EMERGING BIOSECURITY LANDSCAPE IN SOUTHEAST ASIA

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LIST OF ABBREVIATIONS

Abbreviation	Full form
A*STAR	Agency for Science, Technology and Research, Singapore
ACHS	Asia Centre for Health Security
ADMM	ASEAN Defence Ministers' Meeting
ADMM-Plus	ASEAN Defence Ministers' Meeting-Plus
AED	Automated external defibrillator
AFP	Agence France-Presse
AG	The Australia Group
AI	Artificial intelligence
AIDS	Acquired immunodeficiency syndrome
AIP-PRISMA	Australia-Indonesia Partnership for Promoting Rural Incomes through Support for Markets in Agriculture
AMAF	ASEAN Ministers on Agriculture and Forestry
AMR	Antimicrobial resistance
AMS	ASEAN Member States
ARF	ASEAN Regional Forum
ASEAN	Association of Southeast Asian Nations
ASEANAPOL	ASEAN police-to-police network
ASEAN CBR Network	Network of ASEAN CBR (chemical, biological, and radiological) Defence Experts
ASF	African swine fever
ASPR	Administration for Strategic Preparedness and Response
ATC	Anti-Terrorism Council, the Philippines
AVS	Animal & Veterinary Service, National Parks Board, Singapore
BAPPEDA	*Badan Perencanaan Pembangunan Daerah* or Regional Development Planning Agency, Indonesia
BAS	Biorisk Association of Singapore
BATA	Biological Agents and Toxins Act 2005, Singapore
BBC	British Broadcasting Corporation
BIN	*Badan Intelijen Negara* or State Intelligence Agency, Indonesia
BIOTEC	National Center for Genetic Engineering and Biotechnology, Thailand
BMC	BioMed Central
BMS Initiative	Biomedical Sciences Initiative, Singapore
BNPB	*Badan Nasional Penanggulangan Bencana* or National Agency for Disaster Countermeasure, Indonesia
BNPP	*Badan Nasional Pengelola Perbatasan* or National Border Management Agency, Indonesia
BNPT	*Badan Nasional Penanggulangan Terorisme* or National Counter Terrorism Agency, Indonesia
BPBD	*Badan Penanggulangan Bencana Daerah* or Regional Agency for Disaster Management, Indonesia
BPOM	*Badan Pengawas Obat dan Makanan* or National Agency of Drug and Food Control, Indonesia
BRAP	BioRisk Association of the Philippines
BRIN	*Badan Riset dan Inovasi Nasional* or National Research and Innovation Agency, Indonesia
BSB	Biosafety Branch, Ministry of Health, Singapore

BSL	Biosafety level
BWC	Biological Weapons Convention
CBD	Convention on Biological Diversity
CBM	Confidence-building measure
CBR	Chemical, biological, and radiological
CBRE	Chemical, biological, radiological, and explosive
CBRE DG	Singapore Armed Forces CBRE Defence Group
CBRN	Chemical, biological, radiological and nuclear
CBRNE	Chemical, biological, radiological, nuclear, and explosive
CDA	Civil Defence Academy, Singapore, or Communicable Diseases Agency, Singapore
CDC	US Centers for Disease Control and Prevention, or Centre for Disease Control, Malaysia
CHS	Johns Hopkins Center for Health Security
CII	Critical Information Infrastructure
CIIP	Cambridge Industrial Innovation Policy
CNA	Channel NewsAsia
COVID-19	Coronavirus disease 2019
CPR	Cardiopulmonary resuscitation
CRISPR	Clustered regularly interspaced short palindromic repeats
CSA	Cyber Security Agency of Singapore
CSCAP	Council for Security Cooperation in the Asia-Pacific
CSF	Classical swine fever
cVDPV1	Type 1 circulating vaccine-derived poliovirus
DAH	Department of Animal Health, Vietnam
DBN 2.0	National Biotechnology Policy 2.0
DCAF	Geneva Centre for Security Sector Governance, or Geneva Centre for the Democratic Control of Armed Forces
DFAT	Australian Government Department of Foreign Affairs and Trade
DIKES	*Dinas Kesehatan* or Health Agency, Indonesia
DIKNAS	*Dinas Pendidikan* or Education Agency, Indonesia
DINSOS	*Dinas Sosial* or Social Service Agency, Indonesia
DiseaseX	The next infectious disease with pandemic potential
DISKOMINFO	*Dinas Komunikasi dan Informatika* or Communication and Information Agency, Indonesia
DIYbio	Do-It-Yourself Biology
DLF	Department of Livestock and Fisheries, Laos
DMR	Department of Medical Research, Myanmar
DNA	Deoxyribonucleic acid
DOH	Department of Health, the Philippines
DOJ	Department of Justice, the Philippines
DOST	Department of Science and Technology, the Philippines
DSO	Defence Science Organisation, Singapore
DUR	Dual-use research
DURC	Dual-use research of concern
EBS	Event-based surveillance
EDB	Singapore Economic Development Board
EID	Emerging infectious disease
EID/REID	Emerging/re-emerging infectious disease

EIU	Economist Intelligence Unit
EU	European Union
EU CBRN CoE	EU CBRN Risk Mitigation Centres of Excellence
FAO	Food and Agriculture Organization of the United Nations
FAS	Foreign Agricultural Service, US
FBI	Federal Bureau of Investigation, US, or Federal Bureau of Investigation, Malaysia
FMD	Foot and mouth disease
FMDV	Foot and mouth diseases virus
GDPM	General Department of Preventive Medicine, Vietnam
GEF	Global Environment Facility
GHS	Global Health Security
GHS Index	Global Health Security Index
GI-TOC	Global Initiative against Transnational Organized Crime
GLASS	Global Antimicrobial Resistance Surveillance System
GMAC	Genetic Modification Advisory Committee, Singapore
GMO	Genetically modified organism
GMS	Greater Mekong Subregion
GNET	Global Network on Extremism & Technology
GoF	Gain-of-function
H1N1	Influenza A virus subtype H1N1
H2N2	Influenza A virus subtype H2N2
H5N1	Influenza A virus subtype H5N1
H5N6	Influenza A virus subtype H5N6
HHP	Human Health and Potential
HHS	US Department of Health and Human Service
HIV	Human immunodeficiency virus
HKS	Harvard Kennedy School
HKU-PRP	University of Hong Kong-Pasteur Research Pole
HPAI	Highly pathogenic avian influenza
HTX	Home Team Science and Technology Agency, Singapore
IBBC	Institutional biosafety and biosecurity committee
IBC	Institutional biosafety committee
IBP	ISO Browsing Platform
IBS	Indicator-based surveillance
ICA	Immigration & Checkpoints Authority, Singapore
ICRC	International Committee of the Red Cross
IED	Improvised explosive device
IFRC	International Federation of Red Cross and Red Crescent Societies
IFRC-DREF	IFRC Disaster Response Emergency Fund
IHME	Institute for Health Metrics and Evaluation, US
IHR	International Health Regulations 2005, WHO
ILI	Influenza-like illness
INP (or POLRI)	*Kepolisian Negara Republik Indonesia* or Indonesian National Police
INTERPOL	International Criminal Police Organization
IPA	Infrastructure Protection Act 2017, Singapore
IPB University	*Institut Pertanian Bogor*, Indonesia
IQA	Indonesian Quarantine Agency, Indonesia

iSIKHNAS	*Sistem Informasi Kesehatan Hewan Nasional* or National Information System on Animal Husbandry, Indonesia
ISIS	Islamic State of Iraq and Syria
ISO	International Organization for Standardization
ISU	BWC Implementation Support Unit
ITA	International Trade Administration
IWT	Illegal wildlife trafficking
JAKIM	Islamic Development Authority of Malaysia
Jembrana	Jembrana disease virus
KADINKES	*Kepala Dinas Kesehatan* or Head of the Health Agency, Indonesia
KAPOLDA	*Kepala Kepolisian Daerah* or Regional Chief of Police, Indonesia
KESBANGPOL	*Badan Kesatuan Bangsa dan Politik* or National Unity and Politics Agency, Indonesia
KKH PRG	*Komisi Keamanan Hayati Produk Rekayasa Genetik* or Biosafety Commission of Genetically Engineered Product, Indonesia
KOMINFO	*Kementrian Komunikasi dan Informatika* or Ministry of Communication and Information Technology, Indonesia
KOREM	*Komando Resor Militer* or Military Resort Command, Indonesia
KPK	*Komisi Pemberantasan Korupsi* or Indonesian Commission for the Elimination of Corruption
Laos	Lao People's Democratic Republic (LPDR)
LBM	WHO Laboratory Biosafety Manual
LMO	Living modified organism
LOMWRU	Lao-Oxford-Mahosot Hospital-Wellcome Trust Research Unit
LPAI	Low pathogenic avian influenza
LSD	Lumpy skin disease
MABIC	Malaysian Biotechnology Information Centre
MARD	Ministry of Agriculture and Rural Development, Vietnam
MBBA	Malaysian Biosafety and Biosecurity Association
MBT	Mitigation of Biological Threats
MHA	Ministry of Home Affairs, Singapore
MINDEF	Ministry of Defence, Malaysia, or Ministry of Defence, Singapore
MIPR	Ministry of Industry and Primary Resources, Brunei
MISTI	Ministry of Industry, Science, Technology & Innovation, Cambodia
MND	Ministry of National Defence, Vietnam
MOALI	Ministry of Agriculture, Livestock and Irrigation, Myanmar
MoFA	Ministry of Foreign Affairs, Indonesia
MoH	Ministry of Health, Laos
MOH	Ministry of Health, Singapore
MOHS	Ministry of Health and Sports, Myanmar
MOIC	Ministry of Industry and Commerce, Laos
MoINT	Ministry of Interior, Cambodia
MOOTW	Military Operations Other Than War
MoPH	Ministry of Public Health, Thailand
MORU	Mahidol Oxford Tropical Medicine Research Unit
Mpox	Monkeypox
MPS	Ministry of Public Security, Laos
MRF	Medical Response Force, Singapore
MST	Ministry of Science and Technology, Vietnam

MTCR	The Missile Technology Control Regime
MTI	Ministry of Trade and Industry, Singapore
NACW	National Authority for the Prohibition of CBRN Weapons, or National Authority of Chemical Weapons, Cambodia
NAP	CBRN National Action Plan, Cambodia
NDCP	National Dengue Control Programme, Cambodia
NEA	National Environment Agency, Singapore
NIH	National Institutes of Health, the Philippines
NIHE	National Institute of Hygiene and Epidemiology, Vietnam
NIHRD	National Institute of Health Research and Development, Indonesia
NHL	National Health Laboratory, Myanmar
NParks	National Parks Board, Singapore
NRC	United States National Research Council
NRF	National Research Foundation, Singapore
NSC	National Security Council, the Philippines
NSG	The Nuclear Suppliers Group
NSTDA	National Science and Technology Development Agency, Thailand
NTC	National Tuberculosis Centre
NTCBB	National Training Center for Biosafety and Biosecurity, the Philippines
NTD	Neglected tropical disease
NTS Centre	Non-Traditional Security Studies, Singapore
NTT	East Nusa Tenggara/Nusa Tenggara Timur/East Southeast Islands, Indonesia
OH	One Health
OHO	One Health Office, Singapore
PATA	Pathogens and Animal Toxins Act 2015, Thailand
PATH	Program for Appropriate Technology in Health (1980–2014); now, simply PATH
PAVN (or VPA)	People's Army of Vietnam or Vietnam People's Army
PGA	Parliamentarians for Global Action
PHEIC	Public Health Emergencies of International Concern
PLBN	*Pos Lintas Batas Negara* or Cross-Border Posts, Indonesia
PMBU	Prime Minister Bodyguard Unit, Cambodia
PMI	*Palang Merah Indonesia* or Indonesian Red Cross Society
PNAS	Proceedings of the National Academy of Sciences of the United States of America
POLPP	*Satuan Polisi Pramong Praja* or Municipal Police, Indonesia
POLRI (or INP)	*Kepolisian Negara Republik Indonesia* or Indonesian National Police
PRC	People's Republic of China
PRG	*Produk Rekayasa Genetik* or genetically engineered product, Indonesia
PRISMA-2	Australia-Indonesia Partnership for Rural Incomes through Support for Markets in Agriculture, Phase 2
PUB	Public Utilities Board or National Water Agency, Singapore
RAHO	Regional Animal Health Office, Vietnam
RAI	Regional Artemisinin-resistance Initiative
R&D	Research and development
RDI	Resilience Development Initiative
REID	Re-emerging infectious disease
RIE2025	Research, Innovation and Enterprise 2025 plan, Singapore
RIRN	National Research Master Plan 2017, Indonesia

RISTEKDIKTI	Ministry of Research, Technology, and Higher Education, Indonesia
RSIS	S. Rajaratnam School of International Studies, Singapore
RTP	Royal Thai Police
SAF	Singapore Armed Forces
SARI	Severe acute respiratory infection
SARS	Severe acute respiratory syndrome
SARS-CoV-2 virus	Severe acute respiratory syndrome coronavirus 2
SCDF	Singapore Civil Defence Force
SEA Games	Southeast Asian Games
SEALAB	South-East Asia Lab Network
SEAOHUN	Southeast Asia One Health University Network
SFA	Singapore Food Agency
SGCA	Strategic Goods (Control) Act 2002, Singapore
SLORC	State Law and Order Restoration Council, Myanmar
SSO	Singapore Statutes Online
SSR	Security Sector Reform
STEM	Science, technology, engineering, and mathematics
STI	Sexually transmitted infection
STI 2030	Science, Technology and Innovation Roadmap 2030, Cambodia
STMA	Strategic Trade Management Act, the Philippines
STRIDE	Malaysian Science & Technology Research Institute for Defence
TB	Tuberculosis
The Terrestrial Code or TAHC	WOAH Terrestrial Animal Health Code
TNI	*Tentara Nasional Indonesia* or Indonesian National Armed Forces
UGMO	Unauthorised genetically modified organism
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICRI	United Nations Interregional Crime and Justice Research Institute
UNIDIR	United Nations Institute for Disarmament Research
UNODA	United Nations Office for Disarmament Affairs
UNOPS	United Nations Office for Project Services
UP	University of the Philippines
USDA	US Department of Agriculture
VAST	Vietnam Academy of Science and Technology
VERTIC	Verification Research, Training and Information Centre
WA	The Wassenaar Arrangement
WBG	The World Bank Group
WGS	Whole genome sequencing
WHO	World Health Organization
WMD	Weapons of mass destruction
WOAH	World Organization for Animal Health
WTO	World Trade Organization
WWF	World Wildlife Fund
XDR	Extensively drug-resistant

GLOSSARY OF TERMS

Accident	An unintended occurrence that results in harm, such as infection, illness, or injury, in humans, non-human animals, plants and agriculture, or contamination of the environment.[1]
Agrobioterrorism	The deliberate release of biological agents, in particular, plant or animal pathogens, to cause devastating disease in plants and animals in the agricultural sectors and, thereby, disrupt or destroy the agricultural industry and/or food supply system of a population. The intent may be to intimidate or coerce governments or civilian populations, so as to further economic, political, social, or other objectives.[2]
Biocrime	The intentional use of biological agents against a specific individual.[3]
Biological agent	A microorganism, virus, biological toxin, particle, or otherwise infectious material, either naturally occurring or genetically modified, which may have the potential to cause infection, allergy, or toxicity, or otherwise create a hazard to humans, non-human animals, or plants.[4]
Biological diversity (Biodiversity)	The variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are a part; this includes diversity within species, between species, and of ecosystems.[5]
Biological weapons	Biological and toxin weapons are either microorganisms, such as viruses, bacteria, or fungi, or toxic substances produced by living organisms that are produced and released deliberately to cause disease and death in humans, non-human animals, or plants.[6]
Biorisk	The probability or chance that an event caused by accident, or the inadvertent or deliberate misuse of the life sciences can adversely affect the health of humans, non-human animals, plants and agriculture, and the environment.[7]
Biorisk management	An integrated, overarching approach to address the risks associated with the life sciences research enterprise, from accidents and inadvertent actions to deliberate misuse. Biorisk management relies on three core pillars — biosafety, laboratory biosecurity, and the oversight of dual-use research (DUR). It involves the quantitative or qualitative forecasting and evaluation of the probability of harm occurring and its subsequent consequences (risk assessment), together with the identification and implementation of technologies, measures, or practices to avoid or minimise their likelihood or impact (risk mitigation).[8]

[1] World Health Organization (WHO). *Global Guidance Framework for the Responsible Use of the Life Sciences: Mitigating Biorisks and Governing Dual-use Research*. Geneva: WHO, 2022. pp. xviii.

[2] Team synthesis, following: (i) definition of agroterrorism in International Standards Organisation (ISO). "Terms and Definitions," item 3. In *Intelligent Transport Systems*, ISO 26683-3:2019(E). ISO Browsing Platform (IBP), 2019; and (ii) definition of agrobioterrorism in World Organization for Animal Health (WOAH). "Agro-crime and Agro-terrorism." Accessed 8 September 2024. www.woah.org/en/what-we-offer/emergency-preparedness/agro-crime-and-agro-terrorism/.

[3] Oliveira, Manuela, et al. "Biowarfare, Bioterrorism and Biocrime: A Historical Overview on Microbial Harmful Applications." *Forensic Science International* 314 (September 2020): 110366. Doi:10.1016/j.forsciint.2020.110366.

[4] WHO. *Global Guidance Framework*. pp. xviii.

[5] Ibid. pp. xviii.

[6] World Health Organization (WHO). "Biological Weapons." Accessed 8 September 2024. www.who.int/health-topics/biological-weapons#tab=tab_1.

[7] WHO. *Global Guidance Framework*. pp. xviii.

[8] Ibid. pp. xviii.

Biosafety	Containment principles, technologies, measures, and practices that are implemented to prevent unintentional exposure to biological agents or their inadvertent release.[9]
Biosecurity	Principles, technologies, measures, and practices that are implemented for the protection, control, and accountability of biological agents, data, or equipment, biotechnologies, skills, and information related to their handling. Biosecurity aims to prevent their unauthorised access, loss, theft, misuse, diversion, or release.[10]
Biosecurity threats/biological threats	Threats from biological agents that can be harmful to humans.[11]
Biotechnology	The integration of new techniques emerging from modern biotechnology with the well-established approaches of traditional biotechnology. It is a set of enabling techniques for bringing about specific human-made changes in deoxyribonucleic acid (DNA) or genetic material in plants, animals, and microbial systems, leading to useful products and technologies.[12]
Bioterrorism	Bioterrorism refers to the intentional release of biological agents or toxins for the purpose of harming or killing humans, animals, or plants, with the intent to intimidate or coerce a government or civilian population to further political or social objectives.[13]
Confidence-building measure (CBM)	Planned procedure to prevent hostilities, to avert escalation, to reduce military tension, and to build mutual trust between countries. In the context of biosecurity, the objective of confidence-building measures (CBMs) is to prevent or reduce the occurrence of ambiguities, doubts, and suspicions, and to improve international cooperation in the field of peaceful biological activities.[14]
Cyberbiosecurity	Developing understanding of the vulnerabilities to unwanted surveillance, intrusions, and malicious and harmful activities, which can occur within or at the interfaces of co-mingled life sciences, cyber, cyber-physical, supply chain, and infrastructure systems, and developing and instituting measures to prevent, protect against, mitigate, investigate, and attribute such threats, as it pertains to security, competitiveness, and resilience.[15]
Deliberate act/misuse	Malicious acts with the intention to cause harm. The scope includes traditional chemical, biological, and radionuclear agents and emerging threats, such as cyberattacks and disinformation campaigns.[16]
Dual-use	Knowledge, information, methods, products, or technologies generated by peaceful and legitimate research that may be appropriated for non-peaceful or harmful purposes.[17]

[9] Ibid. pp. xix.
[10] Ibid. pp. xix.
[11] Definition synthesised by the team for the purposes of this report.
[12] United Nations (UN). "Sustainable Development Topics." Accessed 8 September 2024. www.un.org/esa/sustdev/sdissues/biotechnology/biot.htm.
[13] INTERPOL. "Bioterrorism." Accessed 8 September 2024. www.interpol.int/en/Crimes/Terrorism/Bioterrorism.
[14] United Nations (UN). "Confidence Building Measures." Accessed 8 September 2024. https://disarmament.unoda.org/biological-weapons/confidence-building-measures/.
[15] Richardson, Lauren C., et al. "Cyberbiosecurity: A Call for Cooperation in a New Threat Landscape." *Frontiers in Bioengineering and Biotechnology* 7 (2019). Doi:10.3389/fbioe.2019.00099. www.ncbi.nlm.nih.gov/pmc/articles/PMC6562220/.
[16] World Health Organization (WHO). "Deliberate Events." Accessed 8 September 2024. www.who.int/news-room/fact-sheets/detail/deliberate-events.
[17] WHO. *Global Guidance Framework*. pp. xix.

Dual-use research (DUR)	Research conducted for peaceful and beneficial purposes that has the potential to produce knowledge, information, methods, products, or technologies that could also be intentionally misused to endanger the health of humans, non-human animals, plants and agriculture, and the environment. In the context of this framework, it refers to work in the life sciences, but the principles are also applicable to other scientific fields.[18]
Dual-use research of concern (DURC)	Dual-use research of concern (DURC) describes research that is conducted for peaceful and beneficial purposes but could easily be misapplied to do harm with no, or only minor, modification. This term has generally been used for research in the life sciences. DURC covers everything from information to specific products that can create negative consequences for the health of humans, non-human animals, plants and agriculture, and the environment.[19]
Emerging infectious disease (EID)	A new disease that is affecting a population for the first time, or an existing disease that is rapidly spreading geographically or affecting an increasing number of people.[20]
Gain-of-function (GoF) research	Research that results in the acquisition of new biological phenotypes, or an enhancement of existing phenotypes. Gain-of-function (GoF) research that is anticipated to enhance the transmissibility or virulence (or both) of potential pandemic pathogens raises significant biosafety and biosecurity risks, as well as dual-use concerns that may warrant additional oversight.[21]
Global health security (GHS)	The multisectoral activities required, both proactive and reactive, to minimise the risk of public health events that endanger the health of humans, non-human animals, plants and agriculture, and the environment across national boundaries, geographical regions, and generations.[22]
Governance	The norms, values, and rules of the processes through which public affairs are managed, so as to ensure transparency, participation, inclusivity, and responsiveness. Governance also represents the structures and processes that are designed to ensure accountability, transparency, responsiveness, and adherence to the rule of law, stability, equity and inclusiveness, empowerment, and broad-based participation.[23]
Hazard	An object, situation, or information that has the potential to cause harm to humans, non-human animals, plants and agriculture, or the environment. A hazard does not become a 'risk' until the likelihood and consequences of that hazard causing harm are taken into account.[24]
Incident	An occurrence that has the potential to cause, or results in, the exposure of laboratory personnel to biological agents or the release of those agents into the environment, which may or may not lead to actual harm.[25]

[18] Ibid. pp. xx.
[19] Ibid. pp. xx.
[20] World Health Organization (WHO). "Glossary of Terms." In *A Brief Guide to Emerging Infectious Diseases and Zoonoses*. New Delhi: WHO, 2014.
[21] WHO. *Global Guidance Framework*. pp. xx.
[22] Ibid. pp. xx.
[23] Ibid. pp. xxi.
[24] Ibid. pp. xxi.
[25] Ibid. pp. xxi.

Laboratory Accident	Unintended occurrences in laboratories that result in harm, such as infection, illness or injury in humans, nonhuman animals, plants and agriculture, or contamination of the environment.[26]
Life sciences	All sciences that deal with living organisms, including humans, non-human animals, plants and agriculture, and the environment, or products of living organisms, or that incorporate components derived directly or synthetically from living organisms; the life sciences include, but are not limited to, biology, biotechnology, genomics, proteomics, bioinformatics, and pharmaceutical and biomedical research and technologies.[27]
Misinformation	Information that is false, but not intended to cause harm. Determining the veracity of information or misinformation relies on assessing the state of evidence and expert consensus on the topic. The person disseminating it may believe it to be true. It involves two dimensions — intentionality (harm/benefit, as variously defined), and knowing or not knowing that the content is false. It is not about opinion because that cannot be fact-checked.[28]
One Health (OH)	An integrated, unifying approach that aims to sustainably balance and optimise the health of people, animals, and ecosystems. It recognises that the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and interdependent. The approach mobilises multiple sectors, disciplines, and communities, at varying levels of society, to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy, and air, as well as safe and nutritious food, taking action on climate change, and contributing to sustainable development.[29]
Pathogen	An infectious agent (a germ) that is capable of causing disease in a human, animal, or plant host.[30]
Re-emerging infectious disease (REID)	An infectious disease that is increasing in prevalence in an area where it was previously absent or controlled.[31]
Risk	A combination of the probability of harm occurring and the severity (consequences) of that harm, if it were to occur.[32]
Risk assessment	A systematic process — quantitative or qualitative — of gathering information and evaluating the nature, probability, and magnitude of potential harms, and determining the appropriate control measures to minimise or otherwise mitigate the risks.[33]
Risk management	The quantitative or qualitative forecasting and evaluation of the probability of harm occurring and subsequent consequences (risk assessment), together with the identification and implementation of technologies, measures, or practices to avoid or minimise their likelihood or impact (risk mitigation).[34]
Risk perception	The subjective judgement(s) about the severity of a risk that accounts for the experiences of individuals in different contexts. These risks may include natural

[26] Ibid. pp. xviii.
[27] Ibid. pp. xxi.
[28] Ibid. pp. xxii.
[29] Ibid. pp. xxii.
[30] Ibid. pp. xxii.
[31] WHO. "Glossary of Terms." In *A Brief Guide*. pp. 97.
[32] WHO. *Global Guidance Framework*. pp. xxii.
[33] Ibid. pp. xxiii.
[34] Ibid. pp. xxiii.

	or man-made biological threats, such as pandemics, bioterrorism, or accidental release of harmful biological agents.[35]
Security sector	The structures, institutions, and personnel responsible for security provision, management, and oversight at national and local levels. The security sector includes both actors that use force and those responsible for controlling how force is used through management and oversight.[36]
Stakeholders	Persons or groups that have an interest in a policy or activity. They include scientists, the scientific community, ethics committee members, institutional and repository managers, biosafety officers, funding bodies, publishers, editors, security officials, regulators, institutional and other authorities, civil society networks, the private sector, other relevant organisations, and publics.[37]
Zoonosis/zoonotic disease	An infectious disease that has jumped from a non-human animal to humans. Zoonotic pathogens may be bacterial, viral, or parasitic, or may involve unconventional agents, and can spread to humans through direct contact or through food, water, or the environment.[38]

[35] Yin, Jason Dean-Chen, and Juliana Nga-Man Lui. "Factors Influencing Risk Perception during Public Health Emergencies of International Concern (PHEIC): A Scoping Review." *BMC Public Health* 24 (2024). Doi:10.1186/s12889-024-18832-z. www.ncbi.nlm.nih.gov/pmc/articles/PMC11110302/.

[36] DCAF – Geneva Centre for Security Sector Governance. "The Security Sector." *SSR Backgrounder Series* Geneva: DCAF, 2015. pp. 2.

[37] WHO. *Global Guidance Framework*. pp. xxiii.

[38] World Health Organization (WHO). "Zoonoses." Accessed 29 July 2020. www.who.int/news-room/fact-sheets/detail/zoonoses.

INTRODUCTION

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In Southeast Asia, porous borders are closely associated with transnational security challenges, including environmental degradation, irregular migration, and smuggling and human trafficking of women and children. Against a rapidly changing environment, the concept of security has evolved, further encompassing not only traditional human security challenges but also unseen threats. One such novel threat comes from lethal biological diseases, pathogens, toxins, and weapons, also collectively referred to as 'biosecurity threats.'

Unlike in the West, where biosecurity is primarily focused on the proliferation of biological weapons and bioterrorism,[1] in the Asia Pacific, particularly Southeast Asia, biosecurity originated as a critical component of national health strategies aimed at combating infectious diseases within a country's borders. Its initial focus was on preventing the spread of diseases that could affect human populations, animals, and plants. Over time, the concept of biosecurity has evolved to cover a broader spectrum of protective measures, acknowledging the interconnectedness of human, animal, and environmental health (One Health; OH), and the potential for disease transmission across species and borders. The 2003 severe acute respiratory syndrome (SARS) epidemic, which caused over 750 deaths in Indonesia, Malaysia, the Philippines, and Singapore,[2] highlighted the region's vulnerability to these infectious diseases.[3] The epidemic initiated discussions on pandemic preparedness and health security. Although not explicitly highlighted, biosecurity was an integral part of the broader conversation.

However, because of conflicting priorities, lack of awareness, and resource constraints, the focus on biosecurity waned years after the 2003 SARS epidemic. It continued to be discussed among professionals, experts, and other stakeholders, but this did not result in any significant policy development. It was not until the coronavirus disease 2019 (COVID-19) pandemic, with its higher impacts and casualties, that discussions on biosecurity were revived in Southeast Asia. The impact of the 2019 pandemic on the discourse and prioritisation of biosecurity is evident in several ways, as it highlighted the — (i) critical role of laboratory capacity in public health surveillance and research; (ii) threats posed by dual-use research of concern (DURC) and gain-of-function (GoF) studies; (iii) potential for laboratories to be sources of biological agents; and (iv) concerns about cyberbiosecurity.[4]

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[1] Renault, Veronique, Marie-France Humblet, and Claude Saegerman. "Biosecurity Concept: Origins, Evolution and Perspectives." *Animal (Basel)* 12, no. 1 (2022). Doi:10.3390/ani12010063. www.ncbi.nlm.nih.gov/pmc/articles/PMC8749630/.

[2] Cicero, Anita, et al. "Southeast Asia Strategic Multilateral Dialogue on Biosecurity." *Emerging Infectious Diseases* 25, no. 5 (2019): e181659. Doi:10.3201/eid2505.181659. https://stacks.cdc.gov/view/cdc/79356/cdc_79356_DS1.pdf.

[3] Ibid.

[4] Shearer, Matthew P. *Southeast Asia Strategic Multilateral Biosecurity Dialogue: With Participation from Indonesia, Malaysia, the Philippines, Singapore, and Thailand*. Johns Hopkins Center for Health Security (CHS), February 2021. Accessed 8 October 2024. https://centerforhealthsecurity.org/sites/default/files/2023-01/20210623-southeastasiastrategicmultibiosecuritydialogue.pdf.

The rapid development of biotechnology has spurred increased discussions on biosecurity, as it brings significant advancements and new capabilities to various fields, including medicine, agriculture, and environmental science. These advancements, while beneficial, also pose potential risks if not properly managed, as they involve manipulating biological materials that could be harmful, if misused or accidentally released. For instance, the 2001 anthrax attacks in the United States,[5] whereby the postal system was leveraged as a means of distributing *Bacillus anthracis* or anthrax spores, served as a glaring example for the importance of establishing and maintaining robust biosecurity mechanisms; lessons from this incident need to be heeded in Southeast Asia as well.

In addition to the developments in conventional biotechnology, the global movement of Do-It-Yourself Biology (DIYbio) is contributing to heightened biosecurity awareness. This trend involves amateurs, enthusiasts, students, and trained scientists working outside traditional scientific institutions.[6] While DIYbio promotes innovation and democratises scientific research, it undoubtedly raises new biosafety and biosecurity concerns, including the potential misuse of biological materials by individuals who lack the necessary training and oversight.[7]

In the 2024 ASEAN (Association of Southeast Asian Nations) Leaders' Declaration on Strengthening Regional Biosafety and Biosecurity, the ASEAN Member States (AMS) made a collective call for the need to "ensure the provision of necessary human resources for biosafety and biosecurity in a sustainable manner through training, education and certification for all relevant personnel."[8] Such declaration recognises that "potential weaknesses in biosafety and biosecurity can give rise to accidental or deliberate pathogen release and misuse in securing, handling, and manipulating high-risk pathogens and associated data, especially in our region where member states have varying levels of capacities and legal instruments…."[9]

This new declaration from ASEAN leaders highlights the growing importance of strengthening biosecurity alongside biosafety in Southeast Asia. It serves as a strong foundation for enhancing regional collaboration on biosafety and biosecurity, both among AMS and with dialogue partners and international organisations, as discussed in this report.

Amid the recent advancements in biosecurity, the main objective of this report is to provide an overview of the biosecurity landscape in Southeast Asia. The analysis is guided by five major questions:

[5] Hughes, James M., and Julie L. Gerberding. "Anthrax Bioterrorism: Lessons Learned and Future Directions." *Emerging Infectious Diseases* 8, no. 10 (2002). Doi:10.3201/eid0810.020466.

[6] World Health Organization (WHO). "Laboratory Biosecurity Guidance." June 2024. Accessed 8 October 2024. https://internationalbiosafety.org/who-laboratory- biosecurity-guidance-2024/.

[7] Sundaram, Lalitha S. "Biosafety in DIY-bio Laboratories: From Hype to Policy." *EMBO Reports* 22, no. 4 (2021): e52506. Doi:10.15252/embr.202152506. www.ncbi.nlm.nih.gov/pmc/articles/PMC8024987/.

[8] Association of Southeast Asian Nations (ASEAN). "ASEAN Leaders' Declaration on Strengthening Regional Biosafety and Biosecurity." Vientiane, Lao PDR, 9 October 2024. Accessed 5 December 2025. https://asean.org/asean-leaders-declaration-on-strengthening-regional-biosafety-and-biosecurity/.

[9] Ibid.

- *How* has the concept and definition of biosecurity evolved over time in each Southeast Asian country?
- *What* are the primary biological threats, concerns, and risks for each country in the region?
- *What* are the key biosafety and biosecurity policies and responses in Southeast Asia?
- *What* are the key challenges to biosecurity governance in Southeast Asia?
- *How* can AMS strengthen biosecurity governance and cooperation?

This report examines the evolution of the concept and definition of biosecurity over time in Southeast Asian countries. It assesses the varying perceptions of biosecurity threats, which include emerging and re-emerging diseases, DURC, accidental release of biological agents, and the deliberate misuse of biological materials or bioterrorism. Research findings draw from field research interviews conducted with biosecurity experts in Indonesia, Thailand, Malaysia, the Philippines, Singapore, Vietnam, and Cambodia between March 2024 and January 2025. These are supplemented by a comprehensive review of related literature covering Brunei Darussalam, Lao People's Democratic Republic (Lao PDR; or, Laos henceforth), and Myanmar, as well as national statements delivered by AMS' permanent representatives at United Nations (UN)-organised review conferences and meetings on the Biological Weapons Convention (BWC).

The report is structured as follows: Chapter 1 serves as an introduction to the study, providing an overview of the biosecurity landscape in Southeast Asia. It delves into the evolving field of biosecurity, outlining adopted definitions and the biosecurity risks perceived by Southeast Asian nations. Chapters 2, 3, and 4 are dedicated to case studies, with a focus on Singapore in Chapter 2 and Indonesia in Chapter 3, followed by Cambodia, Myanmar, Laos, and Vietnam in Chapter 4. Finally, Chapter 5 presents recommendations for pathways to enhance regional cooperation in biosecurity governance.

CHAPTER I

BIOSECURITY: AN EVOLVING FIELD WITH DIVERSE AND EMERGING PRIORITIES

Mely Caballero-Anthony, Julius Cesar Trajano, Jose Ma. Luis Montesclaros, and Jeselyn

Globally recognised definitions of biosecurity, established by major international organisations, such as the World Health Organization (WHO), Food and Agriculture Organization (FAO), and World Organization for Animal Health (WOAH), provide a foundational understanding it. These definitions emphasise various aspects of biosecurity, including the protection of public health, laboratories, animals, and the environment from biological threats.

WHO's definition of biosecurity focuses heavily on laboratory biosecurity and defines it as "policies, principles, technologies and practices implemented for the protection and control of and accountability for biological material, technology, and information or the equipment, methods, skills and data related to their handling."[1] It aims to prevent the loss, theft, misuse, diversion, or intentional release of biological agents being handled in laboratories.[2] This definition is primarily laboratory-focused because laboratories are key environments, where high-risk biological agents are handled, researched, and stored. This focus also aligns with WHO's mandate to protect global public health and to prevent the spread of communicable diseases.

The FAO and WOAH define biosecurity in ways that align with their specific mandates. The FAO refers to biosecurity as "a strategic and integrated approach to analyse and manage risks in food safety, animal and plant life and health."[3] In contrast, biosecurity is defined by the WOAH Terrestrial Animal Health Code (the Terrestrial Code or TAHC), as "a set of management and physical measures designed to reduce the risk of introduction, establishment and spread of animal diseases, infections or infestations to, from and within an animal population."[4]

The differing priorities reflected in the definitions adopted by these global organisations bring both advantages and disadvantages in dealing with catastrophic biological events. The diverse definitions ensure comprehensive coverage of various aspects of biosecurity, including human health, animal health, and agricultural safety. They also offer opportunities for specialisation, leading to more detailed and effective strategies within specific domains, and tailored responses. However, these differing definitions

[1] WHO. "Laboratory Biosecurity Guidance." pp. xiii.

