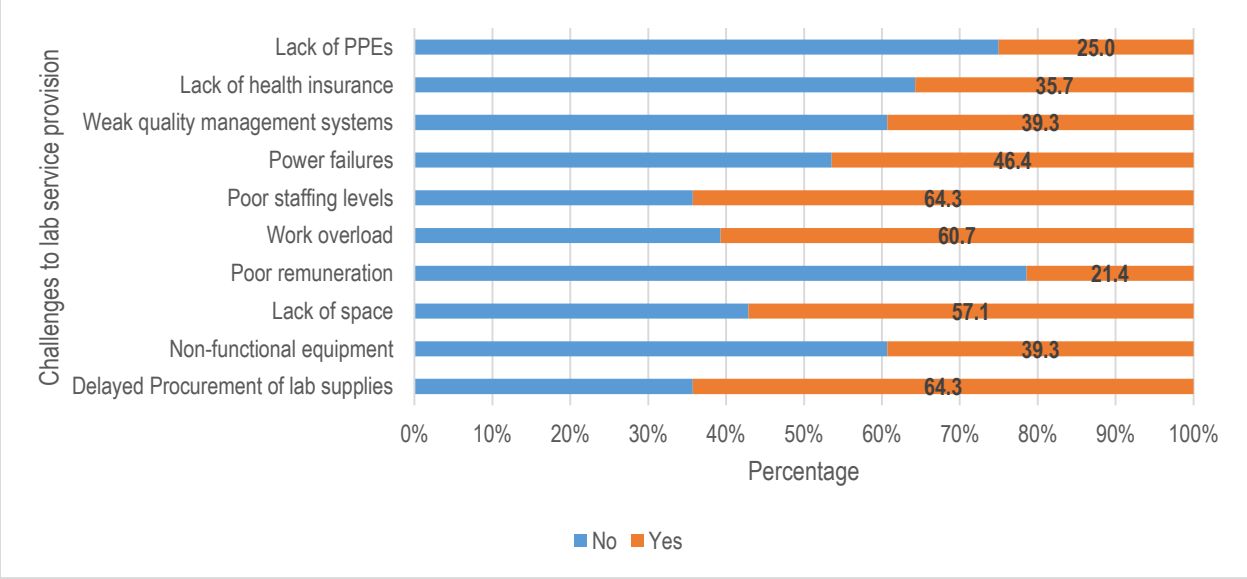


Figure 26: Challenges faced by the laboratory service provision in GVL, Uganda

3.4.2 Laboratory performance in GVL, Rwanda

Rwanda has a highly centralized and efficient diagnostic system reaching the assessed districts namely Musanze, Burera, Nyabihu, Rubavu. There is a functional specimen referral network from districts to National Reference Laboratory (NRL) at RBC. A new National Veterinary Reference Laboratory is being constructed at RBC and will operate at BSL-3 level. Regular biosafety and bio-risk management training is achieved through WHO and CDC partnerships. There is cold chain maintained through courier services and dedicated

transport systems for field samples. Notably, district-level "field" testing for animals remains a bottleneck. Metrics based on a 2025 mobile reporting pilot revealed that while veterinarians are reporting more cases, diagnostic tests were performed in only 3.6% of suspected livestock cases, indicating a high reliance on clinical (visual) diagnosis over laboratory confirmation. There is a public sector gap with 88% of veterinarians operating in the private sector, and often disconnected from the public health reporting system. National KI respondents noted capacity and system gaps in service delivery. About 78% of respondents reported capacity constraints, including shortage of skilled laboratory personnel with skills to diagnose zoonotic diseases, weak diagnostic systems, and limited surveillance integration.

Laboratory infrastructure

The laboratory infrastructure within the Rwandan sector of the Greater Virunga Landscape (GVL) operates under a multi-sectoral mandate, but it faces significant technical and logistical barriers that impact the speed and efficacy of zoonotic disease detection. Detailed assessments from districts including Rubavu, Nyabihu, and Musanze highlight a system characterized by experienced personnel but hindered by infrastructure gaps and interoperability challenges.

Diagnostic capacity and technical performance

The technical capacity of district-level laboratories is centered on a core menu of tests for priority zoonotic diseases (PZDs), although the breadth of these services varies by location. Regional laboratories are primarily equipped for *Brucella* serology, tuberculosis, and malaria. More complex diagnostics for Viral Hemorrhagic Fevers (VHFs) or Mpox require specimen referral to central national hubs.

Workforce expertise

Personnel at the assessed facilities demonstrated significant experience, with an average of 12 years of professional practice in clinical or veterinary diagnostics. Facilities were required to maintain and display standardized case definitions for reporting zoonoses to ensure consistency in community-level surveillance.

Data management and interoperability

A critical focus of current laboratory performance is the transition to digital reporting and inter-sectoral data sharing. Many facilities have adopted computer-based systems for reporting zoonotic events, moving away from purely paper-based logs to enhance reporting speed. Despite the existence of digital tools, significant barriers remain in achieving seamless data exchange between human health, agriculture, and wildlife sectors. Respondents identified a lack of formal shared digital dashboards or monthly multi-sectoral meetings specifically dedicated to routine epidemiological and laboratory data sharing. Laboratories utilized varying protocols for protecting patient and animal data, though the formalization of these security measures remains an area for improvement.

Operational constraints and surveillance gaps

The laboratory system's ability to respond to outbreaks is frequently compromised by environmental and logistical factors. The primary causes for delayed or incomplete reporting include a lack of consistent internet connectivity and insufficient hardware, such as computers or tablets, at the facility level. High staff turnover and the resulting loss of institutional knowledge further strain the consistency of laboratory reporting. While Standard Operating Procedures (SOPs) existed for managing unusual events (e.g., mass animal die-offs),

monitoring is often reactive (conducted only during outbreaks) rather than part of a continuous, proactive surveillance program. Furthermore, there is a lack of harmonized protocols for event verification and diagnostic confirmation across international borders, which is critical in a transboundary landscape like the GVL.

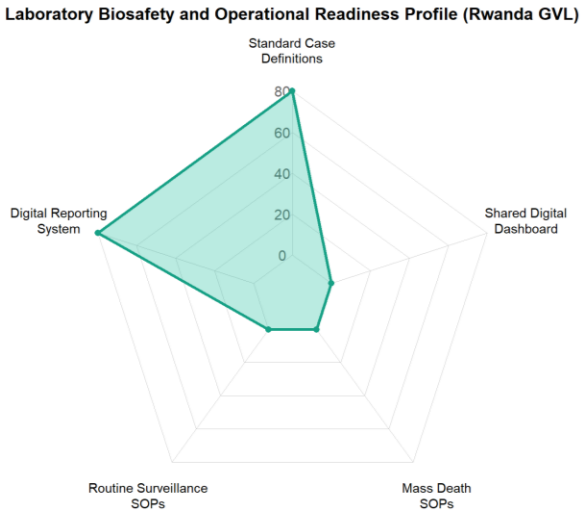


Figure 27: Laboratory biosafety and operational readiness profile

Rwanda has a highly centralized and efficient diagnostic system reaching the assessed districts namely Musanze, Burera, Nyabihu, Rubavu. There is a functional specimen referral network from districts to National Reference Laboratory (NRL) at RBC. A new National Veterinary Reference Laboratory is being constructed at RBC and will operate at BSL-3 level. Regular biosafety and bio risk management training is achieved through WHO and CDC partnerships. There is cold chain maintained through courier services and dedicated transport systems for field samples. Notably, district-level "field" testing for animals remains a bottleneck. Metrics based on a 2025 mobile reporting pilot revealed that while veterinarians are reporting more cases, diagnostic tests were performed in only 3.6% of suspected livestock cases, indicating a high reliance on clinical (visual) diagnosis over laboratory confirmation. There is a public sector gap with 88% of veterinarians operating in the private sector, and often disconnected from the public health reporting system. National KI respondents noted capacity and system gaps in service delivery. About 78% of respondents reported capacity constraints, including shortage of skilled laboratory personnel with skills to diagnose zoonotic diseases, weak diagnostic systems, and limited surveillance integration.

3.4.3 Laboratory performance in the GVL, DR Congo

Laboratory infrastructure and biosafety

The laboratory and health facility landscape in North Kivu is defined by a profound compliance deficit, where systemic gaps across safety, infrastructure, and technical capacity hinder effective disease surveillance. At the core of this vulnerability is a critical safety and quality gap; nearly 78% of facilities fail to meet international BSL-2 biosafety standards, meaning they lack the containment equipment necessary to safely handle dangerous zoonotic pathogens. This risk is compounded by an almost total absence of independent validation, with over 92% of laboratories operating without enrollment in External Quality Assessment (EQA) programs to verify the accuracy of their results.

Furthermore, the system's ability to move from clinical suspicion to definitive proof is severely restricted by a diagnostic and infrastructure bottleneck. Approximately 85% of facilities lack the PCR or molecular capacity required for confirmatory testing, forcing a reliance on presumptive diagnoses that can delay outbreak responses. This technical gap is worsened by the physical environment, as 62% of laboratories report unreliable power, a factor that directly jeopardizes the cold chain stability required to keep diagnostic reagents and patient samples viable. Overall, only a few laboratories were referral ready or had their workforce adequately trained, and had a limited diagnostic reach (**Figure 26).**

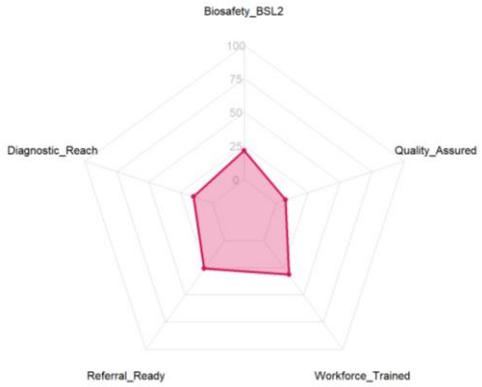


Figure 28: Laboratory capacity compliance in DRC, 2026

Diagnostic capacity and specimen referral

The current state of diagnostic capacity and specimen referral in the DRC presents a significant challenge in the regional One Health surveillance chain. The most alarming finding is the severe lack of confirmatory power at the local level; only 11.2% of the 116 assessed facilities possessed functional PCR or molecular equipment, and only 14.7% had the specific capacity to test for priority zoonotic diseases. This creates a dangerous reliance on clinical suspicion, as over 85% of health zones were physically unable to confirm a suspected spillover on-site.

This challenge is further exacerbated by a fragile and inconsistent supply chain. Nearly 65% of facilities reported major reagent stock outs within the last three months, rendering even the few equipped laboratories occasionally non-functional. Furthermore, the foundational infrastructure required to keep these diagnostics viable was missing in most areas, with only 37.9% of facilities maintaining a stable cold chain (2-8°C). Without consistent refrigeration, temperature-sensitive reagents and viral transport media degrade rapidly, nullifying the accuracy of testing even when equipment is present. The mechanisms for moving samples from the field to higher-level reference laboratories are remarkably underdeveloped. Only 26% of the assessed sites have a functional referral system and access to the triple-packaging materials mandated by international biosafety regulations for transporting infectious substances. This logistical gap is compounded by a near-total absence of quality oversight, as only 7.3% of laboratories participate in External Quality Assessment (EQA) programs. Collectively, these data points illustrate a system that can detect community alerts but struggles to provide the safe, verified, and rapid laboratory confirmation necessary to trigger a timely public health response.

Workforce capacity

The workforce capacity within the assessed regions revealed a fragile foundation built on high personal dedication but severe structural instability. A primary concern is the sustainability risk posed by the current employment model, where nearly 59% of the workforce consists of unpaid volunteers (*bénévoles*). This high reliance on volunteerism is coupled with a significant lack of financial security, as only 28.4% of staff report receiving regular, formal salary payments. This environment creates a high probability of surveillance fatigue and turnover, potentially leading to a collapse of reporting systems if community-level incentives are not formalized.

Furthermore, there is a distinct knowledge and safety gap that threatens both the accuracy of disease detection and the lives of the responders. Only 31.5% of personnel approximately one in three have received formal One Health training, which significantly increases the risk of misidentifying zoonotic clinical signs in the field. This lack of specialized education is mirrored in the laboratory, where less than half (42.2%) of the staff have undergone systematic biosafety training. Without proper grounding in bio risk management, frontline workers face a dangerously high risk of laboratory-acquired infections when handling high-consequence pathogens. The physical and mental toll on the existing workforce is equally alarming, with only 19.8% of staff expressing satisfaction with current workload levels. This chronic understaffing often forces personnel to "cut corners" on Standard Operating Procedures (SOPs) to keep up with high catchment populations. This vulnerability is exacerbated by the near-total absence of social protections; a staggering 91.4% of the workforce lacks any form of occupational health insurance.

Infrastructure resilience

The baseline assessment of infrastructure within the targeted health facilities reveals a system facing severe operational constraints that directly undermine pandemic preparedness. The most critical vulnerability is the energy crisis, with 62.1% of facilities reporting unreliable power. This is compounded by a massive 71.6% gap in backup energy solutions, such as solar power or generators. Without stable electricity, these facilities face a constant risk of reagent spoilage and the failure of the cold chain, which are essential for maintaining the integrity of diagnostic tests and vaccines. When the public grid fails, a vast majority of the surveillance network effectively "goes dark," halting critical laboratory and administrative functions.

Beyond energy, basic utilities and digital tools face significant shortages that compromise biosafety and real-time coordination. Nearly 45% of facilities struggle with an inadequate water supply, a high-risk factor that leads to poor Infection Prevention and Control (IPC) and prevents effective sterilization via autoclaving. This physical vulnerability is mirrored in the digital landscape, where 56.9% of sites face internet connectivity gaps. These digital "black holes" create a major constraint for the One Health mission, as they cause significant delays in reporting community alerts to national databases like DHIS-2 or EWARS, widening the window in which a disease can spread undetected.

The physical security and waste management protocols at these sites present long-term environmental and safety hazards. Only 38.8% of facilities possess functional incinerators, leading to the limited and potentially improper disposal of bio-hazardous materials. This lack of safe waste management is further complicated by poor perimeter security; only 29.3% of facilities have a secure fence. This insecurity not only increases the risk of theft of sensitive medical equipment but also allows for the intrusion of stray animals into clinical areas, creating a direct and unmonitored human-animal interface that could facilitate the very zoonotic spillovers the system is designed to prevent.

Management and governance

Laboratory records were predominantly paper based. The lack of integration with digital surveillance systems (like DHIS2 or EWARS) prevents real-time data sharing between human health, animal health, and environmental sectors. Participation in External Quality Assessment (EQA) programs for zoonotic pathogens is minimal, which impacts the reliability of diagnostic results coming from peripheral laboratories. No district had One Health budget lines and yet 81.9% had active One Health committees with 22.4% having routine non-crisis meetings. Many (34.5%) relied on memory instead of standard SOPs. Multi-sectoral data sharing was only at 12.1%.



Figure 29: Laboratory capacity readiness dashboard in DRC, 2026

The scoring methodology for laboratory readiness was developed as a standardized composite index, designed to normalize data across different national assessment tools, specifically those used in Uganda, the DRC, and Rwanda. This approach prioritizes functional evidence over simple inventory lists. To achieve this, we applied a three-pillar framework that evaluates quality and operations, diagnostic capacity, and infrastructure/governance. Each pillar was weighted to provide a balanced readiness profile, ensuring that a laboratory's ability to conduct a test was balanced by its ability to do so safely and accurately. The referral system is present and ready in 26% of the assessed facility laboratories (**Figure 27** above). The INRB laboratory is at the peak of coordinating referral and transportation of samples from the field.

Overall laboratory readiness in the GVL

The quality and operations pillar (weighted at 40%) assesses the formal operational environment of each laboratory. For this component, we aggregated binary indicators for four key benchmarks: international accreditation (such as ISO standards or SLIPTA enrollment), active participation in External Quality Assurance (EQA) schemes, consistent staff training in bio risk management, and the existence of a formal specimen referral mechanism. By evaluating these elements, the score differentiates between facilities that are merely "equipped" and those that are integrated into a reliable, quality-assured diagnostic network.

The diagnostic capacity pillar (weighted at 30%) was refined to move beyond the inflated reporting noise inherent in many self-administered surveys. Instead of counting every checkbox marked as available, I implemented a validation filter that only tallies tests where the respondent explicitly confirmed active functionality. This step was critical because, in the raw data, many facilities reported a broad array of available tests that were not actually being performed routinely. By cleaning this data, the resulting score provides a high-fidelity count of verifiable testing breadth, separating foundational screening facilities from specialized molecular reference hubs.

The infrastructure and governance pillar (weighted at 30%) assessed the physical and strategic sustainability of the laboratory. This included an audit of seven essential equipment assets such as biosafety cabinets, PCR machines, and cold-chain storage which were scored based on their operational status (fully functional vs. partially functional). When summed, these pillars created a total readiness score that allowed us to compare diverse facility types from national reference laboratories to local district health centers on a single, objective scale, effectively highlighting capacity gaps that require targeted resource intervention.

Table 9: Ranking of sampled laboratories in Uganda

Facility Name Laboratory	District	Quality	Diagnostic Capacity	Equipment readiness	Total	Available Tests
UWA Research Laboratory	Kasese	3.0	10	7.0	20.0	Plague, Marburg, RVF, Anthrax, Brucellosis, Rabies, Trypanosomiasis, HPAI, West Nile, Mpox
Fort Portal Regional Referral Laboratory	Fort Portal	3.0	8	5.5	16.5	Plague, Marburg, RVF, Anthrax, Brucellosis, Rabies, Trypanosomiasis, Mpox
Rukunyu Gen. Hospital	Kamwenge	4.0	3	6.0	13.0	Plague, Brucellosis, Trypanosomiasis
Fort Portal RRH	Fort Portal	3.0	3	6.5	12.5	Plague, Brucellosis, Trypanosomiasis
Bwera Hospital	Kasese	3.0	4	5.5	12.5	Plague, Marburg, RVF, Mpox
Kabale RRH	Kabale	3.0	2	7.0	12.0	Plague, Brucellosis
Busanza HC IV	Kisoro	3.0	2	7.0	12.0	Plague, Brucellosis
Karugutu HC IV	Ntoroko	2.0	4	5.0	11.0	Plague, Brucellosis, Trypanosomiasis, Mpox
Kamuganguzi HCIII	Kabale	3.0	2	5.5	10.5	Plague, Brucellosis
Bundibugyo Gen. Hospital	Bundibugyo	3.0	2	5.5	10.5	Plague, Other
Holy Family Virika	Fort Portal	2.0	3	5.5	10.5	Plague, Brucellosis, Trypanosomiasis
Kibiito HC IV	Bunyangabo	3.0	2	5.0	10.0	Plague, Brucellosis
Kisoro Hospital	Kisoro	2.0	2	6.0	10.0	Plague, Brucellosis
Kanungu HC IV	Kanungu	4.0	2	4.0	10.0	Plague, Brucellosis
Ntoroko HC III	Ntoroko	3.0	2	5.0	10.0	Plague, Brucellosis
Rutete HC IV	Kabarole	2.0	4	4.0	10.0	Plague, Brucellosis, Trypanosomiasis, Other
Ntandi HC III	Bundibugyo	2.0	2	5.0	9.0	Plague, Brucellosis
Bundibugyo Vet Lab	Bundibugyo	1.0	3	4.5	8.5	Plague, Brucellosis, Trypanosomiasis
Rubanga HC3	Rubanda	1.0	2	5.0	8.0	Plague, Brucellosis
Kabarole Vet Lab	Kabarole	1.0	4	3.0	8.0	Plague, Anthrax, Brucellosis, Trypanosomiasis

Kataraka HC IV	Fort Portal	2.0	3	2.5	7.5	Plague, Brucellosis, Trypanosomiasis
Hamurwa HC IV	Rubanda	0.0	2	5.0	7.0	Plague, Brucellosis
Nyakabande HC III	Kisoro	2.0	2	3.0	7.0	Plague, Other
Bufundi HC IV	Rubanda	1.0	2	4.0	7.0	Plague, Brucellosis
Buhara	Kabale	2.0	2	3.0	7.0	Plague, Brucellosis
Kabarole Hospital	Kabarole	2.0	2	2.5	6.5	Plague, Brucellosis
Bigodi HC 3	Kamwenge	1.0	0	4.5	5.5	*None*
Kilembe Mines	Kasese	1.0	2	2.5	5.5	Plague, Brucellosis
Kakiinga HC IV	Bunyangabo	1.0	0	1.0	2.0	*None*
Katebwa HC III	Bunyangabo	1.0	0	0.5	1.5	*None*
Maziba HC IV	Kabale	0.0	0	0.0	1.0	*None*

DRC

Table 10: Ranking of laboratories in the DRC

Facility Name	Quality & Operations	Diagnostic Capacity	Equipment	Total Score	Available Tests
Lab. Vétérinaire Central	2.0	11	6.0	19.0	Plague, Marburg, RVF, Anthrax, Brucellosis, Rabies, Trypanosomiasis, HPAI, West Nile, Mpox
INRB Beni	4.0	4	6.0	14.0	Plague, Marburg, Mpox
Dpt. Zoonoses & One Health	3.0	3	6.0	12.0	Plague, Rabies, Trypanosomiasis
CSR Kyavinyonge	2.0	2	6.0	10.0	Plague, Other
CS de Référence Burusi	1.0	3	6.0	10.0	Plague, Marburg, Other
Centre médical UCNDK	1.0	2	6.0	9.0	Plague, Other
CS la Frontière	0.0	2	6.0	8.0	Plague, Other
CS Kasisi	0.0	2	5.0	7.0	Plague, Other
CSR Lubiriha	1.0	0	6.0	7.0	None
HGR Lubero	0.0	0	6.0	6.0	None
HGR Mutwanga	1.0	0	4.0	5.0	None

Despite insecurity, the DRC has developed world-class "hub" capabilities in Goma, although "last-mile" district laboratories are extremely fragile. There is a functional mechanism for referencing and transporting samples from remote hot spots to the central laboratory. The ICCN sentinel laboratory (PNVi-Gorilla Doctors at the moment) serves 10 provinces. INRB Goma is a P3 level human laboratory and the P2 veterinary laboratory is to be upgraded, aiming for P3).

INRB-Goma now serves as the Next-Generation Sequencing (NGS) hub for the entire Eastern DRC, drastically reducing the "sample-to-sequence" time from weeks to 48–72 hours. Several gaps exist including infrastructure fragility due to constant power outages and insecurity[34] make maintaining "cold chains" for reagents nearly impossible without expensive solar/generator backups. No biosafety level exists for wildlife. There is no regular training of laboratory and other personnel on biosafety and biosecurity. The laboratory and cross-border sample management, transportation, and referral systems are weak. Eastern DRC faces

[34] https://news.mongabay.com/2025/04/poaching-intensifies-in-m23-occupied-areas-of-virunga-national-park/

the largest gaps due to insecurity and limited workforce. Regional laboratory networks are fragmented; sample transport routes and reference laboratories access are limited, leading to diagnostic delays mainly in eastern DRC[35].