[2] World Health Organization (WHO). "Laboratory Biosafety Manual, 4th edition." and associated monographs. December 2020. Accessed 8 October 2024. www.who.int/publications/i/item/9789240011311.

[3] Food and Agriculture Organization of the United Nations (FAO). "Food Safety and Quality: Biosecurity." n.d. Accessed 8 October 2024. www.fao.org/food/food- safety-quality/a-z-index/biosecurity/en/.

[4] Bellini, Silvia. "Application of Biosecurity in Different Production Systems at Individual, Country and Regional Levels." World Organization for Animal Health (WAOH), 2018. Accessed 8 October 2025. www.woah.org/app/uploads/2021/03/2018-eur1-bellini-a.pdf.

Fragmented and differing definitions and priorities on biosecurity can hinder a unified response to catastrophic biological events.

also come with significant disadvantages. Some of the more obvious issues are the fragmentation of efforts and lack of coordination among organisations, which hinder a unified response to catastrophic biological events. This fragmentation can result in inconsistent policies and practices, complicating international cooperation. Resource allocation is another major concern, as some areas might receive more attention and funding while others are neglected, potentially leaving critical vulnerabilities unaddressed.

While the term 'biosecurity' has become more widespread, certain institutions may still opt to substitute it with the term 'biosafety.' It is noteworthy that, compared to biosecurity, biosafety is a more well-established concept, with widely accepted definitions and international guidelines for implementation at the national level.[5] The WHO Laboratory Biosafety Manual (LBM), for example, defines biosafety as "containment principles, technologies and practices that are implemented to prevent unintentional exposure to biological agents or their inadvertent release,"[6] thus focusing more on the safe procedures involved in managing biological materials, especially infectious agents. In this manual, WHO emphasises that laboratory biosafety forms the foundation for establishing laboratory biosecurity.[7] The manual strongly urges WHO Member States to assess the safety of their laboratories, enact safety initiatives, improve adherence to fundamental guidelines, and promote training efforts.[8] In fact, some scholars suggest that, while biosafety and biosecurity share many common concepts and are, sometimes, used interchangeably, they are not entirely identical terms. The United States National Research Council (NRC) summarises these differences as, "biosafety is about protecting people from bad 'bugs'; biosecurity is about protecting 'bugs' from bad people."[9]

Brief Overview of Biosecurity Definitions Adopted in This Report

In this report, we consider 'biological threats' and 'biosecurity threats' *interchangeably*, as representing threats from biological agents that can be harmful to humans. We follow WHO's definition of 'biological agents' in its *Global Guidance Framework for the Responsible Use of the Life Sciences: Mitigating Biorisks and Governing Dual-use Research* (hereafter, *Global Guidance Framework*), as "a microorganism, virus, biological toxin, particle or otherwise infectious material, either naturally occurring or genetically modified, which may have the potential to cause infection, allergy, toxicity or otherwise create a hazard

[5] United Nations Office for Disarmament Affairs (UNODA). "Biosafety and Biosecurity: Meeting of the States Parties to the Convention on the Prohibition of the Development, Production, and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction." Resolution, BWC/MSP/2008/MX/INF.1. 2 December 2008. Accessed 8 October 2024. https://digitallibrary.un.org/record/636795?ln=en.

[6] WHO. "Laboratory Biosafety Manual." pp. x.

[7] Ibid. pp. 83.

[8] Ibid. pp. 83.

[9] Beeckman, Delphine S. A., and Patrick Rudelsheim. "Biosafety and Biosecurity in Containment: A Regulatory Overview." *Policy and Practice Reviews* 8, no. 650 (2020): 2.

to humans, nonhuman animals or plants."[10] WHO's 2014 guide to emerging infectious diseases (EIDs) and zoonoses also considers that "different pathogen classes include viruses, bacteria, fungi and prions,"[11] and that a 'pathogen', is "an infectious agent (a germ) that is capable of causing disease in a human, animal or plant host."[12]

Given these definitions, our coverage of biosecurity/biological threats encompasses risks of emerging/re-emerging infectious diseases (EIDs/REIDs), laboratory accidents, biotech/dual-use research of concern (DURC), and deliberate/bioterrorism, that may cause harm to humans. Each of these are defined, as follows:

- Under the first category of biosecurity threats, namely EIDs/REIDs, we define an EID as "a new disease that is affecting a population for the first time, or an existing disease that is rapidly spreading geographically or affecting an increasing number of people," while an REID is "an infectious disease that is increasing in prevalence in an area where it was previously absent or controlled," building on WHO's guide to EIDs and zoonoses.[13] A key source of novel EIDs are zoonotic diseases, or "diseases that are transferable between animals and humans, and vice versa."[14]

- Under the second category, we define 'laboratory accidents' as "*unintended occurrences in laboratories* that result in harm, such as infection, illness or injury in humans, nonhuman animals, plants and agriculture, or contamination of the environment,"[15] building on WHO's 2022 *Global Guidance Framework* definition. These occur within containment laboratories that are "designated facilities established for the handling and investigation of infectious agents or toxins."[16] Containment laboratories are classified into four levels, ranging from biosafety level (BSL) 1 to 4 (BSL1–BSL4), whereby the categorisation is primarily based on the types of microorganisms they study and the associated level of risk, or the 'risk groups,' of these microorganisms. There are four risk groups based on factors, such as the transmissibility, severity, and origin of the studied microorganisms.[17] The BSL classifications and risk groups are illustrated below (Table 1).

[10] WHO. "Glossary of Terms." In *Global Guidance Framework*. pp. xviii.

[11] WHO. "Glossary of Terms." In *A Brief Guide*. pp. 96.

[12] Ibid. pp. 96.

[13] Ibid. pp. 97.

[14] Ibid. pp. 97.

[15] WHO. "Glossary of Terms." In *Global Guidance Framework*. pp. xviii.

[16] WHO. "Laboratory Biosecurity Guidance." pp. xvi.

[17] Jeselyn. "Biosafety Labs in Asia." *NTS Fast Facts* March 2024. Accessed 11 September 2024. www.rsis.edu.sg/wp-content/uploads/2024/04/fastFacts-Biosecurity-2024.pdf.

Table 1. Risk grouping and corresponding biosafety levels (BSL) of containment laboratories of microorganisms.

Risk Group 1 (BSL1 and BSL2)	Risk Group 2 (BSL2 and BSL3)	Risk Group 3 (BSL3)	Risk Group 4 (BSL3+ and BSL4)
Pathogens that are unlikely to cause human or animal disease – *Escherichia coli* K-12, chickenpox	Pathogens that have the capability to inflict diseases in both humans and animals, but do not pose a significant threat to scientists, the community, livestock, or the environment – *Mycobacterium*, *Salmonella*, *Streptococcus pneumoniae*	Pathogens that have the potential to cause serious diseases in both humans and animals, but typically do not transmit easily from one infected individual to another – influenza virus H1N1, H2N2, H5N1, *Bacillus anthracis* (anthrax bacteria)	Pathogens with the capacity to cause significant diseases in humans or animals, and can easily spread from one individual to another – Ebola, Lassa fever, Marburg virus

Abbreviations: H1N1: influenza A virus subtype H1N1; H2N2: influenza A virus subtype H2N2; H5N1: influenza A virus subtype H5N1
Source: Jeselyn. "Biosafety Labs in Asia." *NTS Fast Facts* March 2024. Accessed 11 September 2024. www.rsis.edu.sg/wp-content/uploads/2024/04/fastFacts-Biosecurity-2024.pdf.

- The third category we refer to is related to DURC, which, based on WHO's 2022 *Global Guidance Framework*,

  > "describes research that is conducted for peaceful and beneficial purposes, but could easily be misapplied to do harm with no, or only minor, modification;" "generally (…) used for research in the life sciences;" "encompasses everything from information to specific products that have the potential to create negative consequences for health of humans, nonhuman animals, plants and agriculture, and the environment."[18]

  One of the potential ways by which DURC can have negative impacts is through gain-of-function research, defined as "[r]esearch that results in the acquisition of new biological phenotypes, or an enhancement of existing phenotypes," which may include enhancement of "the transmissibility or virulence (or both) of potential pandemic pathogens."[19]

- Under the fourth category, we define 'bioterrorism' as "the intentional release of biological agents or toxins for the purpose of harming or killing humans, animals or plants with the intent to intimidate or coerce a government or civilian population to further political or social

[18] WHO. "Glossary of Terms." In *Global Guidance Framework*. pp. xx.
[19] Ibid. pp. xx.

objectives," following the definition by the International Criminal Police Organization (INTERPOL).[20]

Given our expansive definition of biosecurity threats, we scope our consideration of 'biorisk' to 'human biorisk,' in particular, "the probability or chance that a biosecurity/biological threat can adversely affect the health of humans."[21] This builds on WHO's earlier definition of biorisk, while being narrowed down to humans, and, in this report, we only consider further effects on animals, plants and agriculture, and the environment to the extent that these are harmful to humans.

Assessing Biosecurity Risk Perceptions in Southeast Asian Countries

Following the definitions above, the table below indicates the ranking of biosecurity risk perceptions in Southeast Asia, based on our interviews with experts in seven ASEAN countries, namely Cambodia, Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam; while, for Brunei, Laos, and Myanmar, assessments were based on preliminary reviews of existing reports, pending interviews with national experts (Table 2). The prioritisation of biosecurity risks is ranked as high, moderate and low levels.

Table 2. Summary of biosecurity risk perceptions in Southeast Asia.

Country	EIDs/REIDs	Laboratory Accidents	Biotechnology/DURC	Deliberate Misuse/Bioterrorism
Brunei*	High	Low	Low	Low
Cambodia†	High	Low	Low	Low
Indonesia†	High	Moderate	High	Low
Laos*	High	Moderate	Moderate	Low
Malaysia†	High	High	Low	Moderate
Myanmar*	High	Moderate	Low	Low
The Philippines†	High	High	Moderate	Moderate
Singapore†	High	Low	Low	Moderate
Thailand†	High	Low		Low
Vietnam†	High	Low	Moderate	Low

Abbreviations: DURC: dual-use research of concern; EIDs/REIDs: emerging/re-emerging infectious diseases

*Risk perceptions for Brunei, Laos, and Myanmar were only based on literature review.

†Based on the risk perceptions of biosecurity experts and officials interviewed by the authors in each Southeast Asian country.

[20] INTERPOL, *Bioterrorism Incident Pre-planning & Response Guide*. 2nd ed. INTERPOL Bioterrorism Prevention Programme, 2010, 10.

[21] WHO. "Glossary of Terms." In *Global Guidance Framework*. pp. xviii.

Some risks are perceived to be low/moderate because of established health and security regulations that can mitigate or prevent them, but this does not imply that these states completely disregard such risks.

The table shows that, based on interviews and literature reviews, experts ranked: (i) risk of EIDs highest across all countries; (ii) risk of laboratory accidents as high in Malaysia and the Philippines, moderate in Indonesia, Myanmar, and Laos, and low in Thailand, Singapore, Vietnam, and Cambodia; (iii) perception on DURC within the biotechnology industry/research clusters as high risk in Indonesia, moderate risk in the Philippines, Vietnam, and Laos, low in Malaysia, Singapore, Myanmar, and Cambodia, and less significant in Thailand; (iv) perception on deliberate misuse/bioterrorism as moderate risk in Malaysia, the Philippines, and Singapore, but low in other Southeast Asian countries.

It must be noted that risks, such as bioterrorism or laboratory accidents, are perceived to be low/moderate because of established health and security systems and regulations that can mitigate or prevent them, but this is not to imply that these states completely disregard such risks.

Understanding Risks from National Perspectives

Emerging and Re-Emerging Infectious Diseases

Reflecting the growing importance of EIDs/REIDs at the regional level, our interviews reveal that these diseases are of significant concern in all seven Southeast Asian countries, where interviews were conducted.

The recent COVID-19 pandemic revealed the vulnerabilities of all countries affected, showing that diseases can severely debilitate lives, livelihoods, and economies at large. As such, all countries recognise the risk of diseases being 'imported' through international travel, learning from the COVID-19 pandemic experience. In fact, all countries have set up additional structures for centralising control of the pandemic.

In the archipelagic countries of Indonesia and the Philippines, a primary concern is monitoring the emergence and re-emergence of diseases that may arise from their rich biodiversity, or enter through sea or air travel routes. Within Indonesia, four new pathogens have crossed its borders over the past four years, primarily through international air and sea travel routes. These are COVID-19, African swine fever (ASF), foot and mouth disease (FMD), and lumpy skin disease (LSD).[22] In the case of the Philippines, there is also concern over the potential for zoonosis, or the transmission of diseases from animals to humans, as a result of environmental perturbation and increased interactions between

[22] Interview with an Indonesian biosecurity expert, Bogor, Indonesia, 13 March 2024.

humans and wildlife. Experts have noted that animal and human health have become closely connected, owing to more frequent human-wildlife interaction.

Climate change plays an important role in zoonosis, given that shifts in the climate and weather patterns can trigger climate-induced animal movements and habitat changes, thus calling for greater attention to facing up to climate-induced zoonotic threats.[23] A recent study found that even in a "below 2°C" global warming scenario, there would still be more than 300,000 new interactions among different species of wildlife, and 15,000 transmission events across species heading up to 2070.[24] This translates practically to 300 new transmission events per year, or in the range of 5–6 events per week. Faster rates of movement observed in bats is a key driver for new first encounters.[25]

Another concern is the potential for wildlife crimes through illegal wildlife trafficking (IWT). The importance of illegal wildlife trafficking was noted in an earlier report by the Global Initiative against Transnational Organized Crime (GI-TOC), highlighting that "fragile environments are placed under enormous pressure, and this intensifies the emergence and spread of zoonotic infections, as well as other biological threats."[26] Areas with higher wildlife biodiversity also make for richer breeding grounds for EIDs.[27]

Illegal wildlife trafficking intensifies the emergence and spread of zoonotic infections, as well as other biological threats.

Our field interviews have supported the concern of countries over the movement of animals that can carry zoonotic diseases and the migration of people that can bring imported viruses. In the case of Thailand, which shares land borders with multiple countries (Myanmar, Laos, Cambodia, and Malaysia), the threat of land border entry of such diseases was highlighted.[28] One of the examples is the March 2024 anthrax threat on the Laos-Thailand border, which impacted 54 persons in Thailand and led to 65 suspected cases in Laos, initially traced to an infection in buffalo.[29] Similarly, in Malaysia, which shares borders with Thailand, Indonesia, and Brunei, significant attention is given to the 'gazettement' or protection of natural areas of concern.

Like Thailand, Cambodia is very much concerned about imported infectious diseases that can come through its land borders with its neighbouring Mekong countries. The Cambodian government has urged local authorities along border provinces to step up efforts for monitoring and preventing the

[23] Montesclaros, Jose Ma. Luis, and Mely Caballero-Anthony. "Facing Up to Climate Change-induced Biosecurity Threats." *RSIS Commentaries* 9 January 2024.

[24] Carlson, Colin J., et al. "Climate Change Increases Cross-species Viral Transmission Risk." *Nature* 607, no. 7919 (2022): 555–62.

[25] Ibid.

[26] Global Initiative against Transnational Organized Crime (GI-TOC). "Guarding the Gates: Wildlife Crime and Biological Threats in the Mekong." *Organized Crime in The Mekong: Briefing Series* 2023: 55.

[27] Johnson, Christine K., et al. "Global Shifts in Mammalian Population Trends Reveal Key Predictors of Virus Spillover Risk." *Proceedings of the Royal Society B* 287, no. 1924 (2020): 20192736; Montesclaros and Caballero-Anthony. "Facing Up to Climate Change-induced Biosecurity Threats."

[28] Interview with a Thai legal expert, Bangkok, Thailand, 3 May 2024.

[29] AFP. "Thailand Sounds Alarm after Anthrax Outbreak in Laos." *The Straits Times*, March 28, 2024. Accessed 27 October 2025. www.straitstimes.com/asia/se-asia/thailand-sounds-alarm-after-anthrax-outbreak-in-laos.

spread of monkeypox (Mpox) and other infectious diseases, such as influenza A virus subtype H5N1 (H5N1) bird flu and anthrax. Cambodian public health experts have noted cases of anthrax infections in neighbouring countries and the wider region. However, information sharing on potential disease outbreaks from Cambodia's neighbours remains inadequate. Therefore, according to Cambodian health security experts, the country should expand its network of biolaboratories in the border provinces and enhance disease surveillance mechanisms along its land borders.[30]

Various diseases threaten the fragile public health system in Myanmar, some of which cross borders from neighbouring countries while others are endemic. Myanmar has a high prevalence of infectious diseases, with rates of HIV (human immunodeficiency virus) and tuberculosis (TB) being the second highest in Southeast Asia.[31] Furthermore, with its resource-scarce and frail health system and protracted internal conflicts, Myanmar has struggled with tropical diseases that have been eradicated in neighbouring countries in the Mekong subregion. The effects of communicable diseases are exacerbated by persistent underfunding of the public health system, as well as challenges, such as conflict, poverty, internal displacement, and irregular migration. Additionally, Myanmar's geolocation along migratory bird pathways and its proximity to emerging disease hotspots heighten its susceptibility to zoonotic epidemics and pandemics. In an unstable political climate, with a collapsing healthcare system, diseases that have been eliminated in recent years may return.[32] Until recently, the ability to diagnose and monitor these infectious diseases and epidemics was limited, and Myanmar had to rely on support from laboratories abroad.[33]

The effects of communicable diseases are exacerbated by persistent underfunding of the public healthcare system, as well as challenges, such as conflict, poverty, internal displacement, and irregular migration.

While most Southeast Asian countries have primarily focused on the threat of imported diseases, Vietnam has faced recurrent epizootics of avian influenza within its domestic poultry farms and live bird markets in recent years.[34] Compounding this challenge, limited financial resources have hindered farmers' access to education and training, leaving agricultural communities ill-equipped to effectively address and mitigate risks posed by livestock-borne diseases and environmental hazards.[35]

[30] Interview with Cambodian biosecurity and health security experts, Phnom Penh, 22–23 January 2025.

[31] PATH. "Eradicating Infectious Diseases in Myanmar." January 2019. Accessed 24 October 2025. https://media.path.org/documents/ID_FACTSHEET_Myanmar_Final_06092022_00ZdvdD.pdf.

[32] Swe, Myo Maung Maung, et al. "A Systematic Review of Neglected Tropical Diseases (NTDs) in Myanmar." *PLOS Neglected Tropical Diseases* 17, no. 11 (2023). Doi:10.1371/journal.pntd.0011706.

[33] Mérieux Foundation. "National Health Laboratory Project Launched in Myanmar." 27 September 2019. Accessed 24 October 2025. www.fondation-merieux.org/en/news/national-health-laboratory-project-launched-in-myanmar/.

[34] Dao, Duy Tung, et al. "High Prevalence of Highly Pathogenic Avian Influenza: A Virus in Vietnam's Live Bird Market." *Open Forum Infectious Diseases* 11, no. 7 (2024). Doi:10.1093/ofid/ofae355.

[35] Pechdin, Watchara, et al. "One Health in Agricultural Sectors in Thailand, Lao PDR, and Vietnam: Interconnectedness between Awareness and Socioeconomic Factors." *International Journal of Public Health* 69 (2024). Doi:10.3389/ijph.2024.1607088.

In Singapore, the risk of food-borne pathogens was highlighted as an important concern, given that more than 90 per cent of its food supplies are imported from overseas sources. The Singapore Food Agency (SFA) conducts safety checks for imported food, to guard against bacteria (e.g., *Salmonella*, *Listeria*, *Campylobacter*, gastroenteritis-causing bacteria, *Escherichia coli*, etc.). Similarly, in Malaysia, Indonesia, Vietnam, and the Philippines, there is notable concern over imported plant products that can threaten local ecosystems and agriculture. As agriculture-dependent countries, they have highlighted the risk of plant pathogens falling into the wrong hands and being used for agrobioterrorism. For instance, the Philippines has emphasised the need for stronger border security measures, including rigorous plant quarantine protocols to monitor all imported plant products. Meanwhile, in Malaysia, customs officers conduct thorough pre- and post-border inspections, particularly for imports from high-risk countries, to minimise potential threats.

Deliberate Misuse and Bioterrorism

Biological terrorism is a common concern for AMS. But, this concern appears to be expressed within the security sector alone.

In various meetings and conferences convened by the United Nations on the disarmament of weapons of mass destruction (WMDs) and BWC, AMS have consistently and strongly expressed their collective commitment to BWC as well as their concerns over the development and possible use of biological weapons by non-state actors.[36] Biological terrorism is a common concern for AMS. But, this concern appears to be expressed within the security sector alone (i.e., "actors involved in the provision, management and oversight of security in a country,"[37] further elaborated in the Glossary of Terms) and articulated during meetings of the ASEAN Network of Chemical, Biological, Radiological and Nuclear (CBRN) experts, WMD as well as in BWC conferences of States Parties, but the level of concern is unlikely to be shared by civilian agencies. AMS has, nonetheless, called for enhanced international cooperation and information sharing to prevent terrorists and other non-state actors from developing, obtaining, and distributing biological weapons.[38]

[36] ASEAN Member States (AMS). "ASEAN Member States' Perspective on International Cooperation and Assistance under the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction (BWC)." Second Session of Working Group on the Strengthening of the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, Geneva, Switzerland, 7–18 August 2023. Accessed 24 October 2025. https://documents.un.org/doc/undoc/gen/g23/149/05/pdf/g2314905.pdf?token=MQloRcTgTTlQkudf8V&fe=true.

[37] DCAF. "The Security Sector." pp. 2.

[38] Ibid.

Despite the lower risk perception of bioterrorism in the region, experts argue it remains a serious threat requiring government attention.

While most Southeast Asian countries have a low-risk perception of bioterrorism, in comparison to traditional biological threats, such as pandemics and EIDs/REIDs, experts in the region argued that bioterrorism is a serious threat that should not be ignored and must be considered a significant biosecurity threat requiring government attention. The potential for disruptions from intentional misuse should be taken very seriously, as it can have far-reaching consequences. Exposure to genetically modified or naturally occurring pathogens can lead to deaths, with severe and far-reaching implications, such as economic collapse and border closures. Yet, the malicious intent behind such acts often remains hidden. Bioterrorism is not limited to lab-created or imported biological agents; it is particularly challenging because it can involve naturally occurring toxins and other biological materials from natural environments.[39]

Even though the region has yet to experience a mass-casualty CBRN terror attack, Singapore views the potential for bioterrorism not as a question of 'if' but rather 'when.' Singapore's defence minister, Mr Heng Chee How, argued that terror movements and lone-wolf actors have contemplated on misusing biological agents, following an attempt in 2019 by a pro-Islamic State Jamaat Ansharud Daulah cell to use abrin-filled explosives.[40] Indonesian authorities had foiled the said planned biological attack.[41] Indonesia's law enforcement agencies, such as the National Counter Terrorism Agency (BNPT) and State Intelligence Agency (BIN), acknowledged that the potential threat of bioterrorism in Indonesia exists *albeit* on a 'manageable'[42] scale. Even if biological agents can be easily sold and purchased in the absence of strict regulatory requirements,[43] the perception among some Indonesian security sector experts interviewed is that terrorist groups have limited capacity to weaponise these materials.[44]

Malaysia has expressed the need to prevent malicious and terrorist organisations from developing or acquiring biological weapons in its annual national statements at United Nations (UN) WMD disarmament meetings.[45] For instance, agrobioterrorism, particularly deliberate contamination of food and water sources, presents a serious threat to Malaysia, given that there has been an attempt by a

[39] Interview with Philippine biosecurity experts, Manila, the Philippines, 13 June 2024; interview with Indonesian biosecurity experts, Bogor, Indonesia, 13 March 2024.

[40] Ministry of Defence (MOD) of Singapore. "Speech by Senior Minister of State for Defence, Mr Heng Chee How, for the ADMM-Plus Chemical, Biological and Radiological Conference at Shangri-La Hotel." Singapore, 11 October 2022. Accessed 13 December 2025. https://www.mindef.gov.sg/news-and-events/latest-releases/11oct22_speech/.

[41] Ibid.

[42] Interview with an Indonesian biosecurity expert, Jakarta, Indonesia, 13 March 2024.

[43] Ma'aliya, Naila, et al. "Strategy for Treating Bioterrorism Threats in Indonesia Post Pandemic COVID-19." *International Journal of Humanities Education and Social Sciences* 2, no. 5 (2023). Doi:10.55227/ijhess.v2i5.384. Accessed 27 October 2025. https://ijhess.com/index.php/ijhess/article/view/384/372.

[44] Interview with Indonesian biosecurity experts, Jakarta, Indonesia, 11 March 2024.

[45] Permanent Mission of Malaysia to the United Nations (UN). "Statement (1C-ASEAN): Combined Clusters 1-4, 12 October 2021." Accessed 24 October 2025. www.kln.gov.my/web/usa_un-new-york/news-from-mission/-/blogs/9161739; H.E. Mr. Ahmad Faisal Muhamad. "Statement by the Head of Malaysian Delegation at the General Debate of the Ninth Review Conference of the States Parties to the Biological Weapons Convention." 29 November 2022. Geneva, Malaysia. Accessed 27 October 2025. https://docs-library.unoda.org/Biological_Weapons_Convention_-_Ninth_Review_Conference_(2022)/Malaysia.pdf.

militant group to use biological agents.[46] Concern over the deliberate sabotage of their food supply chain using biological agents was shared by experts from Singapore, the Philippines and Indonesia.[47]

While Thailand has also considered the threat of bioterrorism, it is currently not a top priority. Nonetheless, in its national statement at the Ninth Review Conference of BWC, Thailand stated that, even if the development of biotechnologies for peaceful purposes is encouraged by BWC, the same technologies have also increased the risk of non-state actors acquiring and misusing biological weapons.[48]

The risk of bioterrorism and deliberate use of biological weapons is considered to be low by Cambodian and Vietnamese biosecurity experts.[49] Although the nefarious use of biological materials could occur, this scenario is assessed in both countries to be relatively unlikely in the near term. Both, Cambodia and Vietnam, are not a hotbed of terrorism and internal armed conflicts, which limits the likelihood of bioterrorism. Furthermore, for Cambodian security experts, the country's biological facilities and laboratories only maintain generally low-risk pathogens and non-communicable biological agents that would not yield biological weapons.[50] Nonetheless, both nations are aware of the growing global concerns over the threat of bioterrorism, and national experts, therefore, claim that this threat cannot be completely discounted.[51,52]

Although the experts' risk perception of bioterrorism is currently moderate in the Philippines, the security situation in Mindanao (southern Philippines) provides potential training grounds for terror groups using biological materials.[53] For the security sector, bioterrorism is a key biosecurity concern, as expressed by the National Security Council (NSC) and Anti-Terrorism Council (ATC).[54] Security experts warned that terror groups in Mindanao have been trying to recruit university students, especially those in the science, technology, engineering, and mathematics (STEM) courses. There are concerns in universities that students enrolled in these science courses can have access to hazardous biological materials.[55] The porous security situation in the region provides potential training grounds for such activities. To enhance law enforcement awareness concerning bioterrorism, the National Training Center for Biosafety and Biosecurity (NTCBB) at the National Institutes of Health (NIH), University of

[46] Interview with a Malaysian chemical, biological, radiological and nuclear (CBRN) weapons expert, Zoom, Singapore, 30 May 2024.

[47] Interview with a Singapore biosecurity expert, Singapore, 15 July 2024; interview with Philippine CBRN experts, Quezon City, the Philippines, 11 June 2024; interview with an Indonesian biosecurity expert, Jakarta, 13 March 2024.

[48] Permanent Representative of Thailand to UN Geneva. "Thailand's National Statement at the Ninth Review Conference of the Biological Weapons Convention." Geneva, Thailand. Accessed 5 December 2025. https://docs-library.unoda.org/Biological_Weapons_Convention_-_Ninth_Review_Conference_(2022)/Thailand.pdf.

[49] Interview with Cambodian biosecurity experts, Phnom Penh, Cambodia, 21 January 2025.

[50] Interview with Cambodian biosecurity experts, Phnom Penh, Cambodia, 22 January 2025.

[51] Ibid; National Authority for the Prohibition of Chemical, Nuclear, Biological and Radiological Weapons (NACW) of the Kingdom of Cambodia. "CBRN National Action Plan." Phnom Penh: NACW, 2017.

[52] Interview with Vietnamese biosecurity experts, Singapore, 13 November 2024.

[53] Interview with Philippine biosecurity experts, Manila, 13 June 2024.

[54] Interview with Philippine security experts, Quezon City, the Philippines, 11 June 2024.

[55] Interview with Philippine biosecurity experts, Manila, 13 June 2024.

the Philippines (UP) Manila as well as the BioRisk Association of the Philippines (BRAP) have been conducting training sessions and awareness workshops for various stakeholders, including universities, laboratory personnel, local governments, and security sector bodies.

Advances in Biotechnology and Dual-Use Research of Concern

Biosecurity experts from several Southeast Asian countries expressed concerns over emerging and new forms of biotechnology.[56] In the early 1990s, Southeast Asia was only focusing on regulating the utilisation of genetically modified organisms (GMOs), which are a product of biotechnology and being used in food production. Eventually, countries in the region were able to develop biosafety regulation on biotechnology, with a special focus on GMOs. Experts pointed out that GMOs can be used as a platform for bioterrorism and biocrime. The malicious genetic editing of seeds in agriculture can make them harmful, as these can be used for agrobioterrorism through the unauthorised planting of GMO seeds, with the intent to cause damage. The inability to detect unauthorised GMOs (UGMOs) creates an entry point for the distribution of GMO-based weapons. Concerns over GMOs remain prevalent in most Southeast Asian countries. However, the biotechnology sector in the region has evolved beyond GMO development into a diverse and growing industry, spanning healthcare and industrial applications. The risks now stem from the potential dual-use applications of modern biotechnologies.

Countries, such as Singapore, Thailand, Indonesia, and Vietnam, are leading the way in biotechnology. Several state-led initiatives, spearheaded by national science and technology research agencies, have been introduced in recent years primarily to boost biotechnology research and development (R&D), often through collaborations with industry partners.[57] Governments are trying to institutionalise a more balanced regulatory climate for the biotechnology sector to encourage private sector innovations in a secure and responsible manner. Concern arises from the fear that some rapid innovations may create loopholes that may be exploited by dangerous people, damaging the environment and people's health.

Current technologies are unable to precisely trace molecular scars left by genetic modifications associated with gene editing technologies (e.g., CRISPR). It is hard to distinguish genetically modified organisms and pathogens from naturally occurring ones.

However, biotechnology-related biosecurity threats, particularly those associated with gene-editing technologies, such as CRISPR (short for clustered regularly interspaced short palindromic repeats), present significant challenges. One major issue is the current inability of current technologies to precisely trace molecular scars left by genetic modifications. This makes it

[56] Interview with an Indonesian biosecurity expert, Jakarta, Indonesia, 12 March 2024; interview with a Malaysian biosecurity expert, Kuala Lumpur, Malaysia, 20 May 2024; interview with Filipino CBRN experts, Quezon City, 11 June 2024.

[57] Interview with Indonesian biosecurity experts, Jakarta, Indonesia, 12 March 2024; interview with a Singapore biotechnology expert, Singapore, 3 October 2024; interview with Thai biotechnology legal experts, Bangkok, Thailand, 3 May 2024.

difficult to determine whether an organism or a pathogen has been genetically modified or is naturally occurring.

In Southeast Asia, the state of biotechnological development varies from country to country, leading to different challenges and gaps. Indonesia's biotechnological development was rarely a national priority given the country's low ranking in Asia in terms of human resources and R&D in biotechnology.[58] The government's reluctance to engage in biotechnological development is partly due to the controversies surrounding biotechnology products, and the misinformation and disinformation campaigns suggesting they are unsafe to consume or use. Additionally, biotechnology products are often seen as being dominated by multinational corporations from Western countries, a sentiment that is not commonly welcome among local communities.[59] The same issue is faced in the Philippines; although the country is known for championing biotechnology development, it too faces resistance from advocacy groups (mostly environment related) against the use of GMOs.[60] This challenge makes the commercialisation of biotechnologically engineered products particularly difficult.[61]

Indonesia's lack of prioritisation of biotechnological developments does not mean that these are not a concern, though. The secretive nature of big pharmaceutical companies, which possess the technology to conduct gain-of-function research, makes it more difficult to regulate them.[62] By not sharing vaccine formulae and restricting information exchanges, these companies create 'economic dependency,' wherein governments are dependent and beholden to companies for their specialised products. This secrecy and lack of transparency have made it more challenging to regulate the biotechnology industry in Indonesia, resulting in an increased risk of misuse.[63]

Oversight of DURC in Southeast Asia also remains inconsistent, with varying levels of institutional involvement, level of awareness among researchers, and regulatory frameworks.

Malaysia launched the National Biotechnology Policy 2.0 in September 2022, aiming to further develop the national biotechnology industry and transform Malaysia into a progressive, prosperous, inclusive, and sustainable high-tech bioinnovation nation by 2030.[64] However, it has similarly experienced pushback from certain interest groups against the use of GMOs in some

[58] There are only 90 researchers per million population, which is in stark contrast when compared to neighbouring countries, such as Singapore and Malaysia, that bring in 6,729 and 2,274 researchers, respectively. Muna, Ayesha Nadya. "Indonesia Left Behind in Biotech, HigherHeight Aims at Human Resources." *The Jakarta Post*, October 22, 2022. Accessed 24 October 2025. www.thejakartapost.com/business/2022/10/22/indonesia-left-behind-in-biotech-higherheight-aims-at-human-resources.html.

[59] Siregar, Hermanto, and Bustanul Arifin. "Challenges for Sustainable Agricultural Biotechnology Development in Indonesia." *Asian Journal of Agriculture and Development* 7, no. 2 (2010): 22. Accessed 22 September 2025. https://ajad.searca.org/article?p=163.

[60] Interview with a Philippine biotechnology expert, Metro Manila, the Philippines, 11 June 2024.

[61] de la Cruz, Reynaldo E. "Philippines: Challenges, Opportunities, and Constraints in Agricultural Biotechnology." *CGSpace*. Accessed 14 July 2024. https://cgspace.cgiar.org/bitstreams/6c1f8d32-2d2d-4553-8996-d42339cd99c7/download.

[62]Interview with biosecurity experts in Indonesia, Bogor, Indonesia, 14 March 2024.

[63] Interview with a biosecurity expert in Indonesia, Depok, Indonesia, 13 March 2024.

[64] Akademi Sains. "National Biotechnology Policy 2.0 (NBP 2.0)." Accessed 14 July 2024. www.akademisains.gov.my/ar21/national-biotechnology-policy-2-0-nbp-2-0/.

agricultural sectors.[65] Additionally, the lack of resources in Malaysia has resulted in limited commercial production of biotechnologically or genetically engineered products. Some experts even argued that government policies on biotechnology in Malaysia are insufficient and unable to keep pace with the rapid advancements in the field and that, contrary to popular belief, the biotech industry desires regulation, as it provides funding and collaboration opportunities.[66]

Despite the limited biotechnology sector in the country, the government of Laos has implemented a legal framework for biotechnology, the Biotechnology Safety Law of 2014,[67] though it is mainly focused on the use of GMOs.

Unlike countries where the population is less receptive to biotechnology, Thailand and Singapore have embraced biotechnological development for decades. In Thailand, the National Center for Genetic Engineering and Biotechnology (BIOTEC) plays a crucial role in supporting and transferring technology for the development of industry, agriculture, natural resources, and the environment, thereby enhancing the social and economic well-being of the Thai people.[68] The Thai government managed to secure support from its people by giving tax incentives, grants, and subsidies for R&D activities. It has also simplified the regulatory processes to promote technology transfer.[69] In Singapore, support for biotechnological development is evident in the sector's substantial market size, which reached SGD823.5 billion in 2021, with an expected annual growth rate of 8.0 per cent. Currently, there are 52 biotech companies, projected to increase to 84 by 2032.[70]

Meanwhile, other Southeast Asian countries, such as Cambodia, Laos, and Myanmar, have become aware of biosecurity issues with modern biotechnologies. However, their capacity to develop policy frameworks and technical guidelines on biotechnology have yet to be crafted, as they only have a very small biotechnology sector. Experts from Cambodia have noted that the security implications of biotechnologies — such as, CRISPR, genetic engineering, synthetic biology, and artificial intelligence (AI)-enabled cyberbiosecurity — are currently too advanced for the country to address. As a result, it is not a present concern.[71]

[65] The Islamic Development Authority of Malaysia (JAKIM), for example, opposes the production and development of animal biotechnology products for the purpose of consumption in Malaysia. Wahab, G. A., and Chris P. Rittgers. "Malaysia: Agricultural Biotechnology Annual." *USDA FAS Report* 2012.

[66] Interview with an expert in Malaysia (Malaysian Biotechnology Information Centre [MABIC]), Kuala Lumpur, Malaysia, 21 May 2024.

[67] Government of Lao PDR. "Biotechnology Safety Law 2014." 28 January 2014. Accessed 27 October 2025. www.vertic.org/wp-content/uploads/2022/04/LA_Biotechnology-safety-law.pdf.

[68] National Center for Genetic Engineering and Biotechnology (BIOTEC). "Overview: National Center for Genetic Engineering and Biotechnology." n.d. www.biotec.or.th/home/en/overview-en/.

[69] Cao, Jeremy. "How Thai Biotech Is Thriving with Innovations." *BGI*, June 1, 2024. Accessed 24 October 2025. www.bgi.com/global/news/advancing-thai-biotech-and-enhancing-health-outcomes-biospectrumasia.

[70] International Trade Administration (ITA). "Singapore Biotechnology." Accessed 15 July 2024. www.trade.gov/market- intelligence/singapore-biotechnology#:~:text=The%20Singapore%20biotechnology%20market%20size,to%2084%20firms%20by%202032.

[71] Interview, Cambodian biosecurity experts, Phnom Penh, 22 January 2025.

Dual-Use Research of Concern Governance

DURC refers to research intended for beneficial purposes, but with the potential to be misapplied, thus posing a threat to the health of the public, animals, and the environment.[72] In Southeast Asia, research that eventually gets categorised as DURC was initially conducted for good purposes. However, limited awareness among researchers regarding dual-use implications remains a recurring challenge across the region. This lack of awareness is largely attributed to the absence of comprehensive biosafety and biosecurity legislation, inconsistent implementation of relevant policies,[73] and the varying capacities of institutional biosafety committees (IBCs) responsible for assessing dual-use risks.[74] IBCs, if its members have comprehensive biosecurity training, play a crucial role in managing biosecurity risks, including DURC in Southeast Asia.

In Indonesia, IBCs are underdeveloped or absent in many research institutions. While some large universities have IBCs, their scope is usually limited to basic biosafety concerns, and they often lack the biosecurity training or guidelines to assess DURC potential. This gap leaves Indonesia's research institutions vulnerable to the misuse of dual-use technologies. An expert in Indonesia noted that "life scientists and researchers are not aware that their research might already have DURC elements, underlining the need for a more robust and informed IBC framework to address this issue effectively."[75]

IBCs are also not mandatory in Malaysia, and it is estimated that only 30 per cent of public universities have one established. The Malaysia Laboratory Biosafety and Biosecurity Policy and Guideline 2015, Ministry of Health Malaysia, encourages institutions to establish IBCs to oversee research activities.[76] Even where IBCs exist, they often face challenges due to a lack of specialised biosecurity knowledge on DURC and lengthy approval processes. Research proposals can take months to be reviewed, which could delay the identification of potential dual-use risks.[77] The reliance on voluntary compliance, coupled with limited institutional capacity, hinders timely intervention in research with possible dual-use implications.

The Philippines has a similar system, where the establishment of these committees are encouraged in laboratories and universities, but are not legally mandatory. The Department of Health has issued, in 2023, the Manual of Laboratory Biosafety and Biosecurity Standards that serves as a reference document

[72] World Health Organization (WHO). "What Is Dual-use Research of Concern?" 13 December 2020. Accessed 24 October 2025. www.who.int/news-room/questions-and- answers/item/what-is-dual-use-research-of-concern.

[73] Interview with experts in Indonesia (National Research and Innovation Agency [BRIN], IPB University), Jakarta and Bogor, Indonesia, 11–14 March 2024.

[74] Interview, experts in Indonesia (BRIN, IPB University), Jakarta and Bogor, 11–14 March 2024; interview with an expert in Malaysia (Universiti Malaya), Kuala Lumpur, Malaysia, 20 May 2024.

[75] Interview with an Indonesian biosecurity expert, Bogor, Indonesia, 14 March 2024.

[76] World Health Organization (WHO) and World Organisation for Animal Health (WOAH). "A Virtual Dialogue between Animal Health and Public Health Experts on Dual-use Research: Meeting Report, 14 March 2023." Accessed 24 October 2025. https://iris.who.int/bitstream/handle/10665/372842/9789240076273-eng.pdf.

[77] Interview with a Malaysian biosecurity expert, Kuala Lumpur, Malaysia, 21 May 2024.

to update local laboratory biosafety and biosecurity guidance.[78] However, this guideline does not extend to the oversight of DURC or related research activities, leaving a gap in managing dual-use risks domestically. High-containment laboratories and large universities in the country are able to establish IBCs to review and approve research involving high-risk pathogens. However, Philippine laboratory biosecurity experts claimed that "the lack of IBCs in smaller universities located especially in provinces and peripheral regions creates security gaps, as these institutions are less likely to detect and address DURC risks."[79]

Meanwhile, Section 28 of Thailand's Pathogens and Animal Toxins Act 2015 (PATA) mandates that agencies conducting research establish biosafety control committees, providing a clearer regulatory framework for overseeing research involving sensitive biological agents.[80] Additionally, the 2018 notification of the Ministry of Public Health's Book 135, Special Section 43 Ngor, also requires annual reporting on research activities, which contributes to more structured oversight but does not specifically address DURC.[81]

There is limited publicly available information on the issue of DURC in Vietnam. However, a subject matter expert has indicated that the Ministry of Health and Ministry of Science and Technology (MST) are primarily responsible for governing DURC-related matters.[82] The General Department of Preventive Medicine (GDPM) under the Ministry of Health has its own DURC oversight committee, and it is legally mandated for institutions conducting research to establish IBCs. Additionally, this department oversees other divisions within the health ministry, as well as universities, to develop relevant regulations.[83]

In Brunei's case, while it has a BWC implementing law alongside an infectious diseases law that contains a list of controlled biological agents and toxins, a key weakness found is the lack of information available within publicly available sources on how the country oversees life sciences-related DURC. Data is scarce on whether government oversight reviews DURC and whether there are institutional reviews in place for DURC.[84]

Such scarcity of information is also observed in Myanmar. While there is some evidence of oversight of research for animal diseases by the Ministry of Agriculture, Livestock and Irrigation (MOALI), there is no evidence of a comprehensive assessment on on-going research for DUR. Health

[78] Department of Health (DOH) of the Philippines. *Laboratory Biosafety and Biosecurity Standards*. Manila: DOH, 2023.

[79] Interview with Philippine biosecurity experts, Paranaque City, Metro Manila, the Philippines, 13 June 2024.

[80] Kingdom of Thailand. "Pathogens and Animal Toxins Act, 2015." Accessed 24 October 2025. www.tm.mahidol.ac.th/research/Biosafety/PathogensAndToxinsACT_EN.pdf.

[81] Global Health Security (GHS) Index. "Country Score Justifications and References: Thailand." 2021. https://ghsindex.org/wp-content/uploads/2021/12/Thailand.pdf.

[82] Interview with a Vietnamese biosecurity expert, Singapore, 18 December 2024.

[83] Ibid.

[84] United Nations Institute for Disarmament Research (UNIDIR) and Verification Research, Training and Information Centre (VERTIC). "Biological Weapons Convention National Implementation Measures Database: Brunei Darussalam." Accessed 14 February 2025. https://bwcimplementation.org/states/brunei-darussalam.

research on infectious diseases (mainly HIV/AIDS, malaria, TB, typhoid, and hepatitis) is conducted in military hospitals and medical research centres under the Ministry of Defence, as well as the Department of Medical Research (DMR) and medical universities under the Ministry of Health and Sports (MOHS). However, external evaluation found no information on DURC oversight and regulatory supervision on pathogen research.[85]

In Cambodia, the absence of national biosecurity guidelines is a key challenge to DURC governance. Specifically, Cambodia does not have a national policy requiring oversight of DUR, such as research with especially dangerous pathogens, toxins, and/or pathogens with pandemic potential. Nonetheless, local experts noted that Cambodian laboratories and universities do not have high-risk pathogens and do not perform highly sensitive biological research.[86] Universities and health research laboratories have advisory and review committees, similar to IBCs, to assess research proposals covering the biological sciences. These committees forward highly sensitive proposals to the biosafety committee of the Ministry of Health for evaluation and approval, or otherwise. Another key challenge is the lack of regular bioethics training for researchers, students, doctors, and laboratory technicians, which could enable greater awareness on issues, such as responsible science and DURC.[87]

Laos follows the regional trend of lacking a dedicated national biosecurity regulation to govern DURC. While the country lacks national regulations, a recently enacted 2023 Decree on the Management of Dual-use Goods includes provisions that address certain aspects of dual-use materials and technologies.[88] The decree does not cover DURC in institutions but only regulates the export and transit of dual-use goods, including licensing and brokering requirements. It designates the Ministry of Industry and Commerce (MOIC) as the coordinating body responsible for working with relevant ministries, organisations, and sectors to establish, revise, and periodically update the list of dual-use goods. While the decree includes a list of prohibited or regulated items, it does not yet specify any pathogens. Additionally, the ministry is tasked with overseeing the storage of these goods. The decree also outlines measures for enforcement, including rewards for compliance and penalties for violations. Under a separate law, the Committee for Biotechnology Safety Administration functions similarly to IBCs. It is responsible for the technical and academic oversight of biotechnology safety and the organisational implementation of related regulations. While the committee does not explicitly govern DURC, it plays a key role in overseeing biotechnology research and ensuring compliance with safety standards.[89]

[85] Global Health Security (GHS) Index. "Country Score Justifications and References: Myanmar." 2021. Accessed 24 October 2025. https://ghsindex.org/wp-content/uploads/2021/12/Myanmar.pdf.

[86] Interview with Cambodian biosecurity experts, Phnom Penh, Cambodia, 23 January 2025.

[87] NACW of the Kingdom of Cambodia. "CBRN National Action Plan."

[88] Government of Lao PDR. "Decree on the Management of Dual-use Goods: Lao PDR." 20 November 2023. Accessed 15 February 2025. www.laotradeportal.gov.la/upload/files/legal_20241227024839.pdf.

[89] Government of Lao PDR. "Biotechnology Safety Law 2014." Accessed 15 February 2025.

Singapore has a more structured approach, with the Biological Agents and Toxins Act 2005 (BATA),[90] as the main biosecurity law, requiring facility operators to establish a biosafety committee. These committees are responsible for ensuring that no research is conducted without risk assessment, ensuring a higher level of oversight for potential DURC activities.[91] Singapore's approach to DURC oversight is more established, relying on existing regulatory frameworks and collaborative efforts between multiple government agencies. The Genetic Modification Advisory Committee (GMAC), in coordination with agencies, such as Ministry of Health (MOH) and SFA, provides a robust system for assessing the potential risks of DURC in research involving GMOs, viruses, and toxins.[92] Singapore's BATA requires BSL3 laboratories to have IBCs that assess research proposals and recommend risk mitigation strategies, ensuring that dual-use risks are thoroughly reviewed and managed. This integrated, multi-agency approach places Singapore ahead, in terms of addressing DURC, within the region.[93]

A summary of IBC regulations in Southeast Asian countries is presented in Table 3.

Table 3. Summary of IBC regulations in Southeast Asia: Mandatory versus voluntary.

Country	Nature of Regulation		Governing Institutions/Ministries
	Mandatory	**Voluntary**	
Brunei	NA		
Cambodia	✓		Institutional committees, with members selected from relevant ministries (such as health; agriculture; forestry and fisheries; industry, science, technology and innovation; and National Authority for the Prohibition of CBRN Weapons (NACW)
Indonesia		✓	
Laos	✓		Committee for Biotechnology Safety Administration
Malaysia		✓	
Myanmar	NA		
The Philippines		✓	
Singapore	✓		Institutional committees and Genetic Modification

[90] Singapore Statutes Online (SSO). "Biological Agents and Toxins Act 2005." Accessed 2 December 2024. https://sso.agc.gov.sg/Act/BATA2005; interview with a Singapore biosecurity expert, Singapore, 15 July 2024.

[91] Ibid.

[92] Dao, et al. "High Prevalence of Highly Pathogenic Avian Influenza."

[93] Interview with a Singapore biosecurity expert, Singapore, 15 July 2024.

			Advisory Committee (GMAC)
Thailand	✓		Institutional committees and Ministry of Public Health (MoPH)
Vietnam	✓		General Department of Preventive Medicine (GDPM)

Abbreviations: CBRN: chemical, biological, radiological and nuclear; IBC: institutional biosafety committee; NA: not available; NACW: National Authority of Chemical Weapons

Laboratory Biosafety and Biosecurity

Most Southeast Asian countries have been transparent about the existence and operation of their national containment laboratories of various BSL categories (BSL1–BSL3), as well as their new plans to build additional laboratories. Such national facilities are publicly reported, including their health security-related functions. For instance, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Thailand, the Philippines, Singapore, and Vietnam operate BSL3 national containment laboratories.[94] They also have several BSL1 and BSL2 containment laboratories. There is currently no BSL4 laboratory in the region (for further information, please refer to Section 2.i).[95] Top research-intensive universities in several Southeast Asian countries have well-managed, international/ISO (for International Organization for Standardization)-certified and highly secure BSL3 laboratories.[96] A majority of these are run by medical schools, tertiary hospitals, and the public health training institutions of these universities, as well as by tropical medicine research institutes affiliated with government agencies, such as ministries of health. The not-for-profit organisation, Institut Pasteur, France, operates BSL3 laboratories in Cambodia, Laos, and Vietnam, playing a major role in life sciences and health research against EIDs (human/animal), in cooperation with national agencies in these Mekong countries.[97]

BSL3 laboratories in most of the countries in the region are heavily regulated, in the sense that they must be certified by health ministries, while the oversight of the activities of these laboratories is under the respective IBCs of the medical/educational institutions of which they are a part of. These institutions, in turn, create their respective localised guidelines on maintaining sufficient laboratory biosafety and biosecurity. Laboratories in Singapore and Thailand are governed by their respective national comprehensive biosecurity laws and national laboratory biosafety guidelines. Cambodia, Malaysia, the Philippines, Indonesia, Myanmar, and Vietnam, through their health ministries, have

[94] Interview with experts in Indonesia (BRIN, IPB University), Jakarta and Bogor, 11–14 March 2024; interview with an expert in Malaysia (Universiti Malaya), Kuala Lumpur, 20 May 2024; interview with an expert in Cambodia (Ministry of Health), Phnom Penh, Cambodia, 22 January 2025.

[95] Koh, Fabian. "Budget Debate: $90M to Be Spent on Singapore's First Top-level Biosafety Lab, to Be Operational by 2025." *The Straits Times*, March 1, 2025. www.straitstimes.com/singapore/politics/90-million-to-be-spent-on-singapores-first-top-level-biosafety-lab-to-be.

[96] Interview with experts in Indonesia (IPB University), Bogor, 14 March 2024.

[97] Interview with Cambodian biosecurity experts, Phnom Penh, 21 January 2025; Institut Pasteur du Laos. "Emergency Public Health Efforts of Institut Pasteur du Laos for COVID-19 Diagnostics." Accessed 10 February 2025. www.pasteur.la/emergency-public-health-efforts-of-institut-pasteur-du-laos-for-covid-19-diagnostics/.

promulgated national laboratory biosafety regulations,[98] even though they do not have their national biosecurity legislation enacted yet. Several biosecurity experts in the region interviewed by the team noted that such guidelines do not comprehensively include biosecurity guidelines, leaving a gap in laboratory governance.[99]

In terms of adopting international standards, while there is no general legislative framework that requires these laboratories to have annual international certification, it has been a norm across most ASEAN countries for their BSL3 containment laboratories to have annually updated international (re)certification, such as from ISO.[100]

Effective practices in high-containment research laboratories in the region (i.e., BSL3) make them more challenging targets for terror groups or insider threats seeking to steal biological agents. In contrast, hospital and diagnostic laboratories might be more vulnerable to biocrimes.

In biosecurity, a security culture is an assembly of beliefs, attitudes, and patterns of behaviour of individuals and organisations that can support and implement policies, practices, and norms intended to prevent the loss, theft, misuse, and diversion of biological agents.[101] Experts argue that, with effective practices established in high-containment research laboratories in the region (i.e., BSL3 laboratories), these facilities would not be easy targets for terror groups or insider threats seeking to steal biological agents.[102] In contrast, ordinary laboratories in hospitals, as well as clinical and diagnostic laboratories (i.e., where virus research is not conducted), might be more vulnerable to the theft of biological samples due to lack of biosecurity awareness and a lack of security culture.

Information security and cybersecurity breaches can result in unauthorised access to or loss of sensitive data, disruption of operations due to cyberattacks, and espionage targeting biosecurity-relevant information. Southeast Asian biosecurity experts have highlighted cyberbiosecurity attacks as an emerging deliberate biological threat that regional governments need to address.[103] Cyberbiosecurity aims to understand and address cyber risks engendered by the digitisation of biology. Such risks include, for example, embedding malware in deoxyribonucleic acid (DNA), corrupting gene sequencing, manipulating biomedical materials, hacking and unauthorised access to the cyber system of BSL laboratories, stealing epidemiological data, or even developing biological weapons and spreading diseases. Currently, it is not yet in the official security threat or cybersecurity threat policy strategies of

[98] Interview with an Indonesian biosecurity expert, Bogor, 13 March 2024; interview with Philippine biosecurity experts, Metro Manila, the Philippines, 13 June 2024; interview with a Singapore biosecurity expert, Singapore, 20 June 2024.

[99] Ibid.

[100] Interview with an Indonesian biosecurity expert, Depok, 13 March 2024; interview with a Philippine biosecurity experts, Metro Manila, 13 June 2024; interview, Singapore biosecurity expert, Singapore, 20 June 2024.

[101] Interview with a Philippine biosecurity expert, Manila, 13 June 2024; interview with an Indonesian biosecurity expert, Bogor, 13 March 2024; interview, Malaysian biosecurity expert, Kuala Lumpur, 20 May 2024.

[102] Interview with a Singapore biosecurity expert, Singapore, 20 June 2024.

[103] Perkins, Dana, et al. "The Culture of Biosafety, Biosecurity, and Responsible Conduct in the Life Sciences: A Comprehensive Literature Review." *Applied Biosafety* 24, no. 1 (2019).

governments. Nevertheless, national biorisk associations, such as Biorisk Association of Singapore (BAS) and BRAP, have started conducting awareness campaigns on cyberbiosecurity.[104]

Insider threat is a key laboratory biosecurity issue. Biosecurity training programmes remain inadequate to cover all laboratory personnel and managers across the region.

As regional BSL3 high-containment laboratories undergo rigorous international certification processes annually, the primary concern regarding laboratory biosecurity lies with other low-containment laboratories as well as clinical and diagnostic laboratories that operate without a strong security culture. With most countries already having various regulations and guidelines for governing laboratories of all types, the absence of regulations does not particularly contribute to vulnerability in the region. However, these laboratories may pose a potential risk due to limited adherence to protocols and biosecurity measures by their staff, as well as a general lack of biosecurity awareness. Laboratories may be vulnerable to theft, insider threats or unauthorised access to dangerous pathogens, posing a risk of bioterrorism or accidental release of infectious agents.

Laboratory biorisk experts in the region, in our field research interviews, observed some common challenges for low containment and ordinary laboratories across Southeast Asian countries.[105] There may be a lack of consistent enforcement of biosecurity regulations and guidelines in these laboratories, leading to potential gaps in security and safety measures.[106] One potential biosecurity issue that is being considered in several countries in the region is insider threat, that is when individuals within the organisation, with authorised access to biological agents and toxins for research purposes, misuse that access with a malicious intent.[107] Biosecurity training programmes and courses remain inadequate to cover all laboratory personnel and managers across Southeast Asian countries. In this regard, several non-governmental national biorisk organisations, as well as biosecurity training institutions, with support from ASEAN dialogue partners, fill in this gap by offering their own seminars and workshops to adequately train laboratory personnel and managers.[108]

As the region has thousands of private clinical laboratories, another common challenge, in most Southeast Asian countries, is inadequate control measures for the handling, transportation, and disposal of medical waste containing biological materials. The improper and unregulated disposal of medical waste poses significant risk to laboratory staff, the public, and the environment. As noted by our consultation with biosecurity experts in the region, this issue is more prevalent in big Southeast Asian

[104] BioRisk Association of the Philippines (BRAP). "BRAP Webinar Series." 4 September 2023. Accessed 27 October 2025. https://bioriskassociationphilippines.org/2023/09/04/brap-webinar-series-no-5/.

[105] Interview with Malaysian biosecurity experts, Kuala Lumpur, Malaysia, 20 May 2024; interview, Indonesian biosecurity expert, Jakarta, 12 March 2024.

[106] Ibid.

[107] Interview with Philippine biosecurity experts, Manila, 13 June 2024; interview with an Indonesian biosecurity expert, Jakarta, 13 March 2024; interview with a Singapore biosecurity expert, Singapore, 15 July 2024.

[108] Interview, Cambodian biosecurity expert, Phnom Penh, 22 January 2025.

countries, with laboratories located in peripheral regions, where regulations and enforcement may not be consistently applied and regular training for laboratory staff is insufficient.[109]

Nevertheless, experts in Southeast Asia view accidental leaks or releases from laboratories as a minimal threat, indicating a low or moderate likelihood of occurrence.[110] Attention is primarily directed towards naturally occurring EIDs and REIDs, insider threats, and the intentional use of biological agents for the purpose of bioterrorism. The region's low risk perception of laboratory accidents mainly stems from robust national and international biosafety regulation, and the adoption of stringent due diligence measures. However, they do point out that there is a need to strengthen a strong biosecurity culture in laboratories and facilities handling biological samples.[111] Furthermore, given that there are different laboratory types, whether a clinical diagnostic laboratory (primary, secondary, and/or tertiary), academic research or industrial laboratory, it is potentially beneficial to tailor policies, so that the concerns and risks related to these different laboratories are addressed accordingly.

National Frameworks, Approaches, and Practices

Enhancing Policy Frameworks

The table below includes a brief snapshot of biosecurity policies in place or pending or under discussion across the ten Southeast Asian countries that are included in this study (Table 4). It includes both comprehensive policies as well as other relevant frameworks applied at the national level. This list of national regulations and frameworks is non-exhaustive.

Table 4. Key Biosecurity Policies in Southeast Asia.

Country	Comprehensive	Other Relevant Frameworks
Brunei	Biological Weapons Act 1983	Workplace Safety and Health Order 2009, Infectious Diseases Act 2003, Animal (Diseases and Quarantine) Order 2021, Anti-Terrorism Order 2011, Part V of Criminal Procedure Code, Section 17 of Internal Security Act (for inspections)
Cambodia	Law on the Prohibition of Chemical, Nuclear, Biological and Radiological Weapons 2009	Biosafety Law 2008, National Medical Laboratory Biosafety Guidelines, Law on Measures to Prevent the Spread of COVID-19 and Other Deadly Infectious Diseases 2021

[109] Interview with an Indonesian expert, Jakarta, Indonesia, 12 March 2024.

[110] Interview with Singapore experts, Singapore, 15 and 17 July 2024.

[111] Interview, Cambodian biosecurity expert, Phnom Penh, 22 January 2025; interview, Philippine biosecurity experts, Manila, 13 June 2024; interview, Indonesian biosecurity expert, Depok, 13 March 2024.

Indonesia	Draft biosecurity/BWC bill (Pending)	Ministry of Agriculture Decree No. 85/KPTS/HK.330/9/1997, Government Regulation No. 21/2005, Institution Biorisk Laboratory Manual 2019
Laos	No BWC implementing law/biosecurity framework	National Biosafety Regulations 2019 (focusing mostly on laboratory biosafety), Regulation 1 on transportation and shipping of infectious materials, Regulations 9 and 10 on cyberbiosecurity, Law on Prevention and Control of Communicable Diseases 2017, Biotechnology Safety Law 2014
Malaysia	Draft biosecurity/BWC bill (Pending); a policy paper on BWC has been introduced	Biosafety Act 2007, Medical Act 1972, Prevention and Control of Infectious Diseases Act 1988, National Security Council (NSC) Act Directive No. 20, Plant Quarantine Act, Malaysia Laboratory Biosafety and Biosecurity Policy and Guideline 2015
Myanmar	No BWC implementing law/biosecurity framework	Counter Terrorism Law 2014, Environmental Conservation Law 2012, Prevention and Control of Communicable Diseases Law 2011, Animal Health and Livestock Development Law 2020, Imports and Exports Law 2012
The Philippines	Draft biosafety and biosecurity bill (Pending)	Biosafety Guidelines 1991, Executive Order No. 514, Joint Department Circulars 2016 (revised in 2021), Anti-Terrorism Act 2020 Section 4(d), Manual of Laboratory Biosafety and Biosecurity Standards 2023
Singapore	Biological Agents and Toxins Act 2005 (BATA)	Strategic Goods (Control) Act 2002 (SGCA), Singapore Standard – Biorisk Management for Laboratories and Other Related Organisations, Singapore Biorisk Code of Conduct for the Life Sciences Industry and Professionals
Thailand	Pathogens and Animal Toxins Act 2015 (PATA; focusing mostly on laboratory biosafety)	Communicable Diseases Act 2015, Animal Epidemics Act 2015, Plant Quarantine Act 2008, Biodiversity Act 2019 (Draft)
Vietnam	Draft biosecurity policy (Third draft/pending)	03/2007/QH12 Laws on the Prevention of Infectious Diseases

		2007, Decree 92/2010/ND-CP, 79/2015/QH13 Law on Veterinary Medicine, 41/2013/QH13 Law on Plant Protection and Quarantine

Abbreviation: BWC: Biological Weapons Convention

Singapore's primary biosafety and biosecurity framework is implemented through BATA, which also serves as the country's main instrument for fulfilling its obligations under the BWC. Any person who violates these provisions can be punished with a fine, imprisonment (extendable to life imprisonment), or both. Participation in offences, such as those related to biological weapons, is prohibited by Chapter 5 of the Penal Code.[112] The Act is a key achievement of Singapore, as compared to most of its Southeast Asian neighbours, which have yet to codify their national implementation of BWC through a comprehensive legal framework.

Singapore has also established a BWC National Contact Point.[113] Relevant organisations for the implementation of BWC include the Biosafety Branch (BSB) of the Ministry of Health, Ministry of Home Affairs (MHA) and the Director-General of Customs. Singapore has organised outreach related to biosafety and biosecurity, including, for example, through the development of guidance documents that do not mandate but rather inform on ideal biosecurity/biosafety practices, as well as procedures mandated by other laws, such as the Security Recommendation for Facilities Possessing, Storing or Working with Biological Agents and Toxins under the Biological Agents and Toxins Act from the Biosafety Branch of Ministry of Health and Ministry of Home Affairs.[114] To ensure the integrity of its export control system, which regulates the export of biological and chemical items, Singapore maintains a control list of that which can be exported under its Strategic Goods (Control) Act 2002 (SGCA).[115] This list includes all items listed under four existing multilateral export control regimes (e.g., treaties, conventions, or frameworks) — Australia Group (AG), Missile Technology Control Regime (MTCR), Nuclear Suppliers Group (NSG) and Wassenaar Arrangement (WA) — from which its transhipment and transit control lists are also derived. Singapore regularly reviews and updates its control lists to ensure that its system is in line with international practices.[116]

In Thailand, apart from the main legal framework under the Pathogens and Animal Toxins Act (PATA) B.E. 2558 of 2015, there are other existing Thai national laws related to biosafety and biosecurity, such as the Plant Quarantine Act, Public Health Act, Hazardous Substance Act, and Animal Epidemics

[112] Ministry of Health (MOH), Singapore. "About BATA." Accessed 15 July 2024. www.moh.gov.sg/biosafety/about-bata#:~:text=agents%20and%20toxins.,Biological%20Agents%20and%20Toxins%20Act,such%20biological%20agents%20and%20toxins.

[113] United Nations Institute for Disarmament Research (UNIDIR) and Verification Research, Training and Information Centre (VERTIC). "Biological Weapons Convention National Implementation Measures Database: Singapore." Accessed 16 July 2024. https://bwcimplementation.org/states/singapore.

[114] Ibid.

[115] Singapore Statutes Online (SSO). "Strategic Goods (Control) Act 2002." 1 January 2003. Accessed 18 July 2024. https://sso.agc.gov.sg/Act/SGCA2002.

[116] Permanent Mission of Singapore to the United Nations. "Report of Singapore on the Implementation of Security Council Resolution 1540 e." Accessed 24 October 2024. www.un.org/es/sc/1540/national-implementation/pdf/SingaporeReport%20S-AC.44-2019-4.pdf.

Act.[117] However, Thai experts argue that PATA does not focus on detection, but mostly on laboratories; as such, monitoring/detection of naturally occurring diseases and other emerging biosecurity threats was deemed a gap in Thailand's legal framework.[118] Furthermore, there are biosafety guidelines for laboratories and research purposes. The Biodiversity Act, as a major legislative piece to support PATA, has been proposed and has received approval from Thailand's cabinet, and it is currently pending in the parliament.[119] Concerning the prohibition of biological weapons, Thailand implements BWC through a number of laws and other related normative instruments. These include the Control of Item in Relation to the Proliferation of Weapons of Mass Destruction Act B.E. 2562 (2019),[120] which practically serves as the country's strategic export control legal framework, and the PATA.

Brunei has its Biological Weapons Act of 1983, the main BWC implementing law, to "prohibit the development, production, acquisition and possession of certain biological agents and toxins and of biological weapons."[121] A separate framework that can be applied to establish accountability for biological agents and toxins in workplaces (mostly government owned or related) is likewise available in the Workplace Safety and Health Order, 2009, which contains multiple lists of potentially hazardous biological and chemical weapons.[122] These are separated into dangerous occurrences (Second Schedule); occupational diseases (Third Schedule); and machinery, equipment or hazardous substances (Fifth Schedule).

Beyond these, Brunei also has its separate lists of schedules focusing on infectious diseases, through the Infectious Diseases Act of 2003.[123] This act seeks to touch upon the task of conducting "epidemiological surveys of people, animals or vectors in order to determine the existence, prevalence or incidence of any infectious disease or any other disease which the Minister (…) declares to be a disease to which this section applies."[124] The law's strength can be seen in that, upon the minister's discretion, any person can be prohibited from entering the country, if there is doubt in this regard. It, likewise, specifies that "no person shall import or bring or cause to be imported or brought into Brunei any vectors capable of transmitting a disease without first obtaining a written permission from the Director-General;"[125] the same rule applies as well to "disease-causing organism or any agent of disease capable of transmitting a disease."[126] Furthermore, it has a comprehensive list of infectious diseases (First Schedule) and dangerous infectious diseases (Second Schedule), and further guidelines for influenza A, B, and others, as well as SARS (both belonging to the Fifth and Sixth Schedules).

[117] Interview with Thai biosecurity law experts, Bangkok, Thailand, 3 May 2024.

[118] Interview with Thai biosecurity experts, Singapore, 18 April 2024.

[119] Interview with a Thai legal expert, Bangkok, Thailand, 3 May 2024.

[120] Interview with Thai biosecurity law experts and law enforcement officer, Bangkok, Thailand, 2–3 May 2024.

[121] International Committee of the Red Cross (ICRC). "Biological Weapons Act, 1983: Brunei Darussalam." Accessed 14 February 2025. https://ihl-databases.icrc.org/en/national-practice/biological-weapons-act-1983.

[122] Government of Brunei. "Workplace Safety and Health Order, 2009." *Brunei Darussalam Government Gazette*. Accessed 14 February 2025. www.asean.org/wp-content/uploads/2016/05/B9_Workplace-Safety-and-Health-Order-2009.pdf.

[123] UNIDIR and VERTIC. "Brunei Darussalam." Accessed 27 October 2025.

[124] Government of Brunei. "Infectious Diseases Order of 2003." Accessed 14 February 2025. www.vertic.org/media/National%20Legislation/Brunei/BN_Infectious_Diseases_Order_2000.pdf.

[125] Ibid, pt. 41.

[126] Ibid, pt. 42.

Currently, Malaysia does not have a law that implements BWC, as the proposed legislation has been pending since 2015, while a list of sensitive biological agents is still being reviewed by the country's biosecurity experts.[127] In order to strengthen the implementation of BWC at the national level, *sans* a national legislation, the Malaysian Science & Technology Research Institute for Defence (STRIDE), an agency of the Ministry of Defence (MINDEF), has drafted a policy paper on BWC and submitted it for endorsement by Malaysia's cabinet in 2023.[128] STRIDE is the focal agency for the national implementation of BWC. The official dissemination of this BWC policy paper is currently pending. The policy paper outlines strategies to strengthen national implementation, increase awareness and understanding on comprehensive biosecurity culture, enhance oversight mechanisms in science and technology, and ensure effective multiagency coordination when responding to deliberate biological incidents. Malaysia has an export control regime, namely the Strategic Trade Act 2010, Arms Act 1960, and Customs Act 1967.[129] Other related regulations and Malaysian laws relating to import and export; human, plant, and animal health; and environment and biological diversity can be referred to even as a comprehensive BWC bill is yet to be legislated.[130]

The Philippines currently lacks a national law that specifically addresses biosecurity and BWC, despite having some executive and administrative orders in place that are mainly on biosafety.[131] A draft BWC law has been pending in the Philippine Congress since it was first introduced in 2013.[132] Nonetheless, several legislative measures are used to implement BWC within the criminal legislation of the Philippines. Notably, Section 4(d) of the Anti-Terrorism Act of 2020 bans the development, possession, export, supply, and use of biological weapons, when carried out with a terrorist intent.[133] Additionally, the Strategic Trade Management Act (STMA) and its implementing rules and regulations provide a legal framework for export control and the transfer of strategic goods, thereby bolstering BWC implementation.[134]

In Indonesia, the Institution Biorisk Laboratory Manual of the National Institute of Health Research and Development (NIHRD),[135] which was published in 2019, covers general biosafety and biosecurity requirements to be utilised in the country's containment laboratories, but it does not contain details on specific system requirements for the physical containment, reporting, or cybersecurity when handling especially dangerous pathogens. Much like its Southeast Asian neighbours, Indonesia has

[127] Interview, Malaysian biosecurity expert, Kuala Lumpur, 20 May 2024.

[128] Ibid.

[129] Interview with Malaysian biosecurity experts, Putrajaya, Malaysia, 21 May 2024.

[130] Interview with Malaysian biosecurity expert, Kuala Lumpur, 20 May 2024.

[131] Interview with Philippine biosecurity experts, Quezon City, the Philippines, 4 June 2024.

[132] Interview with Philippine biosecurity experts, Metro Manila, 13 June 2024.

[133] Department of Justice (DOJ), the Philippines. "Implementing Rules and Regulations for the Anti-Terrorism Act of 2020." Manila, 16 October 2020. Accessed 24 October 2025. www.doj.gov.ph/files/2025/Press%20Releases%20Attachments/ATA_2020_IRR%2C_as_Amended__Signed__1.pdf.

[134] Congress of the Philippines. "Republic Act No. 10697: An Act Preventing the Proliferation of Weapons of Mass Destruction by Managing the Trade in Strategic Goods, the Provisions of Related Services, and for Other Purposes." Manila, 15 November 2015. Accessed 24 October 2025. https://lawphil.net/statutes/repacts/ra2015/ra_10697_2015.html.

[135] National Institute of Health Research and Development (NIHRD) of the Republic of Indonesia. "Institution Biorisk Laboratory Manual (*Pedoman Biorisiko Laboratorium Institusi*)." 2019. Accessed 8 October 2024. https://repository.badankebijakan.kemkes.go.id/id/eprint/3870/1/Buku_Biorisk.pdf.

prevailing regulations and frameworks covering environmental, plant and animal health, complementing human health.[136] However, there is no biosecurity or BWC implementing law in Indonesia. Existing domestic laws can only partly execute BWC, such as the Law on Criminal Acts of Terrorism; various legislations on quarantine; the Law on the Outbreak of Diseases; Law on Customs; and its Penal Code.[137] Indonesia, currently, has patchy ministerial level regulations on strategic goods subject to export prohibition, and on the control over importation and distribution of hazardous materials, but it has no comprehensive export control legislation.[138]

Vietnam has enacted legislation addressing various aspects of biosecurity depending on activities and outcomes, such as Decree 103/2016/ND-CP, which stipulates the conditions for ensuring biosafety at facilities with laboratories working with microorganisms that pose a risk of causing infectious diseases to humans and clinical samples that may contain microorganisms that pose a risk of causing infectious diseases to individuals in these organisations.[139] Other relevant regulations include a draft circular proposing amendments to existing quarantine regulations for terrestrial animals and animal products.[140] Vietnam's export and import controls do not explicitly regulate the trade of dangerous pathogens either. Instead, they are closely tied to agricultural imports and their potential biological consequences. As of now, there is no publicly available information indicating that Vietnam is drafting a new comprehensive biosecurity legislation akin to Singapore's BATA or Thailand's PATA. The country continues to rely on its existing laws and regulations to manage biosecurity risks. This lack of urgency in developing a law may reflect Vietnam's threat perception, which prioritises EIDs/REIDs, as the most immediate risks.