Table 11: Ranking and Diagnostic Capacity of Laboratories in Rwanda

Facility Name	District	Quality (4.0)	Diagnostic Capacity (10)	Equipment Readiness (7.0)	Total Score	PZD Testing Capabilities
National Reference Lab (NRL)	Kigali	4.0	10	7.0	21.0	Viral Hemorrhagic Fevers (Marburg, Ebola, RVF), Mpox, Anthrax, Brucellosis, HPAI, Rabies, Plague, COVID-19
Nat. Veterinary Ref. Lab (NVRL)	Kigali	3.5	8	6.5	18.0	Anthrax, Brucellosis, HPAI, Rabies, RVF, Trypanosomiasis
Rwanda Military RRH Lab	Kanombe	4.0	5	6.5	15.5	Marburg (confirmatory), Mpox, Anthrax, Brucellosis
Rubavu District Hospital Lab	Rubavu	2.5	4	5.5	12.0	Brucellosis, Mpox (screening)
Musanze District Hospital Lab	Musanze	2.5	3	5.5	11.0	Brucellosis, Anthrax (preliminary)
Nyabihu District Hospital Lab	Nyabihu	2.0	2	4.5	8.5	Brucellosis
Burera District Hospital Lab	Burera	2.0	2	4.0	8.0	Brucellosis

Table 12: Diagnostic capabilities in the GVL in human, livestock and wildlife sectors

Sector	District/Field Level Capabilities	Regional/National Level Capabilities
Human Health Uganda	Basic Screening: Rapid Diagnostic Tests (RDTs) for malaria/HIV; specimen collection and transport for zoonoses. PCR & NGS: Molecular testing for Ebola, Marburg, and Mpox.	Advanced Molecular: PCR and GeneXpert for Ebola, Marburg, and Mpox. Kabale, Kasese Regional Referral Hospitals (RRHs) act as hubs, with samples to Uganda Virus Research Institute (UVRI)
Rwanda	GeneXpert and PCR: Rapid testing for Marburg and Viral Haemorrhagic Fevers	Musanze District Hospital, Ruhengeri Referral Hospital, National Health Lab (NRL)
DRC	NGS & BSL-3: Capable of sequencing new Mpox Clades and Ebola strains.	INRB-Goma (Rodolphe Mérieux), Mobile INRB units in Beni/Butembo
Livestock Health Uganda	Observational: Clinical diagnosis by District Veterinary Officers (DVOs). Very limited field testing (some Brucellosis RDTs, Basic ELISA for Anthrax; clinical necropsies.	Reference Testing: District Veterinary Offices (DVOs), 8 regional laboratories and referral to NADDEC (Entebbe)

[35] https://www.researchsquare.com/article/rs-2800322/v1

Rwanda	Serology: Mostly restricted to national/regional levels; field kits are rare.	Rwanda Agriculture Board (RAB) and the new National Veterinary Reference Laboratory (BSL-3) in Kigali provides confirmatory PCR/ELISA.
DRC	Clinical Only: Almost no functional molecular livestock laboratories in North Kivu.	Provincial Veterinary Services (Goma)
Wildlife Health Uganda	Advanced molecular: Parasitology and pathogen screening (ISO-recommended) by field laboratories: CTPH laboratory (Bwindi) and Gorilla Doctors analyze faecal samples for parasites/pathogens.	International standards: The UWA Diagnostic and Research Laboratory (Mweya) is the first wildlife lab in East Africa recommended for ISO accreditation.
Rwanda	Genomics: Health monitoring of Great Apes and associated livestock.	Gorilla Doctors Lab (Musanze), RDB Veterinary Unit
DRC	Field monitoring of Virunga's wildlife health.	Virunga NP Veterinary Lab, ICCN/Gorilla Doctors
Environmental Health	Samples of water sources are collected and analyzed routinely in Uganda. Soil sampling and analysis for Anthrax is not yet strong	

3.4.4 Gaps and recommendations

The diagnostic gap in North Kivu is not just a lack of knowledge, but a lack of foundational infrastructure. To move from a reactive to a proactive PPR stance, the project must prioritize:

a) Installing solar-to-battery systems in zonal laboratory hubs to ensure 24/7 cold-chain and equipment functionality.
b) Deploying rapid molecular tools (like GeneXpert or portable PCR) to health zones to reduce the alert-to-confirmation window.
c) Intensive training and PPE provision to move priority laboratories from BSL-1 to "BSL-2 Lite" compliance.

More specific analysis and recommendations are in the table below.

Table 13: Summary of gaps and priority actions

Category	Primary Gap	Priority Action
Tools and technology	- Limited sample transport and laboratory capacity across the three borders. - Last-mile logistics are a challenge for regional laboratories which have PCR machines	- Invest in transportation support to reference laboratories. - Support access to timely laboratory logistics
Skills	- Irregular training for staff in some facilities.	- Improve the technical capacity of the laboratories (veterinary, wildlife, human) - Train biosafety personnel (sample transport), event detection and investigations
Staffing and infrastructure	- Over 50% of district-level laboratories lacking consistent alternative energy sources	- Invest in a regional laboratory system with cold chain and sample transport to link field sites to reference laboratories
Systems	- Porous border diagnostics and surveillance at border points like Bunagana and Katuna lacks rapid "Point-of-Care" (POC) testing for animals.	- Design a 24-month pilot with indicators: time-to-detection, time-to-verification, laboratory turnaround (days), cross-border alert share rate, and community reporting coverage. - Procure, train and support utilization of available handheld PCR devices such as Biomeme or MinION to District Health Offices for "on-the-spot" testing

	- Wildlife-livestock silos whereby wildlife diagnostic data and reports are not yet fully integrated	- Expand the GVL regional biobank to store wildlife samples for retrospective study - Establish MoUs across human and environment sample biobanks to fully allow One Health testing allow data and report sharing - Harmonize standard diagnostic "case definitions" and protocols across the GVL

3.5 Public health and community human resource capacity in GVL

Here below we share results about objective 5: To assess the public health and community human resource capacity (knowledge, skills, staffing, and technology) for prevention, preparedness and response (PPR). The national level KIIs, health facility, laboratory checklists, interviews with the district leadership, and community level FGDs' data were used to support literature review.

In the East African region, the human resource structure for public health is increasingly shifting toward a "One Health" model, which integrates human, animal, and environmental health sectors. This is particularly critical in Uganda, Rwanda, and the DRC due to the high risk of zoonotic diseases at the wildlife-human interface. The baseline status of public health and community human resource capacity in the GVL shows a transition from fragmented, sector-specific systems to an integrated One Health framework. Current staffing levels across the GVL remain below global targets, and regional disparities exist. The GVL relies heavily on the VHCT (Village Health and Conservation Team) model, which positions community members as "One Health" volunteers. There is integrated monitoring where community members are trained to monitor both livestock health and human hygiene (e.g., boiling milk, handwashing near parks) to prevent spillover of pathogens across the interfaces. In addition, the CHWs act as cultural brokers between the park authorities (UWA/RDB/ICCN) and the local population. This is a mitigation measure against the risk of disease transmission during illegal park entries or crop-raiding by wildlife. Country level variation and specifics are presented below.

3.5.1 Uganda's public health and community human resource capacity

Uganda's public health and One Health human resource structure is governed by the Health Sector Strategic Plan 2020–2030 and the National One Health Strategic Plan respectively. Despite this, a substantial gap remains between these strategic plans and the actual frontline human resource (HR) capacity when measured against global health security targets. The human health workforce has approximately 7.9 per 10,000 population (doctors, nurses, midwives), below the WHO target of 23 per 10,000 population. The current vacancy rate in public health facilities is roughly 33%. There is roughly 1 doctor per 25,000 people and 1 nurse per 11,000. The health facilities assessed during the surveys in Uganda had an average catchment population of 180,896 people (maximum 2,500,000 people). The total number of clinicians varied from one to 195 (average of 31 clinicians), while 1 to 11 laboratory staff were found per facility (average of 5 staff). For field epidemiologists, Uganda has 1.5 per 200,000 higher than the global target of 1 per 200,000 population. At community level, Uganda is deploying two Community Health Extension Workers (CHEWs) and Village Health Team (VHT) members per village for community level health provision and surveillance. This follows a historic 8.1% national budget allocation to health for financial year 2025/26 provided the funding to professionalize over 21,000 community health workers[36]. In July 2025, Uganda deployed 1,138 newly

[36] Christine Namayanja, 2025. Uganda Prioritizes Community Health with Historic Budget Increase.

trained CHEWs, linked via the electronic Community Health Information System (eCHIS). However, they are below the international target ratio of 1:1000 (supervisors to VHTs) for effective epidemic surveillance.

For the animal health workforce in Uganda, the ratio of veterinarians to livestock in the GVL border districts is far below the World Organization for Animal Health (WOAH) standards. Each of the 11 administrative units assessed is staffed by a District Veterinary Officer (DVO), Veterinary Officer(s), or Animal Husbandry Officers, and a network of official or private Community Animal Health Workers (CAHWs) who handle the bulk of surveillance and vaccinations. Private veterinarians and animal health practitioners contribute to the industry and surveillance system. The KIIs found that Kasese (3.48 vets per 10000 livestock), and Kabarole (3.39), had the highest coverage, while Rubanda (0.9), Bundibugyo (0.7), and Kabale (0.4) had the lowest coverage. A study in 2019 found that the Uganda Veterinary Board had registered 1290 veterinarians and 1169 Para veterinarians[37]. This staffing density is less than one veterinarian per 100,000 livestock (how many in GVL districts, with most veterinary officers covering multiple sub-counties.

The wildlife and environmental health components are managed primarily by the Uganda Wildlife Authority (UWA) and District Health Offices respectively. UWA has centralized veterinary services with about 100 field rangers are increasingly trained in "One Health" surveillance, without the clinical depth required for rapid diagnostic characterization of new pathogens in the wild. As of January 2026, there are about 100 community volunteers specifically trained for disease surveillance in the four main conservation areas (QENP, Rwenzori, Semuliki and Bwindi). Environmental health has gross deficiencies with most GVL districts having only one District Environment Officer, limiting field-level surveillance. There are no environmental toxicologists and ecologists integrated into the national disease response teams, who would support soil and water sampling for antimicrobial resistance. Related to knowledge and skills, the community and frontline workers have a "low suspicion index" for zoonotic diseases. Baseline assessments in 2025 revealed that it can take up to 85 days to detect an outbreak in animals compared to the 7-1-7 target (7 days to detect, 1 to notify, 7 to respond). Most funding for human resources is still vertical and program based (HIV, Malaria) and not general One Health capacity, leaving environmental and wildlife health understaffed.

Limited access to services: Results from the 22 FGDs in Uganda revealed that communities had limited access to services such as health facilities, veterinary services, and safe water sources. Human resource and technical capacity gaps (7%): district level KIIs noted that there was shortage of veterinarians and laboratory personnel, as well as limited One Health training. The participants mentioned that despite a big population of livestock in districts they interfaced with, each district had two veterinarians or less on government payroll. Although UWA had recruited more veterinarians in 2025, they did not have a collaborative arrangement with those who attend to livestock.

> *"There is limited skilled labour especially in laboratories. That is why we are overloaded. In addition, there is low awareness of the One Health approach at lower administrative levels, with many facilities and sub-counties not yet familiar with how to implement it.*

Table 14: Human resource capacity in the GVL (Uganda, Rwanda and DRC)

Cadre	Knowledge/Skill Status

https://hejnu.ug/ugandas-health-budget-boost-a-new-era-for-community-health

[37] Isabella C. Endacott, Abel B. Ekiri et al., 2019. **Continuing Education of Animal Health Professionals in Uganda: A Training Needs Assessment. Journal of Veterinary Medical Education.** https://utppublishing.com/doi/10.3138/jvme-2020-0161

Uganda	
Doctors, nurses, midwives	About 0.4 doctors per 25000 people; about 9.1 nurses, midwives per 11000 people
Veterinary Officers and vet paraprofessionals	Moderate: Stronger at identifying livestock diseases (Anthrax, RVF) than the human health sector, but limited by lack of a diagnostic "refresher" training for emerging pathogens.
Community	FGD and household results indicated that community health workers and wildlife volunteers support lower administrative units. Recently over 2000 CHEWs were deployed.
Wildlife veterinarians and Park Rangers	High capacity: Over 100 ranger guides in Bwindi and Mgahinga have been trained by organizations like Conservation Through Public Health (CTPH) in "Great Ape Health Monitoring" and respiratory disease prevention.
Community Health Workers (CHWs)	Critical Gap: Studies in SW Uganda show 95% of CHWs have "low knowledge" of zoonotic transmission. Many are unaware of specific threats like Crimean-Congo Haemorrhagic Fever (CCHF) or Marburg.
Rwanda	
Doctors, nurses, midwives	Significant progress in recent years; however, continues to face challenges in equitable distribution and specialized training compared to international benchmarks.
Veterinary Officers and vet paraprofessionals	High dependency on paraprofessionals for frontline services; recent shifts toward digital reporting systems for disease surveillance have shown promise, though technical training and diagnostic capacity require further investment.
Community (RECOs/Agents)	Highly organized, institutionalized volunteer model; extensively trained in iCCM (malaria, pneumonia, diarrhea), maternal health tracking, nutrition screening, and family planning.
Wildlife veterinarians and Park Rangers	High technical capacity in anti-poaching and clinical wildlife care; focus on managing complex human-wildlife conflict and high-value ecotourism, with strong logistical support for protected area management.
DRC	
Doctors, nurses, midwives	2 physicians; 12 nursing/midwifery professionals per 10,000 people (2022 est.)Significant shortages compared to WHO recommendations (4.45 per 1,000); high reliance on external funding and NGOs; limited training/supervision capacity.
Veterinary Officers and vet paraprofessionals	High dependency on paraprofessionals for frontline services; skills focus on basic surveillance, disease control, and vaccination; professional training gaps persist. Generally insufficient numbers in the public sector
Community (RECOs/Agents)	High reliance on volunteerism; skilled in basic integrated community case management (malaria, diarrhea, respiratory), WASH, and maternal health referrals. Decentralized, volunteer-based network (*Relais Communautaires*)
Wildlife veterinarians and Park Rangers	Specialized expertise in clinical wildlife care and law enforcement/patrols; operate in high-risk zones with significant security and logistical constraints. Highly specialized, limited scale; supported by international partnerships (e.g., Gorilla Doctors, ICCN)

3.5.2 Public health and community human resource capacity in Rwanda

In Northern and Western provinces, Musanze, Burera, Nyabihu, Rubavu districts were assessed. The country has a decentralized "pyramidal" system. For tools and technology, Rwanda is leading in technology adoption. The country is piloting open-source artificial intelligence (AI) platforms to assist in the early detection of Mpox and Marburg virus clusters in border districts, with a National Veterinary Reference Laboratory and pilots of mobile phone reporting systems for veterinarians to synchronize animal and human health data in real-time.

Knowledge and skills: Community awareness about zoonoses is high (94%) but specific knowledge of zoonotic transmission is low, and the country had 93.5% health insurance coverage. A 2025 study showed that while 79% of farmers have general health awareness, only 22% could correctly identify symptoms of specific zoonoses like Brucellosis or RVF.

Staffing and workforce in Northern and Western Provinces of Rwanda, there are 12 to 20.9 per 10,000 population (skilled professionals) closer to 23/10,000 WHO target. Total available staff in public facilities is

roughly 20,550 against a requirement of 27,345 (75% staffing rate). Of these, 70% are Nurses/Midwives, 7% are Doctors, and 19% are Allied Health Professionals. Rwanda's One Health Policy (2021) formally integrates veterinarians and environmental officers into national rapid response teams. The veterinary capacity is stronger in the private sector. There are approximately 6,220 professional veterinarians in Rwanda, but 88% operate in the private sector. There is high coverage of Community Health Workers (CHWs) who often act as the "eyes" for both human and zoonotic events at the village level. Moreover, 60,000 targeted for event-based surveillance training. However, public sector veterinary clinical staff are scarce, with 88% of veterinarians working in the private sector. At the sector (local) level, over 55% of staff are trained in livestock production rather than veterinary medicine, creating a gap in clinical zoonotic diagnosis. Systems and coordination: Rwanda is the most centralized in its One Health approach. The One Health Multi-Sectoral Coordination Mechanism (OH-MCM) is fully institutionalized, linking the Rwanda Biomedical Centre (RBC) and the Rwanda Agriculture Board (RAB), summarised in **Table 15** above.

DRC

The profile of the KIIs showed that the majority of professionals interviewed were in the 35–44 age group (30.4%) and the 55 and over age group (36.6%), reflecting a relatively mature and experienced population. Men were in the majority (65.2%) compared to women (34.8%), which may influence the dynamics of participation and perception in monitoring activities. A significant proportion of participants (40.4%) had between 11 and 15 years of experience, followed by those with 16–20 years of experience (21.3%). This reflects an overall experienced workforce capable of contributing effectively to monitoring activities.

DRC faces the most significant challenges due to its size and ongoing conflict, relying heavily on "Health Zones" for operational delivery. Human health resources are critically low, with about 6 to 8 qualified health workers per 10,000 population versus the WHO recommendation of 23. In the health zones of Rutshuru, Beni, Nyiragongo, Lubero (near Virunga National Park), tools and technology are extremely limited. For example, in provinces like Kasaï, the density is as low as 0.27 to 0.55 doctors per 10,000 people. A large number of workers are "Nouvelle Unité" (new units), meaning they work without official state contracts or consistent salaries. Domestic animal and wildlife health is managed by the Ministry of Livestock and Fisheries and the Ministry of Environment, Nature Conservation and Tourism (MENCT) in conjunction with the International Union for Conservation of Nature respectively. With FAO support, the DRC has begun moving toward a National One Health Plan to improve the training of veterinary and wildlife staff in the GVL.

Knowledge and skills: Despite the infrastructure collapse, local teams have high "response experience" with viral haemorrhagic fevers such as Ebola and Marburg). However, formal training in the 7-1-7 framework is lacking at the community level. Staffing and workforce is severely degraded due to ongoing conflict. Up to 70% of health facilities in North Kivu are non-functional or operating at minimal capacity. Human resources are permanently overstretched due to concurrent outbreaks of Mpox, Cholera, and Measles.

Systems and coordination are largely driven by the Greater Virunga Transboundary Collaboration (GVTC) and international NGOs. Formal state led One Health committees are often superseded by humanitarian "cluster" systems. The animal health capacity is primarily concentrated in NGO-supported hubs (e.g., Virunga National Park rangers and Gorilla Doctors) rather than the decentralized public health system, summarised in **Table 15** above.

Analysis of the health worker respondents' profiles revealed a male predominance with 75 (65.2%) and a high proportion of experienced professionals, 40.4% of whom had between 11 and 15 years of experience

and 11 (11.7%) had more than 20 years of experience. Geographically, the distribution of the workforce showed a notable concentration in the districts of Lubero with 38 (32.8%) and Nyiragongo with 37 (31.9%). Finally, nearly half of the staff, 55 (47.8%), worked under the direct supervision of the Ministry of Health.

Table 15: Sociodemographic characteristics of health professionals surveyed in Rutshuru, Nyiragongo, Beni and Lubero of North Kivu Province, 2026

	Variables	Frequency	Proportion (%)
Age groups (n=112)	18-24 years	5	4.5
	25-34 years	14	12.5
	35-44 years	34	30.4
	45-54 years	18	16.1
	≥ 55 years	41	36.6
Sex (n=115)	Female	40	34.8
	Male	75	65.2
Sectors (n=115)	Community	52	45.2
	Goma Veterinary Laboratory	8	7.0
	Ministry of Health	55	47.8
Years of	≤ 5 years	8	8.5
professional	6-10 years	17	18.1
experience (n=94)	11-15 years	38	40.4
	16-20 years	20	21.3
	> 20 years	11	11.7
Territory (n=116)	Beni	21	18.1
	Lubero	38	32.8
	Nyiragongo	37	31.9
	Rutshuru	20	17.2

The gaps and recommendations proposed in this area are here below:

Table 16: Summary of gaps and priority actions on public health capacity

Category	Primary Gap	Priority Action
Staffing	- Massive vacancy rates for environmental health officers. - Limited access to veterinary and environmental health services	- Recruit and deploy dedicated "One Health Officers" at the sub-county level. - Lobby for recruitment of more human, animal and environmental health experts at district level
Skills	- Poor recognition of "Reverse Zoonosis" (human-to-animal).	- Expand ranger/CHW training to include the risk humans pose to wildlife. - Implement One Health curricula in universities and health worker training institutions. - Joint simulation exercises and field epidemiology training across sectors and borders.
Technology	- No interoperability between human and animal health databases.	- Finalize the GVL transboundary digital dashboard for real-time data sharing.
System	- Low prevention practices against zoonotic diseases	- Raise awareness among the population living in the GVL about the prevention practices, costs, accessibility.

	- Limited access to veterinary and environmental health services	- Supply the various facilities with human, animal and poultry vaccines - Organize vaccination campaigns against zoonotic diseases (in humans, animals and poultry) - Lobby for recruitment of veterinarians in communities with higher livestock numbers

3.6 Point of Entry (PoE) Assessment

The section below reports findings on objective 6: To assess the capacity of key airports and border points (equipment, human resources, knowledge) to prevent, detect, and respond to zoonotic diseases.

The assessment of Points of Entry (PoE), key airports and border points referred to in the International Health Regulations (IHR 2005) is critical for the Greater Virunga Landscape (GVL). A point of entry is defined as a passage for international entry or exit of travelers, baggage, cargo, containers, conveyances, goods and postal parcels. This region is a "porous" interface where intense human movement and trade meet high-risk wildlife habitats. The baseline status reflects a significant upgrade in infrastructure following the 2024 Marburg outbreak in Rwanda and the ongoing Mpox response in DRC.

In Uganda, the key PoEs assessed were Entebbe International Airport, Ishasha, Mpondwe, Bunagana, Busunga, Ntoroko (Lake Albert) and Cyanika (**Figure 27 below**).

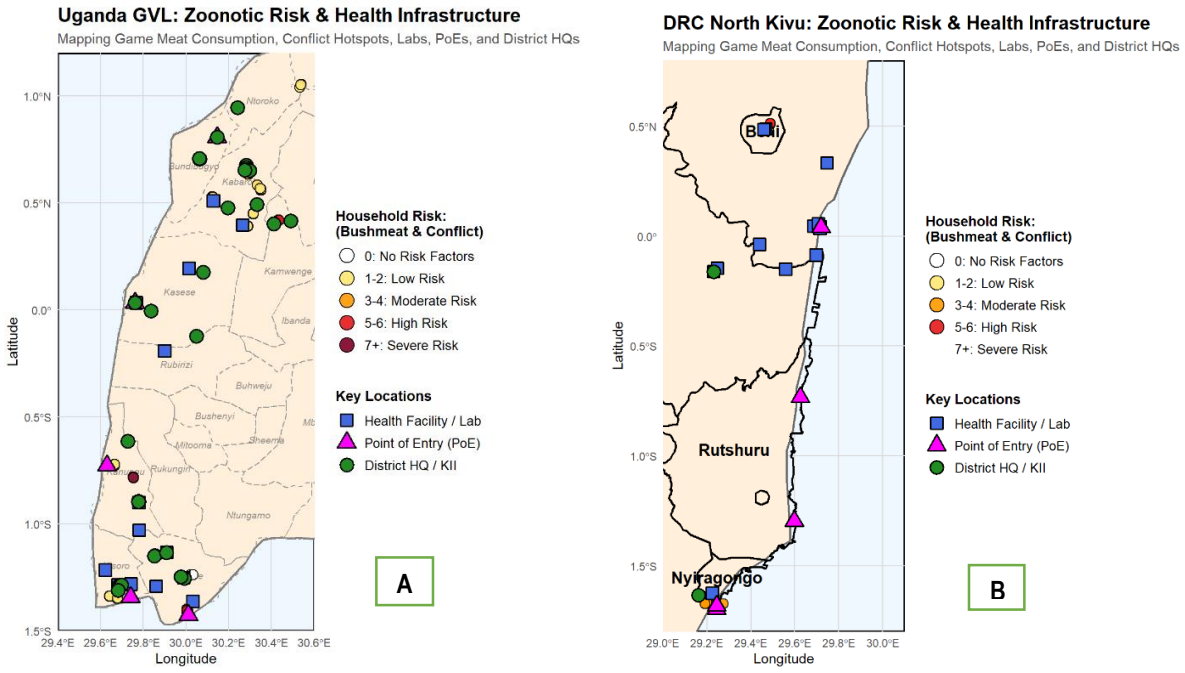


Figure 30: Map showing zoonotic risk, Points of entry, and health infrastructure in Uganda (A) and DRC (B)

According to the IHR metric (SPAR 2024/25): Uganda's PoE capacity (C11) is scored at 67%. While core capacities (60%) are stable, the effective public health response at ground crossings fluctuates during civil unrest in the DRC. However, the capacity also varied across the PoEs assessed. In 2019, Entebbe International Airport, Mpondwe and Busia PoEs were designated by Uganda for IHR POE capacity

development. In this assessment, Entebbe IA had improved from 75% in 2019 to 90% in 2025. Mpondwe has improved from 20% in 2019 to 75% in 2025 while Cyanika scored 67% and Bunagana at 50% respectively in 2025. Communication and coordination, core capacities at all times and core capacities during public health emergencies has significantly improved.

Equipment and technology for surveillance: Entebbe, Cyanika, Bunagana, and Mpondwe were equipped with automated thermal scanners and dedicated isolation suites for cases among humans as per the one stop border point standards. Digital tools such as the electronic Integrated Disease Surveillance System (eIDSR) were active, but a 2025 assessment noted that only 40% of ground crossings had consistent internet for real-time reporting. Paper-based and digital tools**:** routinely, screening of travelers was done and data generated was reported using a paper format and eIDSR. An assessment conducted in 2025 noted that only 40% of ground crossings have consistent internet for real-time reporting, thus the reliance on paper-based systems in such cases. However, there was a shortage of veterinary inspectors at ground crossings like Cyanika and Bunagana. There was a regional staffing model used by MAAIF leading to unregulated cross-border livestock movement.