The primary national law in Cambodia that contributes to the domestic implementation of BWC is the 2009 Law on the Prohibition of Chemical, Nuclear, Biological and Radiological Weapons.[141] This law forbids the production, processing, acquisition, transfer, stockpiling, transportation, and use of biological weapons. Cambodia has taken crucial actions concerning the implementation of BWC — (i) nomination of the National Authority of Chemical Weapons (NACW) for the prohibition of chemical, biological, radiological and nuclear (CBRN) weapons as the BWC National Contact Point under the Ministry of National Defence; (ii) operationalisation of an interministerial cooperation mechanism on BWC matters; (iii) adoption of BWC-related legislation; and (iv) the annual submission of confidence-building measure (CBM) reports that began in 2022 and, thereafter, continued in 2023 and 2024.[142]

[136] Interview with an Indonesian biosecurity experts, Jakarta, 12 March 2024.

[137] Interview with an Indonesian biosecurity experts, Bogor, 13 March 2024.

[138] Global Health Security (GHS) Index. "Country Score Justifications and References: Indonesia." 2021. Accessed 27 October 2025. https://ghsindex.org/wp-content/uploads/2021/12/Indonesia.pdf.

[139] Government of Viet Nam. "Decree No. 103/2016/ND-CP on Biosafety in Laboratories." Accessed 11 February 2025. https://bwcimplementation.org/sites/default/files/resource/VD-Decree%20on%20Biosafety%20in%20Laboratories_EN.pdf.

[140] Foreign Agricultural Service (FAS), US Department of Agriculture (USDA). "Vietnam: Vietnam Releases Draft Circular Proposing Amendments to Existing Circulars Related to the Quarantine of Terrestrial Animals and Terrestrial Animal Products." 30 January 2024. Accessed 27 October 2025. www.fas.usda.gov/data/vietnam-vietnam-releases-draft-circular-proposing-amendments-existing-circulars-related.

[141] Kingdom of Cambodia. "Law on the Prohibition of Chemical, Nuclear, Biological, and Radiological Weapons." Accessed 27 October 2025. www.vertic.org/media/National%20Legislation/Cambodia/KH_Law_Prohibition_CBRN_Weapons.pdf.

[142] United Nations Office for Disarmament Affairs (UNODA). "Cambodian Experts Meet to Further Enhance National CBM Reporting Practices under the BWC." 2 February 2024. Accessed 5 December 2025. https://disarmament.unoda.org/en/updates/cambodian-experts-meet-further-enhance-national-cbm-reporting-practices-under-bwc.

Cambodia's Law on Biosafety was enacted in 2008, primarily to regulate the use of GMOs in order to protect the country's biodiversity and the public from its harmful effects. While there is a legal framework on biological weapons and biosafety, there is currently no legislation specifically on biosecurity. Cambodia is currently exploring different approaches that it may take when drafting and, later, enacting a biosecurity code of conduct/guidelines and a royal decree on biosecurity. Relevant state officials have been attending national and regional biosecurity legal framework workshops, organised by the European Union (EU) and UN bodies, in recent years. Such workshops aim to assist national stakeholders in the preparation and planning of drafting a biosecurity code of conduct for Cambodia.[143]

Similar to most Southeast Asian countries, Laos does not have a single, overarching law regulating biosecurity and the implementation of BWC. However, unlike many of its regional counterparts, the country has enacted more comprehensive individual laws addressing various aspects of biosecurity. Notably, Laos has established legal frameworks for cyberbiosecurity and biotechnology — two critical, yet often overlooked, components of biosecurity, even in nations with well-developed regulations. Key examples include Regulations 9 and 10 of the 2019 National Biosafety Regulations on cyberbiosecurity and the 2014 Biotechnology Safety Law, which provide structured governance in these specialised areas.[144]

Myanmar has no comprehensive law implementing biosecurity and BWC. BWC is only partly implemented by the 2014 Counter Terrorism Law,[145] which outlaws biological weapons. The country has no legislation or regulations regarding biosecurity, except for the Guidelines on Biosafety and Biosecurity for Biomedical Laboratories and biosecurity guidelines for COVID-19 response.[146] The country's Export and Import Law 2012 prohibits the import and export of restricted goods without a license. Supplementing this Law is the Government Notification No. 19/2023, which identifies products that require licenses, such as vaccines, toxins, cultures of microorganisms (excluding yeasts), and similar products, as well as cell cultures.[147]

A One Health Systems Approach for Tracking Diseases

Processes for tracking the emergence/re-emergence of such diseases are critical, and this needs to be done at multiple stages, from before a disease becomes zoonotic until after it has started affecting humans. The One Health approach will ideally help attain optimal health for people, animals, and our

[143] Interview with Cambodian biosecurity and Biological Weapons Convention (BWC) experts, Phnom Penh, Cambodia, 22 January 2025.

[144] United Nations Institute for Disarmament Research (UNIDIR) and Verification Research, Training and Information Centre (VERTIC). "Biological Weapons Convention National Implementation Measures Database: Lao People's Democratic Republic." Accessed 15 February 2025. https://bwcimplementation.org/states/lao-peoples-democratic-republic.

[145] Government of the Republic of the Union of Myanmar. "Pyidaungsu Hluttaw No. 23/2014: The Counter Terrorism Law." 4 June 2014. Accessed 27 October 2025. https://myanmar-law-library.org/topics/myanmar-banking-law/aml-cft-regulations/pyidaungsu-hluttaw-no-23-2014-the-counter-terrorism-law.html.

[146] GHS Index. "Myanmar." Accessed 6 May 2025.

[147] United Nations Institute for Disarmament Research (UNIDIR) and Verification Research, Training and Information Centre (VERTIC). "Biological Weapons Convention National Implementation Measures Database: Myanmar." Accessed 13 February 2025. https://bwcimplementation.org/states/myanmar.

environment. Thailand, the Philippines, Indonesia, Malaysia, and Singapore, for instance, were among those using gene sequencing technologies for conducting such analysis. Thailand is mostly focusing on diseases after they have become zoonotic, that is, once they can infect humans; its goal is to prevent 'DiseaseX' from having a significant impact, although sequencing focuses more on human DNA rather than animal DNA. By contrast, Singapore, Indonesia, Malaysia, and the Philippines are conducting whole genome sequencing (WGS) of human and animal viruses, including analysis of pre-zoonosis, to study how viruses evolve even within animal hosts. This approach is more foresighted and helps to better track future hotspots for disease (re)emergence, premised also on animal behaviours and migration patterns amid climate change.

There are trade-offs, however, given the perception that doing more animal gene sequencing could dilute efforts at human gene sequencing, given resource constraints. Concerning having a national framework, Thailand, the Philippines, Indonesia, Malaysia, Vietnam, Cambodia, Brunei,[148] and Singapore have their respective national action or strategic plans adopting One Health approach in recent years. Laos and Myanmar, however, have yet to come up with such a One Health action plan. Furthermore, most AMS have their respective national One Health university networks, which form the Southeast Asia One Health University Network (SEAOHUN). It aims to develop the next generation of skilful and competent One Health workforce by leveraging education, research, and training developed in collaboration with university networks in Southeast Asia.[149]

Raising Biosecurity Awareness and Expertise Among Policymakers and Across Sectors

The prioritisation of disease surveillance requires policy support, and so efforts are needed to raise awareness among policymakers and the general public alike. In the Philippines, one expert view is that the country lacks sufficient capacity to manage EIDs/REIDs.[150] In the expert's opinion, this lack of capacity owes to its government's underestimation of the potential impact of pandemics, given that the country was not severely affected during the earlier SARS outbreaks. This has led to — (i) underdeveloped primary care systems; (ii) inadequate testing capabilities; (iii) insufficient documentation for reference, limiting their readiness to respond effectively to health crises; (iv) heavy reliance on volunteers, resulting in late reporting of diseases; and (v) under-resourced local health agencies.[151] The concern of underdevelopment of health systems is also shared in Indonesia's

Policy support is needed to prioritise disease surveillance. Awareness needs to be raised among policymakers and the general public alike.

[148] Department of Policy & Planning, Government of Brunei. "Ministry of Health Strategic Plan 2019–2023: Investing for Our Future." Accessed 14 February 2025. https://moh.gov.bn/wp-content/uploads/2024/10/FINAL-MOH-Strategic-Book-2019-compressed-5MB-1.pdf.

[149] Southeast Asia One Health University Network (SEAOHUN) Secretariat. "Making Connections to Promote One Health." Accessed 13 February 2025. www.seaohun.org/philohun.

[150] Interview with a Philippine health security expert, Quezon City, the Philippines, 13 June 2024.

[151] Interview with a Philippine health security expert, Makati City, the Philippines, 11 June 2024.

biosecurity experts' call for educating policymakers on the importance of plant and animal biosecurity frameworks, given that the country is considered a 'megabiodiversity' zone of the world.[152]

Experts have pointed out the need to also include the agricultural sector, particularly farmers, in biosecurity education. For instance, as with other large countries, Indonesia's large size and decentralised command structures also make it challenging to ensure uniform knowledge of biosecurity across all levels of society. It is perceived that many farmers still likely lack awareness of the potential pathogens that can enter through their livestock and the threat of new or re-emerging plant-related diseases that could reduce farms' crop yields. Consequently, the effectiveness of even the most robust regulations is undermined if people lack the knowledge to implement them.

There is significant disparity between biosafety awareness and biosecurity awareness. Scientists, medical professionals, the health security community, academics, and laboratory personnel are traditionally more familiar with biosafety; by contrast, the concept of biosecurity is still new to many of these actors. It is crucial to increase their awareness of biosecurity to be able to respond to biological security threats and incidents. More needs to be done to raise awareness on biosecurity, to match the awareness of biosafety. While biosafety awareness and compliance are relatively high, this owes largely to biosafety requirements being mandated by the government and IBCs. When it comes to biosecurity awareness, it is considerably lacking due to the absence of specific biosecurity provisions in existing national regulations. Therefore, there is a substantial need for improvement in biosecurity awareness and regulatory development. Currently, there is low awareness in the legislative bodies on the importance of a comprehensive biosafety and biosecurity legal framework or BWC national implementation bill.

The lower level of biosecurity awareness among scientists and medical professionals, compared to biosafety awareness, needs to be addressed. Failing to do so could weaken our collective ability to respond to biosecurity threats and incidents.

Security-Health Sectors Cooperation and Joint Training to Boost Enforcement

Even if countries may have robust biosafety and biosecurity laws, th e lack of enforcement may prevent these from being followed consistently. A potential mechanism to strengthen enforcement is through the engagement of the security sectors (including the military, police, home affairs, etc.) for enforcing health- and biosecurity-related agenda. Within Thailand, for instance, there is a need to improve the coordination between the Ministry of Public Health (MoPH) and law enforcement bodies, such as the Royal Thai

A potential mechanism to strengthen enforcement is through the engagement of the security sectors (including the military, police, home affairs, etc.) for enforcing health- and biosecurity-related agenda.

[152] Interview with an Indonesian plant and biosecurity expert, Bogor, Indonesia, 13 March 2024.

Police (RTP). While there are subunits within the police that could be involved in investigating health/biosecurity-related incidents, the perception by one of the experts interviewed is that their efforts are currently focused on investigating top-line issues, such as drug smuggling, animal smuggsling, and money laundering, among others.[153] The police will need guidance from the health sector, conveyed in a language that is easier to operationalise, on the types of biosecurity-related incidents that the policy should be tracking/monitoring within their jurisdiction. For instance, the police cannot be expected to monitor the movements of biological materials in the absence of a prioritised list of biological materials and guidelines on how they are to be tracked. Nonetheless, in Indonesia, Malaysia, Singapore, the Philippines, Thailand, Cambodia, and Brunei,[154] the security and health sector agencies have begun enhancing their coordination mechanisms for responding to biosecurity events, whether accidental or deliberate, through their respective CBRN workshops and joint exercises. Their respective BWC focal agencies, normally under the supervision of their defence or health ministries, convenes interagency meetings and exercises to enhance coordination among the security sector and health sector agencies.

It is also important to recognise that bioterrorists, or individuals involved in acts of bioterrorism, including insider threats, as defined earlier, are hard to track. They are typically highly educated individuals with scientific expertise, and distinguishable only when they act on their strong ideological beliefs. They may appear and behave typically like the rest of the organisation/society they belong to, but their ideologies may drive them to misuse their knowledge and skills towards creating or spreading biological agents as weapons. As such, the security sector can also be tapped for the practical aspects of enforcement of laboratory biosecurity, such as through regular inspections and staff training, even as the health sector communicates the consequences of non-compliance.

Developing National Control Lists and Inventories of Pathogens, Toxins, and Security-Sensitive Biological Agents

Countries need to develop their national inventories of dangerous pathogens and toxins, as well as security-sensitive biological agents warranting specific monitoring regulations in order to mitigate potential health risks to humans, animals, and the environment. These national control lists and inventories need to be consistently monitored across alls human and animal health laboratories, and tailored to their specific needs to ensure adequate oversight mechanisms. The control of access to containment laboratories (or

Access to containment laboratories working with high-risk materials is a potential weak link that needs to be better regulated, *to reduce vulnerability to theft, diversion, or misuse of dangerous pathogens.*

[153] Interview with a Thai law enforcement officer, Bangkok, Thailand, 2 May 2024.

[154] In Brunei, the points of interaction between law enforcement and health lie in policies, such as the Anti-Terrorism Order 2011, Part V of the Criminal Procedure Code, and Section 17 of the Internal Security Act, which allow for audits and inspections. See, Criminal Procedure Code, Government of Brunei. "Anti-terrorism Order, 2011." *Brunei Darussalam Government Gazette*. Accessed 24 October 2025. www.agc.gov.bn/AGC%20Images/LAWS/Gazette_PDF/2011/EN/s045.pdf; Government of Brunei. "Laws of Brunei: Chapter 133, Internal Security Act." Accessed 24 October 2025. www.agc.gov.bn/AGC%20Images/LAWS/ACT_PDF/Cap133.pdf.

'access control') working with high-risk pathogens should be well regulated to reduce vulnerability to theft, diversion, or misuse of dangerous pathogens.

The steps above are critical to ensure strict and effective control of pathogens, toxins and security-sensitive biological agents (or, biological agents with a high 'risk group,' as defined in Section 2.i), which will help maintain national security and prevent potential threats to society and the environment. Singapore has fully developed a systematically categorised list of biological agents, which makes for better regulatory oversight by related ministries.[155] Thailand's Ministry of Public Health has adopted lists of pathogens and animal toxins to be controlled under PATA.[156] Cambodia has two separate lists: a list of pathogens from the Ministry of Health (updated in 2024), and a list of biological agents from NACW, which was made in 2011.[157] With capacity-building assistance from EU, Cambodia aims to fully consolidate these two lists from the Ministry of Health and NACW, as well as other relevant agencies to build a comprehensive national inventory. A key challenge currently is to regularly update the 2011 list of biological agents.[158] Myanmar and Laos do not have a comprehensive list of biological agents and pathogens, or a license requirement for the possession or use of high-risk biological agents and toxins. Meanwhile, some countries in Southeast Asia, such as Malaysia, the Philippines, and Indonesia, have been working on finalising their respective national list through national consultations and workshops with national stakeholders, biosecurity experts, and agencies involved in public health life sciences and biotechnology.

[155] Interview with Singapore biosecurity expert, Singapore, 15 July 2024.

[156] Kingdom of Thailand. "Pathogens and Animal Toxins Act, 2015."

[157] Interview with Cambodian biosecurity and BWC experts, Phnom Penh, Cambodia, 21 January 2025.

[158] Interview, Cambodian biosecurity and BWC experts, Phnom Penh, 22 January 2025.

Chapter 2

The Landscape of Singapore's Biosecurity Governance

Chan Wai Xin

Why Biosecurity?

Singapore embarked on biomedical industry development in 2000, moving the emphasis from the then existing pharmaceutical manufacturing to be more innovation and research focused.[1] This shift allowed Singapore to attract sizable investments from multinational biomedical companies,[2] and, in 2022, Singapore is home to five vaccine manufacturing facilities that can produce over a billion doses annually.[3] This resulted in Singapore achieving a biopharmaceutical export value amounting to SGD19 billion in 2022.[4]

However, the journey to develop a robust industry was met with a laboratory lapse incident in August 2003. A doctoral student developing SARS[5] from laboratory exposure highlighted the importance of, and necessitated the establishing of, biosafety regulations. This incident, combined with the episodes of anthrax attacks in the United States in 2001,[6] prodded Singapore's legislators to put forth the bill on biological agents and toxins in 2005, aiming to address both biosafety and biosecurity matters.[7] The bill was passed, and BATA took effect in January 2006.

However, risk is not limited only to those related to biological agents in a biomedical setting; there are also several other considerations that Singapore faces. One, Singapore is a key regional travelling and business hub and, in 2023, the Changi Airport had 58.9 million passengers passing through,[8] bringing along with them the potential of introducing an infectious disease. The significant flow of global travellers and goods through Singapore makes the island state vulnerable to non-endemic pathogens, which, if an outbreak occurs, can cause substantial harm to its high-density population.

[1] University of Cambridge and Cambridge Industrial Innovation Policy (CIIP). "Singapore's Biomedical Cluster: Lessons from Two Decades of Innovation and Manufacturing Policy." Accessed 2 December 2024. www.ciip.group.cam.ac.uk/wp-content/uploads/2021/02/2021-02-19-SBS.pdf.

[2] Ibid.

[3] Khalik, Salma. "Singapore Goes from Zero to 5 Vaccine Plants As Pharma Firms Seek Flexibility." *The Straits Times*, December 27, 2022. www.straitstimes.com/singapore/from-0-to-5-vaccine-plants-in-s-pore-pharmaceutical-firms-see-need-to-diversify.

[4] EDB Singapore. "Why Singapore Is a Top Choice for Biopharma Firms Seeking Global Expansion." 20 October 2023. www.edb.gov.sg/en/business-insights/insights/why-singapore-is-a-top-choice-for-biopharma-firms-seeking-global-expansion.html.

[5] Senio, Kathryn. "Recent Singapore SARS Case a Laboratory Accident." *The Lancet Infectious Diseases* 3, no. 11 (2003): 679. Doi:10.1016/S1473-3099(03)00815-6.

[6] Hughes and Gerberding. "Anthrax Bioterrorism."

[7] Singapore Parliament Official Report. "Biological Agents and Toxins Bill." Accessed 2 December 2024. https://sprs.parl.gov.sg/search/#/topic?reportid=019_20051018_S0002_T0002.

[8] Loi, Esther. "Changi Airport's 2023 Passenger Traffic Rebounds to 86% of Pre-COVID-19 Levels." *The Straits Times*, January 24, 2024. Accessed 5 December 2025. www.straitstimes.com/singapore/transport/changi-airport-s-2023-passenger-traffic-rebounds-to-86-of-pre-covid-19-levels.

Two, unlike regional countries, Singapore does not have major agriculture and aquaculture industries to sustain its population. Instead, the country is heavily reliant on food imports from neighbouring countries to sustain its daily nutritional needs.[9] The risk of naturally occurring food-borne diseases, pathogens, and biological agents affecting source countries' food production can pose potential supply shock to Singapore. The potential shortage of food supply therefore threatens Singapore in both food security and public health concerns. As such, in terms of plants and livestock diseases, Singapore is dealing with an indirect set of concerns. Furthermore, biosecurity threats in food processing and export can also jeopardise Singapore's global reputation as a trusted and reliable source of food products.

From this vantage point, we observe that Singapore's vulnerability to biological threat is multifaceted. It involves economic concerns, public health, food security, and global reputation. This explains why Singapore has taken a multipronged approach towards ensuring biosafety and biosecurity.

Definition of Biosecurity and Biosafety

Biosecurity is an overarching term that has different interpretations depending on the occupational environment. In a general sense, the definition of biosecurity is to protect the general population from biological threats. Despite the diverse understanding of what constitutes biosecurity, it allows for different specialised measures to counter the corresponding threats. Nonetheless, it is important to avoid working in silos, which may result in areas being overlooked.

In the areas of medical sciences and public health, biosecurity is concerned with the survivability of the public when exposed to infectious diseases of epidemic potential.[10] For the veterinarians, biosecurity is focused on both the risk of animal diseases that may be brought in through cross-border movement and the risk of zoonotic transmission from pets to humans.[11] For the homeland security agencies, biosecurity is to detect and prevent biological agents from entering our borders or terrorism activities from would-be terrorists.[12]

This multitude of perspectives has pushed Singapore into developing a whole-of-government approach, particularly with the formation of the One Health Office (OHO) under the Ministry of Health, and supported by National Environment Agency (NEA), National Parks Board (NParks), SFA and PUB (Public Utilities Board), which is Singapore's National Water Agency.[13] This formation displays Singapore government's recognition of the different avenues of health threats.

Biosafety, unlike biosecurity, is putting emphasis on preventing personnel from being exposed to high-risk pathogens in their course of work. In this case, we observed that the emphasis on biosafety is

[9] Interview with Singapore food industry experts, Singapore, 23 September 2024.
[10] Interview with a Singapore laboratory expert, Singapore, July 2024.
[11] Interview with a Singapore veterinary expert, Email, Singapore, August 2024.
[12] Interview with a Singapore technology expert, Zoom, Singapore, August 2024.
[13] Interview with a Singapore expert, Zoom, Singapore, July 2024.

almost exclusively laboratory centric. A summary of various agencies and their roles in contributing towards biosecurity in Singapore is given below (Table 1).

Table 1. Various agencies contributing to Singapore's biosecurity.

Agency	Roles	Focus Areas
A*Star	Research, develop and commercialise products for diagnostic and treatment purposes	Human and animal health
DSO National Laboratories	Provide laboratory expertise in identifying biological agents for other agencies	Human and animal health, BWC
Genetic Modification Advisory Committee (GMAC)	Provide oversight on all genetic modification products and research	Human and animal health, food safety
HTX	Research and development on biological agents' detection for homeland security	Human health, CBRN bioterrorism
NParks	Survey and detect potential pathogens in animals for both food supply and domestic animal trade	Animal health, zoonotic risk
One Health Office (OHO)	Coordinating agency for the One Health (OH) approach	Human and animal health
Singapore Armed Forces (SAF)	Tackling biological threats when used with explosive devices	Human health, CBRN bioterrorism
Singapore Food Agency (SFA)	Regulate both food production and food importation to ensure food safety requirements are met	Human health, food safety

Abbreviations: A*STAR: Agency for Science, Technology and Research, Singapore; BWC: Biological Weapons Convention; CBRN: chemical, biological, radiological and nuclear weapons; DSO: Defence Science Organisation; HTX: Home Team Science and Technology Agency; NParks: National Parks Board

Emerging Threats and Areas of Concern

With the advancement of technology, one of the potential threats related to medical science is the possibility of synthetic biology activities being undertaken by DIYbio practitioners.[14] DIYbio refers to people who perform biological experiments outside of the regulated environment. The lack of regulation

[14] Interview with Singapore laboratory expert, Singapore, July 2024.

and oversight means there is a high potential for people to accidentally or deliberately create and release high-risk pathogens. An example cited was the creation of horsepox in Canada using mail-ordered genetic material.[15]

One expert involved in research highlighted that, with research activities involving genetic engineering of microorganisms, there will be increase in volume of highly sensitive data.[16] These data may be important to improve regional resilience towards potential diseases, but they may also become high-value targets for cyber threats.[17]

While several experts have identified the potential use of artificial intelligence to assist in threat detection, one concern was that it can similarly be used to accelerate learning by potential terrorists and accelerate the development of possible threat agents.[18] A point of comparison was how 3D-printing (additive manufacturing) has enabled the manufacturing of explosives, which was previously thought impossible.[19] This application of 3D-printing for munitions and weapons has been observed in the on-going conflicts in both Ukraine and Myanmar.[20]

Another area of concern revolves around Singapore's dependency on food imports. Currently, SFA is responsible for the food security and food safety of Singapore. This includes working with the NParks Animal & Veterinary Service (AVS) to accredit overseas farms before their produce can be commercially imported and perform monitoring and surveillance to ensure the imported food remains safe for consumption.[21] Depending on the risk level of the origin country, pre-export testing may be required, but such testing is designed to test for conventional contaminants or known pathogens. In the case of intentional adulteration, the agency is currently dependent on tip-off notification from intelligence agencies and foreign competent authorities.[22] This dependency is due to the technological challenge in testing for unknown agents and presents a vulnerability for Singapore food safety.

Apart from commercial food importation, travellers entering Singapore are also allowed to carry up to 5kg of food items for personal consumption, provided the food is procured from approved countries.[23] Security and Customs personnel at the checkpoints place greater emphasis on explosive, narcotics, and contraband detection, and lack the ability to identify biological threat.[24] This means that the innocuous 5 kg of food products can be a potential threat vector, if spiked with biological agents.

[15] Ibid.

[16] Interview with Singapore technology expert, Zoom, Singapore, August 2024.

[17] Ibid.

[18] Interview with Singapore chemical, biological, radiological, and explosive (CBRE) weapons expert, Zoom, Singapore, September 2024; interview with Singapore biosecurity and biodefence expert, Singapore, July 2024.

[19] Interview, Singapore CBRE expert, Singapore, September 2024.

[20] Dass, Rueben. "3D-printing in Conflict Zones: A Game-Changer?" *Global Network on Extremism & Technology (GNET) Insights*, 14 October 2024. Accessed 2 December 2024. https://gnet-research.org/2024/10/14/3d-printing-in-conflict-zones-a-game-changer/.

[21] Interview with Singapore food industry experts, Singapore, September 2024.

[22] Ibid.

[23] Ibid.

[24] Ibid.

While the policy provides convenience for travellers, the risk of pathogens imported unknowingly by travellers cannot be overstated.

While these emerging threats may appear distinct and unrelated, the risk from the convergence of these threats cannot be ignored. Hypothetically, a DIYbio practitioner experimenting with biological agents for pest treatment within an experimental farm without oversight may allow biological agents to disperse into a neighbouring commercial farm. As a novel biological agent, it can escape detection, both in the farm and during testing at the destination market. This is a simplistic scenario of unintentional dispersal of novel biological agents that can have potential downstream impact, and maybe viable for would be foreign-based bioterrorists.

Lastly, from the interviews, it appears there is low level of concern for accidental laboratory leaks.[25] But, this could be because there has been no reports of laboratory incidents in Singapore since 2003. We can attribute this achievement to the high degree of professionalism exhibited by its highly trained researchers. The nation's legislation also spelled out the expectation on laboratory operators to ensure that activities conducted within the facility comply with the corresponding training, protection, and supervision requirements for the work.[26] However, with high frequency of laboratory work, it is important to develop a safety culture that avoids breeding complacency.

Dual-Use Research of Concern

According to the United States Government, research that can be applied for both benevolent and malevolent purposes are termed DUR.[27] When such research can be directly misapplied to pose significant threat with broad potential consequences, they are further classified as DURC.[28] US policy further stipulates that DURC oversight is required when it involves working with a list of 15 agents and toxins for seven specified categories of experiments that can enhance the agent's potential.[29]

Singapore adopts a broad-spectrum approach towards classifying DURC. This is done by evaluating the consequences of the research without specifying the agents involved.[30] Consequences that can increase the potency or transmissibility will cause the experiment to be treated as DURC and require further risk assessment.

[25] Interview with a Singapore laboratory expert, Singapore, July 2024.

[26] Singapore Statutes Online (SSO). "Biological Agents and Toxins Act 2005." Accessed 2 December 2024. https://sso.agc.gov.sg/Act/BATA2005.

[27] Administration for Strategic Preparedness and Response (ASPR). "United States Government Policy for Oversight of Life Sciences Dual Use Research of Concern." Accessed 5 November 2024. https://aspr.hhs.gov/S3/Documents/us-policy-durc-032812.pdf.

[28] Ibid.

[29] Ibid.

[30] Genetic Modification Advisory Committee (GMAC) Singapore. "The Singapore Biosafety Guidelines for Research on Genetically Modified Organisms (GMOs)." May 2021. Accessed 5 December 2025. www.gmac.sg/wp-content/uploads/2022/03/Singapore-Biosafety-Guidelines-for-Research-2021.pdf.

From the expert input, there is a risk of scientific research being misused, such as the adulteration of vaccine for misuse.[31] However, the robust process of filing risk assessments for approval and submitting research applications to the IBCs is appropriate for mitigating the risk of DURC.[32] Nonetheless, it is recommended that the list of DURC is better aligned with BWC and BATA.[33]

Laboratory Biosafety and Biosecurity

Singapore has approximately ten BSL3 laboratories, with one BSL4 laboratory in the process of building.[34] These facilities allow Singapore to develop high competency in high-risk pathogen research. In a remark made by the expert, it was mentioned that the operating cost of maintaining the laboratories makes it difficult to be sustainable and it is not advisable for countries that cannot commit the resources necessary to develop laboratories at BSL3 level or higher.[35]

This observation was mirrored from another agency as well, where the expert shared that their agency is only equipped with a BSL2 laboratory, as it was not cost efficient to maintain a BSL3 facility.[36] Currently, there is no regulation for oversight of BSL2 laboratories in Singapore, and a majority of these laboratories are clinical diagnostic ones. Interestingly, the said agency is also exploring the potential capabilities of using synthetic biology to create a near-organism to test on.[37]

Laboratories need to conform with infrastructure requirements to contain the pathogens, established operating procedures, and ensuring sufficient appropriate protective equipment for their staff.[38] Furthermore, the personnel working in these laboratories will need competency and culture building training, security screening, and retraining. As each laboratory is constructed differently, long training hours are required before a researcher is permitted to work in a facility.[39] While these stringent rules are well-intentioned, during the COVID-19 pandemic, it hindered cross-laboratory work.[40]

Bioterrorism

The experts interviewed acknowledged that bioterrorism is a real threat to Singapore. Bioterrorism is classified as a 'low-risk, high-impact' event because its urbanised environment, coupled with high population density, makes Singapore a particularly vulnerable target compared to regional countries.[41] But, the impact of bioterrorism, due to the varying effects and reactions between people towards a

[31] Interview with Singapore technology expert, Zoom, Singapore, August 2024.
[32] Interview with Singapore laboratory expert, Singapore, uly 2024.
[33] Interview with Singapore technology expert, Zoom, Singapore, August 2024.
[34] Interview with Singapore laboratory expert, Singapore, July 2024.
[35] Ibid.
[36] Interview with Singapore technology expert, Zoom, Singapore, August 2024.
[37] Ibid,
[38] Interview with Singapore laboratory expert, Singapore, July 2024.
[39] Ibid.
[40] Ibid.
[41] Ibid.

pathogen, can go undetected.[42] This means that bioterrorism may happen inconspicuously, as compared to terrorism activity involving nuclear and chemical attacks.

The complexity of biological threat also stems from the difficulty in distinguishing between naturally occurring or deliberate dissemination.[43] This is further compounded by the possibility of weaponisation of naturally occurring biological threats, disguising a deliberate terrorism act as a naturally occurring event.[44] Synthesised novel biological material can be difficult to identify since they are not likely to have identifiable signature, such as chemical trace.[45] This will demand a great deal of time and effort to identify a biological threat, which gives opportunities for other actors to circulate misinformation and disinformation.[46] The psychological implications will thus become counterproductive for society.

However, experts also mentioned that, with BATA in place, established laboratory practices and procedures are effective in preventing insider threats.[47] The Singapore Civil Defence Force (SCDF) HazMat department is at the forefront for any domestic biological threats in Singapore. They are the first responders and are equipped with the protective gear and triage capability to perform frontline threat assessment.[48] Concurrently, the Immigration & Checkpoints Authority (ICA) officers are given chemical, biological, radiological, nuclear, and explosives weapons (CBRNE) awareness training, as they are the first contact point with travellers crossing borders.[49]

The Singapore Armed Forces CBRE Defence Group (CBRE DG) is the military counterpart of the Home Team agencies. While their functions overlap with the SCDF HazMat department, the CBRE DG is the first responder when chemical, biological, or radioactive threats are used in conjunction with explosive devices, such as biological agents mounted on improvised explosive devices (IEDs).[50] At another branch of the Singapore Army, the Singapore Army Medical Services formed the Medical Response Force (MRF), a team of highly trained elite medical personnel, to support decontamination efforts, as part of consequence management activities.[51] In the event of an incident, MRF will be commanded by CBRE DG to render containment efforts. For incidents unrelated to IEDs, CBRE DG will render assistance to the Home Team agencies, where necessary.[52]

[42] Ibid.
[43] Interview with Singapore CBRE expert, Zoom, Singapore, September 2024.
[44] Interview, Singapore CBRE expert, Singapore, September 2024.
[45] Ibid.
[46] Ibid.
[47] Interview with Singapore laboratory expert, Singapore, July 2024.
[48] Interview with Singapore technology expert, Zoom, Singapore, August 2024.
[49] Ibid.
[50] Interview with Singapore CBRE expert, Singapore, September 2024.
[51] Ibid.
[52] Ibid.

One expert noted that there are no signs to suggest that terrorist groups have become more capable in conducting bioterrorism.[53] The COVID-19 pandemic demonstrated that biological threats have a far-reaching global impact when compared to traditional localised terror threats involving nuclear and radiological threats.[54] Factors, such as transmissibility, incubation period, and varied biological responses, increase the complexity and make biological material difficult to identify.[55]

The expert also noted that the availability of digital media has made the propagation of disinformation, misinformation, and technical knowledge more efficient.[56] The example cited was how train derailing techniques were spread by ISIS (Islamic State of Iraq and Syria) through their magazine, and we should be prepared that such medium may be used to teach people how to grow and disperse cultures. For example, the extraction of abrin toxin from rosary pea is already available on the Internet. On the same thread, the media has enabled various misinformation and disinformation campaigns that are disruptive to societal peace. The difficulty in material identification, coupled with the continuous disruption, can make it difficult for the government to provide authentic and official information.[57]

Biosurveillance

The One Health agencies develop the biosurveillance framework for strategies and intervention to mitigate public health risk from vector-borne and zoonotic diseases.[58] This framework supports the conduct of joint disease outbreak investigations, enhancing biosecurity at the borders to prevent incursion of exotic diseases, and contingency plans to manage outbreaks of major zoonotic diseases.[59]

Historically, biosurveillance approach has focused on a specific disease and working on plans to prevent its spread.[60] This approach resulted in a myopic view towards the situation and made authorities lose sight of other peripheral developments.[61] The modern approach is now to look at the system and value chain to understand the impact that the threat poses to all stakeholders.

The expert interviewed also highlighted the importance of assessing threat by risk level, as Singapore is not simply an island that can isolate itself from the world,[62] unlike self-sufficient states, such as Australia, where stringent rules are implemented to eliminate risk of biological contamination.
While livestock and domestic animals can be screened prior to importation, these activities are not applicable for wildlife, as it is impractical to monitor every animal that has crossed boundaries and thus biosurveillance will rely on horizon scanning. Horizon scanning provides better awareness of potential

[53] Interview with Singapore laboratory expert, Singapore, July 2024.
[54] Interview, Singapore CBRE expert, Singapore, September 2024.
[55] Ibid.
[56] Ibid.
[57] Ibid.
[58] Interview with Singapore expert, Zoom, Singapore, July 2024.
[59] Interview with Singapore expert, Singapore, July 2024.
[60] Interview with Singapore veterinary expert, Email, Singapore, August 2024.
[61] Interview with a Singapore veterinary expert, Singapore, August 2024.
[62] Ibid.

risk of disease from both regional and international sources.[63] This will then allow for appropriate counter measures to be recommended. This includes bird-proofing of bird farms to prevent contact between wild birds and resident birds, and vaccinating dogs in coastal areas to prevent transmission of rabies from wild animals.[64]

Current Legislations and Guidelines

BATA is the primary legislative tool in Singapore that governs the possession, importation, transhipment, transfer, and transportation of biological agents and toxins.[65]

At its fundamental level, BATA prohibits all usage of biological agents or toxins for non-peaceful purposes. This is further reinforced in the enactment of the Terrorism (Suppression of Bombings) Act 2007, where biological agents and toxins that can cause fatal harm are classified as lethal device.[66] A perpetrator, who discharges such lethal device to cause harm, may be punished with death penalty or life imprisonment.[67] The combination of these two laws provides a strong deterrent against bioterrorism.

At the operational level, BATA regulates the roles and responsibilities of a facility operator. This includes the formation of a biosafety committee and appointment of a biosafety coordinator, who will provide oversight on safety measures before activities can be carried out.[68] The operator is also required to ensure that the facility is regularly maintained, the staff are properly trained, risks are assessed and mitigated, inventory is managed, and biological agents and toxins are decontaminated before disposal.[69]

BATA lists down five schedules of biological agents and toxins in accordance with their corresponding biosafety risk groups (Table 2).