Human Resources and Knowledge: In each of the PoEs assessed, the Border Health team was staffed by the Ministry of Health. To assess the knowledge, attitude and practices related to biosecurity, 35 personnel representing seven entities were interviewed as below:

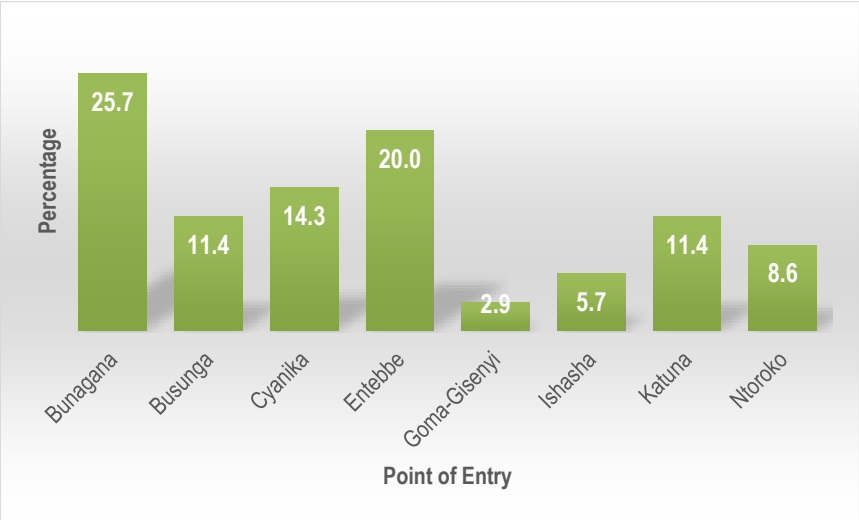


Figure 31: Percentage of personnel interviewed at different Points of Entry in Uganda

The personnel worked with customs (34.3%), port health services Ministry of Health (17.1%), immigration (17.1%), security (14.3%), Civil Aviation Authority (8.6%), aviation authorities (8.6%), clearing agent and Uganda Red Cross (2.9% respectively). The respondents were officers (48.6%), supervisors (8.6%), screeners and security personnel (37.1%), clearing agents and casual workers (5.8%). The education level was graduate (37.1%, post graduate diploma level (8,6%), undergraduate degrees (20.0%), and others (32.5%) at secondary level. The majority had heard about zoonotic diseases (77.1%), and could mention some except 17.1% who did not know any. The zoonoses mentioned were avian influenza (71.2%), rabies (65.6%), brucellosis (47.1%), tuberculosis (14.7%), and malaria (8.8%).

Mpondwe had a large livestock market operating weekly, allowing inspection of live animals (cattle, goats, sheep) and their products before export or import into DRC. According to CDC Uganda, 2025, skills and knowledge varied at PoEs. While staff were proficient in Ebola/Mpox screening, a "low suspicion index" remained for less "famous" zoonoses like Anthrax or Brucellosis. The baseline health care worker interviews revealed the same gap especially in One Health trainings.

Rwanda: The key PoEs assessed were Kigali International Airport (KIA), Gatuna, Rubavu (Grande and Petite Barrière), and Cyanika. From the IHR metric of the SPAR 2024/25, Rwanda scored 67% for PoEs. The country scored 80% during the 2024 Marburg response and improved further during the preparedness for the Mpox outbreak. Rwanda had made strong investments in airport-based surveillance and innovation. However, land borders adjacent to wildlife-dense and conflict-affected areas remained vulnerable to zoonotic spill over. There were advanced pilots such as wastewater and environmental health surveillance. Border health officials have been trained on animal/animal product inspection protocols. There were designated isolation facilities at major PoEs (Kigali International Airport, Rusizi, Kagitumba). Strong collaboration between Immigration, Customs, Rwanda Standards Board, RAB, and RBC existed through the Joint Border Health Management Teams.

Equipment and technology: For laboratory diagnostics, KIA features an on-site rapid molecular testing laboratory capable of delivering results for VHFs like Ebola or Marburg within 4 hours. In terms of tools and technology, the PoEs used paperless health declaration forms and screened travellers using high-resolution thermal imaging.
Human resources and knowledge: There were highly disciplined Port Health teams with mandatory quarterly "One Health" simulation exercises. The main constraint for animal health inspection is that 88% of veterinarians were private. This creates a gap in official state-led animal health inspections at smaller "informal" border crossings. Equipment and technology for laboratory diagnostics, KIA features an on-site rapid molecular testing laboratory capable of delivering results for VHFs within 4 hours. This was part of the Marburg response capacity built in 2024.

DRC

Eastern DRC is an epicenter for emergency of zoonotic diseases. Despite extensive outbreak experience, the capacity of the points of entry remained structurally weak**,** creating regional and global health security risks. There was heavy reliance on emergency outbreak response and minimal permanent border health system. The key PoEs evaluated were Grande Barrière, Petite Barrière, and Bunagana (Figure 26) except Goma International Airport.

Since Goma International Airport has been closed and inaccessible, secondary data sources were used. The IHR score based on the JEE 2023/2024 PoE capacity was 35–40% while the SPAR 2024/25 IHR metric was 40%. The country's PoE capacity remained the most challenged due to infrastructure fragility and the regional conflict. The border agents had protocols for managing animals or animal products suspected of having disease. There was an operational protocol for domestic animal health (PNHF, SQH.) at all PoEs. However, there is need to integrate wildlife into this protocol, and conduct training for all sectors (refresher courses and provision of tools/materials and equipment). There was a designated isolation zone for suspected human cases at points of entry, using the International Organization for Migration (IOM) protocol.

Collaboration existed between immigration, customs, and health services at points of entry regarding zoonotic risks, with established operational framework (CONOPS). Other operational Frameworks are SQAH, PNHF, DGM, DGDA, ARN, SQV, etc. The country has a multi-hazard plan, and few contingency plans like for COVID-19, Ebola, MPox, but not other priority zoonotic diseases.

Equipment and technology: the laboratory hub capacity at Goma Airport and the Grande Barrière benefit from the INRB (National Institute of Biomedical Research) presence, providing Next-Generation Sequencing (NGS) capabilities. Over 50% of border screening posts lack reliable solar/grid power. This affects internet availability and thus electronic surveillance often reverts to paper-based data sharing during outages.

Human resources and knowledge: The staff have vast field experience in Ebola and Mpox detection due to the previous response trainings. However, there is a coordination gap due to regional insecurity in the Rutshuru and Beni territories often prevents Port Health officers from reaching their stations. In addition, the porous routes are easily taken advantage of by the local communities, game meat traders, and poachers. This leaves unmanned access in the GVL surveillance network.

The figure below illustrates the comparative performance trends of selected PoEs in the region, including the Entebbe International Airport (EIA) and various land borders, over a four-year period. By visualizing these metrics from 2020 to 2023, the data highlights the trajectory of capacity strengthening and the operational challenges encountered across these strategic locations. The bars reflect the percentage of successful assessment benchmarks met, providing a clear overview of the growth in infrastructure and surveillance readiness during this period, while also underscoring the recovery and improvement phases observed at sites like Katuna and Cyanika.

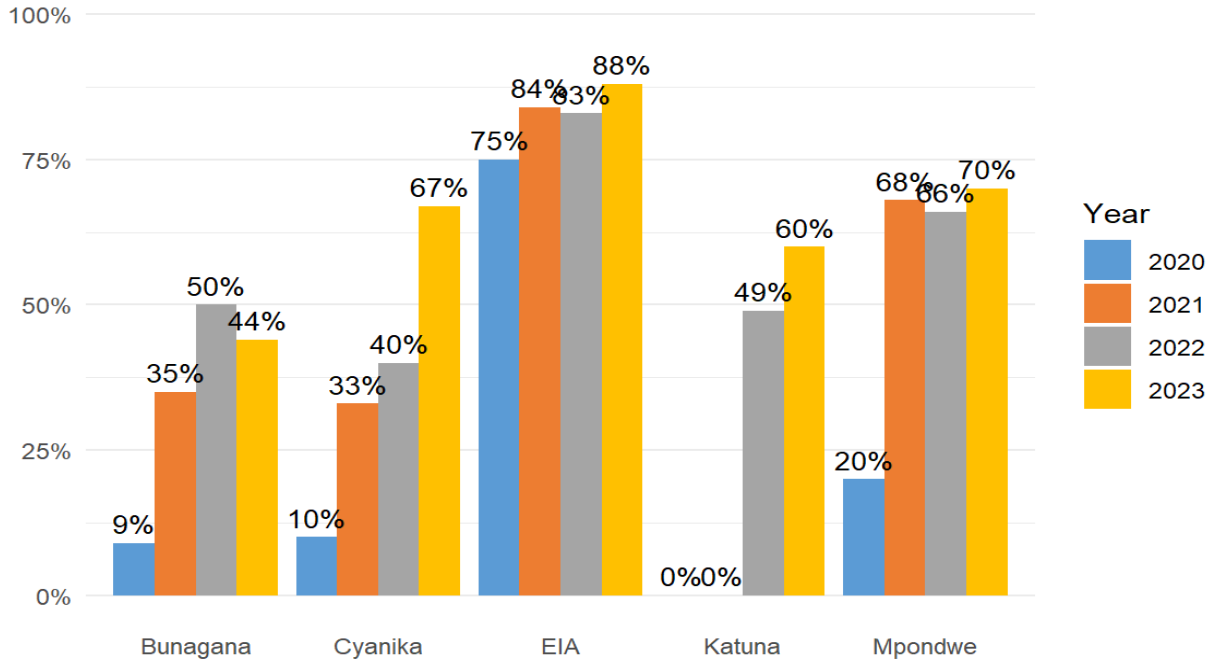


Figure 32: Performance of selected Points of Entry in Uganda, 2020 to 2023

Analysis of PoE One Health Readiness

We did a comparative visualization of Point of Entry (PoE) readiness across the three GVL member states, DRC, Rwanda, and Uganda measured against six critical World Health Organization (WHO) International Health Regulations (IHR) core capacity indicators. In figure 30 below, the analysis shows that Rwanda (Volcanoes Region) exhibited the highest overall readiness scores across all indicators, with peaks in availability of PPE (85%), standardized screening tools (80%), and isolation facility availability (75%). Uganda (GVL Region) showed moderate capacity, particularly in availability of PPE (60%) and functional referral systems (55%), but faced a significant gap in staff trained in OH protocols (5%). DRC (North Kivu Region) displayed the most critical vulnerabilities, with readiness scores for inter-sectoral coordination, functional referral systems, and staff training all falling between 10 to 20%.

The lowest performing indicator across the GVL was for staff trained in OH Protocols (2% in DRC, 20% in Rwanda, and 5% in Uganda). This confirms the baseline finding that while general awareness exists, formal multi-sectoral training for border personnel is currently a primary failure point. Regarding infrastructure and coordination, across all three countries, the physical availability of PPE generally outpaces inter-sectoral coordination. This suggests that hardware investments have been more successful than the software needed to integrate customs, security, and health sectors into a unified One Health response. Concerning isolation and referrals, Rwanda's high score in isolation availability (75%) reflects recent investments following the 2024 Marburg outbreak, whereas the DRC's 15% readiness highlights the severe infrastructure fragility and energy constraints in North Kivu.

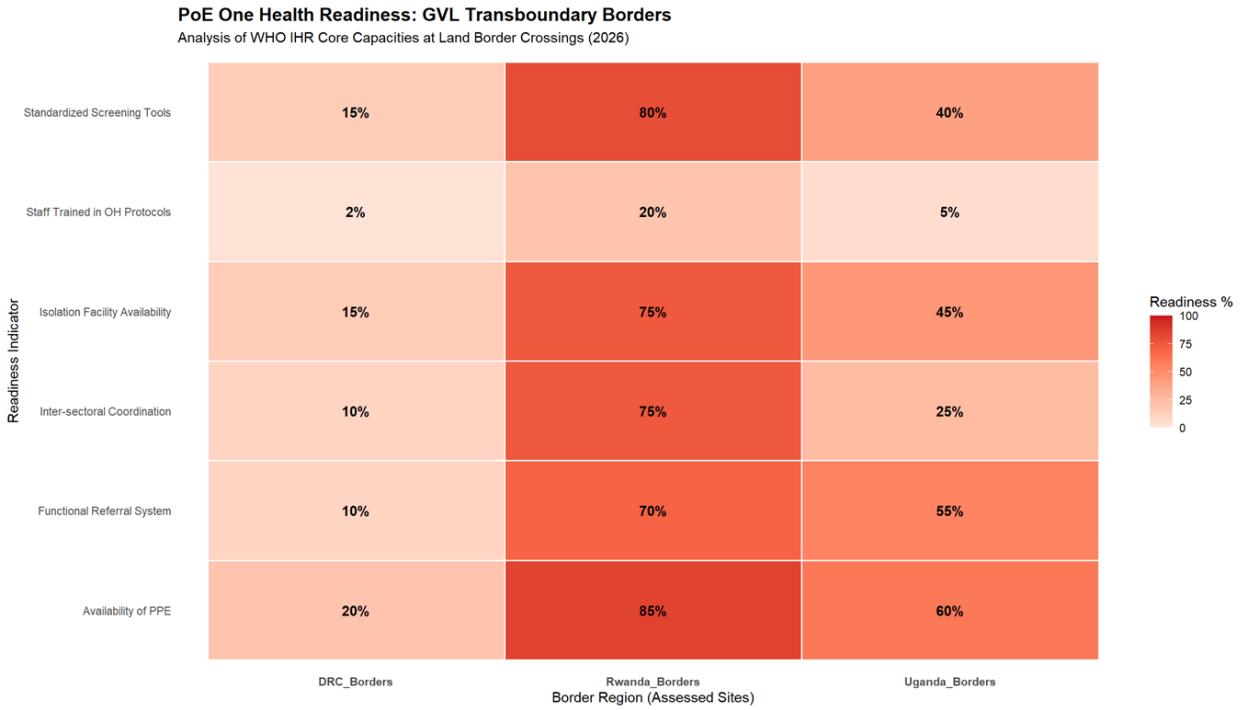


Figure 33: POE One Health Readiness

Overall, there were health security and One Health capacity gaps that call for further action. The following recommendations are generally applicable to the PoEs in the three countries. A) Deploy "One Health" Border Kits by providing Port Health officers with multiplex Point-of-Care (POC) tests that screen for both human and animal pathogens (e.g., Anthrax and RVF); b) expand cross-border data sharing among technical staff

in Uganda, DRC and Rwanda to allow Goma, Kigali, and Entebbe to see real-time "unusual health events" across the border; c) conduct joint cross-border simulations: "Table-top Exercises" (SimEx) specifically for cross-border zoonotic spill-overs, involving customs, wildlife rangers, livestock health and human health officers; and d) harmonize border health SOPs and strengthen informal-border engagement to reduce unmonitored movements of humans, animals and animal products. Specific country needs and recommendations are presented in **Table 17** below.

Table 17: Summary PoE assessment gaps and recommendations

Country	Primary PoE Strength	Primary PoE Weakness	Key Tech	Recommendations
Uganda	Strong specimen transport network (>90% reach).	No rapid diagnostics; weak animal health screening at ground borders; Weak routine zoonotic surveillance at land borders; Limited animal/environmental health staffing; Inconsistent IPC compliance at peripheral crossings	Thermal scanners, PPE, isolation space at airport; eIDSR mobile reporting	- Upgrade high-risk land borders to fully designated IHR PoEs - Deploy rapid zoonotic diagnostics (Ebola, Marburg, anthrax) - Embed One Health teams at borders (human, animal, environment) - Add holding area, and testing laboratory, and equipment - Lobby government of Uganda deploy a veterinary officer at sites with none
Rwanda	Rapid response and high policy compliance.	Limited livestock diagnostic capability; Absence of fully costed PoE emergency contingency plans; limited contingency infrastructure at land borders; limited on-site diagnostic capability; partial One Health operationalization	Digital health declarations; Thermal screening, PoE clinic, digital surveillance pilots	- Scale up innovative surveillance to land borders - Establish PoE emergency operation procedures - Formalize animal–human health coordination at crossings - Lead regional simulation exercises with Uganda & DRC
DRC	Expert clinical recognition of VHFs.	Frequent power and security interruptions. Lack of permanent PoE health infrastructure; severe human resource shortages; weak zoonotic governance and legislation	INRB genomic surveillance; *Ad-hoc* screening during outbreaks	- Establish minimum IHR-compliant PoE packages at priority crossings - Deploy permanent border health staff - Integrate animal health surveillance at borders - Secure pooled regional and donor financing for PoE activities

3.7 Coordination of One Health implementation

In this section, we present results on Objective 7: To assess the level of multi-sectoral coordination and stakeholder engagement in One Health activities at local, sub-national, and regional levels. The data were abstracted from KIIs at national and district levels in each country and community level FGDs (a question on coordination committees). This was augmented by the literature review and presentations made by technical representatives from the National One Health platforms. At baseline, we found that the GVL operates under an increasingly formalized One Health architecture. The level of multi-sectoral coordination has shifted from ad-hoc outbreak responses to institutionalized preparedness.

3.7.1 Transboundary regional level coordination

Generally, there is high engagement at regional level with structured mechanisms for policy harmonization and integrated planning across sectors and borders. Regional coordination is spearheaded by the Greater Virunga Transboundary Collaboration (GVTC), with headquarters in Kigali. The GVTC serves as the central hub for the three member states (Uganda, Rwanda, DRC). In 2025, it established a Regional One Health Centre of Excellence to harmonize policies. There is high stakeholder engagement from international "Quadripartite" partners (FAO, WHO, UNICEF, and WOAH) and conservation stakeholders like WWF, Gorilla Doctors, and the International Gorilla Conservation Programme (IGCP). Part of the partnership are the respective government bodies such as Ministries of Health, Environment, Agriculture/Livestock from the three countries participate in strategy development and coordination forums. One of the big drivers is the operationalization of the GVL Fund for PPR (Prevention, Preparedness, and Response), a public-private-community partnership to ensure financial sustainability beyond donor cycles. This includes transboundary technical committees and frameworks to integrate One Health principles into decision-making and policy alignment. There has been strong multi-national engagement at strategic planning and governance levels (e.g., Kigali workshop, Mbarara contingency planning meeting, and regional work plan development. Similar engagement of cross-ministerial teams (Health, Water & Environment, Agriculture) was reported during a strategic One Health meeting in **Fort Portal, Uganda** where multisector actors agreed on coordination and committee establishment. During the most recent meeting, the country representatives to the GVL Committee were selected and met (Chaired by DRC, rotational chair annually)[38].

National KII respondents in Rwanda noted that cross-border collaboration exists but is constrained. About 72% referenced regional initiatives (e.g., GVTC), but challenges persist. These include policy differences, weak harmonization, and limited real-time data sharing. The differences in surveillance systems, for example complicate implementation.

3.7.2 National and sub-national coordination

All countries have established multi-sectoral representation, bringing together human health, animal health, environmental sectors, international partners, and conservation NGOs in governance and implementation. At sub-national level (district and provincial), coordination is moderately developed and continues to strengthen through formal meetings and emerging committee structures.

In Uganda, the eleven districts assessed had a working relationship across sectors that contribute to One Health implementation. District decision-makers (Resident District Commissioners, Chief Administrative Officers, District Health/Veterinary Officers, Natural Resources Officers) provided support during preparedness planning and response in case of an event. The integration of multiple non-health sectors at sub-national level had not fully commenced.

> *"You are coming at a time when we are trying to strengthen our coordination. We are here at Nyakahita for a One Health training. And I can assure you, previously the One Health team was there, but we were not trained, not formally appointed, and of course, we did not meet regularly. I am very sure that from this training, we will have strengthened One Health activities in terms of coordination, collaboration, and communicating with each other, and of course, there has been capacity building.* District-level stakeholder, KII, Uganda

[38] https://greatervirunga.org/implementing-entities-and-delivering-partners-are-working-to-launch-the-project-aiming-at-strengthening-one-health-based-ppr-in-the-greater-virunga-landscape

In DRC, sub-national coordination structures at provincial and district levels are formally established but remain weak and largely symbolic or consultative, with limited operational engagement and insufficient functionality to effectively support implementation. Findings indicate that while provincial and district-level coordination mechanisms exist, their functionality is limited. Stakeholder engagement at this level is predominantly passive, with actors often participating in meetings without meaningful involvement in decision-making processes. Authority to make and enforce decisions is minimal, with most strategic and operational control retained at higher levels. In addition, significant capacity constraints particularly in terms of technical expertise, resources, and institutional support further limit the ability of sub-national structures to coordinate and implement One Health activities effectively. As a result, these platforms operate more as information-sharing forums rather than action-oriented coordination bodies.

> *"Provincial bodies are invited… but not to truly act as active participants."*
> Sub-national Level stakeholder, DRC

Overall, sub-national coordination in DRC was largely symbolic rather than functional. The limited authority, passive participation, and capacity gaps undermine the effectiveness of decentralized coordination, ultimately constraining timely and context-specific implementation of One Health interventions.

Rwanda demonstrated strong and well-established One Health coordination systems at national and sub-national levels, supported by functional multi-sectoral mechanisms and institutional leadership.

A functional One Health Multi-sectoral Coordination Mechanism was in place, led by key institutions including the Rwanda Biomedical Center, Rwanda Agriculture and Animal Resources Development Board, and Rwanda Development Board. Most respondents (83%) confirmed the presence of multi-sectoral coordination, and 72% reported cross-border collaboration. Despite the strengths, challenges persist in relation to data sharing and harmonization across sectors . also, coordination is more effective during outbreaks than in routine planning.

> *"We collaborate better during emergencies than in routine planning."*
> National level respondent, KII, Rwanda

Overall Rwanda's coordination framework is strong, but remains more responsive than preventive, with a need to strengthen routine coordination and data integration systems.

Cross cutting Challenges

National-level KIIs in Uganda highlighted persistent coordination challenges, despite reported improvements in multi-sectoral collaboration. Approximately 65% of respondents noted ongoing gaps, particularly duplication of efforts and weak alignment across sectors. In addition, vertical coordination between national and district levels remained limited, constraining effective implementation of One Health activities at sub-national levels. These coordination gaps have also contributed to fragmented data sharing systems, with 60% of respondents reporting limited interoperability across platforms, thereby undermining timely information exchange and joint decision-making. This fragmentation was further illustrated by stakeholder perspectives:

> *"Different agencies tend to tackle the same issues separately, which points to gaps in coordination and collaboration."* District-level stakeholder, KII, Uganda

Reactive systems and limited preventive focus: Over half of respondents (55%) described the One Health system as largely reactive, with interventions primarily triggered by outbreaks rather than guided by proactive risk prevention and preparedness planning. Respondents noted that coordination mechanisms were often activated only during emergencies, with limited sustained attention to preventive actions, particularly those targeting animal and environmental health risks. Coordination challenges differ across national and sub-national levels, but both show stronger coherence during zoonotic disease outbreaks.

Findings from DRC further highlighted that routine coordination occurs through periodic multi-sectoral meetings, though these were informal, poorly documented, and limited in scope. Engagement intensifies during outbreaks, enabling joint planning and surveillance; however, gaps persist in documentation, structured training, and development of contingency plans.

> *"Routinely, we have meeting updates… the frequency increases if there is an outbreak… but no minutes shared… We are waiting to develop a contingency plan."* National level, KII respondent, DRC

Persistent coordination and data-sharing gaps: National-level KIIs in Rwanda identified ongoing coordination challenges, despite high reported levels of multi-sectoral engagement (83%). Key constraints include weak inter-sectoral coordination, limited data integration, and inadequate communication across sectors. In addition, vertical coordination gaps between national and decentralized levels continue to hinder effective implementation.

At the district level, although structures such as District One Health Teams were in place, their functionality remained inconsistent. Respondents reported irregular meetings and limited engagement during non-outbreak periods, with coordination significantly improving only during emergencies.

This pattern was reflected in stakeholder perspectives:

> *"We collaborate better during emergencies than in routine planning."* District level stakeholder, KII, Rwanda

Limited multi-sectoral collaboration at community level: At the community level, multi-sectoral collaboration remains weak and insufficiently institutionalized. Most respondents indicated that Village Health Teams (VHTs) represent the primary structured health presence, with minimal involvement of veterinary and wildlife sectors in routine community health activities. As a result, awareness and operationalization of integrated One Health approaches at community level remain limited, with few functional platforms bringing together human, animal, and environmental health actors.

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Table 18: Status of sub-national coordination structures in Uganda, Rwanda and DRC

Country	Sub-national Coordination Structure	Status of Engagement (2026)
Uganda	District One Health Committees (DOHCs) in 11 GVL districts (e.g., Kasese,Ntoroko,Bundibugyo,Kisoro, Kanungu).	**High:** DOHCs are now formalized with specific work plans and technical guidelines. Engagement includes the Ministry of Health, MAAIF, and UWA, with contribution of partners.
Rwanda	One Health Multi-Sectoral Coordination Mechanism (OH-MCM)	**Very High:** Centralized but highly efficient. Links the Rwanda Biomedical Centre (RBC), Rwanda Agriculture Board (RAB), and RDB (Tourism).

	covering Northern and Western provinces.	
DRC	National One Health Plan (Validated 2025) with a focus on North Kivu and Lubero.	**Moderate:** Coordination is resilient but hampered by insecurity. Relies heavily on INRB-Goma and ICCN (park authority) for field-level activity.

3.7.3 Local and Community-Level Coordination

At the community ("last mile") level, coordination for One Health pandemic preparedness and response is primarily anchored in existing health and conservation structures, with emerging but limited efforts to integrate multi-sectoral approaches. Across the Greater Virunga Landscape (GVL), functional grassroots systems for surveillance and communication are evident; however, formalized multi-sectoral coordination remains weak, fragmented, and inconsistently operationalized.

Community-level coordination structures are present in all three countries, though they are largely informal and operate within sector-specific mandates rather than as integrated One Health platforms.

In Rwanda, 63% of respondents reported the presence of One Health-related structures, although these were often informal and functioned in parallel across sectors. While 75% of respondents acknowledged the existence of coordination mechanisms primarily through reporting linkages between communities and district-level systems. These arrangements reflect operational coordination without a clear conceptual integration of One Health. This gap is illustrated by a participant who noted:

> *"They report to health facilities and district level immediately. We don't know if One Health exists…"* FGD participant, Rwanda.

In the Democratic Republic of Congo (DRC), coordination structures at the community level are considerably weaker. Only 15% of respondents reported the existence of multi-sectoral coordination mechanisms, with many describing such systems as either absent or poorly operationalized. Where structures existed, they were reported to be inconsistent and lacked inclusivity, with some community groups, particularly farmers, indicating limited participation in decision-making processes. A respondent highlighted this gap, stating:

> *"This multi-sectoral coordination does not yet exist; health works alone. We are not aware of the existence of these One Health teams."* FGD participant, DRC.

In Uganda, coordination at the community level is predominantly driven by Village Health Teams (VHTs), which serve as the primary interface between communities and the formal health system. VHTs were widely recognized as the most trusted and accessible actors, playing a central role in disease surveillance, reporting, and referral. However, despite their effectiveness, coordination remains largely confined to the human health sector, with limited routine involvement of veterinary, wildlife, and environmental actors. As one participant explained:

> *"We are only aware of the VHTs. We are not aware of any experts from wildlife and veterinary people forming health teams."* FGD participant, Uganda.

Across all countries, community-level coordination was further supported by a range of actors, including Community Animal Health Workers (CAHWs), local leaders, cooperatives, and conservation groups. In addition, recent initiatives such as the training of over 500 community champions (ANICOs) in 2025 have strengthened community-based surveillance capacity by enabling the detection and reporting of unusual

health events across human, animal, and wildlife populations. Despite these efforts, the integration of these actors into a cohesive, multi-sectoral coordination framework remains limited.

A consistent finding across the GVL is the weak integration of human, animal, and environmental sectors at the community level. Veterinary and wildlife actors are rarely involved in routine coordination mechanisms, and engagement across sectors tends to increase only during outbreak situations. This results in a predominantly reactive coordination model, with limited emphasis on preparedness and prevention. Additionally, coordination structures were reported to be insufficiently inclusive, with certain groups, such as farmers, underrepresented in decision-making processes. Overall, the human health sector continues to dominate coordination efforts, reinforcing siloed approaches to surveillance and response.

Communication and information-sharing systems at the community level are relatively strong and widely trusted. Across Uganda and DRC, community members identified health workers, community health volunteers, and local leaders as key sources of information. These actors utilize a range of communication channels, including home visits, local alert systems, and community outreach mechanisms, to disseminate information and support early detection of health events.

In DRC, 40% of respondents identified trusted information sources, while 35% reported the use of community-based communication tools and 25% indicated the presence of early warning awareness systems. These systems have demonstrated effectiveness in facilitating timely reporting and community alerting, as reflected in one account:

> *"Information is disseminated via local health workers and village chiefs. The community was immediately alerted when a hippopotamus died."* FGD participant, DRC.

Overall, the findings indicate that while community-level coordination systems are functional and supported by strong local actors and communication networks, they remain largely informal, sector-driven, and insufficiently integrated. Coordination mechanisms are more effective during outbreak response than in routine preparedness, highlighting a critical gap in the institutionalization of One Health approaches at the community level.

Key Findings

- Community-level coordination structures existed but were predominantly informal and sector-specific.
- Coordination was largely anchored in human health systems, particularly through VHTs/CHWs.
- Multi-sectoral integration across humans, animal, and environmental health remains weak.
- Community-level coordination was more reactive (outbreak-driven) than preventive.
- Communication and early warning systems were functional and trusted but operated in silos.

Recommendations

- Formalize integrated One Health coordination structures at community level with clearly defined multi-sectoral roles.
- Strengthen routine engagement of veterinary, wildlife, and environmental actors in coordination platforms.
- Integrate community-level surveillance and reporting systems across sectors to support joint action.
- Leverage existing trusted platforms, including VHTs/CHWs and community communication systems, strengthen coordination.

- Transition from reactive, outbreak-driven coordination to institutionalized systems that support preparedness and prevention.

3.7.4 Private sector involvement

Private sector engagement in One Health coordination across the Greater Virunga Landscape (GVL) is emerging but remains fragmented and not fully institutionalized. While private actors contribute to surveillance, service delivery, and risk mitigation, they are not systematically integrated into formal coordination structures, particularly at sub-national and community levels.

Role and nature of engagement

Private sector involvement is largely operational, with limited participation in governance or strategic coordination. Engagement is most evident in tourism, veterinary services, and cross-border trade.

In the tourism sector, operators such as Volcanoes Safaris and Wilderness contribute to disease prevention through health screening protocols for tourists and trackers, reducing the risk of pathogen transmission to great apes. These interventions are primarily implemented at sub-national levels within protected areas.

Private veterinary practitioners and professional bodies, including the Uganda Veterinary Association, as well as private medical practitioners in border districts such as Goma and Musanze, were part of zoonotic disease reporting networks, supporting surveillance and early warning systems. Similarly, livestock traders and intermediaries at border points such as Mpondwe informally contributed to monitoring animal health during transboundary trade.

In Rwanda, private sector engagement is reported at a moderate level (67%), mainly through public–private partnerships in laboratory and veterinary services. However, this engagement remains technical and service-oriented, with limited integration into broader coordination platforms.

Overall, private sector participation is strongest at sub-national and operational levels, particularly in high-risk ecosystems and border areas, with limited involvement at national and regional coordination levels.

Challenges limiting engagement

Private sector involvement in coordination is constrained by several factors. There are no formal mechanisms to integrate private actors into One Health coordination platforms, particularly below national level. Engagement is often ad hoc and facilitated through NGO-led initiatives rather than institutionalized government systems. Private actors have limited roles in governance, policy development, and planning, reflecting continued public sector dominance in coordination structures. In addition, weak incentives and limited financing models reduce motivation for sustained engagement.

As a result, private sector participation remains reactive and activity-based rather than strategic and sustained.

Contribution to PPR across levels

Private sector contributions to PPR are evident but uneven across levels.

- At sub-national level, which represents the most active area of engagement, tourism operators implemented disease prevention measures in protected areas, while private veterinary and medical practitioners supported surveillance and reporting systems. Livestock traders also played a role in informal monitoring of animal health at border points.

- At national level, engagement was mainly through public–private partnerships in laboratory and veterinary services, particularly in Rwanda, and through professional associations contributing to reporting systems.
- At regional level, coordination is largely driven by public sector institutions and conservation partners(GVTC) with is minimal private sector involvement
- These contributions demonstrate that private actors are supporting key components of PPR but are not yet embedded within formal coordination frameworks.

***Table* 19: Overall synthesis of One Health in the GVL**

Level	Coordination	Stakeholder Engagement	Public Sector Role	Private Sector Role
Regional	High and formalized & structured Intergovernmental collaborations & joint planning mechanisms	Strong, structured, and highly coordinated, Strong participation of multi-national organizations, govt, NGOs	Leading role	Strategic engagement, Supportive, key conservation partners
National	Coordination is established, structured and policy driven. anchored in national One Health frameworks, strategies, and Technical Working Groups.	Well-established but sector-driven, with strong involvement of government ministries (health, agriculture, environment) and development partners.	Primary coordinator and policy driver. Responsible for developing One Health strategies, policies, and institutional frameworks, with ministries of health, agriculture, and environment leading multi-sectoral coordination platforms, technical working groups, and national planning processes	Moderate engagement, mainly through technical and service-oriented contributions
Sub-National	Operational. Growing through district level committees. Focused on service delivery, surveillance, and response activities Uganda showed more active structures, Rwanda and DRC were still strengthening foundational coordination systems.	Growing and increasingly operational Active in Uganda; foundational & evolving in Rwanda/DRC	Central to implementation	Complementary Operational, Actively involved actively involved but in a fragmented and informal manner
Local	Emerging, informal & fragmented Engagement occurs through ground-level interactions,	Emerging, informal, and community-driven Community structures involved	Frontline service delivery and community engagement	Little evidence of structured involvement in coordination

	community outreach, and basic reporting systems, often driven by human health platforms such as VHTs/CHWs.			

Overall, the private sector engagement in One Health coordination across the GVL was growing but remains underutilized. Participation was concentrated in operational roles, particularly in surveillance and risk mitigation, with limited involvement in coordination, governance, and planning. Engagement was strongest at sub-national level but remained fragmented and insufficiently institutionalized across all levels. The critical gaps and proposed actions are in the table below.

Table 21: Critical gaps and priority actions for improved coordination of One Health

Category	Primary Gap	Priority Action
Tools and technology	Communication tools mainly used by government actors	- Prioritize structured engagement at sub-national level to build on existing operational contributions
Skills	- At district level there is weak institutionalization	- Invest in cross-border data-sharing protocols and joint simulation exercises to operationalize the Pandemic Fund objectives
Staffing and infrastructure	- Limited formal private-sector participation to date - DRC has security and logistics constraints	- Formalize private-sector engagement (veterinary clinics, tourism operators) through MOUs to support recovery. - Expand coordination mechanisms to include private healthcare providers, veterinary and laboratory networks, tourism operators, and agribusiness actors.
Systems	- Over-reliance on short-term donor projects; sub-national public actors are less consistently resourced,	- Prioritize funding for district-level One Health platforms and joint work plans - Stimulate public-private community partnerships by leveraging private sector and community funds alongside government allocations to complement public spending for local surveillance and awareness programs. - Formalize private sector roles within One Health coordination platforms at national, sub-national, and community levels.

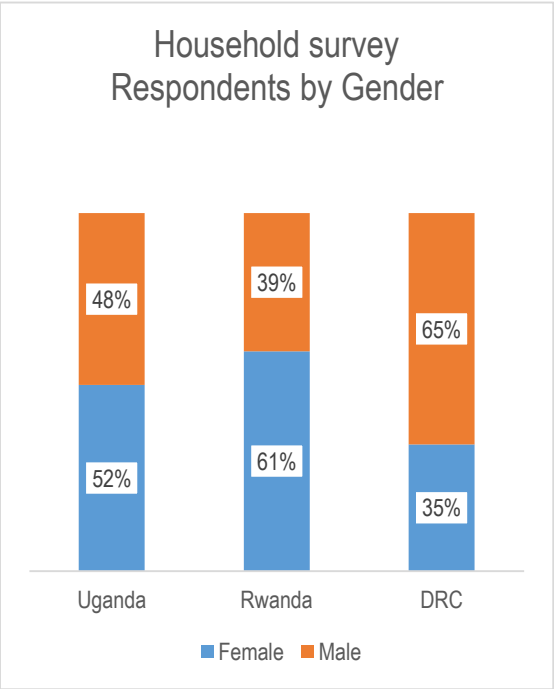
3.8 Community knowledge, attitude and practices (KAP)

This section presents findings on community knowledge, attitudes, and practices (KAP) related to zoonotic diseases and human–wildlife interactions across Uganda, Rwanda, and the Democratic Republic of Congo (DRC). The KAP assessment covered:

- Rwanda:159 household respondents across four districts (Burera, Nyabihu, Rubavu, Musanze), complemented by 8 FGDs (92 respondents).
- Uganda:155 household respondents across II districts complemented by 22 FGDs (136 respondents).
- DRC: 116 Households respondents in four territories complemented by 19 FGDs (189 respondents).

The sample size of 139 households was selected based on 10% prevalence of brucellosis (endemic zoonosis) in the region, at 95% confidence, 5% allowable error; and this was adjusted by 10% to 152 allow for non-response. The villages were selected purposively to represent the communities where some of the following criteria were met: close to a protected area, known high prevalence of bush meat consumption, human-wildlife conflict, close to a butcher or slaughter slab or abattoir, past zoonotic outbreak experience. The District Health Educator and District Health Office or their equivalent guided the selection. The

respondents for the FGDs were also purposively selected to represent local leaders, PWDs, youths, elderly, VHTs, and women in the community.



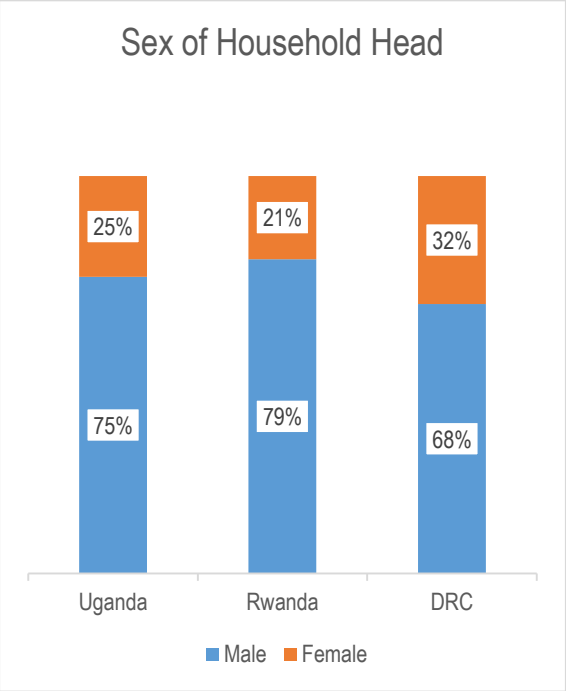


Figure 34:Gender distribution of Household heads

Figure 35:Gender distribution of the KAP survey

Uganda had a relatively inclusive gender representation for both women and men, with DRC having a higher male dominance (65%) followed by Rwanda (61%). Across all countries, household authority is overwhelmingly male, regardless of who responded to the survey. Rwanda shows the highest concentration (79%) of male-headed households despite having strong female respondent participation. The population was predominantly rural and agriculture-dependent, with generally low levels of formal education, shaping both exposure risk and interpretation of zoonotic disease information. Balanced gender representation enabled comparative insights, while age variation (18–83 years) supported demographic disaggregation of findings

The analysis highlights variations across demographic groups and examines how knowledge and attitudes translate into practices, including surveillance behaviours. Overall, findings indicate that while awareness and attitudes toward zoonotic disease prevention were generally strong, practices remain inconsistent, particularly for behaviours requiring system-level support. Exposure to zoonotic risks was structurally high, driven by proximity to protected areas and livelihood dependence on natural resources.

3.8.1 Knowledge of zoonotic diseases

Across all three countries, awareness of zoonotic diseases was high but uneven in depth and scope. In Uganda the majority of respondents demonstrated awareness of zoonotic diseases (approximately 90%), commonly identifying high-profile diseases such as Ebola, rabies, and COVID-19.

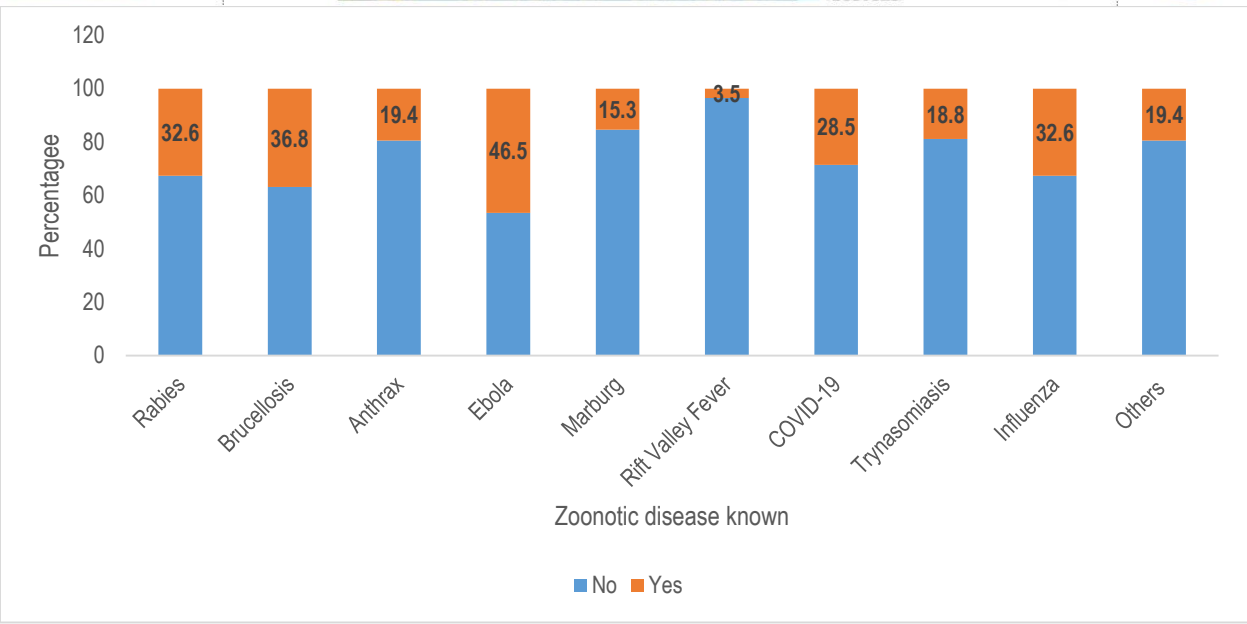


Figure 36: Level of awareness of the priority zoonotic diseases in 11 districts in Uganda

Knowledge was concentrated around a limited set of commonly publicized diseases, with significantly lower recognition of endemic zoonoses such as brucellosis and anthrax. From FGDs, scoring and ranking of the priority diseases common in the areas participants, demonstrated awareness of several zoonotic diseases affecting both humans and animals. Commonly mentioned diseases included: Ebola, Mpox, rabies, brucellosis, anthrax and sleeping sickness. Participants demonstrated moderate awareness of zoonotic disease transmission pathways, primarily focused on direct and visible risks. The most commonly recognized routes included:

- Consumption and handling of bush meat (40%)
- Contact with blood or body fluids (36%)
- Animal bites and scratches (19%)

However, understanding of less visible transmission pathways remained limited. Notably, fewer participants identified:

- Environmental contamination (e.g., shared water sources) (15%)
- Food-borne risks (e.g., consumption of raw milk) (13%)
- Vector-borne transmission (e.g., mosquito, tsetse fly, or tick bites) (9.4%)

Knowledge of prevention

Preventive knowledge was skewed toward individual-level actions. There was less than adequate knowledge of prevention measures for zoonotic diseases among the participants interviewed. Some of the measures mentioned were

- Vaccination (33.1%)
- Handwashing (31.8%)
- Proper cooking (23.0%)

Notably, 15.% of respondents reported no knowledge of prevention measures, indicating critical gaps in functional knowledge. Less understood were system-level and environmental measures, such as:

- Safe waste disposal
- Animal health management
- Separation of human–animal water sources

FGD results indicated similar results to the household surveys.

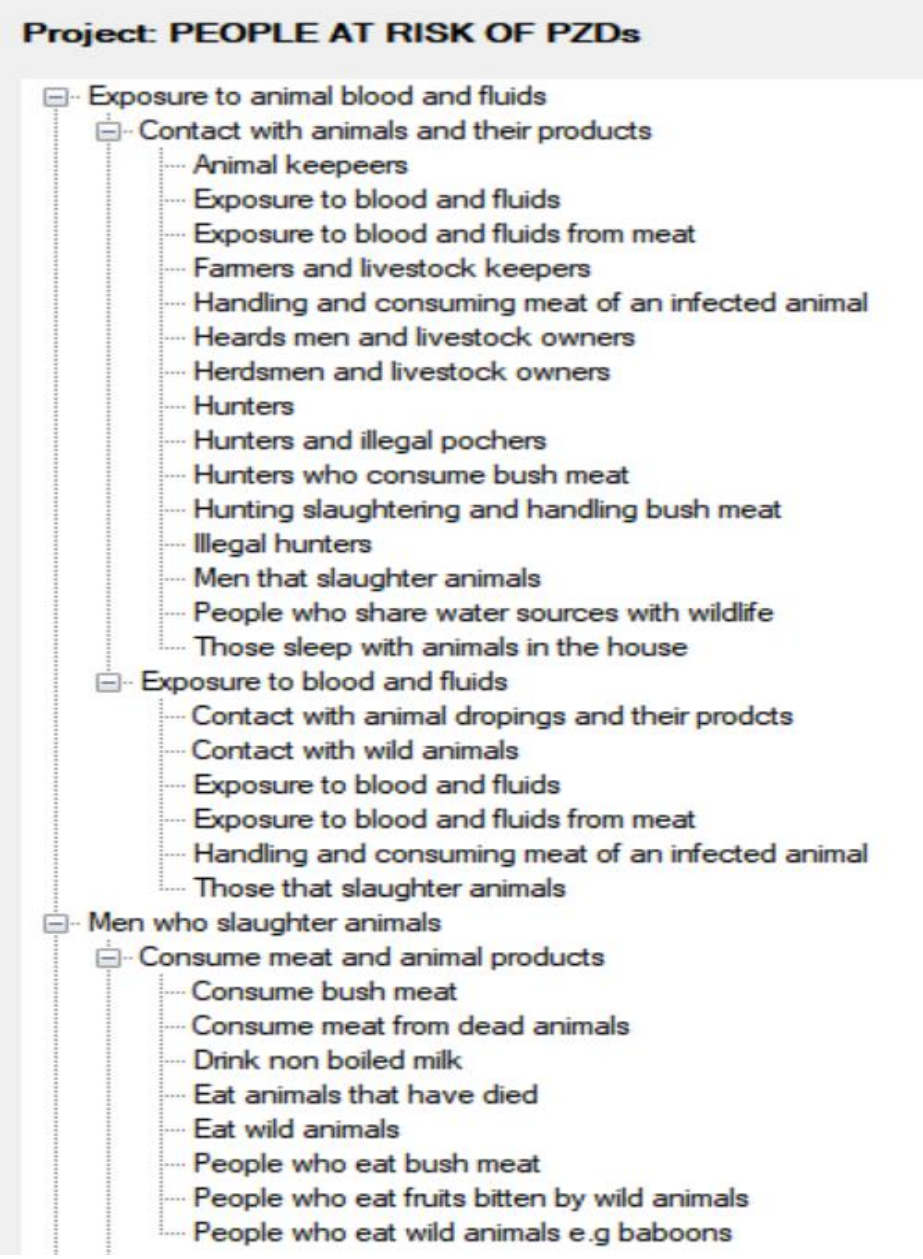


Figure 37: Tree analysis and presentation of linkages between risk factors, gender roles and exposure to zoonoses, Uganda

Overall, respondents demonstrated high awareness of zoonotic disease risks and strong understanding of the One Health concept. The majority (89.6%) recognized the importance of collaboration across human, animal, and environmental health sectors in controlling zoonotic diseases. Similarly, 92.9% acknowledged that interactions among wildlife, livestock, and humans increase the risk of disease transmission. In addition, 89.9% understood that protecting wildlife health contributes to safeguarding human health, although a small

proportion either disagreed (4%) or were uncertain (6%). These findings indicate a strong baseline awareness of key zoonotic disease concepts and interlinkages across sectors.