Table 2. Schedule of Biological Agents and Toxins in BATA According to Biosafety Risk Groups.

Schedule	Biosafety Risk
First Schedule	
Part I	Risk group 3 biological agents
Part II	Risk group 3 biological agents perceived to have the potential to be weaponised
Second Schedule	Risk group 4 biological agents

[63] Ibid.
[64] Ibid.
[65] SSO. "Biological Agents and Toxins Act 2005."
[66] Singapore Statutes Online (SSO). "Terrorism (Suppression of Bombings) Act 2007." Accessed 2 December 2024. https://sso.agc.gov.sg/Act/TSBA2007.
[67] Ibid.
[68] SSO. "Biological Agents and Toxins Act 2005."
[69] Ibid.

Third Schedule	Risk group 2 biological agents that need special attention if produced on a large scale
Fourth Schedule	Risk group 2 biological agents, including those listed under the Third Schedule
Fifth Schedule	Microbial toxins perceived to have the potential to be weaponised

Abbreviation: BATA: Biological Agents and Toxins Act 2005, Singapore

Facilities working on biological agents classified under the First and Second schedules must be certified as BSL3 containment facilities, of which there are approximately ten in Singapore, with one BSL4 facility planned for the future.[70]

Biological agents under the First Schedule Part II, the Second Schedule, and toxins under the Fifth Schedule are materials capable of weaponisation. These include *Bacillus anthracis* and Ebola virus, which have been witnessed to create serious harm, even under natural conditions, and pose specific bioterrorism risk. Facilities working with these agents and toxins are also required to be gazetted as a *protected place* under the Infrastructure Protection Act 2017 (IPA).[71] As a protected place, personnel working in the compound will require security screening before they can be allowed access. This process can take from a week to several months after application.[72]

However, BATA rules are relaxed when research works are conducted on inactivated biological agents listed in the First and Second schedules, and similarly for clinical laboratories conducting diagnostic testing on patient samples.[73] The Fourth Schedule serves as a catch-all list for the provision of the law.[74]

BATA has gone through regular updates and, according to one expert, the ministry has been enabling towards laboratory activities, striking a balance between having controls and innovation.[75] An example is the possibility of using inactivated agents within BSL2 facilities. While BATA concerns the importation of biological agents, SGCA governs the exportation of biological agents that may be reasonably believed to be used for the development, production, or dissemination of biological weapons.[76] The Act must be read in conjunction with the Strategic Goods (Control) Order, with the latest order in effect since 1 October 2023. The Order provides the Strategic Control List, which includes

[70] Interview with Singapore laboratory expert, Singapore, July 2024.

[71] SSO. "Biological Agents and Toxins Act 2005."

[72] Ministry of Health (MOH), Singapore. "Application to Gazette/De-gazette As a Protected Place under the Infrastructure Protection Act and Personnel Vetting for the Possession of Biological Agents and Toxins Listed in the Biological Agents and Toxins Act." Accessed 2 December 2024. https://isomer-user-content.by.gov.sg/4/2b059632-9100-4591-9d04-4014bddec719/applicationforgazette_feb2024187df7488ebb4920982ea5416ce10fc5.pdf.

[73] Interview with a Singapore infectious disease expert, Singapore, October 2024.

[74] Interview with Singapore laboratory expert, Singapore, July 2024.

[75] Interview with a Singapore infectious disease expert, Singapore, October 2024.

[76] SSO. "Strategic Goods (Control) Act 2002."

items from the four multilateral export control regimes[77] — Australia Group (AG), Missile Technology Control Regime (MTCR), Nuclear Suppliers Group (NSG), and Wassenaar Arrangement (WA). SGCA has been crafted with the intention to allow the minister to issue a new order to prescribe any dual-use goods or technology as strategic goods or technology, where there is reason to believe that exportation of these goods will be used for military or related activities.

Additionally, the Cybersecurity Act 2018 considers information infrastructure that enables services related to disease surveillance and response as Critical Information Infrastructure (CII).[78] This compels the owner of the infrastructure to conform with the code of practice established by the Commissioner of the Cyber Security Agency of Singapore (CSA) and to participate in cybersecurity exercises. However, this does not necessarily include organisations that operate laboratories that possess highly sensitive data.

Cooperation Initiatives

The inputs from experts suggest that regional cooperative initiatives have seen mixed results. The most significant progress is observed from the establishment of the Network of ASEAN CBR (chemical, biological, and radiological) Defence Experts (ASEAN CBR Network) in 2019,[79] a product from the ASEAN Defence Ministers' Meeting (ADMM). The network aims to promote cooperation through workshops, expertise sharing, and mutual visits to facilities. It has worked on the codification of transborder information sharing and harmonisation of standards by the end of 2024.[80]

Another initiative was the hosting of CBRNe Convergence Asia in January 2024 at the Civil Defence Academy (CDA) in collaboration with Home Team Science and Technology Agency (HTX). This was the first time Singapore collaborated with CBRNe World and brought together participants from both public and private sectors in the region and beyond, with key points presented by key representatives from the ASEAN countries.[81] The event served as a platform that allowed SCDF to demonstrate its capabilities to respond to chemical, biological, and radiological (CBR) threats.[82]

However, some experts expressed that more openness between regional countries is required for more meaningful outcomes.[83] This is largely dependent on the level of priority the regional platform is willing to accord.[84] The expert shared that joint operations to perform transnational outbreak

[77] Singapore Statutes Online (SSO). "Strategic Goods (Control) Order 2023." Accessed 2 December 2024. https://sso.agc.gov.sg/SL-Supp/S541-2023/Published/20230801?DocDate=20230801&ProvIds=Sc-#Sc-.

[78] Singapore Statutes Online (SSO). "Cybersecurity Act 2018." 16 March 2018. Accessed 27 October 2025. https://sso.agc.gov.sg/Acts-Supp/9-2018/.

[79] Interview with Singapore CBRE expert, Singapore, September 2024.

[80] Interview with Singapore laboratory expert, July 2024.

[81] CBRNe World. "CBRNe Convergence Asia 2024: Speakers." Accessed 30 November 2024. https://cbrneworld.com/events/asia-24/speakers-knoxville.

[82] Rutherford, Zoe, and CBRNe World. "Day One of CBRNe Convergence Asia 2024." Accessed 30 November 2024. https://cbrneworld.com/news/day-one-of-cbrne-convergence-asia-2024.

[83] Interview with Singapore expert, Zoom, Singapore, July 2024.

[84] Ibid.

investigations can strengthen the region's ability to tackle threat, but the expert also questioned the manner in which these teams needed to be deployed.[85]

The region has also advanced with the help of the EU CBRN Risk Mitigation Centres of Excellence (EU CBRN CoE) Initiative. The organisation has assisted in the setting up of the Southeast Asia Regional Secretariat in Manila in 2013.[86] From 2010 to 2024, EU CBRN CoE has contributed €33.5 million towards raising the CBRN risk mitigation capacity in ASEAN,[87] and there are four on-going projects in the pipeline.

Domestically, BAS plays an important role in bringing professionals working in fields related to biological risk management together to cultivate a biosafety culture. To date, they have about 100 members, and actively collaborate with regulatory agencies and international organisations to improve biological risk awareness through workshops.[88] Ground-up initiatives, such as these, are important as they can operate closely with interested parties, especially when authorities have limited outreach into the industry. However, considering the size of the industry, BAS may not have achieved sufficient reach into every organisation in the biomedical field.

Current Challenges and Gaps

Currently, there is no legislation specific to genetic modification technology and its products, and GMAC is the only body providing non-legal binding guidelines for researchers and businesses to adhere to.[89] GMAC is a multiagency committee under the Ministry of Trade and Industry (MTI) overseeing and providing scientific advice to researchers, companies, and the public.[90] Some of the regulatory authorities may depend on GMAC endorsement before issuing import permits. But, this remains insufficient to prevent entities from subsequently changing the use of the imported genetic material. This may require authorities to impose proper accounting for the usage of genetic material.

A concern vis-à-vis biosecurity of laboratories raised by several experts is regarding the information and cybersecurity issues surrounding the data collected during research.[91] Example of research data are those involving genetically engineered microorganisms. These research data can be used by other actors for nefarious reasons. But, these data may also need to be shared with regional

[85] Interview with Singapore expert, Singapore, July 2024.

[86] EU CBRN Risk Mitigation Centres of Excellence (EU CBRN CoE). "15 Years of International Cooperation through the EU CBRN Risk Mitigation Centres of Excellence Initiative." Accessed 28 October 2025. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC142130/JRC142130_01.pdf.

[87] Global Gateway. "EU-ASEAN Strategic Partnership Blue Book 2024–2025." Accessed 27 October 2025. www.eeas.europa.eu/sites/default/files/documents/2024/Blue-Book-EU-ASEAN-2024.pdf.

[88] Biorisk Association of Singapore (BAS). "President's Message." Accessed 2 December 2024. https://biorisk.sg/about/presidents-message/.

[89] Genetic Modification Advisory Committee (GMAC) Singapore. "Guidelines." Accessed 2 December 2024. www.gmac.sg/guidelines/.

[90] Genetic Modification Advisory Committee (GMAC) Singapore. "Overview." Accessed 2 December 2024. www.gmac.sg/about-us/.

[91] Interview with Singapore technology expert, Zoom, Singapore, August 2024.

countries to improve collective biosecurity capabilities. Therefore, there is a pressing need to establish data protection and sharing protocols between countries.[92]

The experts interviewed mostly agreed that cooperation at the international, regional, and interagency levels are of paramount importance towards the biosecurity of the region.[93] There is a sense that, in a post-pandemic world, domestic stakeholders and agencies have reallocated their resources based on individual priorities.[94] This has resulted in standalone, fragmented efforts at preparing for the next pandemic. An example of the gap cited by another expert is in the domains of health, security, and science, where there is general lack of cooperation during peacetime operations.[95]

Areas of improvement and policy recommendations

Review Existing Laws Governing Digital Assets That Hold Research and Genomic Data

To enable deeper regional cooperation on biosecurity matters, it is inevitable that certain degree of data sharing may be required to foster trust and capacity building. As proposed by the ASEAN Socio-Cultural Community Policy Brief, building and optimising big data and the information sharing system is crucial for advancing AMS' capacity to analyse and predict public health emergencies.[96] Countries in the region, such as Singapore, Malaysia, and the Philippines, are already performing whole genomic surveillance, collecting large amounts of genomic data for long-term studies.[97] However, biological data concerning agents may be highly classified, and genomic data may be personally identifiable information.

One legislation that prevents unauthorised access, transmission, and tampering of digital data is the Computer Misuse Act 1993.[98] Under the Act, penalties for offences can range from a fine not exceeding SGD5,000 or imprisonment not exceeding 2 years, to a fine not exceeding SGD50,000 or imprisonment not exceeding 7 years. The law is also given extraterritorial enforceability against foreign actors provided the system affected is in Singapore.[99]

However, the act distinguishes between regular computers and protected computers, of which computers that provide essential services and are related to the security and defence of Singapore are considered as protected computers.[100] Offences committed against protected computers face a penalty

[92] Interview with Singapore technology expert, Singapore, August 2024.

[93] Interview with Singapore laboratory expert, Singapore, 15 July 2024; interview with Singapore infectious disease expert, Singapore, 3 October 2024.

[94] Interview with Singapore expert, Zoom, Singapore, July 2024.

[95] Interview with Singapore technology expert, Zoom, Singapore, 5 August 2024.

[96] Resilience Development Initiative (RDI) and Aly Diana. "Strengthening ASEAN Public Health Emergency Measures." *ASEAN Socio-Cultural Community Policy Brief* 1. Accessed 2 December 2024. https://asean.org/wp-content/uploads/2023/03/8.-20232001_ASCC_Policy-Brief_Issue-1_AMD-20-Jan.pdf.

[97] Interview with Malaysian biotechnology expert, Kuala Lumpur, 21 May 2024; interview with Singapore technology expert, Singapore, 5 August 2024; interview with Philippine biosecurity experts, Manila, 13 June 2024.

[98] Singapore Statutes Online (SSO). "Computer Misuse Act 1993." 30 August 1993. Accessed 27 October 2025. https://sso.agc.gov.sg/Act/CMA1993.

[99] Ibid.

[100] Ibid.

of a fine not exceeding SGD100,000 or imprisonment not exceeding 20 years. While the penalty is heavier, this increased penalty was introduced in 1998, which may not be significant in today's terms. Thus, the monetary penalty ought to be revised to deliver a stronger deterrence. Then, the definition of protected computer is narrowly defined, and a computer system that holds such valuable biological information is currently not considered as a protected computer. To treat these systems as regular computers will not accord the appropriate level of protection necessary against the harm that can potentially arise from their misuse.

Similarly, the Cybersecurity Act 2018 considers information infrastructure for disease surveillance and response system to be of critical importance.[101] By its literal definition, infrastructure owners may not be willing to conform and comply, as there are significant operational overheads. But, a system containing sensitive data connected to the Internet for cross-boundary data sharing will be an attractive target for cyberattack. However, this can be rectified, at the operational level, by ensuring the entity providing the data sharing platform is purposed for disease surveillance and response.

At the domestic level, these revisions are necessary to ensure that the platforms are defended by laws with enough bite. This will improve trustworthiness from the public. At a regional level, harmonisation of cybersecurity laws is already under way with the proposed ASEAN Cybersecurity Cooperation paper.[102] Cyber readiness cooperation between AMS will be a critical pillar to enhance cyberbiosecurity.[103] By having stringent laws, Singapore can demonstrate its commitment to the safety and security of biological data.

Leverage on Novel Food Experience to Promote Bioengineering Awareness in the Region

Novel food refers to food or food ingredients without history of safe use over the past two decades.[104] These include the consumption of insects, laboratory-cultivated protein, and technologically advanced methodologies.[105] This potentially includes gene editing and bioengineering of food products. As the world's first country to legalise the sale of cultivated meat products in 2020,[106] Singapore has the head-start in assessing risk related to novel food.

As Southeast Asia's population is expected to grow, while facing increased risks from climate change, the agriculture industry may have to steer towards using bioengineering technology to improve productivity and ensuring supplies. In the 46th meeting of the ASEAN Ministers on Agriculture and

[101] Singapore Statutes Online (SSO). "Cybersecurity Act 2018." Accessed 2 December 2024. https://sso.agc.gov.sg/Act/CA2018.

[102] "ASEAN Cybersecurity Cooperation Strategy 2021–2025." Accessed 2 December 2024. https://asean.org/wp-content/uploads/2022/02/01-ASEAN-Cybersecurity-Cooperation-Paper-2021-2025_final-23-0122.pdf.

[103] Ibid.

[104] Singapore Food Agency (SFA). "Overview of Novel Food Regulatory Framework." Accessed 2 December 2024. www.sfa.gov.sg/regulatory-standards-frameworks-guidelines/novel-food-framework/overview-of-novel-food-regulatory-framework.

[105] Ibid.

[106] Tan, Audrey. "In a World First, Cultured Chicken Meat Approved for Sale in Singapore." *The Straits Times*, December 7, 2020. www.straitstimes.com/singapore/environment/worlds-first-cell-cultured-chicken-likely-to-be-at-restaurants-in-singapore.

Forestry (AMAF), it was proposed to prioritise identifying the trends and advancements in technology to push for carbon neutrality, reduce agrochemicals, and advance sustainable and regenerative agriculture.[107] While it is premature to specify which technological areas will be leveraged on, synthetic biology may potentially be a domain that can achieve these outcomes. This can, in turn, promote a significant growth in synthetic biology industries and experiments in the region. As discussed earlier, the benefits of synthetic biology experiments must be balanced with proper risk assessment and institutional oversight to avoid the risk of DURC.

SFA has a comprehensive framework for novel foods management. This includes having companies perform premarket safety assessments to ensure risks are identified and managed. Safety assessments are reviewed by the Novel Food Safety Expert Working Group, with inputs from experts from a wide range of fields, including bioinformatics, toxicology, and microbiology.[108] While this framework plays an important role in governing local companies that are entering the novel food industry, it has limited reach towards ensuring foreign food sources are properly assessed.

There are advantages that Singapore can benefit from by sharing the novel food management framework with other AMS. First, this framework can be shared with other AMS to ramp up their risk assessment abilities and capacity building, thus promoting the novel food sectoral growth in a controlled manner. Second, Singapore imports significant amounts of food products from Malaysia, Vietnam, and Indonesia. By using a common framework, Singapore can understand the process of evaluation at the source and thereby be assured of their food safety standards. Having common understanding can also promote effective data sharing and exchange of information. Third, it will be easier for Singapore to invest in and operate food production facilities in ASEAN.

Foster Close Regional Collaboration at High-Containment Facilities

The BSL4 facility represents the highest level of biosafety precautions, covering both the safety of personnel working within and the safety of the environment outside of the facility. As such, BSL4 laboratories are used to work on some of the most dangerous biological agents in the world. During the COVID-19 pandemic, the world saw how a BSL4 facility was accused of experimenting and releasing the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2 virus), causing panic and hurling of accusations by the international community.[109] Despite the absence of concrete evidence, the episode illustrates the politicising related to BSL4 facilities, where countries may be accused of biological

[107] "The Forty-Sixth Meeting of the ASEAN Ministers on Agriculture and Forestry (the 46th AMAF): Joint Press Statement." 24 October 2024. Accessed 2 December 2024. https://asean.org/wp-content/uploads/2024/10/JPS-46th-AMAF-final.pdf.

[108] SFA. "Overview of Novel Food Regulatory Framework."

[109] United States House Committee on Oversight and Government Reform. "COVID Origins Hearing Wrap Up: Facts, Science, Evidence Point to a Wuhan Lab Leak." 8 March 2023. Accessed 2 December 2024. https://oversight.house.gov/release/covid-origins-hearing-wrap-up-facts-science-evidence-point-to-a-wuhan-lab-leak%EF%BF%BC/.

weapons research or promoting DUR. According to a report by Global BioLabs, there are more than 50 BSL4 laboratories in 27 countries around the world.[110]

In 2021, Singapore announced plans to construct and equip the first BSL4 laboratory in the country. The facility aims to improve Singapore's self-reliance and technical competency in handling high-risk biological agents.[111] The initial budget to open the laboratory is projected to be SGD90 million and this amount does not factor in its on-going operational cost. In our interview, we also noted that one expert does not recommend countries with financial constraints to open high-containment facilities.[112]

To facilitate confidence building and expertise sharing in the region, Singapore can therefore propose to collaborate with researchers in ASEAN. Providing laboratory access to researchers without such facilities in their countries can help to promote regional scientific advancement, and deepen collaborations and understanding among the biological research community. A centralised collaborative setup can provide transparency into mutual research interests and avoid high-risk conduct outside of certified facilities. Collaboration can also foster safety culture, risk awareness and sharing of best practices across the region.

As per the requirements of IPA 2017,[113] these researchers will have to clear security screening before being allowed access to high-containment facilities. Approved researchers can therefore become valuable human resources to form the ASEAN laboratory team to deal with outbreak responses.

Additionally, taking successful experience in collaborating with Indonesia during the H5N1 incident in 2005, Singapore can help to build a conducive platform for biotechnology commercialisation in the region.[114] In the long run, the region can benefit from having a more matured biotechnology industry and a robust response framework to take on future healthcare crises.

Broaden Participation of Biosecurity Discussion to Include Public and Private Stakeholders

At present, regional collaboration revolves around the state governments and regulatory authorities. This space is dominated mostly by state agencies and lacks participation from industry practitioners. As previously mentioned, one expert highlighted that a whole-of-government approach will require more buy-in from both the public and private sectors, as promotion of inclusivity and equity in the biosecurity sector can foster deeper conversations and innovation. This is particularly important during peacetime,

[110] King's College London. "Global BioLabs Report 2023." Accessed 28 October 2025. https://www.kcl.ac.uk/warstudies/assets/global-biolabs-report-2023.pdf.

[111] Ministry of Defence (MINDEF) Singapore. "Fact Sheet: DSO Biosafety Lab to Be Upgraded to Handle Biological Threats and Highly Infectious Diseases." 1 March 2021. Accessed 2 December 2024. www.mindef.gov.sg/news-and-events/latest-releases/01mar21_fs.

[112] Interview with Singapore laboratory expert, Singapore, 17 July 2024.

[113] Singapore Statutes Online (SSO). "Infrastructure Protection Act 2017." 23 October 2017. Accessed 27 October 2025. https://sso.agc.gov.sg/Acts-Supp/41-2017/Published/20171031?DocDate=20171031.

[114] Interview with Singapore infectious disease expert, Singapore, 3 October 2024.

as agencies will focus on internal priorities and reduce resources for collaborative efforts.[115] Capacity building within agencies will require the commitment of resources for engaging the public and private sectors. This additional capacity is crucial to facilitate knowledge sharing, and open consultation and communication across all levels to promote active partnership.[116] This can also bridge the gap between agencies, which otherwise would not have overlapping concerns during peacetime operations.

Engaging the public to boost their biosecurity awareness may require a calibrated approach to avoid sending an overalarming message of impending attack. Apt examples are SCDF's efforts in advocating for cardiopulmonary resuscitation (CPR) and automated external defibrillator (AED) training, basic first aid, and firefighting.[117] Boosting public biosecurity awareness can be a simple reminder, such as preparing sufficient personal protection equipment (e.g., masks and hand sanitisers) during seasons of high acute respiratory infections. It is important to note that prior to COVID-19, mask wearing was not a social norm in Singapore. But, from the pandemic experience, the society has continued to don a mask, even as the country considers COVID-19 as an endemic issue.

Incidents, such as the mass food poisoning at ByteDance Singapore office[118] and the gastroenteritis incident involving 24 children at the Little Seeds Preschool branch, of which three were confirmed to be infected by *Salmonella* bacteria,[119] are cases that serve as reminders and lessons that biosecurity is everyone's business and demands our attention.

For the private sectors, regulators can assist to support, invite, and engage organisations and their researchers to participate in industry dialogue domestically and regionally. Much like how diplomacy is conducted across different tracks, having a 'Track 2' platform for corporations, start-ups, and the academia can allow for innovative exchanges and concerns to be aired. This can then be brought up on to the 'Track 1.5,' where these ideas and concerns can be presented to authorities to deliberate upon and address accordingly. Concurrently, ground-up initiatives, such as by BAS, can leverage on such occasions to broaden their outreach with domestic researchers and regional partners.

Industry Exercises and Simulated Response to Laboratory Leaks

While recognising the achievement of staying incident-free in the Singapore biological industry, it remains a risk that a laboratory leak may occur. Unlike the Cybersecurity Act 2018, BATA does not require facilities to conduct exercises to evaluate the operator's readiness for any biological incident.

[115] Interview with Singapore laboratory expert, Singapore, 15 July 2024.

[116] Ibid.

[117] Interview with a Singapore biosecurity expert, Singapore, August 2024.

[118] Yow, Daphne. "Catered Food behind ByteDance Mass Food Poisoning Case; SFA to Take Enforcement Action." *CNA*, November 29, 2024. www.channelnewsasia.com/singapore/bytedance-office-food-poisoning-catered-food-enforcement-action-putien-yun-hai-yao-4778021.

[119] Mohan, Matthew. "24 Children at Little Seeds Preschool Branch Ill with Gastroenteritis Symptoms, 7 Hospitalised." *CNA*, December 2, 2024. www.channelnewsasia.com/singapore/little-seeds-preschool-calvary-baptist-church-children-sick-hospital-gastroenteritis-salmonella-4781801.

The Singapore homeland security agencies are no strangers to emergency exercises. The Exercise NorthStar XI, held in 2023, simulated terrorist attack on key installations and SCDF demonstrated its ability to handle chemical attack alongside other agencies.[120] However, there has not been a publicly known exercise handling laboratory leaks.

Considering that most biomedical facilities are in the proximity of the Buona Vista Biopolis cluster, the regulator or the industry should consider conducting such exercises to test the readiness of containment strategies. As the nature of laboratory research may vary, the exercises may require different scenarios involving different industries.

Involvement with a wider range of stakeholders, such as universities, will send a signal that the regulator takes a serious view towards biosafety in laboratory activities and their consequences. This will be useful to impart safety culture to students, who will soon be entering the workforce. Making such exercise public can instil confidence in the public that countermeasures, in case of accidental leaks, are in place.

Even in the absence of a physical exercise, key industry players can work with the agencies to have tabletop exercises, where they can present their procedures and controls for discussion. This will allow the identification of any weaknesses for future improvement.

[120] Chua, Nadine. "Anti-terror Exercises Must Be Taken Seriously As 'One Day, We May Not Be Lucky': PM Lee." *The Straits Times*, March 23, 2023. www.straitstimes.com/singapore/anti-terror-exercises-must-be-taken-seriously-as-one-day-we-may-not-be-lucky-says-pm-lee.

Chapter 3

Biosecurity Governance in Indonesia: A View from the Periphery

Dominggus Elcid Li

Introduction

How to manage biosecurity — which includes protection against diseases affecting plants, animals, and humans — is a major challenge for Indonesia, with its vast territory and archipelago formation. On the one hand, the archipelago model is the best defence system in breaking, isolating, and slowing the spread of disease during a pandemic. On the other, it is a weakness due to the limited reach, coordination, and capacity of biosecurity surveillance infrastructure. Especially for Indonesia, the decentralisation process, called regional autonomy, does not extend to the decentralisation of strengthening biosecurity capacity, which makes the pattern of handling pandemics always centralised, necessitating alternative strategies to accommodate the biodiversity of the archipelago system.

This chapter attempts to discuss the challenges of biosecurity governance in Indonesia. First, it explains the role of National Agency for Disaster Countermeasure (BNPB) in dealing with biosecurity threats, especially those that have strengthened since the COVID-19 pandemic. Second, it explores biosecurity threats and identity politics bias. This section discusses the present pattern of centralised emergency response to biosecurity threats, and also inherent elements of discrimination from policymakers and its impact on the peripheral areas. Third, it examines governance vis-à-vis the main threat of post-COVID-19 biosecurity in Indonesia, which will require a reinterpretation of cross-sectoral coordination at every stage of government, from the central government to the village level, to arrive at an ideal model for handling future pandemics.

Research Methods

This study uses qualitative research methods by interviewing experts, practitioners, researchers, and market participants, who are in direct contact with biosecurity issues at the local, district, provincial, regional, and national levels (Table 1). In addition, it also uses the results of border surveys to map the impact of biosecurity threats for border residents.

Table 1. Research Methodology.

Research Questions	Methods	Scope
What is the current situation of biosecurity governance in Indonesia?	Literature review, in-depth interviews, observation, and institutional ethnography study	Local, district, provincial, regional, national, and international
Who are the key actors to anticipate biosecurity threat?	In-depth interviews, literature review, and institutional ethnography study	Local, district, provincial, regional, national, and international
What are the challenges for coordination within the Indonesian bureaucracy when anticipating biosecurity threat?	Literature review, in-depth interviews, observation, and institutional ethnography study	Local, district, provincial, regional, national, and international
What are the problems, from the periphery, related to the biosecurity problem within the national biosecurity framework?	In-depth interviews, surveys, and institutional ethnography study	Local, district, provincial, regional, and national
What are the impacts of unanticipated biosecurity threats to local farmers?	In-depth interviews and surveys	Local, district, and provincial
What are the problems of biosecurity related to transboundary issues?	In-depth interviews, observation, and institutional ethnography study	Local, district, provincial, regional, national, and international
What could be done to anticipate new pandemic threats vis-à-vis after experiencing the COVID-19 pandemic?	Literature review, in-depth interviews, observation, and institutional ethnography study	Local, district, provincial, regional, national, and international

Abbreviations: COVID-19: coronavirus disease 2019

Formally, this research was carried out from March 2024 to July 2024, but, in real terms, the researcher himself has been conducting biosecurity research since the end of September 2019 and continues to do so until the present day, in lieu of his position as a researcher in the border areas. Since March 2020, following the outbreak of the pandemic, the researcher has become one of the coordinators of COVID-19 volunteers, who conducts risk communication at the provincial and national levels, and is the Deputy Chairman of the East Nusa Tenggara (Nusa Tenggara Timur/East Southeast Islands; NTT) provincial public health laboratory. This laboratory conducts free COVID-19 examinations by introducing the pooled test method, and is a partner of various institutions and the Ministry of Health, Indonesia. Border research was carried out jointly with United Nations Development Programme (UNDP)-Indonesia, in the territory of Indonesia and Timor Leste during 2019–2020. A study on the impact of ASF was carried out for border residents of the Malaka Regency in August 2023. Qualitative research photographed biosecurity threats in the NTT province, and especially in Kupang, Sumba Timur, and Malaka Regency.

Findings

Current Trends of Biosecurity Risk

In Indonesia, when it comes to biosecurity, it is a concept familiar to the veterinarians, with strategies including isolating livestock, maintaining enclosure hygiene, inhibiting infectious agents, and preparing for livestock regeneration. The concept of biosecurity targeting humans only developed during the spread of avian influenza. However, biosecurity in plants has not yet contextually developed to a practical level, as it continues to receive minimal public policy attention and minimal budget allocation.

The trend of biosecurity handling has strengthened since the COVID-19 pandemic in 2020, and was followed during the treatment of FMD in cattle in 2023. In addition, the treatment trend in various regions is also related to ASF disease, that attacks pigs, as well as zoonotic rabies disease, that attacks dogs and humans, which has appeared since 1997. The handling of plant diseases is still not part of the public campaign.

Governance and Institutional Mechanisms

Formal actors and organisations: Biosecurity, the pandemic, and BNPB

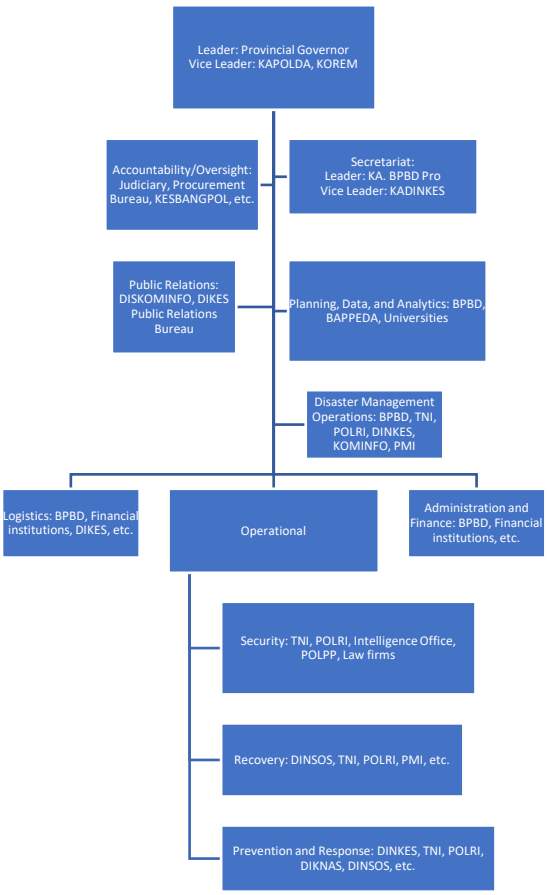
In general, Indonesia is undergoing structural and governance changes in the government, which was originally dominated by civilian politicians since the end of the New Order in 1999.[1] Since gaining momentum from the COVID-19 pandemic in 2020, the space for involvement of the Indonesian National Armed Forces (TNI) has been enlarged in various government systems, especially in disaster management through BNPB, which is managed by active military generals. Since the COVID-19 pandemic, BNPB's role is not just limited to the handling of natural disaster threats but is also related to biosecurity threats.

In the structure below, it can be seen that the territorial military command system has gained momentum to become active again through the coordination of handling COVID-19 (Figure 1). Based on Minister of Health Decree No. 209 of 2020,[2] in addition to the civilian government, two other structures that are active in the pandemic command and coordination structure involve two other institutions, namely the Indonesian National Police (POLRI or INP), and the Indonesian Army Territorial Forces Command.

[1] ASH Center for Democratic Governance and Innovation, Harvard Kennedy School (HKS). "From Reformasi to Institutional Transformation: A Strategic Assessment of Indonesia's Prospects for Growth, Equity and Democratic Governance." 2011. Accessed 29 October 2025. https://ash.harvard.edu/wp-content/uploads/2024/02/1267185_01.pdf.

[2] Ministry of Health, Indonesia. "*Rencana Operasi Penanggulangan COVID-19 Bidang Kesehatan di Indonesia*." 2020. Accessed 29 October 2025. https://pusatkrisis.kemkes.go.id/download/dtkmh/files9284final_Buku_Respons_Plan.pdf.

Figure 1. Coordination, functions, and duties of relevant units in the Ministry of Health according to the Ministerial Decree 01.07/MENKES/209/2020.



Abbreviations: BAPPEDA: *Badan Perencanaan Pembangunan Daerah* (Regional Development Planning Agency); BPBD: *Badan Penanggulangan Bencana Daerah* (Regional Agency for Disaster Management); DIKNAS: *Dinas Pendidikan* (Education Agency); DIKES: *Dinas Kesehatan* (Health Agency); DINSOS: *Dinas Sosial* (Social Service Agency); DISKOMINFO: *Dinas Komunikasi dan Informatika* (Communication and Information Technology Agency); KADINKES: *Kepala Dinas Kesehatan* (Head of the Health Agency); KAPOLDA: *Kepala Kepolisian Daerah* (regional chief of police); KESBANGPOL: *Badan Kesatuan Bangsa dan Politik* (National Unity and Politics Agency); KOMINFO: *Kementrian Komunikasi dan Informatika* (Ministry of Communication and Information Technology) ; KOREM: *Komando Resor Militer* (Military Resort Command); PMI: *Palang Merah Indonesia* (The Indonesian Red Cross Society); POLPP: *Satuan Polisi Pramong Praja* (Municipal Police); POLRI: *Kepolisian Negara Republik Indonesia* (Indonesian National Police); TNI: *Tentara Nasional Indonesia* (Indonesian National Armed Forces)

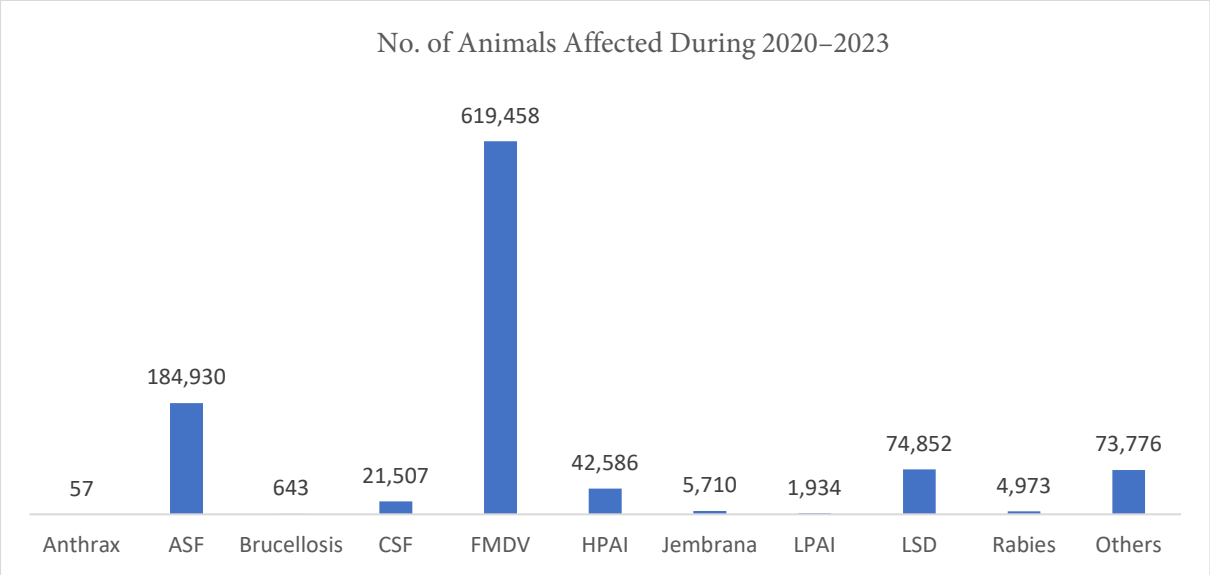
The main challenge during the COVID-19 pandemic was the complexity of coordination between institutions at various levels, from the central government to the village level. In addition, interprofessional coordination, for example, the dualism of authority between clinical pathologists and biomolecular experts is also often debated in terms of who is authorised to examine samples. At the technical level of the government, the mechanisms for changing its budgets, which has experienced massive cuts, has also become a hurdle.

Response frameworks

One way out is to use a disaster response mechanism managed by BNPB, which is the national disaster management agency, and, in this case, is managed by the Indonesian Army (TNI).[3] When managed by BNPB, disaster management activities fall within the purview of the military command unit. The advantage is that complex bureaucratic constraints and communication networks can be simplified by 'hitching a ride' on the military command structure of the Indonesian Army.