In Rwanda, findings revealed high awareness, but shallow and uneven knowledge. Awareness of zoonotic diseases was high but characterized by limited depth and uneven understanding. Most respondents (91.0%) had heard of zoonotic diseases; however, knowledge is concentrated around a few high-profile conditions such as COVID-19, rabies, influenza, Ebola, and Rift Valley fever. Awareness of other important zoonoses (e.g., brucellosis, anthrax) remained low, indicating gaps in knowledge breadth.

Transmission knowledge: Understanding of transmission pathways was strong and skewed toward direct, visible risks, particularly animal bites/scratches (62.9%) and consumption of undercooked animal products (56.3%). In contrast, awareness of indirect pathways such as water-borne (25.2%) and vector-borne transmission (19.9%) was limited**.** Qualitative findings further highlight that risk perception was closely tied to daily livelihood activities (e.g., animal handling, farming), with additional exposure linked to co-habitation with animals and occupational roles.

Preventive knowledge: Knowledge of preventive measures follows a similar pattern. Respondents demonstrated stronger awareness of individual-level practices such as vaccination (73.9%), safe food preparation (62.4%), and hand hygiene (56.1%), but limited understanding of environmental and systems-level measures, including water source separation (36.3%) and sanitation practices (<20%).
The overall knowledge score was low to moderate (mean: 37.3/100), with notable geographic disparities (higher in Nyabihu, lower in Rubavu). These findings are reinforced by FGD narratives, where participants demonstrated clear awareness and articulation of safe practices, particularly around handling dead animals:

> *"Dead animals should not be handled or consumed, as they may transmit infection; instead, responsible authorities should be notified, and precautions such as wearing gloves should be taken."* FGD participant, Musanze District, Rwanda.

These consistent messages across FGDs suggested that risk avoidance behaviours, especially those linked to visibly high-risk situations, were well internalized at community level. Despite strong awareness of preventive measures, implementation remained inconsistent, particularly for livestock vaccination and biosecurity. Only 41.1% of households reported consistently vaccinating animals, while 20.5% never do, and some households continue to cohabit with animals, thus increasing exposure risk. Qualitative findings from FGDs point to underlying drivers such as resource constraints and limited access to veterinary services, as reflected by participants:

> *"We need to improve hygiene practices for our domestic animals and avoid sharing living spaces with them"* (FGD participant, Musanze District) and *"Protecting domestic animals through vaccination… is essential for preventing disease."* FGD participant, Rubavu District, Rwanda

These findings indicate that while community awareness of zoonotic risks was widespread, understanding remained shallow and narrowly focused. Communities can recognize immediate risks but lacked deeper, systems-level knowledge, particularly regarding indirect transmission pathways and environmental prevention key gaps. This may limit effective One Health risk mitigation, especially in high-exposure settings.

In the DRC, findings indicated relatively high awareness of zoonotic diseases, but with uneven depth and significant gaps in understanding.

Most respondents (84.5%) had heard of zoonotic diseases and 94.0% recognized their potential severity. However, knowledge was largely outbreak-driven, with strong recognition of diseases such as Ebola (68%), COVID-19 (31%), and Mpox (27%), while endemic zoonoses like rabies and brucellosis remained poorly understood. A considerable proportion of respondents also demonstrated uncertainty or misclassification of diseases. Key informant interviews showed that Mpox (80–85%) was the most frequently cited zoonotic disease, followed by anthrax, viral hemorrhagic fevers, rabies, and brucellosis. This pattern reflects a strong influence of recent outbreaks on risk perception.

Transmission knowledge: Understanding of transmission pathways is partial and focused on direct contact risks, particularly handling bush meat and animal bites (74.1%). In contrast, awareness of indirect pathways such as environmental contamination (6.0%) and foodborne risks (4.3%) was very limited, reflecting a narrow interpretation of disease transmission.

Preventive knowledge: Knowledge of preventive measures was similarly skewed toward basic hygiene practices, including hand washing (57.4%), vaccination (38.3%), and safe food preparation (27.8%). However, awareness and application of animal health and environmental prevention measures remain low, with minimal understanding of practices such as deworming, waste management, and livestock vaccination. This is compounded by a clear gap between knowledge and practice, as most livestock owners lack awareness of vaccination schedules and rarely vaccinate animals.



Photo 8: FGD with eco guards in Beni, North Kivu province, DRC

Overall, the knowledge was reactive, shaped by outbreak exposure, and constrained by structural factors such as poverty, proximity to wildlife, and limited access to veterinary and health services. These gaps are particularly critical given the high level of exposure among communities living near protected areas.

3.8.2 Attitudes

Attitudes toward zoonotic disease prevention and One Health approaches were consistently positive across all countries, representing a key enabling factor for intervention.

In Uganda the attitudes toward zoonotic disease prevention and One Health approaches were generally positive, providing a strong foundation for intervention. Most respondents supported multi-sectoral collaboration (90%), recognized the risks associated with human–animal–wildlife interactions (92.9%), and acknowledged the link between wildlife and human health (89.9%). Overall, 64.5% of respondents demonstrated positive attitudes, indicating broad support for prevention and integrated approaches.

Attitudes toward zoonotic risk and bush meat consumption (Uganda): While overall attitudes toward zoonotic disease prevention were generally positive, these were undermined by inconsistencies in practice particularly around animal vaccination and bush meat consumption revealing a gap between perceived risk and actual behaviour.

Measurement of attitudes: Attitudes were assessed using six Likert-scale statements (1–5: strongly agree to strongly disagree) covering collaboration, vaccination, human–animal interaction risks, reporting behaviours, safe consumption practices, and environmental hygiene. Aggregate scoring classified respondents into positive (scores 6–13) and negative attitudes (≥14). Overall, 64.5% of respondents demonstrated a positive attitude toward zoonotic disease risk, transmission, and control.

Preventive attitudes vs practice gaps: Despite positive attitudes, important contradictions emerged. While vaccination is a key preventive measure, only 34.8% of households reported vaccinating animals on schedule, and 25.5% never vaccinated. Notably, 91.3% of respondents did not associate vaccination with zoonotic disease prevention, indicating a critical disconnect between knowledge and perceived effectiveness of interventions.

Bush meat consumption patterns: Although the majority (85.9%) reported not consuming bush meat, a notable minority (14.1%) continued the practice primarily on a rare basis (12.8%), with a small proportion (2.1%) consuming it monthly. Consumption was more common among older individuals (≥60 years) and those living within 5 km of protected areas. Access to bush meat occurs through informal and often covert channels, including trading centers, neighbors, smugglers, and, in some cases, direct sourcing from protected areas.
Qualitative findings highlight both historical and opportunistic drivers of consumption. Many respondents noted that bush meat consumption has declined following increased fencing of protected areas, which reduced wildlife intrusion. However, opportunistic consumption persists, particularly when animals stray into communities or are found dead. Economic incentives also play a significant role, with cheaper prices for such meat influencing behaviour:

> *"Most of the time people in villages want free things. When they find dead animals, its meat is always cheap… They look at it as an opportunity to eat cheap meat."* FGD respondent, Bundibugyo District, Uganda.

Community sharing practices further normalize consumption when wildlife is killed during crop or property protection:

> *"When a gorilla or game animal is hunted down upon invasion of a garden, meat is then shared by the neighbors."* Household respondent, Kisoro District, Uganda.

These findings suggest that attitudes toward zoonotic risk are not uniformly translated into safe practices. Bush meat consumption, though not widespread, persisted due to a combination of economic incentives, proximity to wildlife, historical practices, and social norms. This reflects a broader pattern where positive attitudes coexist with risk-normalizing behaviours, underscoring the need for interventions that address both behavioural drivers and structural constraints.

In Rwanda, findings indicate consistently strong and positive attitudes toward zoonotic risk prevention and One Health practices. Nearly all respondents recognized the importance of livestock vaccination (99.4%) and separating human and animal water sources (98.1%). A large majority also acknowledged the risk of disease

transmission between humans and wildlife (96.8%) and rejected the consumption of meat from dead animals (89.2%). The high mean attitude score (90.7%) reflected broadly favorable perceptions across districts.

In DRC, the findings revealed mixed and sometimes contradictory risk perceptions. While a majority of respondents expressed positive attitudes such as willingness to report dead animals (63.8%) and recognition of the importance of animal vaccination (76.5%), high-risk beliefs persisted. Over half (56.5%) considered consumption of meat from dead animals safe. Overall, while awareness of zoonotic risks and the importance of preventive measures was relatively high in DRC, this was undermined by persistent risk-normalizing attitudes and livelihood pressures resulting in continued engagement in unsafe practices, including the acceptance of consuming meat from animals that died suddenly.

in conclusion, across the three countries, strong positive attitudes toward prevention and collaboration were evident but were partially undermined by livelihood pressures and cultural practices. These observations underscore the need to leverage these attitudes through behaviour change interventions that address risk normalization. This calls for integrating social and cultural drivers and reinforcing safe practices through trusted community structures.

3.8.3 Practices

Across the three countries, despite relatively high awareness and positive attitudes, translation into safe practices was inconsistent.
In Uganda, findings showed a mix of protective and high-risk practices. Positive practices and behaviours such as boiling milk (85.9%) and handwashing after animal contact (80.6%) were widely adopted. However, risky practices persisted, including consumption of meat from sick (22.1%) or dead animals (4.7%), sharing water sources with animals (27.5%), and improper carcass disposal.

A clear gap exists between knowledge and action, particularly in surveillance and reporting. Only 29.6% of respondents reported unusual animal deaths, despite awareness of reporting pathways. This suggests an intention–behaviour gap, likely driven by weak reporting systems, limited feedback from authorities, and low trust or incentives. Overall, the practices were partially protective but inconsistent, with risk behaviours driven by livelihood necessity, weak systems, and environmental exposure.

In Rwanda, findings indicated partial adoption of protective practices, with stronger adherence to immediate, visible risks. Regarding positive practices, most respondents reported consistently boiling milk (69.7%) and low consumption of meat from dead (1.9%) or sick animals (3.2%), while hand washing after animal contact remains moderate (45.9%). However, significant gaps exist in animal health practices. Only 41.1% consistently vaccinated animals, and 20.5% never vaccinated, with ongoing cohabitation with animals increasing exposure risk.
A critical gap is evident in surveillance and reporting. Although 80.1% are aware of the need to report unusual animal deaths, only 14.7% have ever done so, highlighting a clear intention–behaviour gap.
FGD findings confirm that communities are aware of reporting pathways and expected procedures:

> *"Any suspected case should be reported immediately to the village leader, who can then engage veterinary services for follow-up."* FGD participant, Rubavu District, Rwanda.

> *"We report such incidents to park rangers or Rwanda Development Board staff for further action."* FGD participant, Burera District, Rwanda.

Despite this, reporting remained low in practice, indicating a significant intention–behaviour gap. This gap may be driven by:

- Weak or unclear reporting systems
- Limited feedback mechanisms
- Perceived inefficiencies or delays in response

Overall, behaviour change was selective and risk-triggered, high for visible risks such as food safety, but low for system-dependent actions like vaccination and reporting.

In DRC, the reported practices demonstrated a clear gap between knowledge and behaviour, with preventive measures inconsistently applied. There waas continued engagement in high-risk activities such as unsafe handling of animals and animal products, limited use of protective measures, and delayed care-seeking.

In addition, livestock management practices were weak. Most livestock owners (64.0%) were unaware of vaccination schedules, and only 4.4% vaccinated animals regularly, reflecting low uptake of veterinary prevention. This is particularly concerning given high exposure to wildlife, with 93.6% of households living near Virunga National Park and 85.2% within 5 km. Among those visiting the park (31.0%), the majority (61.1%) did so regularly.
Although most households did not keep animals, those that do reported frequent human–animal interaction, mainly involving poultry and small ruminants. Overall, these findings highlight a combination of risky behaviours and limited preventive practices in a high-exposure setting. These patterns were largely driven by structural constraints including limited access to human and veterinary services, weak community-level One Health engagement, and entrenched cultural norms rather than purely informational gaps. Despite moderate awareness of zoonotic risks (30%), risky consumption practices persisted, particularly the consumption of bush meat and animals found dead or sick, underscoring this disconnect, as reflected by one respondent:

> *"We eat everything we find there, sick or dead. We eat it and take it home…"* FGD respondent, DRC.

Overall, the evidence suggests that behavioural gaps were primarily structural, indicating that improving access, systems, and coordination is critical for effective risk mitigation.

3.8.4 Human–wildlife interaction and exposure

Exposure to zoonotic risk was high and structurally embedded across all three countries. Most households lived within close proximity to protected areas, with frequent wildlife intrusion into farms and shared resources. High livestock densities further intensify human–animal–wildlife interaction.

In Uganda, 65% of household respondents ranked human–wildlife conflict as the primary challenge, including crop destruction, livestock loss, and safety risks. Exposure to wildlife was frequent and structurally embedded, with 39.6% of respondents reporting regular intrusion. Communities largely relied on reactive coping strategies, such as chasing animals using vuvuzelas, beating jerrycans or loud plastics, or raising alarms when attacked, rather than preventive measures. Places in Kasese District faced the most burden, despite the electric fence on most of the visible areas along the road side.

> *"Elephants are creating insecurity… we are sharing water with wildlife, and the water is not safe."* FGD respondent, Kasese District, Uganda.

This implies that zoonotic risk is embedded in daily livelihoods, indicating that behavioural interventions alone are insufficient without addressing the structural drivers.

In Rwanda, findings indicated high and persistent exposure to zoonotic risk across all districts, driven primarily by proximity to protected areas and livelihood patterns. Nearly all households (99%) lived within 5 km of protected areas. Over half (53.6%) reported wildlife intrusion into farms or compounds, and 24.7% of the respondents entered the protected areas. Agriculture (73–100% across districts) and widespread livestock ownership (for grazing) further intensified daily human–animal interaction. The overall exposure index was moderate (mean: 21.4/100), with higher levels observed in Nyabihu (25.6%) and Burera (21.5%) compared to Musanze (19.4%) and Rubavu (18.9%). These findings demonstrate that zoonotic exposure was systemic rather than occasional, embedded in routine livelihood activities. It was reinforced by limited environmental control measures, and communities consistently linked risk to frequent wildlife intrusion into settlements, farms, and shared resources.

In DRC, findings highlight frequent and multidimensional human–wildlife interaction, shaping both exposure and risk perception. Participants consistently identified wildlife as both a reservoir of zoonotic diseases (20%) and a direct threat to livelihoods, noting that:

> *"Wild animals are reservoirs of disease… can be asymptomatic carriers."* FGD respondent, Beni, DRC.

Beyond disease transmission, communities reported recurrent negative interactions (30%), including crop destruction, livestock predation, and occasional human harm: *"Animals damage our fields… carnivores ravage our livestock and even humans"* (FGD respondent, DRC). Proximity to protected areas further amplifies exposure (20%), with encroachment and limited control over wildlife movements increasing vulnerability. Awareness of zoonotic risk was substantial, particularly regarding occupational exposure, with high-risk groups such as hunters, farmers, butchers, and veterinarians frequently identified. Direct contact with animals, especially wildlife, was widely perceived as the primary transmission pathway, as emphasized by one participant:

> *Hunters are among the groups of people most likely to contract zoonotic diseases… All groups are affected… livestock farmers, consumers of bush meat, butchers, veterinarians…"* FGD respondent, Lubero Territory, DRC.

Overall, exposure was routine and livelihood-driven, embedded in daily interactions at the human–animal interface. There is need to invest in structural risk mitigation measures, including improved water access, strengthened park boundary management, and community-level interventions that reduce direct contact between humans, livestock, and wildlife.

3.8.5 Perceptions of Wildlife Conservation

Community perceptions of wildlife conservation were mixed and conditional, reflecting a balance between benefits and challenges across the three countries in the GVL.

Common perceived benefits included:

- Tourism income

- Employment opportunities
- Community infrastructure development

Perceived risks or challenges included:

- Crop destruction and livestock loss
- Human injury and insecurity
- Limited access to benefits
- Perceived inequities

In Uganda, community members recognize that wildlife conservation contributed to livelihoods, health, and economic development. However, these perceived benefits were tempered by notable public health and livelihood challenges. Reported negative impacts included health-related risks (3%), such as disease outbreaks and injuries to humans and animals, as well as economic and social effects (4%), including food insecurity, livestock losses, fear, and stress. These mixed experiences shaped community attitudes, with some expressing negative perceptions of conservation benefits particularly the view of protected areas as sources of meat which in turn drives practices such as poaching and unauthorized entry into parks.

> *"Wild animals can provide cheap meat to the community".* And *"The good things we get from the park are cheap meat, herbs, and firewood."* FGD Respondents, Kasese District, Uganda.

> *"I confirm that conserving the environment is good. However, we have not yet witnessed the goodness of conserving. For example, there are children around here born in this community. They are well educated, but unfortunately, they have not even managed to secure jobs from the park that is neighboring them. They apply, but unfortunately, they are not shortlisted nor given these jobs."* FGD Respondent, Kibale Forest Community, Kamwenge District, Uganda.

> *"Tourism revenue provides economic opportunities for local communities through employment, business activities, and revenue-sharing initiatives. Despite existing challenges, as community members we recognize wildlife as an important asset for environmental protection and socio-economic development.* Local leader and FGD respondent, Bunyangabu District, Uganda.

Case Study 2 - Batwa Communities in Uganda: Conservation Displacement, Public Health Concerns and Responses

The Batwa are one of Uganda's indigenous forest-dwelling communities traditionally living in Semuliki National Park (Turk, 2022), Bwindi Impenetrable National Park and Mgahinga Gorilla National Park. Conservation policies introduced in 1991, which gazetted forests into national parks to protect critically endangered mountain gorillas and promote tourism, led to the Batwa's forced eviction without adequate compensation or resettlement (Kokunda *et al.,* 2023). The gorilla population in Bwindi increase from 300 individuals in 1991 to 459 in 2018 (UWA *et al.,* 2018), came at a high human cost. Their culture and livelihoods were deeply tied to forest resources as hunter-gatherers. They lost access to forests that provided food, medicine, and cultural identity, which pushed them into living below the national poverty line, with limited land ownership. They rely on casual labor or illegal forest entry, and face persistent discrimination in accessing education, health, and political representation (Ampumuza *et al.,* 2020; Kokunda *et al.,* 2023). UBOS estimated a 38% decline of Batwa population from 6,200 in 2014, to 3,857 in 2024 (UBOS, 2014; 2024). Severe public health consequences include high rates of alcohol use, smoking, HIV prevalence, and poor maternal and child health access (MUST & BMCT, 2020). Loss of traditional herbal medicine increased vulnerability to scabies, tuberculosis, and intestinal worms.

Proximity to parks heightens zoonotic risks, as human–gorilla–livestock interfaces facilitate potential spill over of Ebola, anthrax, and other PZDs.

Uganda Wildlife Authority (UWA) introduced revenue-sharing in 1994/1997 (supported by IGCP), allocating 20% of gate fees and gorilla trekking permits to fund community projects, including health clinics and schools in adjacent sub-counties. BMCT[39] and IGCP[40] have purchased land for Batwa resettlement and supported livelihoods (case study below). Conservation Through Public Health (CTPH)[41] trained 14 Batwa Village Health and Conservation Teams (VHCTs).

In Rwanda, communities hold a generally positive but conditional perception of wildlife conservation, recognizing tangible economic and social benefits alongside persistent livelihood risks and uneven access to gains.

Perceived benefits: Engagement in conservation-linked livelihood activities was present but remained limited, informal, and small-scale. Some households reported participation in tourism-related activities, small businesses serving visitors, and cooperative-based initiatives linked to conservation. Wildlife, particularly gorilla tourism was widely perceived as a key driver of local development, contributing to household income, employment, and broader community benefits. Economic benefits were the most prominent, including income from tourism services, small enterprises (e.g., sale of goods and local products), and employment opportunities.

> *"Tourism provides income opportunities, as we receive money from visitors who come to our community."* Youth FGD respondent, Rubavu District, Rwanda.

Social and community-level gains were also frequently cited, such as the construction of schools and health facilities, improved access to water, and education subsidies. Institutional support, particularly from Rwanda Development Board, was acknowledged for facilitating community development projects and conservation-linked programs.

> *"Yes, looking after wildlife animals is very important because, when tourists visit them, the country builds for us health centers… and schools for our students."* FGD respondent, Musanze District, Rwanda.

Perceived risks and limitations: Despite these benefits, communities emphasized significant and ongoing risks associated with wildlife. Crop destruction, livestock predation, property damage and threats to safety remain common, resulting in economic losses that offset perceived gains.

> *"Wild animals frequently destroy crops, leading to significant losses, poverty, and food insecurity within the community."* FGD participants, Musanze District, Rwanda.

> *"A neighbor was attacked by a buffalo and now lives with disabilities affecting both the arms and legs."* FGD participants, Rubavu District, Rwanda.

Benefits from conservation were also unevenly distributed, with some households reporting improved incomes and opportunities, while others experience limited or no direct advantages.

[39] https://www.thevoiceug.com/en/politics/bwindi-mgahinga-conservation-trust-unveils-ugx-200-million-batwa-model-village/
[40] https://igcp.org/updates/working-with-the-batwa-of-uganda/
[41] https://ctph.org/batwa-bridging-the-conservation-and-culture-divide/

In DRC, communities demonstrated strong awareness of zoonotic risks; however, perceptions were shaped by a complex balance of livelihood dependence, persistent exposure, and unevenly distributed conservation benefits, resulting in continued high-risk behaviours.

Perceived benefits: Although less prominently emphasized, participants acknowledged several benefits associated with wildlife conservation (15%). Economic gains were most frequently cited, including tourism, employment opportunities, and development initiatives:

> *"Attracting tourists, creating jobs… development projects like Virunga Energy"* (FGD respondent, DRC).

Environmental services, such as improved air quality and climate regulation (30%), were also recognized: *"The park provides us with good oxygen… a good climate"* (FGD respondent, DRC). Some respondents further highlighted educational and cultural value (20%), particularly for younger generations. However, these benefits were unevenly distributed (10%), with some communities reporting limited or no direct gains from conservation efforts.

Perceived risks: Risk perceptions were primarily driven by frequent human–animal interaction and livelihood pressures. Participants widely identified wildlife as a reservoir of zoonotic diseases (20%) and direct contact with animals particularly through occupations such as hunting, farming, butchery, and veterinary work (40%) as the main transmission pathway:

> *"Hunters are among the groups of people most likely to contract zoonotic diseases… livestock farmers, consumers of bush meat, butchers, veterinarians…"* FGD respondents, DRC.

Despite this awareness, risky consumption practices remained common (30%), including the consumption of bush meat and animals found dead or sick, reflecting a clear knowledge–practice gap:

> *"We eat everything we find there, sick or dead. We eat it and take it home…"* FGD respondents, DRC.

Preventive measures such as avoiding contact with dead animals and reporting unusual events were generally understood but inconsistently applied (20%). Human–wildlife interaction further intensified risk, with communities reporting frequent crop destruction, livestock predation, and occasional human injury or death (30%):

> *"Animals damage our fields… carnivores ravage our livestock and even humans."* FGD respondent, DRC.

Proximity to protected areas and encroachment (20%) increased exposure, while structural factors particularly poverty, limited access to alternatives, and weak service systems drive behaviours such as hunting, poaching, and consumption of unsafe meat. This was also noted by a key informant:

> *"Poverty causes the population to frequently visit the park for farming and hunting… some eat undercooked bush meat."* KII respondent, DRC

Perceptions of wildlife conservation in DRC were ambivalent. While benefits were acknowledged by some community member, they were overshadowed by immediate livelihood risks and structural vulnerabilities. Risk behaviours were therefore less a function of limited awareness and more a reflection of constrained choices, underscoring the need for integrated interventions that address both economic realities and public health risks. Although there is insecurity that affected livestock, human and wildlife populations, the effect was not fronted as a major cause of increase in zoonotic risk.

Overall, community attitudes toward wildlife can be characterized as cautiously positive but context dependent. Coexistence with wildlife is therefore conditional and often tension-filled, shaped by an ongoing trade-off between conservation objectives and community safety and well-being.



Photo 7: Locally made brooms made with grass from Semuliki National park, Ntoroko District, Uganda
Photo 8: Rainwater harvesting tanks donated and installed by UWA to improve safe water access in communities surrounding Kibaale National Park, Kabarole District, Uganda.

Differential KAP patterns across population groups

Table 19: KAP findings by group for Uganda, Rwanda and DRC

Group	Knowledge	Attitudes	Practices	Key metrics
Women	Moderate awareness of zoonoses; lower technical knowledge	High concern for family health; receptive to community messaging	Primary caregivers handle livestock and food prep; variable PPE use	**Knowledge score** often 40–60% on basic zoonoses; **PPE use** low
Men	Higher exposure knowledge (hunting, livestock)	Risk-tolerant in livelihoods; mixed trust in authorities	More likely to engage in hunting, butchers, field work	**Higher exposure events** per household
Youth	Awareness via schools/NGOs; misconceptions common	Open to behaviour change via peers/social media	Risk behaviours include bush-meat consumption, informal animal care	**Knowledge gaps** on transmission routes
Elderly	Traditional beliefs shape attitudes	May resist new practices	Continue traditional animal care and herbal remedies	**Lower adoption** of new practices
Persons with disabilities	Less access to outreach; lower knowledge	Vulnerable, often excluded from programs	Practical barriers to safe practices	**Under-served** in outreach

We compared KAP responses across population groups including women and men; youth (18–35), mature adults (36–59), and the elderly (60+); as well as persons with disabilities and refugees. The analysis incorporated human–wildlife exposure variables, and results were synthesized by country and population group.

Sub-group analysis (minimum n=30) was not feasible for refugees and persons with disabilities due to limited sample sizes.

Overall, knowledge, protective attitudes, and safe practices were uneven across demographic groups. Slightly more than half of respondents (57.7%) reported perceived benefits of proximity to protected areas, including tourism-related income (21.8%), employment opportunities (19.2%), and environmental benefits such as fresh air.

Age-disaggregated analysis showed relatively consistent awareness of zoonotic risks across age groups. However, middle-aged adults demonstrated higher engagement in surveillance-related behaviours, such as reporting suspected cases. Younger respondents showed lower participation in reporting, possibly reflecting reduced involvement in livestock management and community decision-making structures.

Geographic variation was also evident. Districts such as Bundibugyo, Kanungu, and Kisoro demonstrated near-universal support for One Health collaboration, while Fort Portal showed comparatively lower levels of support. Awareness of livestock disease outbreaks followed a similar pattern, with higher levels reported in Kanungu and Rubanda and lower levels in Fort Portal and Kabale. These differences may reflect variation in prior outbreak exposure, effectiveness of local communication strategies, and the strength of surveillance systems.

Findings from 22 FGDs conducted across 11 districts in Uganda (Annex 2) provide further context to these patterns. Gendered exposure pathways were consistently reported. Men were perceived to face higher direct risk due to hunting and slaughtering activities, while women experienced indirect exposure through domestic roles such as food handling and caregiving. Children were also identified as highly vulnerable due to frequent exposure to wildlife incursions and unsafe environments.

FGDs further highlighted how cultural practices influence risk. Among some women, the consumption of raw or fermented milk—sometimes associated with perceived nutritional or weight-gain benefits—was linked to increased exposure to zoonotic diseases such as brucellosis in communities surrounding Queen Elizabeth National Park and Bwindi Impenetrable National Park (Agaba et al., 2025). These practices point to inequities in access to food safety information and preventive services.

However, survey findings indicate relatively high adoption of protective practices, with no significant difference between men (82.2%) and women (89.3%) who reported always boiling milk before consumption. A small proportion reported doing so occasionally (men 5.5%, women 5.3%), while very few reported not boiling milk. These patterns reveal underlying gender and social inequities, further explored in the GESI section

Table 20: Comparative KAP metrics by demographic group (2025) and baseline data 2026

Demographic Group	Knowledge (Zoonotic Transmission)	Key Attitude/Practice Trend	Metric Baseline (Source: 2025-26 Studies)
Men	**High** awareness of specific diseases (e.g., Anthrax, Rabies).	**High-risk practices:** Men dominate hunting and "bush-meat" handling.	50.3% identify transmission; <15% use PPE during slaughter (Bundibugyo, 2025).
Women	**Moderate**; often focus on hygiene and child health.	**Caregiver risk:** High exposure when caring for sick family/livestock.	64.5% do not separate animal and human utensils

			in households (Rwanda, 2025).
Youth (18-35 years)	**Higher** awareness than older generations in rural areas.	**Tech-adoptive:** Likely to report via mobile apps (e.g., One Health apps).	23.3% awareness in rural Bwindi vs. 7.9% in urban areas (Bwindi, 2025).
Elderly (60 years or more)	**Low** (rely on traditional beliefs); high familiarity with symptoms.	**Resistant to change:** Often refuse to boil milk or quarantine new stock.	83.9% fail to quarantine new animals; 34.5% consume raw milk (Bugesera, 2025).
PWDs	**Significant Gap** (Inaccessible information).	**High Vulnerability:** Limited access to veterinary/health services.	GVL Assessment (2025) identifies "No formal inclusion" in 90% of local surveillance.
Refugees	**Moderate/Emerging** (driven by recent aid programs).	**Strong Surveillance Participation:** Active as Community Volunteers.	Case reports increased from 2 to 15 per month via refugee volunteers (Nakivale, 2025).

Socioeconomic drivers of zoonotic risk in all three countries was notable. Community-level behaviours such as consumption of unsafe meat and wildlife interaction are strongly linked to poverty and food insecurity. This reinforces the need to integrate socioeconomic interventions into zoonotic disease prevention strategies, as highlighted in EcoHealth and Planetary Health frameworks.

3.8.8 Cross-Cutting Conclusion

Across the Greater Virunga Landscape, community KAP is characterized by:

- Moderate awareness with critical knowledge gaps
- Strong attitudes but inconsistent practices
- High structural exposure to zoonotic risks
- A persistent intention–behaviour gap
- Mixed perceptions of wildlife conservation

Overall, effective zoonotic disease prevention requires integrated approaches that combine behaviour change, system strengthening, and livelihood-sensitive interventions.

Table 21: Gaps and recommended next steps

Category	Primary Gap	Priority Action
Tools and technology		
Skills	- Low public awareness of other zoonotic diseases, namely (Anthrax, Brucellosis, Rift Valley Fever, Influenza, Marburg, Trypanosomiasis, Rabies.	- Integrate One Health education modules into school and community outreaches and track uptake. - Organize a local language translation workshop and validation of different definitions of standard cases of zoonoses under surveillance in DRC with all stakeholders according to the One Health approach. - Increase awareness and strengthen health education using translated materials at community level
Staffing and infrastructure	- Special groups lack appropriate diagnostic studies and interventions	- Collaborate with refugee and disability networks to ensure inclusive data collection and interventions. - Improve livestock disease surveillance, deploy animal health workers

Systems	- No indicators linking behaviour change to intervention outcomes.	- Establish community sentinel systems linking reported exposures to surveillance data.

Recommendation: Adopt a holistic One Health approach that integrates community engagement, strengthened surveillance systems, and socioeconomic interventions to sustainably reduce zoonotic disease risk. There is need to Strengthen equitable benefit-sharing mechanisms and improve community engagement to enhance trust and align conservation efforts with local livelihood priorities.

3.9 Gender Equity and Social Inclusion (GESI) in Prevention, Preparedness and Response

This section present results for objective 9: To identify gender-related disparities and assess the involvement of women, youth, persons with disabilities, and refugees in One Health approaches.
In the GVL, the "One Health" approach while conceptually inclusive displays significant gender and social disparities in its practical implementation. At baseline, we assessed structural inequities in voice, representation, participation, access, and decision-making.

3.9.1 Overview of Participation and Inclusion

Findings indicate that participation of women, youth, PWDs, and refugees in One Health activities is present but uneven across the Greater Virunga Landscape (GVL). Engagement is primarily at community level and largely consultative, with limited representation in formal decision-making structures.
Across countries:

- Men predominantly occupy leadership and technical roles
- Women and youth participate in community activities but have limited influence in decision-making
- PWDs and refugees are minimally represented in structured One Health systems

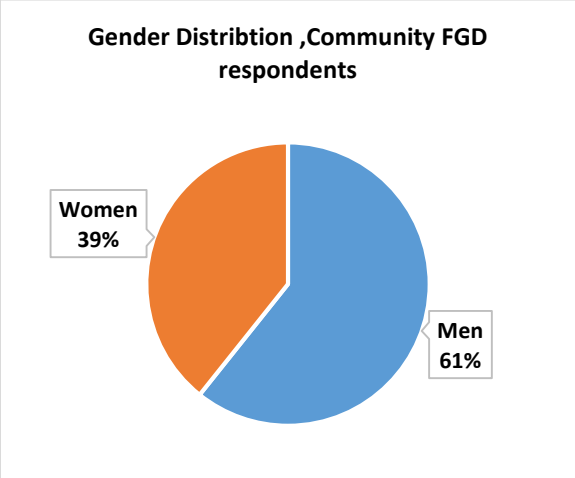


Figure 39: Gender Distribution across community stakeholders

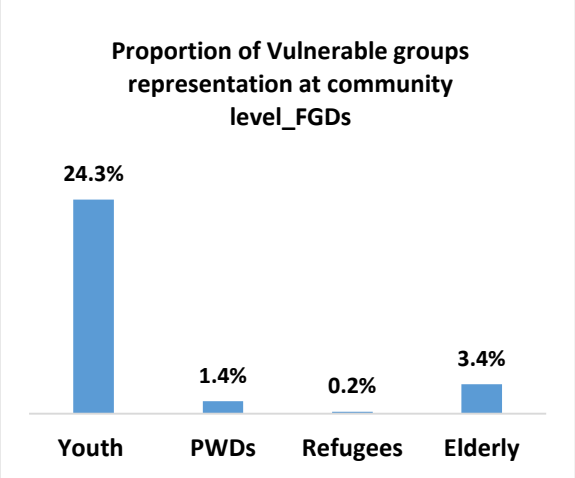


Figure 38: Vulnerable group representation at community level

Across the 3 countries, Youth were relatively represented (24%) compared to all the Vulnerable groups. Community level dialogues were male dominated however women involvement at household level was fairly balanced across the three countries.

3.9.2 Gendered exposure to zoonotic risk

In Uganda, gender roles shaped exposure to zoonotic diseases, with men and women engaging in different activities that influence risk patterns at community level. Most surveyed households were male-headed (75.8%), compared to female-headed households (24.2%). The population was largely composed of mature adults aged 36–59 years (49.3%), followed by youth aged 18–35 years (31.8%) and the elderly aged 60 years and above (18.9%). Households including persons with disabilities were minimal (2%), indicating limited representation of this group in community-level risk and response dynamics.

FGD findings identified three main exposure pathways linked to gender roles:
Men engage in high-risk activities such as hunting, livestock grazing near protected areas, and bush-meat handling:

> *"Men are more at risk because they go to the park more often for hunting, cutting timber and grazing animals."* Male FGD participant, Rubanda District, Uganda

Women's exposure to zoonotic diseases is primarily driven by domestic and livelihood roles. These include food preparation, water and firewood collection, livestock care, and farming near park boundaries. Women are frequently responsible for collecting firewood, herbs, and grass from protected areas, which increases their likelihood of encountering wildlife and contaminated environments. Additional risk arises from handling animal products such as preparing potentially infected meat, cleaning animal shelters further elevating their exposure to zoonotic pathogens.

> *Women are heavily involved in cross-border trade with the Democratic Republic of Congo, particularly in fish, palm oil, cocoa, and plantain. These activities increase their interaction with park-adjacent communities, including hunters. Women are also more frequently engaged in collecting firewood from the park, which raises their potential exposure to wildlife."* Male FGD Respondent, Bundibugyo District, Uganda.

Household-level transmission occurs where men bring potentially infected materials into the home. Gender roles create pathways where men bring infections or infected animals home. Conversely, women handle preparation of food, potentially spreading infections. Due to fear of theft of their livestock, 75% of the households involved in livestock keeping shared living spaces at night, increasing the exposure risk.

> *"Since the forest was gazette into a national park, we can no longer farm or graze there. Land is now limited, and anyone found inside risks being shot or taken to court."* Female FGD participant, Kamwenge District, Uganda.

In addition, Kamwenge District hosts refugee populations supported by a structured health system. However, these services are not specifically tailored to One Health approaches. Insights from community-level discussions further highlighted clear gendered patterns in exposure to zoonotic disease risks, linked to differentiated roles and daily activities.

Existing outbreak related data in Uganda indicates an imbalance in risk. For example, during the Kanungu anthrax outbreak, males had an attack rate of 48 per 100,000 compared to 15 per 100,000 among females[42]. Similarly, national RVF surveillance data from 2017 to 2020 indicated that approximately 92% of all confirmed RVF cases in Uganda occurred among males, predominantly those engaged in high-risk occupations such as herdsmen, butchers, slaughterhouse workers and livestock traders[43](MOH surveillance data, 2017–2020). Being a butcher or having direct contact with animals was identified as a statistically significant risk factor for RVF transmission, particularly in cattle corridor districts such as Kabale following the 2016 outbreak[44].

In **Rwanda, e**xposure patterns vary by gender, age, and occupation:

- **Men** are exposed through high-risk occupational activities such as grazing and hunting
- **Women** are exposed through caregiving, water collection, and livestock-related tasks
- **Children and elderly** are identified as vulnerable due to dependency and environmental exposure

Conversely, FGDs reported frequent interaction with wildlife, including contamination of water sources and crops.

The household surveys showed a moderately balanced gender distribution, though with slight male dominance (61%). However, disparities in One Health vulnerability were not primarily driven by participation levels, but by differentiated livelihood roles and exposure pathways.

Findings from FGDs indicate that vulnerability to zoonotic diseases is shaped by age, gender roles, occupation, and proximity to wildlife.

- Children and the elderly are more susceptible due to lower immunity, while exposure among adults is strongly role-based.
- Women face increased risk through domestic and environmental responsibilities such as livestock care, water collection, and caregiving which increase contact with contaminated water, animal waste, and domestic animals.
- In contrast, men are more exposed through high-risk occupational activities, including hunting, grazing, and direct interaction with wildlife, often involving unsafe handling or consumption of infected animals.

Occupational groups such as farmers, hunters, and livestock handlers experience elevated risk due to frequent interaction with animals and contaminated environments. Similarly, communities located near protected areas faced heightened exposure driven by wildlife intrusion and contamination of water sources and crops.

While perceptions of risk varied across communities with some viewing exposure as equal and others associating higher risk with male-dominated activities there was consistent evidence that exposure pathways differ by gender due to socially defined roles rather than inherent biological differences.

Despite these differentiated risks, the structured inclusion of vulnerable groups (women, youth, elderly, and other at-risk populations) in One Health activities remained limited at both community and district levels. This highlights critical gaps in inclusivity and raises concerns about the sustainability and effectiveness of current One Health interventions.

In DRC, the key informants and FGDs identified vulnerable groups as:

- Communities near protected areas (70%)

[42] https://doi.org/10.21203/rs.3.rs-6854973/v1
[43] Nyakarahuka *et al.,* 2023. https://doi.org/10.4269/ajtmh.22-0410
[44] Nyakarahuka *et al.,* 2018. https://doi.org/10.1371/journal.pntd.0006412

- Hunters, farmers, and livestock handlers (65%)
- Women and children (40%)

Exposure was linked to livelihood activities such as farming, hunting, and bush-meat handling.

> *"It is the women who are much more exposed because they are the ones who often go to the field and the husbands stay in the village having fun."* Male FGD respondent, DRC.

Inclusion of gender and vulnerable groups in community activities was inconsistent. While gender considerations are acknowledged in principle (60%), actual representation remains uneven (40%), particularly for persons with disabilities and the elderly, who are often excluded (60%).

> *"Gender is considered. Women make up 30% of the committees."* Male FGD participant, DRC.

The absence of functional One Health structures (50%) further limits inclusive participation, highlighting a gap between policy commitments and implementation. Despite gender mainstreaming in government and private sector activities, at community level, however, there was persistent exclusion for vulnerable groups:

> *"People with disabilities and older adults are not represented."* KII respondent, DRC.

3.9.3 Access to services and decision-making

Uganda

- Male-headed households dominated (75.8%), and took the decisions affecting access to resources.
- Women performed a significant share of livestock-related tasks but had limited access to technical training. In addition, when it came to health care seeking for the household members, men made the decision in 85% of the cases, both women and men decided together 10% of the times, while women decided only in 5% of the cases.
- PWDs are minimally represented (2% of households) and the household head decided about their welfare.

Rwanda

- There was clear male dominance among respondents, with 86.2% of KIIs conducted with men.
- Women and vulnerable groups were underrepresented in leadership and decision-making roles. While present at community level, youth, persons with disabilities, and refugees were largely excluded from One Health planning and response structures, reflecting persistent structural and cultural barriers.
- Gender Equity and Social Inclusion (GESI) was recognized in policy (61%) but remained unevenly implemented. This gap is evident across national, district, and community levels, with patterns in Rwanda mirroring those observed in Uganda and DRC.

DRC

- Access to services was constrained by low education levels, insecurity, and limited infrastructure in the GVL territories assessed.
- PWDs and elderly groups were underrepresented in community and institutional processes

3.9.4 Inclusion in One Health Systems

Across the GVL:

- Women had limited representation in leadership roles
- Youth participation is emerging, particularly in digital surveillance activities
- PWDs are largely excluded from planning and response systems
- Refugees participate informally but are not integrated into formal decision-making

In DRC based on KIIs, gender inclusion was acknowledged (60%) with uneven representation of some groups. For example, PWDs and the elderly were underrepresented (60%), with notable absence of OH structures limiting inclusion (50%).

Key gender and social inclusion disparities in One Health PPR (GVL)

Gendered exposure vs. unequal access to knowledge ("Knowledge–Access Paradox")

Across the three countries, men receive the majority of veterinary and animal health training (estimated at 85%), despite women performing many high-risk tasks such as handling aborted animal materials and processing raw meat. This imbalance limits early detection of zoonotic diseases as primary observers are not adequately trained to recognize symptoms. Across the Greater Virunga Landscape (GVL), a consistent mismatch exists between exposure to zoonotic risk and access to training.

- **Uganda and DRC:** Women and children are heavily engaged in high-risk activities such as livestock care, food preparation, and handling animal products, placing them at the frontline of zoonotic exposure. However, they have limited access to formal PPR and veterinary training.
- **Rwanda:** While policy frameworks recognize gender inclusion, implementation gaps persist, with technical training still largely accessed by men.

Digital divide in surveillance systems (Youth vs. Elderly)

The transition toward digital surveillance systems, particularly Event-Based Surveillance (EBS) has created generational disparities in participation.

- **Uganda:** Adoption of mobile-based reporting systems has increased youth participation in surveillance activities. However, older community members, who possess valuable experiential knowledge of past outbreaks (e.g., anthrax patterns), are less engaged due to limited digital literacy.
- **Rwanda and DRC:** Similar trends are emerging, though less formally documented, with digital systems gradually shaping participation dynamics.

This shift risks excluding traditional knowledge systems and weakening early warning signals that were not easily captured through structured digital reporting platforms.

Structural exclusion of vulnerable groups (PWDs, Elderly, Refugees)

Significant structural and systemic barriers limit the inclusion of vulnerable populations across all three countries.

- **GVL-wide finding:** A 2025 assessment indicated that approximately 92% of outbreak preparedness and evacuation plans do not include specific provisions for persons with disabilities.
- **Uganda and DRC:** Risk communication materials were often not adapted for diverse needs (e.g., visual, hearing, literacy limitations), excluding groups such as the blind, deaf, and low-literacy populations.
- **Refugee populations (Uganda and DRC):** Despite being among the most mobile and high-risk groups, refugees were rarely represented in transboundary coordination mechanisms or technical committees.
- **Rwanda:** While governance structures are more formalized, inclusion of PWDs and elderly populations in operational One Health activities remains limited in practice.

Barriers to inclusion

Findings highlight multiple barriers across countries:

- Structural: Limited access to health and veterinary services; weak community-level One Health structures
- Socio-cultural: Gender norms restricting participation; marginalization of vulnerable groups
- Economic: Poverty influencing exposure and limiting preventive actions
- System-level: Limited integration of GESI in One Health planning and coordination

Overall, findings show that while GESI was recognized in principle, implementation remained uneven across all countries. Gender roles strongly influenced exposure pathways, while access to services and decision-making remained unequal. Vulnerable groups, particularly PWDs and refugees, were consistently underrepresented in One Health systems. These patterns reflect structural and socio-economic constraints rather than lack of awareness alone.

Table 22: Gender and Social Inclusion (GESI) Assessment Matrix for Uganda

Group	Voice and Representation	Participation in PPR	Access to OH Services	Decision-Making Power
Men	**High:** Dominate District One Health Committees (DOHCs) and technical roles (DVOs, DHOs).	**High:** Primary actors in wildlife ranging and livestock trade.	**High:** Access to professional training and PPE.	**Dominant:** Control budgets and community-level responses.
Women	**Low:** Often excluded from formal leadership; voices restricted to domestic health.	**Invisible:** Handle 70% of livestock care or milking but are seldom called for "technical" training.	**Limited:** Face time-poverty and mobility constraints to reach diagnostic centers.	**Low:** Household-level influence only; rarely lead surveillance teams.
Youth (18-35 years)	**Moderate:** Emerging as "Digital Champions" for eIDSR (surveillance) reporting.	**High (Field):** Active in community-based event reporting via mobile apps.	**High:** Tech-savvy; easy access to digital health info.	**Low:** Often blocked by traditional elders in community councils.
Elderly (60 years and more)	**Moderate:** Respected for traditional knowledge but ignored by "tech" shifts.	**Decreasing:** Sidelined by digital surveillance systems they cannot operate.	**Low:** Physical barriers to accessing regional referral laboratories.	**High (Traditional):** Influence community adherence to "quarantines."
PWDs	**Near Zero:** Frequently "forgotten" in official One Health strategies or disaster plans. IEC materials not responsive to needs	**Low:** Excluded from field simulations due to physical inaccessibility.	**Critically Low:** Lack of inclusive transport to health facilities during outbreaks.	**Nil:** Minimal representation in any GVL health governance body.
Refugees	**Emerging:** New inclusion via Community One Health Volunteers (COHVs).	**High (Local):** Essential for "border sensor" networks (e.g., Nakivale, Uganda).	**Variable:** Dependent on humanitarian aid vs. national health systems.	**Low:** Excluded from national-level policy and budget planning.

In conclusion, GESI disparities persist across the GVL, with uneven participation, limited access to services, and underrepresentation of vulnerable groups in One Health systems. Gender roles and livelihood activities continue to shape exposure to zoonotic risks.

Table 23: Recommendations and priority actions for equitable One Health

Category	Primary Gap	Priority Action
Tools and technology	- Inadequate gender focused risk communication and behaviour change capacity	- Establish intergenerational knowledge hubs as "One Health Circles" where elders provide historical context while youth provide digital reporting to ensure that the "Voice" of experience complements technology. - Enhance (RCCE): Develop targeted messaging for: Women (domestic exposure) Men (occupational risks), Youth (behavioural change)
Skills	- Inadequate GESI trained staff to program and share messages	- Disability-inclusive PPR by standardizing "Inclusive Rapid Response Teams" (RRTs) that have sign-language interpreters and accessible transport for PWDs during zoonotic crises. - Target at least 40% female participants in community awareness sessions. - Strengthen community engagement strategies to work with the "gender" special groups.
Staffing and infrastructure		- Formalize refugee community One Health volunteers to transition refugee volunteers from "informal helpers".
Systems	- Weak community-level One Health coordination structures - Inadequate financing for GESI among One Health activities	- Establish and institutionalize community-level One Health platforms (Define clear, roles, promote inclusion) - Gender-responsive budgeting where at least 30% of Pandemic Fund local grants are allocated to women-led community surveillance groups. – Lobby for dedicated financing to design inclusion-focused programs in each country.

3.10 Financing at national and sub-national levels

This section reports findings for objective 10: *To determine the status of financing for One Health at local, national, and regional levels.* The data were generated from review of ministerial policy statements, national development plans, project documents, KIIs at national and sub-national levels. Financing for One Health and PPR capacities across Uganda, Rwanda, and the Democratic Republic of Congo (DRC) was characterized by a transition from reactive, donor-funded programming to more structured but still underfunded national and regional systems. Across all countries, financing was predominantly externally driven, with development partners, multilateral agencies, and international NGOs constituting the primary funding sources. Domestic financing directly for OH activities remained limited, and One Health was not consistently embedded within national public financial management systems. The respective funding by the governments was still allocated through the independent ministries, rather than through the OH platforms or coordinating mechanisms. The funding for PPR was holistic and developmental to support all health functions.