After the COVID-19 pandemic, BNPB's role, in the context of biosecurity, has expanded to involve biosecurity threats, such as during the handling of COVID-19 in 2020, and FMD in cattle since July 2022. BNPB has declared FMD an "Emergency Status for livestock,"[4] as it has affected 233,370 active cases of cattle, spread across 246 districts/cities in 22 provinces, according to data from the Ministry of Agriculture's iSIKHNAS system, which is Indonesia's national animal health and production information system.[5] According to data in iSIKHNAS for the last four years (period 2020–2023), in the context of biosecurity, the highest animal disease spreading in Indonesia is FMD, with 619,458 cases recorded (Figure 2).

Figure 2. Incidence of animal diseases in Indonesia during 2020–2023.



Abbreviations: ASF: African swine fever; CSF: classical swine fever; FMDV: foot and mouth diseases virus; HPAI: highly pathogenic avian influenza; Jembrana: Jembrana disease virus; LPAI: low pathogenic avian influenza; LSD: lumpy skin disease

Source: iSIKHNAS (*Sistem Informasi Kesehatan Hewan Nasional* or National Information System on Animal Husbandry)

[3] Djuyandi, Yusa, Heri Casnoto, and Wahyu Hidayat. "Military Operations Other Than War (MOOTW): Synergy of Indonesian National Armed Forces (TNI) and National Disaster Management Agency (BNPB) in Disaster Management." *Humanities & Social Sciences Reviews* 7, no. 4 (2019): 111–21. Doi:10.18510/hssr.2019.7416.

[4] Hidayati, Nabila Nur, et al. "Characteristics of Dairy Cattle Farmers Post Foot and Mouth Disease (FMD) in the Lowlands of Malang Regency." *International Journal of Scientific Research and Engineering Development* 7, no. 3 (2024). https://ijsred.com/volume7/issue3/IJSRED-V7I3P143.pdf.

[5] International Federation of Red Cross and Red Crescent Societies (IFRC). "Indonesia: Foot and Mouth Disease Outbreak." DREF Operation-Final Report. Accessed 30 October 2025. https://adore.ifrc.org/Download.aspx?FileId=682143.

In the context of biosecurity threats, there are visible signs of discrimination and myopic functioning at the policymaking level. This is evident in the interventions by BNPB in combating animal diseases, where the use of resources is only deemed appropriate if the situation meets the 'national disaster standard,' the scope of which tends to be centralised, neglecting the context of Indonesia's biodiversity. In recent cases, the national disaster status related to biosecurity threats has also been influenced by elements of national identity.

Policy biases are apparent in, for example, the specific emergency standards issued by BNPB for FMD in cattle while turning a blind eye to the spread of ASF among pigs.[6] Within the scope of biosecurity, BNPB's post-COVID-19 role has prioritised FMD in cattle as a national issue. A common question arises as to why ASF in pigs has not been considered a 'specific emergency condition' to date, despite the higher number of deaths and losses incurred by pig farmers, when compared to cattle, due to the higher fatality rates in pigs.

One concerning aspect is the strengthening of identity politics, which significantly influences public policy and opens the door to uncontrolled biosecurity threats. This issue is not limited to BNPB but also extends to the Ministry of Agriculture when concerning the handling of diseases classified as 'forbidden animals,' such as ASF in pigs and rabies in dogs.

Although the handling of FMD under the command of BNPB is new, there are at least some weaknesses in this system — (i) the lack of cross-sectoral coordination between BNPB, as the disaster organ, and the livestock sector, quarantine facilities, and the network of laboratories in various regions that handle animal health; (ii) lack of scientific backing in handling emergencies is also evident when it comes to the determination of the right type of FMD vaccine needed based on scientific standards; (iii) the integrated surveillance strategy mechanism practised in dealing with this biosecurity threat for cattle requires coordination, down to the smallest unit of the animal health bureaucracy in the field, considering the type of disease, epidemiological pattern, and preventive mechanism to develop a progressive surveillance system; and (iv) procurement of vaccines has become immeasurable and redundant.

The latest weak point is also related to corrupt practices that are closely related to money politics that dominate the Indonesian political system. This has a direct impact on the performance of various ministries, including the Ministry of Agriculture, which also oversees plant diseases and animal health. The BNPB itself, while managed by the active army, is considered inaccessible to interference by the civilian judiciary, including the Indonesian Commission for the Elimination of Corruption (KPK).

In the future, BNPB, which is positioned as 'a super body' to handle natural disasters and certain emergencies, such as biosecurity threats, needs to expand cooperation mechanisms with various laboratories and research institutions, and enable cross-sectoral coordination that should have begun to

[6] Interview with an Indonesian biosecurity expert, Denpasar, October 2024.

be built long before the pandemic arrived. In particular, it is necessary to consider how to link the early warning system element through the border quarantine system or how it can be combined with the biosecurity surveillance process for various commodities, and how to develop community management to manage biosecurity.

Research and Development

Coordination Mechanisms

Besides discrimination at the policymaking level, in terms of dealing with biosecurity threats, the focus of BNPB should not just be on vaccinations, as was the case during the COVID-19 pandemic. It is now being deployed to manage and overcome biosecurity threats, such as FMD, as well. BNPB should begin to develop more adequate surveillance capabilities, coordination capabilities with various related institutions, such as laboratory networks, and ensure cross-sectoral cooperation to conduct surveillance, etc. This is enabled in Presidential Instruction No. 4 of 2019 on Capacity Enhancement in Preventing, Detecting and Responding to Outbreaks of Disease, Global Pandemic and Nuclear, Biological and Chemical Emergencies.[7]

Complex matters, for instance, surveillance schemes that can be developed, should be able to extend beyond textbook studies that often tend to be late. For example, BNPB and other related institutions should start thinking about cross-border surveillance schemes. As control over biosecurity threats is insufficient through border surveillance alone, there is a requirement for coordination with the *chefe de suco* in Timor Leste and the village heads in Indonesia, as grassroots actors, for conducting surveillance of the smallest government coordination areas between countries with land borders.

For this reason, community management at the village (*desa*, Indonesia) or *suco* (Timor Leste) level, when handling biosecurity cases, needs to be developed. Village or *suco* government is very important, considering that the land border between Indonesia and Timor Leste is 266.8 km long, and is represented by 5 entrance posts in three districts (Table 2). It would be impossible to build a monitoring system with a sole reliance on checks at formal checkpoints. In the case of handling biosecurity threats, such as ASF and rabies, regional coordination needs to be carried out down to the village level. However, even this action does not guarantee a complete check of disease spread, because livestock, in general, in border areas are difficult to control, as they are usually released wild. Only with a community-based approach can biosecurity threats across countries with land borders be effectively dealt with.

[7] Database Peraturan. "*Peningkatann Kemampuan Dalam mencegah, Mendeteksi, dan Merespon Wabah Penyakit Pandemi Global, dan Kedaruratan Nuklir, Biologi, dan Kimia*." Accessed 30 October 2025. https://peraturan.bpk.go.id/Details/110251/inpres-no-4-tahun-2019.

Table 2. List of Cross-Border Posts on the Land Border Between Indonesia and Timor Leste.

Name of Cross-Border Post	District and Province	Border Between	Year of Foundation
PLBN Mota Ain	Belu district, NTT province	Indonesia-Timor Leste	2015
PLBN Mota Masin	Malaka district, NTT	Indonesia-Timor Leste	2015
PLBN Wini	Timor Tengah Utara district, NTT	Indonesia-Timor Leste	2015
PLBN Napan	Timor Tengah Utara district, NTT	Indonesia-Timor Leste	2020
PLBN Oepoli	Timor Tengah Utara district, NTT	Indonesia-Timor Leste	2020

Abbreviations: NTT: East Nusa Tenggara/Nusa Tenggara Timur/East Southeast Islands, Indonesia; PLBN: *Pos Lintas Batas Negara* (Cross-Border Posts)

The coordination element of Indonesia's biosecurity governance also involves difficulties associated with handling biosecurity for two countries on a single island, which continues to be very centralised, and requires further anticipatory steps for biosecurity threats for outer islands bordering other countries or within an island with land borders (e.g., Borneo, Papua, and Timor).

Especially for border areas, as it should be in the context of NTT province, biosecurity threat mapping should already include the risk of spreading infectious diseases from Dili, as an international port, to anticipate transboundary threats. Conversely, the same thing needs to be done by the government of Timor Leste towards Indonesia (e.g., for NTT and Bali), as well as Australia. Timor Leste's position, as an international port, needs to be considered by the NTT provincial government during biosecurity risk analysis. This is because the initial spread point of ASF in Indonesia appears to be in the NTT province from Timor Leste areas bordering West Timor (part of NTT).[8] The Timor Leste government's official declaration of the ASF threat only appeared in September 2019,[9] but online news sources indicate that ASF was already observed in Timor Leste in March 2019. ASF itself was officially declared to be spreading in PRC (People's Republic of China) from August 2018.[10] In Indonesia, ASF was first known to appear in December 2019 in North Sumatra and in West Timor in February 2020.[11] This delay was because only North Sumatra has an ASF testing laboratory, while, for Timor Leste, there is dependence on the Australian government, which has a testing laboratory in Melbourne.

[8] Interview, Indonesian biosecurity expert, Denpasar, October 2024.

[9] Government of Timor-Leste. "African Swine Fever in Timor-Leste." 27 September 2019. Accessed 30 October 2024. https://timor-leste.gov.tl/?p=23069&lang=en.

[10] You, Shibing, et al. "African Swine Fever Outbreaks in China Led to Gross Domestic Product and Economic Losses." *Nature Food* 2 (2021): 802–8. www.nature.com/articles/s43016-021-00362-1.

[11] Primatika, Roza Azizah, et al. "Cartographical Analysis and Anthropogenic Risk Factor of African Swine Fever Outbreak in North Sumatra, Indonesia on 2019–2020." *Veterinary Practitioner* 23, no. 1 (2022): 200–6. www.researchgate.net/publication/368787921_CARTOGRAPHICAL_ANALYSIS_AND_ANTHROPOGENIC_RISK_FACTOR_OF_AFRICAN_SWINE_FEVER_OUTBREAK_IN_NORTH_SUMATRA_INDONESIA_ON_2019-2020.

The difficulty for these outer islands is that there is very limited fiscal space to deal with biosecurity threats. The lack of local fiscal capacity means that agriculture and livestock officials do not have operational funds to conduct counselling and surveillance. In the context of an island province, such as NTT, there should be a laboratory integration mechanism that accommodates diseases in the context of One Health, which includes human, animal, and plant health. However, budget savings, in terms of designing an integrated laboratory (to examine human, animal, and plant samples), are currently not possible because the concept of One Health is as yet only an idea that has still not become consolidated in the Indonesian bureaucratic system. Sectoral ego, as a term used by bureaucrats to refer to the condition of lack of fiscal resources, transforms budget plots into a struggle between various agencies and ministries.[12]

Meanwhile, at the level of cross-border cooperation, the complexity at the governance level, for example, to make the biosecurity handling policy operational, requires cooperation with the Ministry of Foreign Affairs (MoFA) to bridge coordination abroad, the Ministry of Agriculture, which oversees the Director General of Animal Health and Animal Quarantine, and National Agency of Drug and Food Control (BPOM), which is under the Ministry of Health, the National Border Management Agency (BNPP), which oversees Cross-Border Posts (PLBN), as well as the Indonesian Quarantine Agency (IQA) and BNPB, which are both directly under the President.[13]

Biosecurity Risk Communication After Pandemic COVID-19

After the vaccine arrived and the COVID-19 pandemic became less deadly, the parties who were on alert seemed to have relaxed their vigilance. The COVID-19 pandemic is a valuable experience for anyone who has experienced and fought on the frontlines, especially to study how the Indonesian state responds to emergencies with its many localities. With 38 provinces, 514 cities/districts, 7,277 subdistricts/districts, 83,763 villages/subdistricts, and 6,000 inhabited islands, until July 2024, the number of COVID-19 cases in the country was 6.8 million cases, with 162,063 deaths.[14]

For example, in the case of the NTT province, which borders Australia and Timor Leste, when COVID-19 was announced in Indonesia in early March 2020, the main intervention adopted by the islanders was to close entry into the island. This was done even long before COVID-19 was detected in the Provincial City, or even Indonesia.

The story of thousands of islanders in NTT is more or less the same, as the story of people from other small islands in Indonesia, who do not have a protective biosecurity network and use isolation strategies as the easiest way to tackle such situations, as they have no ability to check the spread of disease otherwise. Until August 2020, it took 3–6 weeks to determine whether someone had COVID-19 in NTT. At that time, laboratory detection equipment in NTT was minimal, with only one government

[12] Interview with a veterinary biosecurity expert, Denpasar, Indonesia, August 2024.

[13] Interview with Indonesian biosecurity experts, Jakarta, Indonesia, March 2024.

[14] Covid Totals, Today. "Coronavirus COVID-19 Cases in Indonesia." Accessed 30 October 2025. https://covid19-today.pages.dev/countries/indonesia/.

laboratory that had limited examination capacity of just 20 examinations per day for a population of over 4 million people.

Over the last five years, Indonesia's ability to detect infectious diseases has also improved. Currently, in NTT alone, there are 6 health laboratories that meet BSL2 standards compared to only one such laboratory five years ago. In 2023, for instance, the Indonesian government aimed to create 10,374 non-biosafety level laboratories at the *Puskesmas* (village-level, integrated public community health centres) level, 28 provincial health centres of BSL2 category, 12 regional health centres of BSL2 category, and 2 national health centres of BSL3 category.[15]

At the laboratory infrastructure level, this step forward by the Indonesian Ministry of Health is a breakthrough because most of the laboratories used to detect COVID-19 during the pandemic were originally animal disease examination laboratories under the Director General of Animal Health under the Ministry of Agriculture. During the COVID-19 pandemic era, the network of laboratories with biosafety and biosecurity capacity that were entitled to conduct examinations was formed from clinical laboratories, laboratories in health facilities, regional health laboratories, large centres for environmental health and disease control techniques, large health laboratory centres, laboratories of health R&D agencies, and research laboratories in universities or independent non-university institutions.

In general, however, the experience of dealing with the COVID-19 pandemic has not made people better prepared for the next pandemic, and there are major concerns about the declining capacity of the bureaucracy in responding to biosecurity threats within the government, as well as the inability to initiate coordination steps during ordinary times or without threats for preparation.

The system's weak ability to anticipate threats is twofold. Firstly, merit-based technocrats working in the bureaucracy are excluded due to 'outsiders' being installed by political parties in the ministries, so that the career ladder mechanism is no longer well organised. The main complaint that arises is that technocrats in the bureaucracy, who have received capacity building training, are often excluded due to political party pressures. In the New Order era, the role of political parties had only reached the ministerial level, but, now, the influence of political parties has seeped in extensively from the lower positions extending up to the level of director general even. The bureaucracy's ability to anticipate various threats has diminished correspondingly.

Secondly, the pervasive nature of corruption within the Indonesian system is a concern.[16] Simple matters, such as procurement of vaccines and laboratory equipment, are often the targets of corruption. The collaboration between corrupt officials and the support of political elements has led to poor-quality

[15] Ministry of Health, Indonesia. "*Kemenkes Lakukan Tata Ulang Laboratorium Kesehatan di Indonesia*." 17 April 2023. Accessed 30 October 2025. https://penanggulangankrisis.kemkes.go.id/kemenkes-lakukan-tata-ulang-laboratorium-kesehatan-di-indonesia.

[16] Polio Pulse. "Posts Claim That the Indonesian Government Is Hiding Incriminating Vaccine Data." 4 February 2025. Accessed 30 October 2025. www.poliokit.org/pulse/posts-claim-indonesian-government-hiding-incriminating-vaccine-data.

public policies. This state of affairs extends from the central government level to that of the local governments.

Conclusion: Biosecurity, Indonesia, and the Asia Pacific

Within the scope of countries in the Asia Pacific, Indonesia's main support for addressing biosecurity issues comes from the Australian government. Since the Second World War, in the context of Australia's defence, the Indonesian territory has been considered as Australia's barrier zone in the Asia Pacific. This is evident from Australia's support for various biosecurity-related programmes in Indonesia over the last four decades, such as support for a network of veterinary laboratories that were the main backbone of COVID-19 testing, as well as programmes with Australian Government support related to biosecurity, including AUSVET and AIP-PRISMA.[17]

Internally, it appears that the Indonesian government's main concern is currently directed at zoonotic diseases, especially in terms of developing laboratory infrastructure since 2019.[18] Meanwhile, the main threat for the future is influenza virus-related diseases, in addition to four other viruses, such as coronavirus, paramyxovirus, flavivirus, and filoviruses (e.g., Ebola).[19] For this reason, since 2020, the Government of Indonesia, with the support of WHO, has simulated the possibility of a breakout of influenza.[20]

In the context of One Health, the Indonesian government's attention is still focused on human infectious diseases, zoonotic diseases, animal diseases, and plant diseases. Biosecurity threats that attack plants still receive very little attention. This disease priority pyramid is also reflected in Indonesia's government structure.[21] Human diseases are handled directly by the Ministry of Health, while animal diseases are managed by the Director General of Animal Health under the Ministry of Agriculture. The main difficulty is that, when it comes to coordinating zoonotic diseases, such as rabies, the level of coordination becomes unequal between the Minister of Health and the Director General of Animal Health.

[17] AUSVET. "The Indonesia Biosecurity Support Project." Accessed 30 October 2025. https://ausvet.com.au/projects/indonesia-biosecurity-support/; Australian Government Department of Foreign Affairs and Trade (DFAT). "Strategic Review: Australia-Indonesia Partnership for Rural Incomes through Support for Markets in Agriculture, Phase 2 (PRISMA-2)." 12 January 2023. Accessed 30 October 2025. www.dfat.gov.au/sites/default/files/prisma-isr-review-report.pdf.

[18] Interview with Indonesian expert, Bogor, Indonesia, March 2024.

[19] Interview with veterinary biosecurity expert, Bogor, Indonesia, March 2024.

[20] World Health Organization (WHO). "Indonesia: Strengthening Pandemic Preparedness in Indonesia amid the COVID-19 Response." Accessed 30 October 2025. www.who.int/about/accountability/results/who-results-report-2020-mtr/country-story/2022/strengthening-pandemic-preparedness-in-indonesia-amid-the-covid-19-response#:~:text=%22Indonesia%20developed%20an%20influenza%20pandemic,from%20the%20COVID%2D19%20response.

[21] Interview with veterinary biosecurity expert, Denpasar, August 2024.

Recommendations

In the pandemic governance scheme, Indonesia has proven to have the resilience to carry out complex coordination through three main official structures — civil administration, police, and army — and through a lesser-mentioned structure of multilayered volunteer organisations. However, to deal with expansive issues, such as biosecurity and pandemic threats, revamping the bureaucracy at various levels should be possible.

First, with the high level of connectivity between regions due to trade flows and the increasing biosecurity threats due to the threat of climate change that can trigger various events, Indonesia needs to develop a coordination system for pandemic anticipation that can be exercised even with no emergencies. Strategic planning capabilities designed to deal with future pandemics should be created, and not placed in an emergency scheme of things.

Second, in dealing with biosecurity threats, Indonesia should continue to develop an adequate surveillance system, especially to monitor infectious diseases for which there is no vaccine, including ASF. BNPB's focus on dealing with biosecurity threats should not only be limited to providing vaccines but also extend to developing surveillance systems and strategies to manage pandemics properly. Most likely, BNPB's intervention on FMD was adopted because the vaccine for FMD is already available while that for ASF is not so. So, it is recommended that BNPB, in the future, further develop surveillance capabilities and determine adequate strategies for isolating diseases during a pandemic, and not just repeat its limited role and function as seen during the last pandemic, namely in merely intensifying vaccination.

Third, the biodiversity element that characterises archipelagic countries, such as Indonesia, must be translated into non-discriminatory public policies. If the subjective bias of policymakers, who tend to be centralised, can be reduced, the ability to anticipate surveillance and the application of biosecurity disciplines could be expanded immensely, especially for anticipating the food security crisis that could be experienced by its peripheral regions due to biosecurity threats.

Fourth, one of the fundamental challenges in the surveillance process in the early phase of the COVID-19 pandemic, which occurred between February and May 2020, was the lack of examination capabilities to detect the COVID-19 virus. Until the present day, there persists a weakness in anticipating future pandemics because, even currently, the government is still only focussing on the number of laboratories available but not figuring in examination capacity, especially for conducting massive examinations for surveillance purposes. Indonesia needs to reform the bureaucracy, that tends to be corrupt, and also achieve budget efficiency by operationalising the concept of the One Health laboratory in order to maximise the use of cross-sectoral laboratories that will be necessary for handling biosecurity threats.

Furthermore, although all measures have been taken to anticipate possible outbreaks through the surveillance of goods and people in a transboundary context at various border entrances, a key vector

that cannot be controlled is transmission through bird migration. Mapping the possibility of future transmissions will also largely be determined by the ability to quickly deal with the next pandemic and strategies for isolating it.

Chapter 4

Biosecurity Landscape in Cambodia, Laos, Myanmar, and Vietnam

Chan Wai Xin

Introduction

Cambodia, Laos, Myanmar, and Vietnam are the four countries located in the heart of the Greater Mekong Subregion (GMS). The subregion connects to Yunnan, China, to the north and to Thailand in the south. The Mekong River flows from Yunnan to the southern tip of Vietnam before it empties out into the sea, acting as a conduit for intraregional transportation and providing the essential water resource for rice field irrigation. The floodplains deposits contributed by the annual Mekong River floods also provide nutrient-rich soil for cultivation, and the supply of freshwater fish supports the livelihood of millions of people.[22]

The landmass of the GMS area is home to a wide range of wildlife, with no fewer than 20,000 species of plants, 1,200 bird species, 800 species of reptiles and amphibians, and 430 mammalian species, according to the World Wildlife Fund (WWF).[23] It is also part of the East Asian-Australasian Flyway for migratory bird species travelling from as far north as the Himalayas to Singapore in the south.[24]

However, this high degree of dependency on the river also raises serious concerns. The implementation of hydropower dams in the upstream areas would have severe consequences for downstream countries. By restraining the flow of the river, freshwater fish supply becomes limited downstream, and the reduced volume causes salinity intrusion in the Mekong Delta in Vietnam.[25] This salinity intrusion into farmlands will further exacerbate the ability to sustain food production.[26]

The wide range of environmental damage and subsequent ecological damage would severely impact the biodiversity native to GMS. Governments in the region have attempted to adopt the One Health approach towards preserving better environmental, animal, and human health. However, the general state of poor economic development in the region has put limitations on the spending power needed to improve these aspects.

[22] Ziv, Guy, et al. "Trading-off Fish Biodiversity, Food Security, and Hydropower in the Mekong River Basin." *Proceedings of the National Academy of Sciences – PNAS* 109, no. 15 (2012): 5,609–14. Doi:10.1073/pnas.1201423109.

[23] World Wildlife Fund (WWF). "Greater Mekong." Accessed 9 May 2025. www.worldwildlife.org/places/greater-mekong.

[24] Li, David, et al. "Shorebirds Wintering in Southeast Asia Demonstrate Trans-Himalayan Flights." *Scientific Reports* 10, no. 21232 (2020). Doi:10.1038/s41598-020-77897-z.

[25] Briesen, Detlef, and Vo Van Thang. *Mekong Delta Handbook*. 1st ed., Cuvillier Verlag Göttingen, 2021, 163–82.

[26] Ibid.

The enduring state of poverty had, at one point, made the region the Golden Triangle of drug trafficking.[27] In more recent years, illegal activities by way of cybercrime and scam call centres has put the spotlight on the region's border security.[28] Victims from different parts of the world are lured to one country before being trafficked across to a neighbouring country, making these victims illegal immigrants who are then coerced to work in the call centres. Organised criminals have been able to exploit the porous nature of the 12,000-km land border shared by these countries.[29] Poorly patrolled by the authorities, and coupled with the inhabitants' customary ways of forming informal crossings, the borders have become a hotspot for biosecurity challenges.[30] These include the potential transmission of EIDs, illegal trade of animal commodities, and exchange of illicit drugs.[31]

In summary, the health issues faced in GMS are driven by the state of its economic development, the porous nature of its extensive land borders, and the environmental interdependencies associated with the Mekong River.

Laboratory Capacity and Biosafety Regulations

Despite their economic and budget limitations, the four countries comprising GMS have an extensive network of laboratories for both animal and human health. These capacities were largely supported by various sponsors, including the Pasteur Institute, France. The primary function of these laboratories focuses on diseases, such as HIV and TB, along with COVID-19. However, despite the large laboratory setup, most of these countries do not appear to have sufficient legal coverage to ensure the safety of their biological work.

Cambodia

Cambodia is reported to have two BSL3 laboratories. The first facility was established in April 2008 at Institut Pasteur du Cambodge (Institut Pasteur Cambodia).[32] It consists of four modules dedicated to respiratory viruses, arboviruses and emerging viruses, HIV and retroviruses, and mycobacteria and TB bacillus.[33] It was reported to be the biggest BSL3 complex in Southeast Asia when it was completed.[34]

[27] Yasid, Mohamad, and Amer Fawwaz. "Drug Trafficking from Thailand's Golden Triangle Region and Its Implications on Malaysia's Political Security." *Journal of International Studies* 19, no. 2 (2023): 1–25. Doi:10.32890/jis2023.19.2.1.

[28] Head, Jonathan, Lulu Luo and Thanyarat Doksone. "'I Need Help': Freed from Myanmar's Scam Centres, Thousands are Now Stranded." *BBC*, February 27, 2025. Accessed 5 May 2025. www.bbc.com/news/articles/c5yr7j18edjo.

[29] Global Initiative against Transnational Organized Crime (GI-TOC). "Organized Crime in the Mekong." *Briefing Series* August 2023.

[30] Ibid.

[31] Ibid.

[32] University of Hong Kong-Pasteur Research Pole (HKU-PRP). "Inauguration of the BSL3 Laboratory at Institut Pasteur Cambodia." 25 April 2008. Accessed 5 May 2025. www.hkupasteur.hku.hk/post/inauguration-of-the-bsl3-laboratory-at-institut-pasteur-cambodia.

[33] Ibid.

[34] Ibid.

The second BSL3 facility commenced construction in June 2023 and was expected to complete by July 2024.[35] This project was supported by the World Bank, as part of the Cambodia COVID-19 Emergency Response Project.[36] It was also reported, in 2023, that Australia is looking to help Cambodia strengthen its laboratory capacity for infectious diseases, particularly for HIV, TB, and malaria, as part of the IndoPacLab project.[37]

The Biosafety Law in Cambodia was enacted in 2008, but, strangely, it explicitly ruled out its applicability on living modified organisms (LMOs) for pharmaceutical usage and processed products derived from non-living modified organisms (non-LMOs).[38] The law was repealed and replaced by the Code on Environment and Natural Resources in 2023.[39] In both these laws, the biosafety purview falls within the scope of the Ministry of Environment and approval from the ministry precedes any application for authorisation from competent authorities. This demonstrates the high emphasis the Cambodian government has placed on their natural environment and biodiversity.

Laws pertaining to laboratory biosafety can only be traced to the *Prakas* (ministerial proclamation of intent) issued by the Ministry of Health in 2018.[40] While the *Prakas* marks the first step towards formal legislation, the actual bill does not seem to have been formulated yet. Furthermore, the mandate of the Cambodian Ministry of Health is focused on improving the quality of the healthcare system and accessibility for its population, and so laboratory biosafety may be left to the discretion of practitioners.

Laos

Laos is similarly reported to have at least one BSL3 laboratory housed in the National Tuberculosis Centre (NTC), Vientiane, and operated by the Ministry of Health (MoH),[41] although the actual number of such laboratories may be more. Several diagnostic laboratories are funded by foreign entities, such as the Pasteur Institute and the Lao-Oxford-Mahosot Hospital-Wellcome Trust Research Unit (LOMWRU).[42]

While Laos has a high-level laboratory, the national health security workplan has listed some critical points for laboratory capacity across the country. These include an on-going priority to create a

[35] The World Bank (WBG). "Cambodia COVID-19 Emergency Response Project (P173815): Implementation Status and Results Report." Accessed 5 May 2025. https://documents1.worldbank.org/curated/en/099011624063032781/pdf/P17381512d82ba0db191ad1f331f35b9b1d.pdf.

[36] Ibid.

[37] "Australia Helps Strengthen Laboratory Capacity for Infectious Diseases in Cambodia." *Khmer Times*, November 11, 2023. Accessed 5 May 2025. www.khmertimeskh.com/501390503/australia-helps-strengthen-laboratory-capacity-for-infectious-diseases-in-cambodia.

[38] Kingdom of Cambodia. "Law on Biosafety." Accessed 5 May 2025. https://faolex.fao.org/docs/pdf/cam198871.pdf.

[39] Ministry of Environment, Kingdom of Cambodia. "Code on Environment and Natural Resources." Accessed 5 May 2025. https://faolex.fao.org/docs/pdf/CAM227966.pdf.

[40] Centers for Disease Control and Prevention (CDC). "CDC in Cambodia – Strengthening Laboratory Biosafety and Biosecurity through Legislation." Accessed 5 May 2025. https://archive.cdc.gov/www_cdc_gov/globalhealth/stories/strengthening_laboratory_biosafety.html.

[41] "Appendix E: List of Labs Identified in Low-resource Countries." In *Developing Norms for the Provision of Biological Laboratories in Low-resource Contexts: Proceedings of a Workshop*, edited by Micah D. Lowenthal and Frances E. Sharples. www.ncbi.nlm.nih.gov/books/NBK542569/.

[42] Mahidol Oxford Tropical Medicine Research Unit (MORU) Tropical Health Network. "LOMWRU (Lao PDR)." Accessed 5 May 2025. www.tropmedres.ac/units/lomwru-lao-pdr.

list of biological agents and toxins, installation of systems to track and control pathogen inventory, and acquisition of biosafety cabinets and autoclaves for all provincial laboratories.[43] Furthermore, the noted challenges include limited number of staff with technical expertise, limited national testing capacity for COVID-19 (only 1,000 samples a day), lack of proper waste management capacity, and the absence of designated biosafety officers in many laboratories.[44] This highlights a potentially severe lack of capacity to conduct effective and safe laboratory work.

Laos has legislated the Biotechnology Safety Law in 2014, which serve as safety guidelines towards driving socioeconomic developments in the areas of genetic resources, agriculture and forestry, health, industrial processing, and the environment, and advocate for the promotion of biotechnological advancements.[45]

Concerns about laboratory safety are discussed in the National Biosafety Regulations of 2019,[46] which also covers genetic modification activities and stipulates that such derived organisms must not cause any harm or adverse effects on human, animal, and environment health.[47] The broad stroke approach follows the 'do-no-harm' principle, but does not adequately address any potential issue of dual-use concerns.

Biosafety regulations are further spelled out in several legislations, including Law on Animal Husbandry and Veterinary Medicine 2016,[48] and Law on Prevention and Control of Communicable Diseases 2017[49]. However, biosafety requirements for these laboratories are not defined.

Myanmar

In 2020, Myanmar reported the opening of its fourth BSL3 laboratory supported by the Global Fund project.[50] These laboratories were funded primarily to deal with the TB challenge in Myanmar, and provide testing and diagnosis of COVID-19 samples.[51] Up to date information for Myanmar is difficult to source due to the Internet being shut down since April 2021.

[43] Ministry of Health (MoH), Lao PDR. "National Workplan for Health Security 2022–2025." Accessed 6 May 2025. https://cdn.who.int/media/docs/default-source/wpro---documents/countries/lao-people's-democratic-republic/our-work/whe/national-workplan-for-health-security-2022-2025-(lao).pdf.

[44] Ibid.

[45] Government of Lao PDR. "Biotechnology Safety Law 2014." Accessed 6 May 2025.

[46] Government of Lao PDR. "National Biosafety Regulation 2019." Accessed 6 May 2025. https://cdn.who.int/media/docs/default-source/wpro---documents/countries/lao-people's-democratic-republic/our-work/whe/national-biosafety-regulation-2019-(lao).pdf.

[47] Ibid.

[48] Government of Lao PDR. "Law on Animal Husbandry and Veterinary Medicine 2016." Accessed 6 May 2025. https://faolex.fao.org/docs/pdf/LAO210801.pdf.

[49] Government of Lao PDR. "Law on Prevention and Control of Communicable Diseases 2017." Accessed 6 May 2025. https://data.opendevelopmentmekong.net/dataset/3555ecd0-142c-4dea-b4ff-864f74f8e3d4/resource/2cc042a8-7817-4805-9185-96de95b194ff/download/-.pdf.

[50] The Global Fund Programme in Myanmar. "Inauguration of Biosafety Level-3 TB Lab in Mawlamyine." 26 June 2020. Accessed 6 May 2025. https://pr-myanmar.org/en/news/inauguration-biosafety-level-3-tb-lab-mawlamyine.

[51] Ibid.

At the lower biosafety level, National Health Laboratory (NHL) has developed over a 1,000 diagnostic laboratories in hospitals.[52] However, despite the high number of laboratories, the health of its population is comparatively poor when compared to other ASEAN countries. Myanmar has the second highest HIV prevalence among adults aged between 15 and 49 years in the WHO South-East Asia region.[53] This coupled with its TB prevalence and malnutrition form key major health concerns for the country.[54]

Although biosafety regulations have been developed with the support of external parties, it remains unimplemented in Myanmar, and thus there are no laws with regards to the activities conducted in laboratories.[55] There are several laws that provide provisions to ensure that the public is not harmed due to other environmental factors. For instance, the Prevention and Control of Communicable Diseases Law stipulates the need for the public to report cases of animals dying *en masse*, and any occurrence or suspicion of epidemic diseases happening.[56] This measure aims to contain potential outbreaks before requiring laboratory confirmation.

Owing to the extensive agriculture industry, the Myanmar government passed a law to regulate the use of pesticides in 2016 and another to manage the risk of plant pests in 1993. The Pesticide Law requires pesticides to be registered for its specific intended use and that the user of pesticides shall comply with the safety guidelines issued by the department, as well as to exercise care to prevent contamination of food and harm to children.[57]

Thus, even though there are no regulations to prevent harm arising from the laboratories, there are provisions to regulate biosecurity in the environment. However, ultimately, Myanmar still needs to develop the necessary national biosafety and biosecurity regulations. This can then lead to subsequent comprehensive training across the human, animal, and agricultural sectors.

Vietnam

The COVID-19 pandemic saw Vietnam ramping up its diagnostic capacity from four regional laboratories in early 2020 to 143 laboratories by the end of 2021, and from 14,000 tests a day to over 100,000 tests a day.[58] This increase in capacity was supported by the World Bank and allowed Vietnam to have the capacity to handle similar-scale pandemics.[59] Additionally, Vietnam is reported to have four

[52] South-East Asia Lab Network (SEALAB). "Myanmar." Accessed 6 May 2025. www.sealab.asia/countries/myanmar/.

[53] World Health Organization (WHO). "Public Health Situation Analysis – Myanmar, Conflict and Humanitarian Crisis." December 2024. Accessed 6 May 2025. https://cdn.who.int/media/docs/default-source/searo/whe/him/mmr-ext-phsa-2024.2.pdf.

[54] Ibid.

[55] GHS Index. "Myanmar." Accessed 6 May 2025.

[56] Myanmar State Law and Order Restoration Council (SLORC). "The Prevention and Control of Communicable Diseases Law." Accessed 6 May 2025. https://faolex.fao.org/docs/pdf/mya196324.pdf.

[57] Myanmar State Law and Order Restoration Council (SLORC). "The Pesticide Law." Accessed 6 May 2025. https://faolex.fao.org/docs/pdf/MYA224943.pdf.

[58] The World Bank Group (WBG). "Enhanced Testing-capacity in Quickest Time Helped Vietnam Fight COVID-19." *Results Briefs* 8 August 2023. Accessed 6 May 2025. www.worldbank.org/en/results/2023/08/08/enhanced-testing-capacity-in-quickest-time-helped-vietnam-fight-covid-19.

[59] Ibid.

BSL3 laboratories[60] and seven regional centres of animal health (Regional Animal Health Office [RAHO]), each with its own diagnostic laboratory for animal health testing.[61]

Comparatively, Vietnam has a significantly more comprehensive approach towards the biosafety laws. In the decree for the Regulations on Ensuring Bioethics Safety in Laboratories in 2016, it categorises microorganisms into four risk groups and indicates which level of biosafety test facilities are required to work on these risk groups.[62] This is supplemented by Circular 41/2016/TT-BYT.[63] It then goes into the extent of the codified facilities requirements, equipments, and conditions for the facilities to be recognised at the corresponding biosafety levels.[64]

These rules are applied to all laboratories and biosafety certificates are issued by the Minister of Health for those satisfying BSL3 and BSL4 criteria. Only exception is that the Minister of National Defence is allowed to issue certificates for those under military authority. Laboratories that meet the BSL2 requirements can self-declare based on the checklist provided by the Department of Health. The Ministry of Health conducts ad-hoc inspections at least once every three years to ensure that the facilities conform to the certified standards.

In the event of a severe biosafety incident resulting in a mass casualty event, the decree requires the handling of the incident to be in accordance with the Law on Prevention and Control of Infectious Diseases,[65] where a state of emergency can be declared. Despite its comprehensive approach towards the facilities requirement, the law does not address any concerns over research areas and research oversight.

Existing and Emerging Infectious Diseases

Cambodia

Cambodia has been dealing with malaria transmission, and data from 2022 to 2024 shows that it has achieved some degree of success in malaria management.[66] Similar controls have been in place for

[60] "National Central for Veterinary Diagnosis Certified for a Biosafety Level 3 Laboratory." *Vietnam Agriculture*, August 12, 2023. Accessed 6 May 2025. https://vietnamagriculture.nongnghiep.vn/national-central-for-veterinary-diagnosis-certified-for-a-biosafety-level-3-laboratory-d359015.html.

[61] Luong, Van-Vinh, and Department of Animal Health of Vietnam (DAH). "Enhencing Capacities of Veterinary Workforce to Prevent and Manage Emergencies." Presented at the Sub-regional Workshop on Emergency Management, Bangkok, Thailand, August 14–16, 2024. Accessed 6 May 2025. https://rr-asia.woah.org/app/uploads/2024/08/82_VIE1.pdf.

[62] Government of Viet Nam. "Regulations on Practices to Ensuring Bioethic Safety in Laboratories." Accessed 6 May 2025. https://bwcimplementation.org/sites/default/files/resource/VD_Circular%20Regulations%20on%20practices%20biosafety%20in%20labs_EN.pdf.

[63] "Vietnam: List of Infectious Pathogens according to Circular 41." *LawNet*, July 10, 2024. Accessed 6 May 2025. https://lawnet.vn/thong-tin-phap-luat/en/chinh-sach-moi/vietnam-list-of-infectious-pathogens-according-to-circular-41-154236.html.

[64] Government of Viet Nam. "Regulations on Practices to Ensuring Bioethic Safety."

[65] Government of Viet Nam. "Law on Prevention and Control of Infectious Diseases (No. 03/2007/QH12)." 21 November 2007. Accessed 28 October 2025. https://natlex.ilo.org/dyn/natlex2/natlex2/files/download/84337/VNM84337.pdf.

[66] UNOPS (United Nations Office for Project Services) Asia Regional Health Cluster, and Regional Artemisinin-resistance Initiative (RAI). "Cambodia's Journey toward Malaria Elimination." Accessed 6 May 2025. https://raifund.org/sites/raifund.org/files/publication_docs/cambodia_malaria_elimination_2024_final.pdf.

dengue through the National Dengue Control Programme (NDCP).[67] But, there are other existing diseases of concern, including sexually transmitted infections (STIs)/HIV, TB, rabies, and mosquito-borne diseases, such as chikungunya, dengue, Zika virus disease, and Japanese encephalitis.[68]

Surveillance systems are in place for EIDs/REIDs, such as COVID-19, Mpox, and avian influenza, including highly pathogenic avian influenza (HPAI) and H5N1. One disease of concern appears to be extensively drug-resistant (XDR) gonorrhoea, which may render antibiotics ineffective.[69]

Laos

For managing EIDs, the national health security workplan noted that Laos adopted a hybrid approach towards disease surveillance. This includes event-based surveillance (EBS) and indicator-based surveillance (IBS).[70] This multisource approach has enabled reporting across different administrative levels and for the data to be collected at the central level. Surveillance for influenza-like illnesses (ILI) and severe acute respiratory infections (SARIs) has enabled the identification of human infections of both H5N1 and influenza A virus subtype H5N6 (H5N6).[71]

Training of field epidemiologists has been conducted to develop the manpower required to better detect major outbreaks and public health emergencies, such as COVID-19, H5N6, dengue, seasonal influenza, measles, H5N1, type 1 circulating vaccine-derived poliovirus (cVDPV1), and hepatitis A.[72] The programme is jointly supported by the Department of Livestock and Fisheries (DLF), Ministry of Public Security (MPS), and Ministry of Defence.

Some of the proposed improvements include strengthening the capacity for surveillance of strains, following emergency plans and action plans to ensure all parties are actively performing surveillance, and enhancing the laws to include enforcement and quarantine measures. However, antimicrobial resistance (AMR) is not considered a key priority by the Ministry of Health and greater awareness is recommended in the workplan.

In terms of animal disease concerns, HPAI strains (such as, H5N6 and HPAI) and rabies are two key concerns, of which the latter has been actively communicated to reduce the risk to public health.

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[67] Echaubard, Pierre, et al. "Fostering Social Innovation and Building Adaptive Capacity for Dengue Control in Cambodia: A Case Study." *Infectious Diseases of Poverty* 9, no. 126 (3 September 2020). https://idpjournal.biomedcentral.com/articles/10.1186/s40249-020-00734-y.

[68] US Centers for Disease Control and Prevention (CDC). "CDC Yellow Book: Health Information for International Travel, Cambodia." Accessed 6 May 2025. www.cdc.gov/yellow-book/hcp/asia/cambodia.html.

[69] Ouk, Vichea, et al. "The Enhanced Gonococcal Surveillance Programme, Cambodia." *The Lancet Infectious Diseases* 23, no. 9 (2023): e332–3. Doi:10.1016/S1473-3099(23)00479-6.

[70] MoH, Lao PDR. "National Workplan for Health Security."

[71] Ibid.

[72] Ibid.

Concerns on animal health are covered in the Law on Animal Husbandry and Veterinary Medicine established in 2016.[73] The law requires the establishment of veterinary epidemiology networks connecting both the central and local governments. The appointed veterinary unit is responsible for monitoring, controlling, and reporting on animal epidemics.[74] The management of animal epidemic control zones falls under the purview of the local government, but if the zone crosses provincial boundaries, then it will be escalated to higher political levels and requires the Prime Minister to make a declaration.[75]

Laos has participated in the Global Antimicrobial Resistance Surveillance System (GLASS) since 2018, and has nine surveillance sites at both the central and provincial levels to monitor human health-related AMR cases.[76] Similar measures when dealing with AMR in livestock are undertaken at the provincial level, with samples analysed at the Animal Disease Research Centre. The key focus areas for animal disease due to AMR are *Salmonella* and *E. coli* in poultry and pigs.[77]

Myanmar

Myanmar was originally on track to reach malaria-free status by 2030 and to eliminate TB. However, the civil war that broke out in 2021 has dashed the progress made in previous years. Myanmar has seen a sevenfold increase in TB and malaria cases since 2021. While malaria is treatable with medication, the ineffective control and misuse of malaria medications can result in the development of drug-resistant malaria, in the same manner that it did in the late 1960s.[78]

HIV has similarly seen an upward trend of 10 per cent increase and is likely to be higher due to untested and unreported cases.[79] The on-going civil war will continue to worsen the state of infectious diseases transmission in Myanmar, and can cause a ripple effect to China and Thailand, where undocumented refugees seek shelter across the border.[80]

Vietnam

Vietnam has an on-going challenge against dengue fever due to climate change and difficulties with vector control.[81] Other vaccine-preventable diseases, such as measles, are also re-emerging due to the

[73] Government of Lao PDR. "Law on Animal Husbandry and Veterinary Medicine 2016."

[74] Ibid.

[75] Ibid.

[76] MoH, Lao PDR. "National Workplan for Health Security."

[77] Ibid.

[78] Lay, Maw, and Khin. "In Myanmar, Healthcare and Diseases Prevention are Neglected Casualties of War." *The New Humanitarian*, January 15, 2025. Accessed 7 May 2025. www.thenewhumanitarian.org/news-feature/2025/01/15/myanmar-healthcare-and-disease-prevention-are-neglected-casualties-war.

[79] Ibid.

[80] Ibid.

[81] "Treating and Preventing Infectious Diseases Will Be Increasingly Complex Next Year." *Viet Nam News*, December 27, 2024. Accessed 7 May 2025. https://vietnamnews.vn/society/1689792/treating-and-preventing-infectious-diseases-will-be-increasingly-complex-next-year.html.

low vaccination rate, often resulting in hospitalisations.[82] Zoonotic diseases, such as rabies and Mpox, continue to be a concern due to the proximity between humans and animals.[83] HPAI is also posing a threat to the live poultry markets, with potential to cause harm to human health and economic damages.[84]

Commercial partners are working with government agencies and non-government organisations to promote stronger awareness of diseases transmission and prevention efforts. It is worth noting that spikes occur in specific localities, warranting the need for regular disease surveillance. The National Institute of Hygiene and Epidemiology (NIHE) and Pasteur Institutes are assisting in sample collection and disease identification to determine risks and appropriate countermeasures.

Infectious disease surveillance is described in the Law on Prevention and Control of Infectious Diseases and allows health agencies to collect samples for investigation.[85] However, the responsibilities of coordinating surveillance activities is handled by the People's Committees (a political unit) that is authorised to instruct healthcare establishments on conducting surveillance testing.[86] For instance, specific class-A infectious diseases require the health establishment to notify state agencies; this class is classified as extremely dangerous infectious diseases that can spread very rapidly and widely with high mortality rates.[87] Examples include H5N1, smallpox, Ebola virus, and others.

Vietnam has a high rate of AMR infection as well as AMR death due to overuse and misuse of antibiotics. The availability of antibiotics over the counter without prescription for both human and animal diseases is making surveillance and treatment of diseases increasingly difficult. In 2019, close to 5 million people died from drug-resistant infections, and nearly 20 per cent of mortality was among children aged under 5 years.[88]

Bioterrorism

Cambodia

The country agency responsible for CBRN is the National Authority for the Prevention of Chemical, Nuclear, Biological and Radiological Weapons, abbreviated as National Authority of Chemical Weapons (NACW). Officials under NACW are authorised to perform policing tasks when investigating places suspected of unauthorised possession of CBRN substances and weapons.

[82] Ibid.

[83] Ibid.

[84] Ibid.

[85] Government of Viet Nam. "On Prevention and Control of Infectious Diseases: (No. 03/2007/QH12)." 21 November 2007. Accessed 7 May 2025. www.vertic.org/media/National%20Legislation/Vietnam/VN_Law_on_Prevention_and_Control_of_Infectious_Diseases.pdf.

[86] Ibid.

[87] Ibid.

[88] Institute for Health Metrics and Evaluation (IHME). "The Burden of Antimicrobial Resistance (AMR) in Viet Nam." Accessed 7 May 2025. www.healthdata.org/sites/default/files/2023-09/Viet_Nam.pdf.

Cambodia launched its CBRN National Action Plan (NAP) in 2017, with the support of EU CBRN CoE.[89] The National Action Plan serves to help articulate a national vision for CBRN risk mitigation and to strengthen capacities. This partnership was elevated in 2023, with the conduct of a multiagency CBRN response exercise to enhance Cambodia's readiness for CBRN incidents during the Southeast Asian Games (SEA Games) and ASEAN Para Games.[90]

This exercise saw the participation of frontline officers from NACW, the national police security and fire departments, the Royal Cambodian Gendarmerie, the Prime Minister Bodyguard Unit (PMBU), Ministry of Health, Central Security Department of the Ministry of Interior (MoINT), and other relevant operational entities.[91]

Laos

While there are laws governing the use of chemical and radioactive materials, there is limited operational budget and human resource to develop chemical and radiological preparedness and response in Laos. A CBRN National Action Plan has been formulated, but results have not been observed.[92]

Currently, CBRN security appears to be handled by the military. It does not appear that the homeland security department or the police have the capacity to deal with bioterrorism threats.

Terrorism law in Laos considers toxics and radioactive substances as material contributing towards acts of terrorism, and outlaws the processing and production of these materials with malicious intent.[93] This list does not include any biological materials.

Myanmar

The EU funded the CBRN workshop in Myanmar in 2014. The organiser, EU CBRN CoE, shared best practices and assisted in developing guidelines to help Myanmar in its development and implementation of CBRN policies.[94] However, there is no official unit known to be responsible for a CBRN response in the event of a biological threat incident.

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[89] Delegation of the European Union to the Kingdom of Cambodia. "EU-Cambodia Partnership Brings Multi-agency CBRN Response Exercise to Enhance Preparedness to Respond to CBRN Incidents and Attacks in Advance of the 2023 Southeast Asian Games and ASEAN Para Games." 3 April 2023. Accessed 7 May 2025. www.eeas.europa.eu/delegations/cambodia/eu-cambodia-partnership-brings-multi-agency-cbrn-response-exercise-enhance-preparedness-respond-cbrn_en.

[90] Ibid.

[91] Ibid.

[92] United Nations Interregional Crime and Justice Research Institute (UNICRI). "EU Helps Lao PDR to Prepare the National Action Plan to Mitigate Chemical, Biological, Radiological and Nuclear Risks." 30 May 2019. Accessed 7 May 2025. http://files.unicri.it/index.php/news/eu-helps-lao-pdr-prepare-national-action-plan-mitigate-chemical-biological-radiological-and-nuclear-risks.

[93] Government of Lao PDR. "Penal Code." Accessed 7 May 2025. https://faolex.fao.org/docs/pdf/lao208931.pdf.

[94] United Nations Interregional Crime and Justice Research Institute (UNICRI). "First Workshop in Myanmar to Mitigate Chemical, Biological, Radiological and Nuclear Risks." 30 May 2019. Accessed 7 May 2025. https://files.unicri.it/news/first-workshop-myanmar-mitigate-chemical-biological-radiological-and-nuclear-risks.

Vietnam

The Army Chemical Corps of the People's Army of Vietnam (PAVN) is the primary force responsible for the response to CBRN incidents. However, they have been described as primarily focused on chemical and radiological threats, which are fundamentally different from the effects of biological threats.[95] This also stems from a lack of emphasis on biological threats being a key security priority. Deeper cross-sectoral integration between the Chemical Corps and the Ministry of Health is encouraged to develop strategic understanding of the unique nature of biological threats, as it is essential for Vietnam to have the required preparedness against bioterrorism.

Dual-Use Research of Concern

Cambodia

In 2021, Cambodia's Ministry of Industry, Science, Technology & Innovation (MISTI) presented the Science, Technology and Innovation Roadmap 2030 (STI 2030).[96] STI 2030 prioritises the economic sectors of agriculture, manufacturing industry, and digital services, while simultaneously looking at five scientific and technological domains, including health and biomedical sciences.

As it is, it does not appear that the country has a defined framework concerning the possibility of scientific innovation resulting in DURC. The interest primarily lies in ensuring economic growth and sustainable agricultural output for the country's food needs. This, rather clean, condition of Cambodia's industry is a good opportunity for robust frameworks to be introduced to ensure that development in the biological and biomedical domains is undertaken in accordance with biosafety standards.

Laos

For Laos, there is a decree on the management of dual-use goods, where biological weapons are listed under WMD.[97] But, the ten categories of dual-use goods do not include biological materials. Laws on biosafety do not explicitly mention the aspect of DURC.

Myanmar

Myanmar has no notable laws on DURC, and the only law that can prevent the use of biological materials for malicious purposes is the Counter Terrorism Law.[98] It prohibits the production, transfer, maintenance, or providing of biological weapons to terrorists or terrorist groups.

[95] Pham, Phuong. "Why Vietnam Needs to Adopt a Biological Defense Strategy." *The Diplomat*, June 7, 2021. Accessed 7 May 2025. https://thediplomat.com/2021/06/why-vietnam-needs-to-adopt-a-biological-defense-strategy/.

[96] Kingdom of Cambodia. "Cambodia's Science, Technology & Innovation Roadmap 2030." 2021. Accessed 29 October 2025. https://misti.gov.kh/public/file/20210826162999011 7.pdf.

[97] Government of Lao PDR. "Decree on the Management of Dual-use Goods." Accessed 29 October 2025.

[98] UNIDIR and VERTIC. "Myanmar." Accessed 14 February 2025.

Vietnam

The term dual-use is mentioned in the Decree 81/2019/ND-CP for the purposes of preventing and countering proliferation of WMDs. The decree aims to prevent any research or development that can lead to the potential production of a WMD.[99] The Ministry of National Defence (MND) is the coordinating authority for the prevention of WMD, and the decree instructs the Ministry of Health and Ministry of Agriculture and Rural Development (MARD) to be responsible for biological weapons and veterinary-related threats, respectively.

However, besides this mention, the biosafety laws did not address the need for a biosafety committee that oversees the governance of biological research projects nor does it address potential risk and mitigation of DURC.

Policy Recommendations

Raise Biosecurity Awareness and Expertise Among Policymakers and Across Sectors to Improve Biosafety and Biosecurity

The analysis showed that the four countries in GMS have already established high-level BSL laboratories that are capable of performing laboratory work on high-risk pathogens and agents. However, it is noted that there is a general lack in corresponding legislation to manage risks. Only Vietnam has a thorough governmental circular that dictates the biosafety requirements for such laboratories, but even so there remains a lack of biosecurity measures.

Considering that, for biosecurity threats to materialise, it requires either substantial amount of technical knowledge to synthesise the agent or unimpeded access to high-risk biological materials, it should be borne in mind that both these avenues can manifest through the availability of research laboratories. This also suggests that biological threats are more likely to be posed or supported by insiders at a research facility. Since this may seem like a sweeping statement that casts aspersions on scientific communities and research professionals, governments will need to tactfully engage the research community in this regard. Scientific practitioners are often more focused on biosafety to protect themselves from harm during work, and less likely to consider the potential of causing harm. Regardless, it is imperative that governments and research institutions not shy away from recognising and preventing any potential danger that could arise on account of even the remotest possibility of an insider threat.

For a start, Cambodia, Myanmar, and Laos should have similar codified regulations to ensure that laboratory standards are monitored and maintained at a high level of competency instead of being left

[99] Government of Viet Nam. "Decree on Prevention and Control of Promulgation of Weapons of Mass Destruction." Accessed 7 May 2025. https://bwcimplementation.org/sites/default/files/resource/VD_Decreee%20WMD_EN.pdf.

to the discretion of individual operators. This can ensure high degree of transparency and confidence in the facilities' biosafety measures.

To counter the risk of insider threat, all four countries will need to establish a common security understanding among the state, institutions, and practitioners. The government can initiate this by highlighting and sharing its security concerns while encouraging the scientific community to develop a ground-up approach to identify potential areas of security vulnerabilities. Both, the policymakers and experts, can jointly formulate strategies to promote a security culture and oversee its implementation. This ground-up approach towards forming a security culture can encourage better buy-in among researchers, and the act of sharing it can help policymakers become more aware of the balance required between security and development. These security strategies can subsequently be spelled out in the legislation as part of the biosafety and biosecurity requirements that must be met before laboratories can be granted operating licenses.

Security-Health Sector Cooperation and Joint Training to Boost Enforcement

Among the four countries analysed, only Cambodia appears to have a national action plan that involves multiagency coordination in response to CBRN threats. The other countries are either dependent on the military or lacking a designated task force for CBRN incident response. While the military is directly related to a country's security, the military may not have the expertise to investigate criminal intent within the domestic domain. Similarly, the health sector, which possesses the knowledge to spot potential threats, may not have the enforcement powers to arrest and prevent such incidents. As such, this gap in technical knowhow and enforcement capabilities will require the coordinated involvement of both these sectors.

As the foremost technical experts, the health sectors of the four countries can form an advisory council on biological threats to assist their respective countries' law enforcement and security agencies. Building on their epistemic network and academic exchanges, the advisory councils can identify evolving and developing technologies that may pose potential security risk, particularly in areas of DURC, which is not well addressed in any of the countries analysed.

With their technical expertise and facilities, they can support less well-equipped enforcement agencies in the area of laboratory testing to determine whether the evidence and samples collected point to a culpable or naturally occurring biological threat. Furthermore, the health sector can train and enable law enforcement agencies to be better prepared for responding to incidents and better protect their officers in their line of work. Likewise, the security sector can assist the health sector in a few areas. For example, it can tap on intelligence exchange with regional countries and share knowledge of on-going threats to alert the health sector of potential security incidents. It can also provide the framework and support for personnel screening.

Promote and Institutionalise a Security Culture to Prevent Biosecurity Threats at the Regional Level

A unique challenge faced by the four countries in GMS is the 12,000-km land border that divides them. This geographical closeness allows the creation of informal land crossings that make it difficult for security agencies to police and secure. As noted, cases of illicit trade have taken place across these crossings and therefore governments must not exclude the risk of malicious actors trafficking biological agents for the purpose of executing acts of bioterrorism. Furthermore, land borders are easier for wildlife to cross, potentially bringing in diseases from across borders.

These factors make the security arrangements in GMS fundamentally different from the other ASEAN states, which are mostly separated by water bodies. Policymakers may need to employ a series of different engagements to address these challenges in a timely and effective manner. The security culture, in this context, will require going beyond scientific conduct and also encompass the forming of norms of conduct for law enforcement agencies and border communities.

The ASEAN police-to-police network, ASEANAPOL, is an existing platform that allows collaboration between law enforcement agencies and aims to combat transnational criminal activities. The four countries can leverage on this existing arrangement and facilitate the sharing of near real-time police intelligence to stub illegal activities at these land crossings. With advancement of drone technologies, countries can jointly develop a network of border surveillance drones that can provide real-time information for more efficient and effective deployment of police resources. This security collaboration can benefit these four countries, beyond the issues of biosecurity, by aiding to address other existing security challenges as well.

However, it may not be entirely practical to count out trading activities at these informal crossings, as these have customarily served as a meeting place for border communities to trade their produce. Therefore, policymakers in all four countries will need to separately engage these communities to promote awareness of biosecurity issues, and the threat it poses to their families and communities. By encouraging them to spot, identify, and report potentially illegal activities, these communities can play a crucial role in protecting their health and safety.

One possible approach is for the authorities to register these meeting places as official market zones to regulate their functioning and participation. For instance, a list of safe commodities that are permissible for trade can be shared with and distributed among regular market participants along with a similar list for wildlife trade that should be avoided to prevent the transmission of zoonotic diseases. Keeping in mind that these commercial exchanges stem from informal arrangements, policymakers should avoid introducing excessive and undue pressure to enforce compliance that may end up being counterproductive towards the building of a biosecurity culture among these communities.

While legitimate human activities can be regulated, wildlife movement will require a more comprehensive and interventionist approach. Laws related to forestry and agriculture in the region have already placed significant emphasis on environmental protection and disease management. Myanmar's laws on the prevention and control of communicable diseases, requiring the public to report on mass dying of animals, is a useful instrument for active public participation in monitoring animal health.

The remaining three countries can follow similar practices of open reporting, so that corresponding veterinary departments can be deployed expeditiously. The four countries should also harmonise these practices and establish a regional veterinary institution to jointly monitor and manage wildlife diseases. A veterinary animal health security culture will encourage rapid response and prevent diseases from spilling over to farm animals.

Develop Regional Networks for Knowledge Exchange

For the epistemic communities in both the human and animal health sectors, knowledge exchange with the remaining AMS can help to improve overall ASEAN capacity to tackle new threats. To achieve effective knowledge exchange, the four states would have to first align themselves with existing frameworks adopted by the scientific community. This includes having a consistent protocol, security screening for personnel reliability, and transparency in reporting among various existing facilities. Notably, existing biotechnology laboratories in the four countries are mostly funded through foreign development assistance, such as by the Pasteur Institutes, and their integration into the ASEAN network may require considerable amount of effort to align the interests of all parties.

Due to the large geographical landmass in GMS, the natural resources within these countries may possess an immense scientific value, which can contribute to the pool of knowledge for the rest of AMS. Part of these can contribute to a regional list of pathogens, pests, and diseases that are endemic in GMS. As such, it would be useful to discuss equitable access and benefits sharing. One potential early-stage benefit is garnering more technical assistance from AMS to accelerate the involvement of the four countries and include upcoming issues, such as cyberbiosecurity. This is important since the other AMS have both the experience and resources to support such transition.

The next step of integration is to encourage partnership between scientific communities, jointly conduct research on emerging diseases, and finding suitable solutions towards these challenges. These partnerships between countries can demonstrate the commitment towards access and benefit sharing, allowing researchers to bring their findings back to their home countries for competency development. This may vastly improve the detection and response capabilities not only for GMS countries but also for the entire Southeast Asian region.

Conclusion

The challenges faced by the GMS countries are unique and different from the remaining Southeast Asian states. The main factor contributing to this lies in their proximity, as state boundaries are divided by the flow of the Mekong River. Its long history of borderland settlements contributes to the traction that informal meeting places receive for facilitating local trade and commerce. However, due to their unregulated nature, they may become a conduit for the illegal trade of wildlife, illicit drugs, and even hazardous biological agents.

The wide landmass is also home to many wildlife populations and lies along the flight route of many migratory birds. This increases the risk of animal disease passing from one species to another and getting carried across land boundaries into different states. As the Southeast Asian region develops, greater integration of economic activities between AMS will be seen, and this increased flow of human traffic and goods will bring with it risks from beyond the boundaries of the GMS states. Therefore, the current level of existing biosecurity governance in the GMS states poses considerable levels of risk for the rest of AMS.

AMS states that have already achieved a considerable level of readiness can and should aid the GMS states, so that they too can be brought up to speed, to ensure the biosecurity readiness of the whole of ASEAN.

Chapter 5

Recommendations for Enhanced Regional Cooperation

Mely Caballero-Anthony, Julius Cesar Trajano, Jose Ma. Luis Montesclaros, and Jeselyn

Promote Harmonisation of Biosecurity Protocols Through ASEAN Regional Networks

The 2024 ASEAN Leaders' Declaration on Strengthening Regional Biosafety and Biosecurity expresses AMS' collective commitment to "establish the ASEAN Biosafety and Biosecurity Network to enhance functions, roles, and responsibilities in facilitating knowledge sharing, coordination, and cooperation among ASEAN Member States, partners and relevant stakeholders."[1] With such commitment, AMS aims to strengthen their international cooperation and assistance through various capacity building programmes.

The creation of this network can be built on existing regional networks and projects that separately address various biosecurity issues. For instance, through the ASEAN CBR Network, which was established in 2019, CBR experts actively organise workshops, table-top exercises, and regular exchanges of visits to build capacity for country experts and nurture cooperation in areas where CBR defence awareness remains relatively low. This includes the successful ASEAN CBR Defence Experts Technical Meeting for Harmonisation of CBR Sampling and Analysis Reporting Protocol held in Singapore in August 2023.[2] Under the ASEAN Regional Forum (ARF), the Philippines, in collaboration with the US State Department, hosted several workshops and table-top exercises that tackled biological weapon risk mitigation measures, such as biological threat reduction; biorisk management; disease detection and surveillance; preparedness and response to a biological event; countering illegal/illicit trafficking of CBR materials; and raising awareness on CBR risk management, with a special focus on biological incidents.[3]

Building on the initial success of the ASEAN CBR Defence Experts Technical Meeting in developing standardised protocols for CBR sampling, analysis, and reporting across all member states, biodefence and biosecurity experts in the region can conduct regular reviews and updates of biosecurity-related protocols to incorporate the latest advancements and best practices. The ASEAN CBR Network can also consider joint reviews and initiatives with other related networks and institutions within the ASEAN system.

[1] ASEAN, ASEAN Leaders' Declaration on Strengthening Regional Biosafety and Biosecurity, Vientiane, Lao PDR, 9 October 2024.

[2] "Statement on Behalf of the Members of the Association of Southeast Asian Nations (ASEAN) by Ambassador Anouparb Vongnorke, Permanent Representative of the Lao PDR to the United Nations for Cluster 2 of the First Committee: Other Weapons of Mass Destruction (WMD) of the 78th Session of the of the UN General Assembly. New York, 17 October 2023." Accessed 27 October 2025. www.un.int/lao/sites/www.un.int/files/Lao/final_asean_statement_at_ga78th_for_1st_com_on_cluster_2_other_wmd.pdf.

[3] Rocamora, Joyce Ann. "PH Hosts ASEAN Forum Exercise vs. Biological Incidents." *Philippines News Agency*, June 13, 2022. Accessed 27 October 2025. www.pna.gov.ph/articles/1176572.

The mutual recognition of biosecurity measures across different institutions and countries can be explored. By standardising and acknowledging each other's biosecurity protocols, organisations and nations can build trust, improve collaboration, and create a more cohesive and effective regional defence against biological/biosecurity threats.

To encourage more collaborative initiatives under ARF, AMS and their dialogue partners in the broader Asia-Pacific region can explore the creation of expert working groups in collaboration with the Council for Security Cooperation in the Asia-Pacific (CSCAP) to tackle specific issues, such as biological threat reduction, disease detection, preparedness for biological events, and peace and the security impact of advances in biotechnology.

Further capacity-building exercises through regional networks will be needed for EIDs, so that all AMS may achieve a minimum agreed level of surveillance, testing, and monitoring to detect new pathogens. This has to do with the difficulty in responding collectively to biosecurity threats, as the types of resources for different issues/threats that are available vary across countries, and there is often an absence of a framework that allows for the effective use of these resources at the national level. The most cost-effective approach is to implement a framework at the regional level. Forward-looking and action-based discussions will be needed on how to promote further investments on surveillance systems to ensure that robust testing protocols are in place.

Conduct Workshops on Biosecurity

Countries in the region have set up workshops on the implementation of BWC, and other relevant biosafety and biosecurity conventions, treaties, and guidance documents. The purpose of these workshops has always been to deepen understanding of biosecurity, share effective practices related to the preparation of CBMs (see glossary for further reference) as part of BWC requirements, and inform participants about capacity-building opportunities available to strengthen biosafety and biosecurity.[4] These workshops are beneficial as countries can learn not only from their regional counterparts but also from international partners, such as EU CBRN CoE.[5] These workshops may further encourage countries to submit their CBM reports, thus deepening their understanding of their own biosecurity

CBM workshops may further encourage countries to submit their CBM reports, thus deepening their understanding of their own biosecurity capacities, enhance transparency, and foster greater trust and cooperation within the region.

[4] BIOTEC. "Overview."

[5] It is often conducted in collaboration with the BWC Implementation Support Unit (ISU), EU CBRN CoE Initiative Regional Secretariat for Southeast Asia, and United Nations Interregional Crime and Justice Research Institute (UNICRI), United Nations (UN). See, United Nations Office for Disarmament Affairs (UNODA). "Southeast Asian States Convene for Workshop on Promoting CBMs in the Framework of the Biological Weapons Convention." 16 October 2023. Accessed 29 October 2025. https://disarmament.unoda.org/en/updates/southeast-asian-states-convene-workshop-promoting-cbms-framework-biological-weapons.

capacities, enhance transparency, and fostering greater trust and cooperation within the region. Southeast Asian countries have been enhancing their information sharing regarding their national implementation of BWC through regional workshops in collaboration with ASEAN external partners and UN bodies.

Such regional workshops allow AMS to strengthen their CBMs and biosecurity cooperation. In October 2024, Laos, together with China, co-hosted the first Regional Workshop on Implementing the Biological Weapons Convention (BWC) and Promoting Biosafety and Biosecurity in Southeast Asia.[6] Recognising the dual-use nature of biological materials, technical experts from eight countries in Southeast Asia gathered in Bangkok in July 2024 for a regional conference aimed at enhancing regional biosecurity measures.[7] With support from EU CBRN CoE, it provided a platform for experts from Brunei, Cambodia, Indonesia, Laos, the Philippines, Singapore, Thailand, and Vietnam to address biosecurity challenges through a multifaceted approach. Thailand, as the host country, provided training and laboratory facilities for Southeast Asian participants, as well as shared their good practices and lessons in managing biorisks.[8] Singapore hosted the ARF Workshop on Detection, Response, and Deterrence of Chemical, Biological and Radiological Incidents in June 2024, in collaboration with EU CBRN CoE and ASEAN CBR Network.[9]

Capacity-building workshops on CBMs between two Southeast Asian countries are also being conducted that can lead to increased knowledge transfer and information sharing. From 2022 to 2023, the Philippines, which has steadily gained experience in CBMs for BWC, worked with Laos in a country-to-country training programme to raise awareness about CBMs under BWC and to provide hands-on training on how to make CBM submissions.[10] This bilateral training programme provided by the Philippines to Laos was cited at the Ninth BWC Review Conference in 2023 as a model for intraregional cooperation.[11] This accomplishment highlighted the role of regional expertise and cross-country collaboration in developing and delivering training that enhances national efforts to implement international legal frameworks and conventions aimed at mitigating biosecurity risks.[12] The role of other AMS also matter in Cambodia's CBM initiatives, as experts from the Philippines and Singapore briefed Cambodian participants on their national CBM report preparations and shared good practices in data collection and information sharing on biological activities.[13]

[6] United Nations Office for Disarmament Affairs (UNODA). "Regional Workshop on Implementing the Biological Weapons Convention and Promoting Biosafety and Biosecurity in Southeast Asia." Accessed 29 October 2025. www.unrcpd.org/regional-workshop-on-implementing-the-biological-weapons-convention-and-promoting-biosafety-and-biosecurity-in-southeast-asia/.

[7] EU CBRN Risk Mitigation. "Southeast Asia Region Working Together to Enhance Biosecurity." 12 July 2024. Accessed 5 December 2025. https://cbrn-risk-mitigation.network.europa.eu/news-1/southeast-asia-region-working-together-enhance-biosecurity-2024-07-12_en.

[8] Ibid.

[9] "Meeting of the States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction." Accessed 29 October 2025. https://documents.un.org/doc/undoc/gen/g24/233/46/pdf/g2423346.pdf.

[10] EU CBRN Risk Mitigation. "Lao PDR, Philippines: Country-to-country Training in Southeast Asia Strengthens Implementation of the Biological Weapons Convention (BWC)." Accessed 29 October 2025. https://cbrn-risk-mitigation.network.europa.eu/eu-cbrn-centres-excellence/success-stories-2023/success-story-philippines-and-lao-pdr_en.

[11] Ibid.

[12] Ibid.

[13] Interview with Cambodian BWC experts, Phnom Penh, Cambodia, 22 January 2025.

Regional workshops can also provide guidance to develop national frameworks that cover both naturally occurring and man-made biosecurity threats, craft better risk communication strategies (science diplomacy and diplomacy in science), and strengthen biosecurity threat-oriented intelligence work. These workshops can also be geared towards developing regional databases to map, monitor, and track biosecurity threats. They can further promote mutual agreement and recognition of country-level biosecurity measures (as described in the previous recommendation), and improve the transparency of cross-country information exchange.

Develop Regional Networks for Knowledge Exchange

A regional network for information exchange in Southeast Asia is essential for enhancing biosecurity by facilitating the timely detection of disease outbreaks, development of treatments, and effective data sharing.

Information sharing on biosecurity issues among AMS still needs strengthening. Experts we interviewed disclosed that some countries in the region are concerned that their neighbours might be hesitant, for multiple reasons, to immediately share critical information about potential biosecurity incidents, especially disease outbreaks, that occur near their shared borders.[14] In this regard, a regional network for information exchange in Southeast Asia is essential for enhancing biosecurity by facilitating the timely detection of disease outbreaks, development of treatments, and effective data sharing. Such a network would allow countries to quickly share information on emerging biological threats, enabling coordinated responses, and reducing the time needed to develop and distribute treatments. Through joint research initiatives, regional experts can collaborate on understanding pathogens, developing vaccines, and creating strategies to mitigate biosecurity risks. To build confidence, foster information sharing, and harmonise protocols, it is recommended that a network of high-containment laboratories be established in Southeast Asia. Sharing of biological samples, for instance, among these laboratories can be explored through this network.

Strengthening regional research networks and partnerships on biosecurity is key for balancing between R&D, security, and health. While some information exchange and technological sharing partnerships have been established, they are not happening at a pace that meets the current biosecurity needs of the region. This type of cooperation could expand to regional sharing of information on EIDs/REIDs, and for developing a regularly updated list of controlled pathogens, toxins, and security-sensitive biological agents.

[14] Interview with Cambodian animal health experts, Phnom Penh, Cambodia, 22 January 2025.

Compiling a list of biological agents that are uniquely relevant to the region and to individual countries is a crucial step in strengthening biosecurity in Southeast Asia.

Creating a country-specific list of biological agents unique to Southeast Asia or individual countries is a crucial step in strengthening regional biosecurity. This list would differ from global or other regional lists by focusing on organisms that are particularly prevalent or pose significant risks within Southeast Asia, such as tropical diseases, endemic pathogens, or agricultural pests specific to the region. Identifying these organisms requires thorough research and collaboration among Southeast Asian countries to ensure that the list accurately reflects the biological threats that most affect the region. By prioritising these unique threats, countries in the region can develop targeted surveillance, prevention, and response strategies, better safeguarding public health, agriculture, and the environment against local biosecurity risks. Relative to developing national lists, a further step forward is to develop national and regional inventories for such pathogens; the challenge, however, is that there is limited authority on the part of health agencies to mandate or implement inventory reporting. In addition, several Southeast Asian countries have yet to complete their respective national list of security-sensitive biological agents, toxins, and pathogens while those that already have need to continuously review and update their list.