The key sources of funding for field activities included multilateral and bilateral donors (e.g., World Bank/Pandemic Fund, USAID, UK Aid, Fleming Fund), international organizations (FAO, WHO, UNICEF), NGOs and conservation partners, as well as limited government allocations through sectoral ministries (health, agriculture, environment). The latter focused on infrastructure, human resources and service delivery related to PPR.

Despite these multiple sources, financing remained project-based and short-term, fragmented across sectors, and insufficiently institutionalized. A consistent finding across KIIs was that financing was largely reactive, with resources mobilized during outbreaks rather than for preparedness and prevention activities. Thus, the financing system across the GVL remains externally dependent and reactive, limiting sustained investment in prevention, preparedness, and system strengthening.

> *"Funding becomes available when there is an outbreak, but routine preparedness activities are rarely funded."* National-level KII respondent, Uganda.

3.10.1 Regional level: Transboundary collaboration

At the regional level, there was the Greater Virunga Transboundary Collaboration (GVTC) through which financing was primarily channeled, supported by international intergovernmental organizations. Financing was often allocated to high-profile conservation targets, such as Mountain Gorilla protection, a "proxy" for broader ecosystem health[45]. The Pandemic Fund hosted by the World Bank and supporting One Health efforts in the GVL is aligned to global pandemic prevention preparedness and response. The project was helping Uganda, DRC, and Rwanda in preparing other transboundary project proposals to strengthen health security[46]. In 2024–2025, the Fund approved about USD 24.5 million, with USD 15.6 million in co-financing and over USD 35 million in co-investment from partners including FAO, WHO, UNICEF, and local governments[47]. The Pandemic Fund project, one of the largest coordinated financing instruments specifically targeted transboundary One Health challenges in the region for surveillance integration, cross-border diagnostics, workforce development, and governance**.** The regional financing mechanisms show strength of external donor and multilateral engagement. However, sustainability depends on national buy-in and co-financing, yet there are slower domestic financing options**.** In plan is establishment of a Greater Virunga Landscape (GVL) Regional Fund to improve sustainability through blended public-private contributions.

Best Practice Scenario: Regional One Health Trust Fund

The establishment of a pooled fund managed by the GVTC to facilitate immediate resource mobilization during transboundary zoonotic outbreaks (e.g., Ebola, Marburg, or Anthrax) can ensure that surveillance does not stop at national borders. Each country can contribute this proportion from the tourism revenue. Establish pooled One Health financing windows at regional and national levels with multi-year commitments and co-financing rules to ensure sustainability using the Pandemic Fund model. Allocate funds for shared laboratories, data systems, and rapid response teams. Regional pooled funding mechanisms (e.g., African Development Bank, COMESA).

[45] Kalema-Zikusoka, G., Rubanga, S., Ngabirano, X., & Zikusoka, L. (2021). Mitigating impacts of the COVID-19 pandemic on gorilla conservation: Lessons from Bwindi Impenetrable Forest, Uganda. *Frontiers in Public Health*, *9*. https://doi.org/10.3389/fpubh.2021.655175

[46] FAO. (2024). *Reporting on the recommendations of the 32nd Session of the Regional Conference for Africa*. FAO Knowledge Repository. https://openknowledge.fao.org/server/api/core/bitstreams/85384860-bec6-4a97-aec2-7d24b8ad5095/content

[47] https://nilepost.co.ug/index.php/news/286797/wwf-launches-shs95-billion-%27one-health%27-project-to-combat-cross-border-disease-threats-in-uganda%2C-rwanda%2C-and-drc

3.10.2 National level financing

At national level, all three countries demonstrated policy commitment to One Health, but this was not consistently matched with adequate or institutionalized financing. The main sources of funding were:

- Government sectoral budgets (health, agriculture, environment)
- Donor-funded projects and grants
- Emergency funding during outbreaks
- Global health security initiatives (e.g., Pandemic Fund, Fleming Fund)

Uganda: The Ministry of health budget (PPR for zoonoses and other diseases) was UgX 1,343,858,000,000 in 2024/25 compared to UgX 1,546,250,000,000 in 2025/2026 showing a 25% increase to be spent on surveillance, community mobilisation, and laboratory services. A deeper review of the Ministerial policy statement revealed that the total direct funding allocated to PPR functions (i.e. emergency medical services, Health Sector Partners and Multi-Sectoral Coordination, Health Infrastructure, Health Education, Promotion and Communication, Institutional and Human Resource Development, Communicable Diseases Prevention and Control, Environmental Health, Integrated Epidemiology, Surveillance and Public Health Emergencies, National Health Laboratory and Diagnostic Services) was more than 85% (UgX 1,426,337,000,000/3700) or USD 385,496,486.5[48].

The country reflected a moderately functional but fragmented financing model, with multiple partners supporting different components of One Health. While government structures were in place, financing was not pooled and remained largely partner driven.
Financing emerged as the most dominant theme (90%), with respondents consistently highlighting heavy reliance on donor funding and limited domestic investment. Financing constraints and sustainability challenges were noted by national KIIs in Uganda. Short-term project cycles and sector-specific donor priorities were reported to undermine long-term planning and integration. This highlighted a structural dependency on external funding, with minimal domestic financing. In turn, this undermines sustainability and reflects limited integration of One Health into national budgeting systems.

> *"The National One Health Platform can only operate with funding from partners. There is no money… we call upon partners immediately to assist. The biggest challenge is fundraising… donors think in a single-sector mind set. No sustainable funding had been secured from the government."* National level respondent, KII, Uganda.

National financing for epidemic preparedness was often the "weakest link" due to competing demands like poverty reduction and food security, in OH ministries other than health. A best practice scenario can be to mainstream One Health into National Development Plans (NDPs). The funding sources are national health, environment, and agriculture budgets; donor projects; emergency pandemic allocations[49]. There were therefore variable domestic allocations to One Health functions; Rwanda shows stronger integration of animal/human health in planning than parts of DRC, whereas Uganda has both models. The national development plans lacked ring-fenced One Health budget lines, although Uganda's NDP IV mentioned One Health in the program on human capital development.

[48] https://budget.finance.go.ug/sites/default/files/Sector%20Spending%20Agency%20Budgets%20and%20Performance/2025-2026_VoteMPS_014_MinistryofHealth_26_3_2025_07_31_35_PM.pdf
[49] https://link.springer.com/article/10.1186/s12982-025-01028-0

According to Mwatondo *et al.,* 2023, the code "One Health" as a line item in the national budget rather than a "special project," can ensure that sustainable funding for joint surveillance activities and laboratory infrastructure is provided for in each country[50]. Published the JEE report on implementation progress of Uganda's National Action Plan for Health Security (NAPHS) from 2019 to 2023 under One Health indicated varied financial achievements. Funding was available for many planned activities (78.3% in total), but only about 39 to 40 % were fully funded, 38% were partially funded**,** and 23 % had no funding[51],[52]**.** Uganda has commenced on this integration practice in the NAPHS 2024 – 2029 to address this gap. Implementation and monitoring was coordinated by the Office of the Prime Minister, although the funds were directed under each OH implementing ministry. While Uganda and Rwanda have established National One Health Platforms, they remained heavily reliant on external funding from agencies like USAID, the Fleming Fund, and the World Bank[53]. For example, previously the Fleming Fund provided specific funding for antimicrobial resistance (AMR) mitigation among humans and animals in the region. Generally, these financing streams from international sources were catalytic but not yet matched by sustainable, predictable domestic budget lines for disease preparedness and surveillance functions. This pattern is similar to broader African health financing trends where external aid remains dominant[54].

Field findings illustrated that domestic budget allocation for One Health remains limited. Most funding was channeled through sector-specific ministry budgets (health, agriculture, environment), resulting in fragmented, siloed implementation. This structural constraint within the Greater Virunga Landscape (GVL) reduces the efficiency and coordination of integrated One Health activities that span across sectors.

Rwanda: Up to RwF 374,318,368,726 was allocated to the Ministry of Health in 2024/25 compared to RwF 415,087,067,783 in 2025/26 towards strengthening infrastructure and health facilities, human resource capacity improvement, laboratory services upgrade, disease prevention interventions like indoor residual spraying, vaccination, among others. If 85% goes to PPR, then the resources allocated in 2025/26 are USD 239,920,325.2[55].

Exhibited a relatively structured and coordinated financing environment, supported by pooled donor funding mechanisms. However, financing remained heavily donor-dependent, with limited domestic allocation and absence of dedicated One Health budget lines.

> *"Rwanda's One Health work is mainly funded by external partners… domestic funding remains limited."* National-level stakeholder, KII, Rwanda.

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[50] Mwatondo, A., Rahman-Shepherd, A., Hollmann, L., Chiossi, S., Maina, J., et al. (2023). A global analysis of One Health Networks and the proliferation of One Health collaborations. *The Lancet*, *401*(10376), 605-616. https://doi.org/10.1016/s0140-6736(22)01596-3

[51] Contribution of the One Health approach in strengthening health security in Uganda: a case study. BMC Public Health. https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-023-15670-3

[52] Joint external evaluation of the International Health Regulations (2005) core capacities of Uganda Mission report 23–27 October 2023. https://www.who.int/publications/i/item/9789240112971

[53] Fasina, F. O., Fasanmi, O. G., Makonnen, Y. J., Bebay, C., Bett, B., & Roesel, K. (2021). The one health landscape in Sub-Saharan African countries. *One Health*, *13*, 100325. https://doi.org/10.1016/j.onehlt.2021.100325

[54] https://iris.who.int/bitstream/handle/10665/101282/9789290232131.pdf

[55] https://www.minecofin.gov.rw/fileadmin/user_upload/Minecofin/Dept_Stats_Strategies/Reports/Budget_Framework_Paper_FY_2024-2025.pdf

Rwanda had a national One Health framework**,** strategic planning documents and integration of One Health within multi-sectoral planning, ensuring that financing and integration was optimum. Rwanda had robust (level 5 JEE score) financing commitment through a dedicated national budget line for One Health coordination, domestic resource mobilization for health security, and partnership funding leveraged through strong government co-financing.

DRC: By 2021, the national budget allocation for health had increased to 11.5% and nearing 14.5% in 2025, closer to the Abuja declaration of 15%. The government allocated less than 20%, while external donors and out-of-pocket payments by households each contributed about 40%. In March 2026, this picture was the same Although in 2026, the core health allocation from government funding (The Health Promotion Fund) surpassed 5.5 trillion Congolese francs, while the public sector coverage and gradual private sector integration, led to internal projections beyond CDF 1.1 trillion (approximately $2.9 billion), the real transformation lies beyond this baseline[56].

The DRC presented the most constrained financing environment. Findings indicate extreme reliance on external funding. Across KIIs, respondents consistently reported that approximately 89% of One Health activities were funded by external partners, with limited and unreliable domestic financial contribution coupled with weak domestic financing systems and inconsistent disbursement.

> *"89% of the funding for One Health activities is provided by partners. We try to align with government financing systems, but disbursement remains a major challenge."* National-level stakeholder, KII, DRC

Across all countries, national financing systems were characterized by absence of dedicated One Health budget lines, limited pooling of resources across sectors, and continued reliance on partner-funded implementation. This reflects a persistent policy–financing gap, where coordination structures exist but are not backed by sustainable financial mechanisms.

3.10.3 Sub-national (District/Provincial) Financing

Sub-national financing emerged as the weakest component of the financing system across all countries. The themes generated from the discussion in the field included absence of dedicated One Health budgets at district/provincial level, heavy reliance on partner support, and limited financial autonomy for local response. In Uganda and Rwanda, districts depended on central government transfers, NGO and partner-supported activities to implement OH activities such as community engagement, training of community volunteers, joint meetings.

In Uganda, sub-national One Health teams (e.g., in districts) received in-service financing for training and coordination through a mix of government allocations and donor support. The implementation of activities, however, often remained incomplete due to gaps in predictable operational financing. In Rwanda, Uganda and DRC, despite existence of national plans, there was inadequate sub-national implementation because units often lacked adequate direct budget lines**.** Reliance on project funds or *ad hoc* allocations undermined continuity in surveillance, workforce training, and multi-sectoral coordination across districts.

[56] https://www.devex.com/news/sponsored/drc-nears-historic-14-5-abuja-target-for-health-sovereignty-112036

The funding sources were mostly project grants from NGOs, conservation bodies, and occasional national sub-grants, with minimal community contributions. These sources were short-term, and donor-driven which limited continuity of surveillance, veterinary outreach, and community risk-reduction. At the community interface, financing was often indirect, linked to "livelihood security" programs that reduce human pressure on protected areas. Local funding was frequently tied to eco-tourism revenue sharing as expressed in the case study above. Several partners were present and supported various activities on zoonotic disease control and prevention. Formal arrangements existed such as memorandum of understanding, and consultation with the district plans before partners committed funds for activities.

> *"GCRC is very active, MTI supports sample transportation during Mpox, Red cross was also part sometime back, Bwindi Community Hospital during the first anthrax outbreak provided us with a lot of PPEs. Yes, every year we have some MoUs signed for example, with GCRC in the district they sign one about area of coverage, so do MTI, and all other partners like WHO, Save the Children, UNICEF."* KII District Respondent, Uganda, while another respondent mentioned that:
>
> *"I know MAAIF and MoH have partners supporting One Health, but the department of environment does not have. WWF is coming on board probably since they have invited us for a meeting in the coming week, we will work together."* KII District Respondent, Uganda,

In the DRC, sub-national financing was further constrained by limited visibility of funding flows, centralized control of resources, and reactive deployment during outbreaks.

> *"At our level, we do not know how funds are mobilized… we only implement activities when resources arrive."* National-level stakeholder, KII, DRC

Support at this level was largely in-kind support (PPE, transport, supplies, laboratory materials), operational support (training, supervision, logistics), which were *ad hoc* and project-dependent. Sub-national systems were financially constrained and operationally dependent, limiting timely response, local planning, and preventive action.

3.10.4 Local level financing

Across all countries, community-level financing for One Health was minimal and largely informal. The findings indicated absence of structured financing mechanisms characterized by reliance on volunteer systems by community and technical members, NGO-led interventions, and indirect support (e.g., livelihood and conservation programs). These led to progress and collaboration at sub-national levels, without direct monetary exchange. In Rwanda and Uganda, some indirect support existed through community engagement and conservation-linked initiatives. However, in the DRC, financing at this level was particularly limited. Despite being critical for early detection and prevention, community-level financing remained systematically underdeveloped across the GVL.

In Uganda funding and resource gaps (3%) was one of the sub-themes generated from the community level FGDs in 11 districts in Uganda. Participants highlighted insufficient financial support for community One Health activities and outbreak response. Several respondents reported that meetings and community mobilization activities often occurred without facilitation or logistical support. During previous outbreaks such as COVID-19, communities reported receiving supplies such as masks and sanitizers, but these were insufficient to the meet community needs. Notably, there was lack of budgets for One

Health activities in communities. At district level, participants mentioned donor dependency as one of the bottlenecks.

> *"There is no budget line from the district or national level allocations and thus, regular meetings are not facilitated."* District stakeholder, KII respondent, Uganda.

Case study on UWA revenue sharing with communities

The park supports community development initiatives; for example, Semuliki National Park contributed to the construction of Kirumya Catholic Church in Ntoroko District. They gave out tanks in one scheme of revenue sharing but the tanks go only to few individuals that are extremely close to the park. Others whose crops were destroyed did not get. The only benefit from being near protected areas would be revenue sharing but not everyone got this support. Schools and other community projects have empowered communities, sometimes selected without involvement of the main beneficiaries, apart from leaders. One time UWA in one of the revenue sharing schemes gave out 600 goats to over 3000 people which were not enough. Similar scenarios were presented throughout the assessment, indicating a mixture of gratitude and demand for more support.

In Rwanda, from the field findings, financing and resource management for OH was an issue at national, districts and community level. Heavy reliance on donor funding and limited domestic financing was a major constraint (83%). National respondents reported reliance on government funding (limited) and donor funding (e.g. Pandemic Fund, partners). Approximately 78% highlighted lack of dedicated One Health budget lines, affecting sustainability.

> *"Rwanda's One Health activity work is mainly funded by the World Bank's Pandemic Fund… Rwanda won a grant, which is supported by the One Health GVTC funding. The government has set up a One Health desk with staff, and continues to contribute to routine health service provision including laboratories."* National KII respondent, Rwanda.

According to district level KIs, they heavily relied on external donor funding, with limited domestic financing and absence of dedicated budget lines for One Health activities. Most funding came from partners with minimal local government contribution. There were no dedicated government budget lines for One Health.

> *"We depend on partner support; there is no clear budget for these activities."* District level, KII respondent, Rwanda.

FGDs in Rwanda similarly reported absence of dedicated financing mechanisms. Over half (56%) reported lack of specific One Health budgets, with reliance on *ad hoc* support, sectoral funding, and volunteer systems. Community-level financing mechanisms were weak (38%), with limited savings schemes for outbreak preparedness. However, the communities benefited from in-kind projects from the tourism sector.

> *"There is no specific budget for One Health at community level. All sectors work independently."* FGD respondent Rwanda.

In Rwanda's Volcanoes National Park, a percentage of tourism revenue is reinvested into community health and infrastructure[57]. However, these funds were volatile during major epidemics like previously experienced during Ebola, Marburg outbreaks, and the COVID-19 pandemic. This negatively impacted tourism in the region, instantly depleting local One Health financing. At this level, a proposed Community-Based Health Insurance (CBHI) linked to Conservation can enhance funding support. Local disease monitoring can be facilitated by motivations such as One Health "vouchers" for authorized park entry, trophy hunting or subsidized health insurance premiums, for communities that participate in wildlife health surveillance[58].

In DRC, during the KIIs and FGDs, financing of One Health activities at district ad community level generated three themes. Majority of the respondents noted that there were no funding sources (80–90%), no budget lines (85%) and thus reliance on external partners (30%). This highlights systemic underinvestment which affected implementation. The districts noted financial constraints (85–90%) as the most pervasive challenge to One Health implementation. Others included lack of logistics and equipment (70–80%), limited partner support (65%), weak coordination structures (60%), human resource gaps (50–60%), and poor community awareness (50%). One respondent mentioned*:*

> *"There is lack of government support, in the absence of partners."* Whereas another noted that: *"The major challenge is that everyone works within their own sector, there is little collaboration across sectors."*

Budget conflicts and ownership issues (3%) due to unequal funding across sectors and competition over resources made some sectors dominate implementation. Monitoring, evaluation and learning (3%) from past outbreaks for system improvement was low. For example, lack of after-action reviews (2%) was mentioned often as rarely conducted due to funding gaps. However, districts had informal evaluation practices (1%) such as follow-ups through DTF meetings during, before and after outbreaks.

> *"We have never done after action review. From the side of the environment, I can't say we have these but there are usually review performances from the health and production. This is because they implement most of these strategies such as a quarantine, they have to go back and lift it." KII respondent, DRC.*

Some of the participants during FGDs in DRC, noted that financial limitations (mentioned 5% of the time) were a cross-cutting barrier to effective One Health implementation at community level. Participants consistently reported the absence of dedicated funding:

> *"There is no budget… No support or budget for the 'One Health' coordination."* FGD respondent, DRC

Existing initiatives were often described as donor-dependent (25%), raising concerns about sustainability. Some participants also highlighted inefficiencies as well as inequity (15%) in resource allocation and management. Comparative summary of financing status: regional level has Pandemic Fund, GVTC, FAO, World Bank, challenged by fragmented data sharing; cross-border logistics. At

[57] Sabuhoro, E., Wright, B. A., Munanura, I. E., Mkumbo, P., Bernhard, K. P., & Mgonja, J. T. (2022). Livelihood security and perceived prevalence of illegal activities threatening mountain gorilla conservation in East Africa's Virunga Landscape. *Land*, *11*(9), 1509. https://doi.org/10.3390/land11091509

[58] Sabuhoro, E., Ayorekire, J., & Munanura, I. E. (2023). The quality of life and perceived human-wildlife conflicts among forest communities around the mountain gorilla's Virunga landscape in Africa. *Sustainability*, *15*(3), 2248. https://doi.org/10.3390/su15032248

national level, UK Aid, US government, Fleming Fund, BMZ (Germany), with issues around dependence on external donors; siloed ministries. At local level, NGOs, CBOs, and tourism revenue sharing occurs, affected by volatility of tourism; lack of direct health investment.

Cross-cutting Financing Constraints

Several systemic constraints were consistently identified across all countries:

- **Heavy donor dependency:** One Health financing was largely externally driven, posing sustainability risks.
- **Lack of dedicated budget lines:** Absence of explicit One Health financing structures limited accountability and institutionalization.
- **Reactive financing models:** Funding was primarily mobilized during outbreaks, with limited investment in preparedness.
- **Fragmented financing structures:** Sector-specific funding streams undermined integrated One Health implementation.
- **Weak sub-national financing:** Local governments lacked financial autonomy to implement and respond effectively.
- **Limited Private Sector Engagement:** Private sector involvement in financing was minimal and largely informal.
- **Contextual Constraints (DRC):** Insecurity and governance challenges significantly affected financing effectiveness and resource utilization.

Table 24: Comparative financing matrix

Dimension	Rwanda	Uganda	DRC
Donor dependency	High	High	Very High
Domestic financing	Low	Low–Moderate	Very Low
Financing structure	Coordinated	Fragmented	Weak/Unstable
Sub-national financing	Low	Low	Very Low
Community financing	Very Low	Very Low	Very Low
Private sector role in OH	Indirect, in-kind	Indirect and in-kind	Indirect and in-kind
Sustainability	Moderate Risk	High Risk	Severe Risk
Contextual constraints	Low	Moderate	High (security)

Overall, financing for One Health and PPR capacities across the GVL remained externally driven, insufficiently institutionalized, and operationally constrained, with notable variation across countries.

- Rwanda demonstrated strong coordination but limited financial autonomy beyond ministries.
- Uganda reflected a functional but fragmented ministry based financing model.
- The DRC exhibited systemic financing instability compounded by governance and security challenges.

Implications for PPR Capacity

The current financing landscape had significant implications for PPR system performance. Chronic underfunding of preparedness functions reinforces a reliance on reactive, emergency-driven responses rather than proactive risk management. This was further compounded by delayed outbreak response, particularly at sub-national levels where operational resources were most constrained. In addition, the functionality of coordination structures was weakened by insufficient funding to support routine

operations, limiting effective multi-sectoral engagement. At the community level, inadequate investment constrained prevention and surveillance capacity, undermining early detection and timely response to emerging health threats. To help close current gaps, institutionalize integrated health financing, and strengthen resilience to zoonotic and pandemic threats across the transboundary GVL, the following actions are proposed.

Table 25: The key gaps and priority actions to strengthen financing in the GVL

Category	Primary Gap	Priority Action
Tools and technology	- Inactive plans and strategies	- Integrate One Health into existing health security plans by embedding One Health financing strategies within National Action Plans for Health Security (NAPHS) or health sector strategic plans to improve resource flow alignment and monitoring.
Skills	- Lack of evidence based on cost-benefit for preparedness against zoonoses	- Develop cost-effectiveness and impact evidence using rigorous economic evaluations and simulations to support policy advocacy and justify increased domestic allocations.
Staffing and infrastructure	- Inefficient reach	- Private sector engagement in surveillance technologies and community outreach.
Systems	- Lack of dedicated One Health financing mechanisms	- Ring fence minimal recurrent budgets for district One Health functions (surveillance, veterinary outreach) within national budgets to reduce donor dependency. - Performance linked blended finance by combining donor catalytic grants with domestic budget commitments tied to measurable One Health indicators (surveillance coverage, joint outbreak drills). - Allocate national budget lines for One Health.

4. Conclusions and Recommendations

Without increased domestic financing, dedicated budget lines, and strengthened sub-national financing mechanisms, the sustainability and effectiveness of One Health and PPR systems across the GVL will remain limited. Priority actions should focus on institutionalizing domestic financing, strengthening decentralized funding mechanisms, and establishing pooled multi-sector financing systems to reduce dependency on short-term external funding. In this section, we present the final priority recommendations in response to objective 11: To generate tailored recommendations for targeted One Health interventions based on the identified gaps and risk profiles.

Based on the priority actions for each objective, a panel of experts prioritised the most relevant. A weighting of criteria was used for ranking of priority actions on hotspots in 1000minds.com. During the validation meeting, using the Delphi method, 25 human, livestock and wildlife professionals belonging to various conservation agencies were divided into five groups. These then participated in the ranking of criteria that were used to select the priority actions. Technical and operational feasibility of the interventions (37.5%) as well as their epidemiological impact (37.5%) were most weighted by the panels as compared to sustainability and maintenance (12.5%), and transboundary synergy (12.5%).

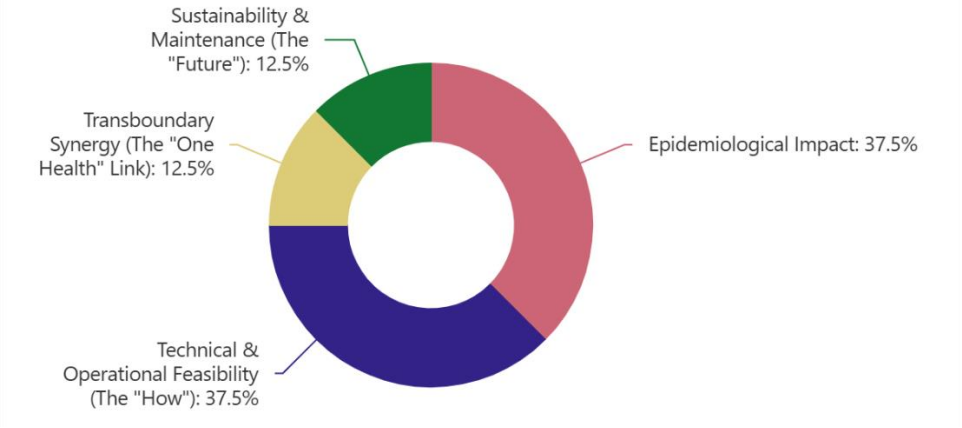

Figure 40: The criteria selected by the Delphi panel of experts from Uganda, Rwanda, and DRC

Ranking of alternatives

The prioritization of alternatives was derived by aggregating individual participant preference scores through the 1000minds software, which utilized pairwise trade-offs to calculate consistent utility weights for each intervention. These results were normalized into a percentage-based priority index, where a higher percentage value directly corresponds to a higher rank; mathematically, these values reflect the collective utility of each alternative, with higher scores signifying immediate prioritization for resource allocation. Conversely, lower priority percentages indicate a diminished relative preference, positioning those interventions at the end of the hierarchy. To ensure statistical robustness and account for inter-rater variability, the analysis moved beyond simple central tendency; dispersion metrics, specifically standard deviation, were integrated to visualize the level of consensus among scoring sources and to validate the reliability of the priority rankings. The lists of recommendations as presented in each section by objective above was shared with the experts, after which these were entered into the 1000minds.com. The actions were prioritised as below per objective. The project teams can select the actions to implement based on the lists or with additional input of the district and national OH teams.

1. Hotspots for zoonotic diseases

Recommendation	Rank	Score
Support community vaccination programs to protect sylvatic cycle spill overs	1st	97.3%
Conduct medical camps in areas closest to parks	2nd	94.9%
Strengthen community IPC through communal hand washing facilities	3rd	94.3%
Support IPC programs implementation roll out in all health facilities in the GVL	4th	91.6%
Reinforce the existing stone walls with low-voltage electric wires (Rwanda)	5th	89.2%
Support investigational vaccine use and antivirals prior to outbreaks	5th	89.2%
Fast-track the 2022 Wildlife Compensation Regulations (Uganda)	7th	77.8%
Improve critical infrastructure for prevention (wildlife-human interface barriers, access to safe water	8th	66.4%
Promote low-cost, community-owned methods like chili-briquettes and beehives to empower locals.	9th	65.9%
Support surveillance and early warning efforts in animals, wildlife	10th	65.0%
For land use, continue the "Buffer Zone" policy for regenerative agriculture (e.g., Pyrethrum)	11th	64.5%

Conduct cross-border simulations to share experiences	12th	63.0%
Ecological mapping of areas with varying rainfall patterns and vector changes	13th	60.8%
Lobby for increased technical workforce	14th	56.2%
Establish or strengthen sentinel surveillance sites for RVF, YF in the GVL	15th	55.7%
Establish and deepen community awareness systems involving VHTs, community and district One Health teams	15th	55.7%
Integrate HWC mitigation into IDP support programs.	17th	49.2%
Strengthen the Ranger-Community dialogue toward collaborative monitoring	17th	49.2%
Hybrid (beehive and electric) fencing in hotspots	19th	42.4%
Conduct trainings of different cadres of staff in human, animal and wildlife settings	20th	42.0%
Link tourism revenue sharing to HWC insurance premiums for farmers less than 1 km from the PA.	21st	34.2%
Conduct economic evaluation studies on outbreaks, prevention and preparedness cost benefits	22nd	32.8%
SMS-early warning systems by trained community scouts to use GPS warning of communities	23rd	32.3%
Hybrid fencing in hotspots like QENP, KNP by integrating beehive fences alongside electric fences	24th	25.8%

3. Surveillance and early warming systems

Recommendation	Rank	Score
Create mandatory monthly data-sharing meetings between Park Wardens (wildlife), DVOs (livestock), and DHOs (human)	1st	96.3%
Adopt interoperable digital platforms for human-animal-environmental health data across ministries and cross-border.	2nd	74.2%
Digitalize from the Rwandan surveillance information sharing model throughout the region to ease coordinated, effective information sharing	3rd	72.1%
Popularize the different definitions of standard cases of zoonoses under surveillance in the DRC, translated into local languages, in all four territories bordering Virunga Park.	4th	69.1%
Support integrated surveillance systems	5th	68.7%
Integrate routine wildlife health monitoring with community reporting	6th	67.7%
Conduct "Joint table top, drill, and functional simulation exercises" (SimEx) specifically for cross border issues	7th	65.0%
Train One Health agents (INOA: National Institute of One Health/UNIKIN); veterinary technicians and environmental health	8th	64.5%
Operationalize the planned GVTC One Health Secretariat to host a tri-national early warning hub	9th	63.0%
Identify and train stakeholders at the animal, environmental and human interface (One Health approach)	10th	59.4%
Share standardized as well as community case definitions for the PZDs	11th	58.4%
Conduct community "sentinel surveillance" training by scaling the Village Health and Conservation Team (VHCT) model.	12th	58.0%
Scale VHCT community surveillance into two cross-border pilot clusters	13th	42.4%
Share cross-border risk mapping and early warning systems.	14th	36.9%
Conduct "Joint table top, drill, and functional simulation exercises" (SimEx) specifically for cross-border zoonotic spillovers.	15th	0%

4. Laboratory Services

Recommendation	Rank	Score
Establish MoUs for sharing data between biobanks	1st	96.3%
Technical capacity building for laboratory staff across sectors	2nd	94.3%
Specialized biosafety training for sample transport/investigation	3rd	86.5%
Implement rapid "Point-of-Care" testing for animal diagnostics	3rd	86.5%

Install consistent alternative energy sources in district-level laboratories	5th	85.5%
Launch a 24-month OH pilot project for cross-border alerts	6th	82.8%
Harmonize standard diagnostic "case definitions" & protocols	7th	69.1%
Expand the GVL Regional Biobank to include wildlife samples	8th	60.8%
Invest in last-mile logistics and transportation support	9th	59.4%

5. Public Health capacity

Recommendation	Rank	Score
Joint simulation exercises and field epidemiology training across sectors and borders.	1st	96.3%
Expand ranger/CHW training to include the risk humans pose to wildlife.	2nd	93.6%
Recruit and deploy dedicated "One Health Officers" at the sub-county level.	3rd	78.5%
Raise awareness among the population living in the GVL about the prevention practices, costs, ace	4th	74.2%
Implement One Health curricula in universities and health worker training institutions.	5th	64.5%
Finalize the GVL transboundary digital dashboard for real-time data sharing.	6th	63.5%
Lobby for recruiting veterinarians in communities with higher livestock numbers	7th	55.7%
Lobby for recruiting more human, animal and environmental health experts at district level	8th	49.2%
Supply the various facilities with human, animal and poultry vaccines	9th	48.1%
Organize vaccination campaigns against zoonotic diseases (in humans, animals and poultry)	10th	26.6%

6. Border Health

Recommendation	Rank	Score
Harmonize border health SOPs and strengthen informal-border engagement to reduce unmonitored movement	1st	93.6%
Deploy "One Health" Border Kits: Provide Port Health officers with multiplex Point-of-Care (POC) tests that screen for both human and animal pathogens (e.g., Anthrax and RVF).	2nd	91.2%
Equip with knowledge through continuous training for Port health and animal health staff	3rd	82.8%
Add holding area, and testing laboratory, and equipment	4th	71.5%
Harmonize transboundary data sharing: Move from national silos to the GVL Digital One Health Dashboard	5th	67.7%
Conduct joint cross-border simulations: joint "Joint Table-top Exercises" (SimEx) specifically for cross-border issues	6th	59.9%
Lobby government of Uganda deploy a veterinary officer at site	7th	10.7%

7. One Health co-ordination

Recommendation	Rank	Score
Invest in cross border data sharing protocols and joint simulation exercises to operationalize the Pandemic Fund objectives	1st	94.3%
Stimulate public-private community partnerships by leveraging private sector and community funds	2nd	69.1%
Prioritize funding for district-level One Health platforms and joint work plans	3rd	64.5%
Formalize private-sector engagement (veterinary clinics, tourism operators) through MOUs to support	4th	48.6%

8. Community KAP

Recommendation	Rank	Score
Improve livestock disease surveillance, deploy animal health workers	1st	86.5%
Establish community sentinel systems linking reported exposures to surveillance data.	2nd	84.2%
Organize a local language translation workshop and validation of different definitions of standard cases of zoonoses under surveillance in DRC with all stakeholders according to the One Health approach.	3rd	71.5%
Increase awareness and strengthen health education using translated materials at community level	4th	69.1%
Integrate One Health education modules into school and community outreaches and track uptake.	5th	65.9%
Collaborate with refugee and disability networks to ensure inclusive data collection and interventions.	6th	55.7%

9. GESI

Recommendation	Rank	Score
Establish and institutionalize community-level One Health platforms (Define clear, roles, promote in the district and communities)	1st	86.5%
Enhance (RCCE): Develop targeted messaging for: Women (domestic exposure) Men (occupational risks), Youth (behavioural change)	2nd	65.9%
Strengthen community engagement strategies to work with the “gender” special groups.	3rd	60.8%

10. OH Financing

Recommendation	Rank	Score
Private sector engagement in surveillance technologies and community outreach.	1st	60.8%
Performance linked blended finance by combining donor catalytic grants with domestic budget commitment	1st	60.8%
Develop cost-effectiveness and impact evidence using rigorous economic evaluations and simulations to support policy advocacy and justify increased domestic allocations.	3rd	37.3%
Allocate national budget lines for One Health.	4th	34.2%
Ring fence minimal recurrent budgets for district One Health functions (surveillance, veterinary out	5th	26.6%
Integrate One Health into existing health security plans by embedding OH financing strategies	5th	26.6%

5. Annexes

Annex 1: List of contributors

Uganda		
Dr. Christine Kihembo	Technical input, Coordination, supervision	AFENET

Dr. Nabukenya Immaculate	Principal Investigator, Technical design, Coordination, supervision	Makerere University
Jacob Bibohere	Technical input, Coordination, supervision	AFENET
Dr. Kalule John Bosco	Technical input, Coordination, supervision	Makerere University
Dr. Namara Delilah Dee	Data Collection & synthesis	University of Cape Town
Basiibye Joel Steven	Data Collection & synthesis	Makerere University, Bwindi NP
Ndibalekera Ritah	Data Collection & synthesis	Makerere University
Akampurira Bruce	Data Collection & synthesis	Makerere University
Semaganda Vincent	Data Collection & synthesis	Makerere University, Lyantonde DLG
Sseruuma Akiram	Data Collection & synthesis	Makerere University, Bombo Hospital
Babirye Catherine	Data Collection & synthesis	Makerere University
Caroline Nabimanya	Data Collection & synthesis	Makerere University, Nakasero Hospital
Mariah Namuwanga	Data Collection & synthesis, administration	AFENET
Rwanda		
Dr. Mutabazi Vincent	Technical input, coordination, supervision	AFENET
Batamuliza Jeannette	Technical input, coordination, supervision	Biomedical Research and Conservation Centre
Kamayirese Eric Noël	Data collection & synthesis	AFENET Rwanda
Havugimana Shaban	Data Collection & synthesis	Kibungo L2TH
Imukuze Elise	Data Collection & synthesis	Ruhengeri L2TH
Nyinawabeza Solange	Data Collection & synthesis	Kibogora DH
Hategekimana J. Paul	Data Collection & synthesis	Nyagatare DH
Gaspard Bizimungu	Data Collection & synthesis	Kigeme DH
Zabulon Mutabazi	Data Collection & synthesis	Nyanza DH
Uwase Anita	Data Collection & synthesis	Ines Ruhengeri
Mukashyaka Joyeuse	Data Collection & synthesis	Kabaya DH
DRC		
Dr. Gauthier Mubenga Manshimba	Technical input, Coordination, supervision	Catholic University of Graben
Dr. Linda Matadi Basadia	Technical input, Coordination, supervision	CH Bisengimana
Kasereka Masumbuko Claude	Supervision, Coordination	Catholic University of Graben
Bahati Mbambu Félicité	Supervision, Coordination	CH Bisengimana
Zabona Kahunga Mathieu	Data Collection & synthesis	BCZS Nyiragongo
M Ukirania Nzurawa Angelot	Data Collection & synthesis	Division of Fishing and Livestock
Paluku Lwanzo Pablo	Data Collection & synthesis	BCZS Butembo

Hatua Bizimungu Jules	Data Collection & synthesis	DPS North Kivu
Mukoko Kambale Jean	Data Collection & synthesis	B CZS Katwa
Kakule Musubao Kizito	Data Collection & synthesis	ICCN
Musubaho Keukeu Blaise	Data Collection & synthesis	BCZS Musienene
Kakule Ngitsi Praise	Data Collection & synthesis	Division of Fishing and Livestock
Faida Kahiwa Luc	Data Collection & synthesis	PNHF
Shukuru Turano Thierry	Data Collection & synthesis	BCZS Nyiragogno
Basimuoneye Kahutsi Jean Paul	Data Collection & synthesis	DPS
Ndizihiwe Nshokeyinka Isaac	Data Collection & synthesis	BCZS Rutshuru
Katenge Vuyingo Alain	Data Collection & synthesis	SQAH
Kasereka Katoto Firmin	Data Collection & synthesis	Goma Veterinary Lab

Annex 2: Data Collection Tools

Data collection tools.zip

Annex 3: Additional photo documentation





Figure 41: KII with staff at Busunga PoE, Uganda-DRC border





Figure 42: 1) FGDs with community in Bunyangabu Uganda and 2) staff of Virunga National Park, DRC

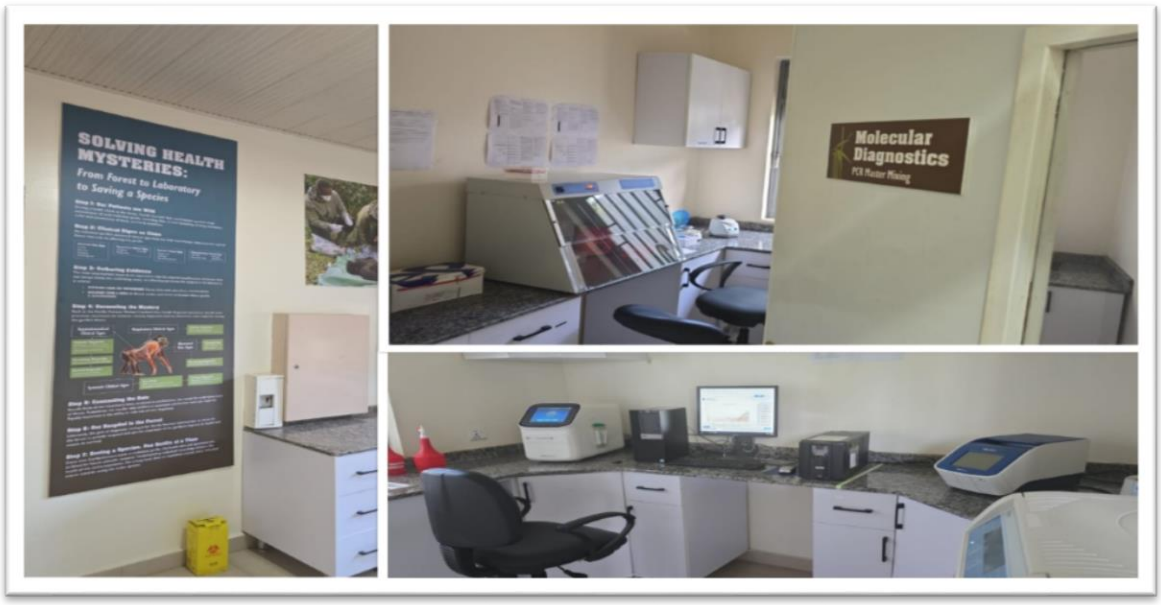

Figure 43: Observation of laboratory status, Gorilla Doctors Regional Health Laboratory, Rwanda







Figure 44: Human wildlife conflict, Garden Destroyed by elephants in Queen Elizabeth NP communities

Figure 45: Electric Fencing in Queen Elizabeth NP,Uganda to deter elephants' encroachment

Annex 4: List of Key Informant Interview (KII) Respondents

Uganda

No.	Institution / Organization	Stakeholder Category	Level
1	Ministry of Health	Government	National
2	Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)	Government	National
3	Uganda Wildlife Authority (UWA)	Conservation	Sub National
4	National Environment Management Authority (NEMA)	Government	National
5	Office of the Prime Minister (OPM)	Government	District
6	World Health Organization(WHO)	Partner	National
7	United Nations Children's Fund(UNICEF)	Partner	National
8	Food and Agriculture Organization(FAO)	Partner	National
9	National Emergency Operation Center	Government	National
10	Gorilla Doctors	Conservation	District
11	World Wide Fund (WWF)	Conservation	Community

Rwanda

No.	Institution / Organization	Stakeholder Category	Level
1	Rwanda Biomedical Center (RBC)	Government	National
2	Rwanda Development Board (RDB)	Government	National
3	Rwanda Agriculture and Animal Resources Development Board (RAB)	Government	National
4	Ministry of Health	Government	National
5	University of Rwanda- School of Public health	Academic	National
6	Rwanda Foods and Drugs Authority	Government	National
7	World Health Organization	Partner	National
9	Ministry of Environment	Government	District
10	International Union for Conservation of Nature (IUCN)	Conservation	National
11	Rwanda Council of Veterinary Doctors(RCVD)	Public Sector	National
12	Greater Virunga Transboundary Collaboration (GVTC)	Conservation	National
13	JHPIEGO	Partner	National

(Add Gorilla Doctors in Rwanda)

Democratic Republic of Congo (DRC)

No.	Institution / Organization	Stakeholder Category	Level
1	International Gorrilla Conservation Program (IGCP)	Conservation	National
2	Institut National de Recherche Biomédicale (INRB)	Government / Research	National
3	Kinshasa School of Public Health / AFROHUN	Academic	National
4	National Border Hygiene Program (PNHF)	Government	National
5	Epidemiological Surveillance Directorate	Government	National
6	Directorate for Nature Conservation (DCN)	Government	District
7	Institut Congolais pour la Conservation de la Nature (ICCN)	Conservation	District
8	Public Health Emergency Operations Center (COUSP)	Government	National
9	Central Veterinary Laboratory	Government	National
10	Department of Ecology and Environment/Vector surveillance service	Government	National
11	One Health Coordination Commission (CCUS)	Partner	National

Annex 5: Communities engaged in KAP survey (FGDs, Household surveys)

UGANDA

DISTRICT	LOCATION	NEAREST PROTECTED AREA
Kabale	Katuna Town Council,Kyanamira	Mgahinga NP,Bwindi NP
Rubanda	Hamurwa,Ruhija	Bwindi NP
Kisoro	Muramba,Nyarusiza	Mgahinga NP
Kanungu	Kihihi,Katete,Nyanga	Bwindi NP
Ntoroko	Kanara Town Council,Kanara A, Rwenyange	Semuliki NP
Bundibugyo	Ntandi Town Council,Busunga	Semuliki NP
Bunyangabo	Kakiinga,Katebwa	Kibale NP
Kabarole	Kiko,Nyabinyonyi	Kibale NP
Kamwenge	Bigodi,Busiriba	Kibale NP
Kasese	Namuhuga Ward,Bwera	Queen Elizabeth NP
Fort Portal	Central Division	Kibale NP

RWANDA

DISTRICT	LOCATION	CLOSEST PROTECTED AREA
Burera	Bugarama	Volcanoes National Park
Musanze	Jenda,Kinigi,Rugarama	Volcanoes National Park
Nyabihu	Jenda,Kabatwa,mukamira	Volcanoes National Park
Rubavu	Bugeshi	Virunga National Prk

DRC

TERRITORY	LOCATIONS	CLOSEST PARK / ECOSYSTEM
Beni	Kasindi, Lubiriha, Kanyatsi, Mujoga, Congo ya Sika	Virunga National Park
Lubero	Katolo, Kisanga, Kyambo, Majengo	Virunga National Park
Nyiragongo	Kibati, Bukanda, Mujoga, Rwanguba	Virunga National Park
Rutshuru	Bunagana, Jomba, Nyamilima, Kisharo, Rubare	Virunga National Park

Annex 5: Gorilla Doctors (GD) Laboratory – Musanze

The Gorilla Doctors Laboratory is a specialized, private non-profit (NGO) facility located in the Muhoza Sector of Musanze District. It serves as a primary technical hub for wildlife health in the Volcanoes National Park region, specifically focused on mountain gorilla conservation and zoonotic pathogen surveillance at the human-wildlife interface.

A. Diagnostic & Laboratory Capacity

The facility demonstrates a high level of molecular readiness compared to typical district-level health centers, operating as a dedicated Wildlife/Referral Laboratory.

1. Accreditation status**:** The laboratory is currently enrolled in the international accreditation process (SLIPTA), indicating a commitment to standardized quality management.
2. Priority pathogens tested**:** On-site testing is available for high-consequence zoonotic pathogens, including Ebola/Marburg (PCR), Rift Valley Fever (PCR), and Brucellosis (Serology). It also maintains capacity for Salmonellosis and Plague diagnostics.
3. Specimen volume: The lab processes an average of 20–30 animal specimens per month, with samples primarily originating from the forest (Volcanoes NP).
4. Biobanking Infrastructure**:** The facility maintains a robust biobank containing 220 samples stored according to standard operating procedures, with 100% of samples biobanked and tracked via a functional labeling system.

B. Surveillance & One Health Early Warning

1. Alert Frequency: The facility monitors daily gorilla health reports, which generate early warning alerts on a near-constant basis. Actionable response decisions include field investigations, risk communication, and laboratory confirmation.
2. Public health safeguards: The lab plays a role in tourism management, occasionally recommending the restriction of tourists from visiting certain gorilla groups to prevent anthropozoonotic transmission.
3. Digital tools: For record-keeping and sample management, the facility utilizes specialized software called "Open Space".

C. Workforce & Training Indicators

The facility maintains a highly specialized but lean staff, with 3 full-time laboratory personnel.

1. Capacity building: There is evidence of successful One Health training; three stakeholders (Wildlife and Laboratory sectors) recently completed training with a 100% improvement rate in post-training competency assessments.
2. Biorisk management: Staff are consistently trained in biorisk management, and the facility utilizes strict protocols, including PPE usage, biohazard removal, and emergency response.

D. Critical gaps & challenges

1. Equipment & maintenance: Top challenges identified include financial constraints and equipment maintenance. Specifically, the lab lacks several essential functional items: a Biosafety Cabinet (BSC), a Microscope, a Centrifuge, and a Water Distiller were all marked as "Not Available" in the current assessment. This means that though the vision
2. Supply chain: While the lab uses a dedicated software for sample capture, it currently reports no specimen-transport shipments sent in the last 6 months, suggesting that most diagnostics are either finalized on-site or sample movement is restricted.
3. External Quality Assurance: Despite its molecular capacity, the lab does not currently participate in EQA schemes for priority zoonotic pathogens.