The ASEAN health sector has been implementing the Mitigation of Biological Threats (MBT) programme,[15] where one of the strategies is focused on biosafety and biosecurity, especially in the field of biological containment, including inventory of high-risk pathogens and the networking among AMS, partners, and relevant stakeholders. Established in 2013 and now in Phase 3, a key on-going project is the feasibility study on the establishment of a biobank of high-risk pathogens in the ASEAN region. The biobanking landscape in each AMS being highly fragmented needs to be addressed; fragmentation fosters the preconditions for risks in biosecurity.[16]

Encourage Security-Health Sector Cooperation

While sharing of best practices among relevant sectors is ongoing within ASEAN, a potential focus moving forward lies in the cooperation between the health and security sectors for managing biosecurity threats. For instance, Malaysia's on-going use of the US' model of interagency biosecurity cooperation between law enforcement/security (Federal Bureau of Investigation; FBI) and the health sector (Centre for Disease Control; CDC), presents a potential model to consider for ASEAN countries that have decentralised or subnational levels of government. Each country will, nonetheless, need to determine which model suits it best. In Thailand, one suggestion was to establish a law enforcement unit within the Ministry of Public Health as the focal point for enforcement of PATA.

[15] Singmin, Vicky. "ASEAN, Canada Work Together for Health Security." *The Jakarta Post*, November 9, 2024. Accessed 29 October 2025. www.thejakartapost.com/opinion/2024/11/09/asean-canada-work-together-for-health-security.html.

[16] Lansang, Ma. Patricia M. "PH, SG Leads ASEAN Biobank Feasibility Study 2nd Regional Meeting." 19 September 2023. Accessed 29 October 2025. https://ritm.gov.ph/ph-sg-leads-abfs-regional-meeting/.

In contrast, Singapore works with existing structures within a whole-of-government approach, while encouraging greater collaboration among the health, security, veterinary, environment, food, water, and trade sectors. In the Philippines, Malaysia, Thailand, and Cambodia, one gap identified by biosecurity experts is varying awareness (ranging from low to high) on biosecurity threats of security-sector bodies, public health agencies, and other civilian agencies, as they view such threats from different angles, for example, from a CBRN perspective, WMD/non-proliferation perspective, or from a health security perspective. This is being addressed through interagency national meetings and national training workshops.[17]

To strengthen cooperation in the health sector within ASEAN Defence Ministers' Meeting-Plus (ADMM-Plus) at the regional level, it is beneficial to follow the framework established by the security cluster, especially in military medicine. Although the security sector tends to be reserved when discussing sensitive security issues, it is notably open and vocal about health and biosecurity matters. In contrast, the health cluster, which plays an equally or even more crucial role in biosecurity management, has been reticent, with limited information sharing. Similarly, the education cluster requires significant improvement, as many discussions occur, but information is not being adequately shared, especially in areas, such as research and innovation in health. Given that multiple networks cover different types of biosecurity threats differently, such as biocrimes as opposed to naturally occurring diseases, a 'networking of networks' from different fields of specialisation is required to enable synergies across these networks.

Sharing of best practices is also critical in light of the emergence of new types of threats, such as cyberbiosecurity. There can be a lack of awareness and understanding of the potential cybersecurity risks and threats associated with digital laboratory data and digital information about biological samples inside laboratories. Regional research networks should prioritise molecular epidemiology and create opportunities for effective collaboration. Increased research activity will lead to more regulation, so it is crucial to build trust, engage in joint research, and facilitate policy dialogues between researchers and policymakers to ensure mutual benefit.

It is important to engage all ASEAN pillars to further improve biosecurity governance in Southeast Asia. Joint research initiatives allow regional experts to better collaborate and craft strategies to mitigate regional biosecurity risks.

A regional network for information exchange in Southeast Asia is essential for enhancing biosecurity by facilitating the timely detection, development of treatments, and effective data sharing. Such a network would allow countries to quickly share information on emerging biological threats, enabling coordinated responses and reducing the time needed to develop and distribute treatments.

[17] Interview with Cambodian BWC experts, Phnom Penh, 22 January 2025; interview with Philippine biosecurity experts, Quezon City, the Philippines, 11 June 2024; interview with Malaysian CBRN expert, Zoom, Singapore, 30 May 2024.

Through joint research initiatives, regional experts can collaborate on understanding pathogens, developing vaccines, and creating strategies to mitigate biosecurity risks. It is also important to engage all ASEAN pillars to further improve biosecurity governance in Southeast Asia.

Explore The One Health Approach to Preventing Biosecurity Threats

Given resource constraints, AMS today commonly prioritises early detection and response to diseases, or vaccine preparedness (i.e., "procurement, distribution and information management" as well as "interlink[ing] supply, delivery and demand, and considering how these interlinkages could be anticipated")[18] once diseases have evolved into zoonotic forms that can infect humans. However, given the significant uncertainty over what kind of DiseaseX (or, the next infectious disease with pandemic potential) will emerge, a disease-centric approach may be insufficient. A systems-level One Health approach is required for preparing for DiseaseX, which focuses on 'primary prevention,' or preventing systemic factors that lead to the occurrence of zoonosis, as opposed to 'secondary prevention,' which focuses on early detection of the problem once it has emerged.

The starting point of primary prevention should be monitoring and planning urban, ecological and land-use developments in a manner that reduces the likelihood of new human-to-animal interactions and, in turn, consequent animal-to-human spill over events in the future, hence a One Health approach. Beyond this, there is a need to advocate for a One Health approach that not only accounts for the human-animal-environment health interactions but also human-induced biosecurity threats. This is given that biological threats cut across multiple functions and sectors and go beyond the conventional silos of disease outbreaks (medical/health perspective) and bioterrorism (security perspective).

There is a need to study biosecurity approaches beyond preparedness and response. Lessons learned from the past indicate the need to add layers to current policies and practices, which may include laboratory policies, environmental policies, and engagement with the civil society. While current efforts are heavily focused on preparedness and response, it is crucial to integrate these additional layers to enhance overall effectiveness. Strengthening laboratory policies can ensure safer handling of biological materials, while environmental policies can mitigate the impact of degradation of ecosystems that may lead to biosecurity events. Involving the civil society can improve community resilience and awareness, creating a more comprehensive approach to bioterrorism prevention and response.

Biosecurity approaches need to go beyond preparedness and response; a more comprehensive approach should also prioritise strengthening laboratory and environmental policies, and better engaging the civil society towards reducing biosecurity threats.

[18] Leach, M., et al. "Vaccine Anxieties, Vaccine Preparedness: Perspectives from Africa in a COVID-19 Era." *Social Science & Medicine* 298 (April 2022): 114826. Doi:10.1016/j.socscimed.2022.114826.

Encourage The Development of Guidelines on Responsible Dual-Use Research of Concern and Managed Cyberbiosecurity

The regulation of DURC and cyberbiosecurity represents a critical opportunity to safeguard scientific advancements while mitigating potential risks. DURC necessitates stringent oversight to prevent misuse of biological agents for bioterrorism or other nefarious activities. Given the digitalisation of biological information, cyberbiosecurity measures need to be integrated within both cybersecurity and biosecurity frameworks. By implementing comprehensive regulatory frameworks, Southeast Asian states can ensure the responsible conduct of life sciences research, protect sensitive biological data from cyber threats, and foster public trust in scientific innovation.

Such regulations, however, will need to consider the delicate balance that needs to be maintained between safety and innovation. If regulations are too strict, such as those concerning reporting and monitoring, these can decrease researchers' or industries' motivation to conduct further research on biotechnology. Hence, more regional forums are needed to discuss whether new law or regulations are required, or if such policies can be achieved within existing legal frameworks. A critical concern remains, though, on whether a new, separate agency would be better suited to providing monitoring and oversight of DURC.

A stakeholder analysis is critical. Stakeholders in DURC, including principal investigators, researchers, students, and IBCs, must have their expectations holistically studied to understand the messages they need, who will communicate with them, and how to communicate effectively. Principal investigators, students, and researchers require clear guidelines, detailed protocols, and regular updates, typically communicated by IBCs and regulatory bodies. Additionally, industry stakeholders must be actively engaged through forums, partnership meetings, and collaborative initiatives to ensure awareness of DURC.

WHO has already issued its own guidelines with the *Global Guidance Framework*.[19] A potential initiative for AMS is to explore pathways to align with it, such as by developing national guidelines that are adapted to unique local country contexts.

Establish National/Regional Supply Chain Security Frameworks for Sensitive Pathogens, Toxins, and Biological Agents

Supply chains are potential conduits to biosecurity threats from DURC, as well as threats from imported commodities (whether food, animal, or plant). By rigorously monitoring vendors or primary sources of biological materials, maintaining a secure chain of custody, and implementing physical and information security measures, regulatory institutions can prevent unauthorised access, theft, accidental releases, or misuse of sensitive materials. In light of the potential for 'invasive alien species' and harmful products

[19] WHO. *Global Guidance Framework*.

A balance must be struck between stringent security measures for food safety and adherence to global trade standards. Moreover, genetic materials produced from synthetic biology should be better regulated to avert future risks of their misuse across supply chains.

being imported into ASEAN countries, which can pose threats to human, animal, and plant health, it is important equally to explore measures that will allow countries to ban imports from selected high-risk countries. An ideal Regional Supply Chain Security Framework should encompass both traditional trade as well as digital trade/e-commerce, the latter being less regulated. Such approaches, while taking a more conservative stance to prevent threats to food safety (e.g., poisoning/contamination), can potentially conflict with the World Trade Organization's (WTO) stance against non-tariff barrier to trade. Nonetheless, a balance must be struck between stringent security measures for food safety and adherence to global trade standards. In addition, given the potential of synthetic biology being misused or weaponised, a supply chain security framework needs to include genetic materials produced from synthetic biology (e.g., gene editing/modification).

Promote and Institutionalise a Security Culture to Prevent Biosecurity Threats

Low biosecurity awareness and a lack of security culture create security challenges and vulnerabilities in ordinary laboratories (i.e., those not involved in research). Given the potential for insider threats, in this regard, AMS will benefit from promoting and developing strict personnel reliability standards that will be rolled out across all member states. Such standards include comprehensive screening of personnel, and compulsory training and retraining of staff. Also important are fostering positive workplace cultures; enhancing biosecurity awareness among staff and managers; promoting adherence to security protocols; detecting potential issues early; and preventing accidental release from laboratories. Maintaining such standards can promote greater accountability for laboratory-related biosecurity within borders and prevent incidents of transnational threats, thus contributing to regional biosecurity. Future research can explore how Southeast Asian countries' biosecurity efforts can be stepped up to increasingly recognise the importance of integrating social and cultural approaches to effectively manage biological risks. These approaches involve engaging local communities, respecting cultural practices, and fostering public awareness about biosecurity threats.

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Appendix

A1. Legal framework based on countries[1]

Brunei

There are no known biological related industries master plan in Brunei, but the Brunei Agro-Technology Park which was built in 2011 was reportedly converted to Bio-Innovation Corridor in 2014.[2] It was reported that the main objective for the rebranding was to diversify Brunei's economy and transform itself into an export economy focusing on Halal products for China and the ASEAN market.[3]

Biosecurity laws

The Biological Weapons Act 1983 aims to prevent the development, production, and possession of any biological agent or toxin for non-peaceful purposes. It also provides the power to search and obtain evidence if the magistrate is satisfied by the information provided.

Pending legislation

There is a draft formation of the National Authority of Genetic Modification, which will be the competent authority for the regulation of genetic modified products.[4]

Infection control

The Infectious Diseases Act 2003 provides the power to conduct inspection, surveillance, isolation, and vaccination to prevent and control infectious disease transmission into and within Brunei.

The Animal (Diseases and Quarantine) Act 2021 legislate the need for importation and exportation licensing of animal or veterinary biologics, and permission to possess GMOs. It also authorises the examination, inspection, disposal of diseased animals, and disinfection and destruction of facilities believed to be contaminated.

Dual-use research of concern and control

There are no known laws specific to DURC.

National biosafety regulations

There are no known biosafety regulations currently in-force.

Laboratory biosafety regulations

There are no known biosafety regulations currently in-force.

Bioterrorism

The Anti-Terrorism Order 2011 is the primary law tackling acts of terrorism, which includes the use of microbial, biological agents, or toxins for terrorism purposes and causing harm. It provides extra-territoriality jurisdiction against acts of terrorism.

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[1] Compiled by Chan Wai Xin.

[2] SQW China Limited. "Brunei Agro-Technology Park Now Renamed As Bio-Innovation Corridor." Accessed 29 July 2025. https://sqwchinagroup.com/brunei-agro-technology-park-now-renamed-as-bio-innovation-corridor/

[3] SQW China Limited. "Gary Ho presented in Chile 'Brunei Bio-innovation Corridor.'" 15 September 2014. Accessed 29 July 2025. http://sqwchinagroup.com/gary-ho-presented-chile-brunei-bio-innovation-corridor/.

[4] Ministry of Industry and Primary Resources (MIPR), Brunei. "Opening Remarks at the Seminar on Biosafety Framework for Brunei Darussalam, 31 August 2015." Accessed 11 July 2025. www.agriculture.gov.bn/SiteCollectionDocuments/Press%20Release/Press%20Release%202.pdf.

Cambodia

Despite the number of diagnostic laboratories in Cambodia, there is no notable biologically related industry.

Biosecurity laws

The Sub-Decree on the Organisation and Functioning of the General Secretariat of the National Authority for the Prohibition of Chemical, Nuclear, Biological and Radiological Weapons 2007 defines the responsibility of the National Authority to provide oversight on CBRN substances. This is supplemented by Law on the Ban of Nuclear, Chemical, Biological and Radiological Weapons 2009, which prohibits manufacturing, processing, receiving, transferring, storing, transporting, and use of chemical weapons, nuclear weapons, biological weapons and radiological weapons, and other chemical substances related to the production of weapons in the Kingdom of Cambodia.

Pending legislation

There are no known draft legislations on biosecurity matters.

Infection control

Infection control law was introduced to tackle the COVID-19 pandemic, the Law on Measures to Prevent the Spread of COVID-19 and Other Deadly Infectious Diseases 2021 provides the authorities rights to impose administrative measures to isolate and contain areas with high infection rates.

Dual-use research of concern and control

No known laws that govern the areas of dual-use research of concern.

National biosafety regulations

The Code on Environment and Natural Resources 2023 supersedes the Biosafety Law that was enacted in 2008. Its primary objectives are to implement a precautionary approach towards biosafety, and prevent adverse impacts to biodiversity caused by transboundary movement, development, and release of LMOs. The emphasis on biosafety in the law put emphasis on environmental concerns and biodiversity protection. The management of highly dangerous pathogens and toxins was placed under *Prakas* (ministerial proclamation) by the Minister of Health, which may pave the way for an eventual legislation.

Laboratory biosafety regulations

There are no known laboratory-specific biosafety regulations.

Bioterrorism

While there is no official legislation for tackling bioterrorism in Cambodia, the National Authority for the Prohibition of Chemical, Nuclear, Biological and Radiological Weapons (NACW) is the agency responsible for handling CBRN threats. The CBRN National Action Plan (NAP) 2017 provides the national vision for CBRN risk mitigation and capacity building.

Indonesia

Indonesia launched its National Research Master Plan (RIRN) in 2017 to layout the scientific roadmap until 2045. Among its focus industries, it is expected that biotechnology will be involved in the advancement of food, pharmaceutical, advanced manufacturing, cosmetic and medical devices industries.[5] The plan also intends to tap

[5] Ministry of Research, Technology, and Higher Education (RISTEKDIKTI), Indonesia. "National Research Master Plan Year 2017–2045." 2017. Accessed 30 July 2025. www.lpmu.upj.ac.id/userfiles/files/RENCANA-INDUK-RISET-NASIONAL.pdf.

on the natural biological resources available within Indonesia. The wide range of applications will require competency development in the areas of biotechnology, molecular biology, and medical sciences.[6]

Biosecurity laws

While there are no specific biosecurity laws, the Health Law No. 17/2023 provides an overarching legislation towards preventing the spread of disease-causing agents (Article 399), conducting disease surveillance, isolation, and quarantine measures (Articles 371–378), ensuring risk management standards (Article 397).

Pending legislation

There are no known draft legislations for biosecurity.

Infection control

The Health Law Articles 371–378 provision the powers required for infection control through surveillance, isolation, and quarantine measures.

This is supplemented by Minister of Health Regulation 27/2017 on Infection Prevention and Control in Health Service Facilities, which aims to reduce and prevent acquired infections from healthcare facilities.

The Law on the Quarantine of Animals, Fish, and Plants 21/2019 provides for the supervision and quarantine of animals, fish, plants, their genetic resources, the safety of their derived food products, and genetically engineered products (PRG).

Dual-use research of concern and control

While there is no DURC specific legislation, the Health Law Articles 335 and 336 require researchers to comply with ethical principles, and they must consider benefit, risk, safety, and environmental impact.

National biosafety regulations

The Governmental Regulation No. 21/2005 provides guidelines for the use of genetically modified agricultural biotechnology products that must be formally approved by the Commission for Biological Safety of PRG (KKH PRG). This includes animal, fish, plant, microorganisms, and their derived products.

Laboratory biosafety regulations

The Health Law 17/2023 Article 397 requires that personnel operating with high-risk agents meet the required risk management standards. The Laboratory Biorisk Management Quality Guidelines (SNI 8340:2016) and Institution Biorisk Laboratory Manual 2019 provide the operating guidance for laboratories to meet their biosafety requirements. The guidelines also provide some aspects to address biosecurity concerns.

Bioterrorism

The Government Regulation No. 1/2002 recognises the use of biological weapons to create mass casualties as acts of terrorism. It provides extraterritoriality jurisdiction against acts of terrorism. The law was amended in 2018 with Law No. 5 of 2018, with a new article on the unlawful importation and possession of biological weapons or pathogens for the intent of terrorism and punishable with imprisonment.

Laos

Laos is pursuing biotechnology advances in genetic resources, agriculture and forestry, health, industrial processing, and the environment.[7] The country strives to leverage on scientific advances to achieve socioeconomic

[6] RISTEKDIKTI. "National Research Master Plan."

[7] Government of Lao PDR. "Biotechnology Safety Law 2014." Accessed 30 July 2025.

developments by improving animal and plant breeding, better use of genetic resources along with conservation, improving traditional and modern medicine development, and disease detection.[8]

Biosecurity laws

Although the National Biosafety Regulation 2019 puts emphasis on laboratory biosafety measures. It also requires the implementation of measures, such as personnel access control, and inventory accounting of pathogen storage, thereby providing a degree of biosecurity control.

Pending legislation

No known draft legislation on biosecurity.

Infection control

Law on Prevention and Control of Communicable Diseases 2017 focuses on any disease that can be transmissible to humans. It classifies communicable diseases by severity and states the corresponding actions required in terms of surveillance, detection and reporting to prevent and contain the transmission.

Law on Animal Husbandry and Veterinary Medicine 2016 requires the authority to develop a system to detect and monitor the diseases to provide timely advice and implementation of control measures. It also requires the Ministry of Agriculture and Forestry to have veterinary checkpoints to conduct animal product inspections.

Dual-use research of concern and control

While there is a decree on the control of dual-use goods, there is no specific legislation on the control of DURC.

National biosafety regulations

The Biotechnology Safety Law 2014 put emphasis on the management and monitoring of biotechnological safety with regards to the research, development, handling, movement, and use of GMOs, which may result in negative consequences on biodiversity and environmental conservation. The implementation of the Regulation is coordinated by the National Committee for Biotechnology Safety.

Laboratory biosafety regulations

The National Biosafety Regulation 2019 focuses on laboratory biosafety practices to prevent laboratory-acquired infection. To a certain extent, the regulations provide certain safeguards with respect to DURC and biosecurity.

Bioterrorism

While the Penal Code has an article on acts of terrorism, which lists explosive, radioactive substances, toxics, and inflammable materials, it does not govern the use of biological agents under it. Only a brief mention on the release of viruses among communities or animals under a separate article in the Penal Code is mentioned.

Malaysia

Malaysia launched its National Biotechnology Policy 2.0 (DBN 2.0) in 2022 focusing on three areas of development — agricultural biotechnology and food security, healthcare and wellbeing, and biotechnology in industrialisation and the circular economy.[9] It also has several key targets, including having institutions conducting world-class biotechnological research, and having biotechnology companies contributing around 5 per cent of the gross domestic product by 2030.[10]

[8] Ibid.

[9] Bioeconomy Corporation. "National Biotechnology Policy 2.0 (DBN 2.0)." Accessed 28 July 2025. www.bioeconomycorporation.my/corporate/nbp/.

[10] Ibid.

Biosecurity laws

While there are no specific laws for biosecurity in Malaysia, the Malaysia Laboratory Biosafety and Biosecurity Policy and Guideline published by the Ministry of Health in 2015 covers some of the administrative and engineering controls for biosecurity.

The Malaysian Biosafety and Biosecurity Association (MBBA) is actively promoting biosafety and biosecurity practices through training and networking with similar regional and international associations.

Pending legislation

It is reported that the Biological and Toxin Weapons Bill is still being drafted, which will serve as the basis of biosecurity laws.

Infection control

The Prevention and Control of Infectious Diseases Act 1988 Act 342 allows the authority to declare that an area has been infected by communicable disease, conduct surveillance, and isolate and quarantine potentially infected persons. The authority may also order for the disinfection of vehicles and premises. The law also requires individuals who are aware of the existence of infectious disease to report to the health office.

The Animals Act 1953 Act 647 specifies the requirements for animal importers, control of the slaughter of animals, prevention of cruelty, and preventing the introduction and spread of animal diseases within Malaysia.

The Plant Quarantine Act 1976 Act 167 aims to control, prevent and eradicate agricultural pests, noxious plants and plant diseases within Malaysia and during plant movement for the purpose of international trade.

Dual-use research of concern and control

The Malaysia Laboratory Biosafety and Biosecurity Policy and Guideline requires the formation of institutional biosafety and biosecurity committees (IBBCs), which will oversee that all activities related to infectious agents and toxins do follow the legal frameworks with controls in place.

The Strategic Trade Act 2010 Act 708 restrict the technical assistance, exportation, transhipment, brokering of biological material that may be used for the development of WMDs.

National biosafety regulations

Biosafety Act 2007 Act 678 primarily governs the activities related to GMOs. This includes the importation and exportation, usage, and release of such organisms. The law also requires an emergency response plan stipulating the safety measures and procedures required to prevent unintended consequences.

Laboratory biosafety regulations

The Malaysia Laboratory Biosafety and Biosecurity Policy and Guideline provides a checklist and control recommendations to ensure that facilities comply with the required biosafety level.

Bioterrorism

The Penal Code Act 574 is the primary law that defines the act of terrorism. It includes biological weapons as a lethal device in such an act. It also considers providing, training, and receiving training related to the use of biological weapons for acts of terrorism as an offence.

Myanmar

Despite the coup, Myanmar was reportedly performing biotechnology research on agricultural crops such as orchids, sesame, rice, chrysanthemum and other food crops.[11] However, only one genetically engineered cotton variety has been commercialised and there are no plans to conduct genetic engineering research on food crops.[12]

Biosecurity laws

There are no laws specific for biosecurity.

Pending legislation

It was reported that Myanmar was drafting the National Biosafety Framework and Policy, with assistance from the United Nations Environment Programme (UNEP) and Global Environment Facility (GEF) in 2020.[13] The framework that covers risk assessment, public awareness and regulatory structures for GMOs remains unpublished following the military coup in 2021.[14]

Infection control

The Animal Health and Livestock Development Law 2020 aims to prevent infectious and zoonotic diseases and to provide for systematic response and control measures during an outbreak.

The Plant Pest Quarantine Law 2000 aims to control the importation of plant and plant-related material, and provide officials the authority to inspect, seize, and destroy such material, where necessary.

The Prevention and Control of Communicable Diseases Law 2011 empowers the Department of Health to carry out surveillance, prevention, and control of communicable diseases, and provides a legal basis for the restriction of movements of affected individuals.

Additionally, Myanmar has the National Action Plan for Health Security which aims to raise public health security in line with International Health Regulations 2005 (IHR) by promptly detecting, preventing, and reducing the likelihood of outbreaks to save lives.

Dual-use research of concern and control

There are no laws specific for DURC controls.

National biosafety regulations

There are no laws specific to national-level biosafety.

Laboratory biosafety regulations

There are no laws specific to laboratory biosafety.

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[11] Foreign Agricultural Service (FAS), US Department of Agriculture (USDA). "Agricultural Biotechnology Annual: Burma–Union of." 4 November 2024. Accessed 30 July 2025. https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Agricultural%20Biotechnology%20Annual_Rangoon_Burma%20-%20Union%20of_BM2024-0015.pdf.

[12] FAS, USDA. "Burma."

[13] Zaw, Thura. "Fourth Year Serving the People As Ministry of Agriculture, Livestock and Irrigation in Civilian Government Administration." *The Global New Light of Myanmar*, August 24, 2020. Accessed 1 August 2025. https://myanmar.gov.mm/documents/20143/0/24_April_20_gnlm.pdf/a2752767-e4f3-05ce-9857-d58cda3dfc9b?version=1.0&t=1587705923486.

[14] FAS, USDA. "Burma."

Bioterrorism

The Counter Terrorism Law 2014 aims to prevent acts of terrorism and covers the usage of chemical, nuclear and biological weapons in an act of terrorism.

The Philippines

The Harmonized National Research and Development Agenda (2022–2028) places research emphasis on six areas — water security, food and nutrition security, health sufficiency, clean energy, sustainable community, and inclusive nation building.[15] Apart from genetic studies, these priority areas will tap on biotechnology in matters, such as pest studies, biopollution, bioecology, biodiversity and biorefinery.[16]

Biosecurity laws

There are no laws specific for biosecurity.

Pending legislation

It is reportedly drafting a new biosafety and biosecurity bill.

Infection control

The law on Mandatory Reporting of Notifiable Diseases and Health Events of Public Health Concern Act (Republic Act 11332) allows for the Department of Health to conduct disease surveillance to provide timely response. It also requires organisations and healthcare professionals to accurately and timely report notifiable diseases.

Dual-use research of concern and control

The Strategic Trade Management Act (STMA) (Republic Act 10697) provides governance over the export and transhipment of strategic technologies that can contribute towards the development of WMDs, this includes biological agents and toxins.

National biosafety regulations

The National Biosafety Framework promulgated by the Executive Order 514 enhanced the National Committee on Biosafety of the Philippines by giving it the authority to guide the conduct of all other governmental departments and agencies in the matters of biosafety and biotechnology. This framework provides the Philippines a comprehensive approach to handle biotechnology issues, both present and future.

Laboratory biosafety regulations

While there is no specific law for biosafety, the Philippines Biosafety Guidelines for Contained Use of Genetically Modified Organisms (GMOs) 2014[17] provides guidance on the requirements for the different biosafety levels. It also advises the formation of IBCs to provide oversight and categorise pathogens and toxins by risk levels. It is considered a revision of the Biosafety Guidelines 1991.

Similarly, the Manual of Laboratory Biosafety and Biosecurity Standards 2023 published by the Department of Health provides a more concise document to guide facilities in implementing the core requirements to achieve biosafety.

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[15] Department of Science and Technology (DOST), Republic of the Philippines. "Harmonized National Research and Development Agenda 2022–2028." Accessed 30 July 2025. www.dost.gov.ph/phocadownload/Downloads/Resources/Quick_Links/HNRDA_2022-2028.pdf.

[16] DOST. "Harmonized National Research."

[17] DOST Biosafety Committee, the Philippines. "The Philippines Biosafety Guidelines for Contained Use of Genetically Modified Organisms (GMOs): Revised Edition." September 2014. Accessed 5 December 2025. https://ovcre.uplb.edu.ph/downloads/category/16-resources-for-researchers%3Fdownload%3D120:the-philippine-biosafety-guidelines-for-contained-use-of-genetically-modified-organisms&ved=2ahUKEwjJwJ-5wqWRAxWRSGwGHf2UMN8QFnoECAcQAg&usg=AOvVaw3F_Qx1ICjknxv-tNGABdke.

Separately, the Philippines Biosafety Guidelines for Containment of Transgenic Arthropods[18] documents the biosafety guidelines related to experiments on genetically modified insects.

Bioterrorism

The Anti-Terrorism Act 2020 (Republic Act 11479) recognises biological weapons as WMDs and aims to prevent the development, possession, and usage of such weapons for acts of terrorism.

Singapore

Singapore embarked on the Biomedical Sciences Initiative (BMS Initiative) in the early 2000s and completed the Biopolis, a dedicated biomedical R&D centre.[19] In the first decade, the centre attracted research organisations spanning a range of fields, including bioinformatics, stem cell research, immunology, and genomics.[20]

The latest Research, Innovation and Enterprise 2025 (RIE2025) plans published by the National Research Foundation (NRF) included Human Health and Potential (HHP) as one of the four pillars of focus.[21] Building on existing biomedical science capabilities, RIE2025 aims to expand the development of precision medicine research. Precision medicine includes the use of biological, medical, genetic and environmental information to provide targeted clinical treatment.[22]

Biosecurity laws

Singapore biosafety and biosecurity laws are primarily driven by Biological Agents and Toxins Act 2005 (BATA). The law provides legal oversight over the importation, possession, and transportation of biological agents and toxins. Different tiers of protection are prescribed in accordance with the risk categorisation of these agents and toxins. This law also codifies the biosafety requirements for laboratories working with high-risk agents, including requiring the facilities to be classified as a protected place in accordance with Infrastructure Protection Act 2017 (IPA). This Act requires personnel screening by security agencies before they can be authorised to access facilities, enhancing the biosecurity control of the laboratories.

The exportation of the biological agents is governed by Strategic Goods (Control) Act 2002 (SGCA), and it aims to prevent exportation when there is reason to believe the agents will be weaponised. The restrictions are applied in accordance with the four multilateral export control regimes.

Pending legislations

No pending legislation related to biosafety and biosecurity.

Infectious disease control

Infectious Disease Act 1976 is responsible for the controlling and prevention of infectious disease transmission to human beings. It empowers the corresponding officers to impose isolation and quarantine, surveillance, and detection of diseases. This is also supplemented by Animals and Birds Act 1965, which prevents the introduction and spreading, within Singapore, of diseases of animals, birds, or fish.

The newly formed Communicable Diseases Agency (CDA) is the overarching coordinating agency responsible for infectious disease control in Singapore and its role and functions are described by the

[18] DOST Biosafety Committee, the Philippines. "The Philippines Biosafety Guidelines for Containment of Transgenic Arthropods." Accessed 5 December 2025. https://dost-bc.dost.gov.ph/guidelines/guidelines-for-containment-of-transgenic-arthropods/.

[19] A*Star Research. "Biopolis: Ten Years On." Accessed 28 July 2025. https://research.a-star.edu.sg/articles/features/biopolis-ten-years-on/.

[20] A*Star Research. "Biopolis."

[21] National Research Foundation (NRF). "Research, Innovation and Enterprise 2025 Plan." Accessed 28 July 2025. https://file.go.gov.sg/rie-2025-handbook.pdf.

[22] NRF. "Research, Innovation and Enterprise 2025 Plan."

Communicable Diseases Agency Act 2025. This includes research, surveillance, and the development of technical expertise for the prevention, management and control of infectious disease in Singapore.

Dual-use research of concern and control

While there is no explicit governmental legislation stipulating oversight for DURC, the biosafety committee stipulated in BATA is responsible for the risk assessment and implementation of control measures to mitigate the risk of DURC.

The same broad-spectrum approach towards risk assessment, instead of identifying solely based on specific agents, is also practised in the Singapore Biosafety Guidelines for Research on Genetically Modified Organisms (GMOs) by GMAC.

Separately, BAS has also published the Singapore Biorisk Code of Conduct for the Life Sciences Industry and Professionals. It aims to promote a culture of responsibility and awareness of the dual-use implication of research among professionals.

National biosafety regulations

There is no known regulation for national-level biosafety concerns.

Laboratory biosafety regulations

The primary guideline for laboratory biosafety level is based on the risk classification stated in the BATA. To facilitate the commission of such facilities, operators can rely on the Singapore Standard – Biorisk Management for Laboratories and Other Related Organisations (SS ISO 35001:2021+A1:2024) or the Biorisk Management Standard for Large-Scale Work with Biological Agents for facilities producing biological agents in large quantity.

Bioterrorism

Terrorism (Suppression of Bombings) Act 2007 serves as the primary law that deals with the threat of biological agents being used to cause substantial material damage. Apart from suppressing the act of terrorism through punitive measures, it aims to compel people with information on potential act of terrorism to disclose the information to prevent the act from taking place.

Thailand

Thailand has launched a plan in 2019 to develop the Bio-Circular-Green economy model targeting four key industries — agriculture and food; bioenergy, biomaterial and biochemical; medical and wellness; and tourism and the creative economy.[23] It is expected that biotechnology will contribute to the development of agricultural innovation and farm productivity, precision medicine and biopharmaceuticals. BIOTEC is also contributing to research that enhance the food production, bioproduct and medical areas.[24]

Biosecurity laws

While Pathogens and Animal Toxins Act 2015 (PATA) serves as the primary law related to biological activities, it is largely a biosafety-centric guidelines. It classifies the categories of pathogens and toxins by their risk levels, and stipulates the corresponding licensing requirements for the production, possession, importation, exportation, sales and transit of such agents.

[23] National Science and Technology Development Agency (NSTDA). "Thailand's Vision and National Policy." Accessed 28 July 2025. www.nstda.or.th/thaibioeconomy/why-bioeconomy/thailand-vision-national-policy.html.

[24] National Center for Genetic Engineering and Biotechnology (BIOTEC). "Explore BIOTEC." Accessed 28 July 2025. www.biotec.or.th/home/en/biotec-home-2021-en/.

The Control of Item in Relation to the Proliferation of Weapons of Mass Destruction Act enacted in 2019 provides high-level regulatory oversight over any material that can be used to design and develop WMDs, and the exportation and transhipment of such material. This control also applies to biological weapons and items that are potentially dual-use.

Pending legislation

A draft National Biodiversity Act is in the pipeline with regards to genome editing regulations for the agricultural and aquaculture industries. Once it has been passed, the law will serve as the national focal point for the Convention on Biological Diversity (CBD) and the Cartagena Protocol on Biosafety.

Infection control

Communicable Diseases Act 2015 is the law responsible for the prevention and control of infectious diseases that are transmissible to human. The Animal Epidemics Act 2015 focuses on the prevention and control of communicable diseases in animals, and the Plant Quarantine Act 2008 focuses on the control of importation of plants into Thailand.

An additional Ministerial Regulation of Public Health on the Disposal of Infectious Waste was revised in 2021 to ensure proper accounting of infectious waste management.

Dual-use research of concern and control

While PATA provides indirect governance over research through the establishment of IBCs to provide research oversight, and the Control of Item in Relation to the Proliferation of Weapons of Mass Destruction Act to prevent dual-use items, which can potentially be used for the development of WMDs, there is no explicit control over the domestic development of DURC.

National biosafety regulations

PATA provides the licensing and biosafety committee requirements for organisations working with high-risk agents. The Pathogens and Animal Toxins Committee consists of the Permanent Secretary of Ministry of Public Health, and 14 members, including representatives from the defence, science and technology, foreign trade, and many other relevant departments. This demonstrates a whole-of-government approach towards biosafety issues.

Laboratory biosafety regulations

There are no laboratory-specific biosafety regulations.

Bioterrorism

There are no specific laws pertaining to bioterrorism prevention.

Vietnam

The Vietnam Politburo aims to make Vietnam one of the world's leading biotechnology hubs by 2045.[25] This continues the longstanding recognition of biotechnology being a key driver for the country's modernisation efforts and ensuring its food security. The biotechnology industry is expected to contribute between 10–15 per cent of its

[25] Vietnam Academy of Science and Technology (VAST). "Scientific Conference on 'Biotechnology: Serving Sustainable Development and Promoting the Circular Economy.'" 11 June 2025. Accessed 31 July 2025. https://vast.gov.vn/web/vietnam-academy-of-science-and-technology/tin-chi-tiet/-/chi-tiet/scientific-conference-on-biotechnology-serving-sustainable-development-and-promoting-the-circular-economy--140103-871.html.

gross domestic product by 2045, and Vietnam is likely to pick up pace in developing the required human resources and financial foundations to meet the industry needs.[26]

Biosecurity laws

There are no specific laws towards the management of biosecurity.

Pending legislation

There are reports on a draft Law on Disease Prevention and Control, which aim to enhance preventive measures, improve healthcare, and especially include provisions on ensuring financial resources for preventive health.[27]

Infection control

The 03/2007/QH12 Laws on the Prevention of Infectious Diseases 2007 allows health agencies to impose quarantine, and conduct surveillance to prevent the transmission of infectious diseases in humans. It is supplemented by Decree 92/2010/ND-CP, which details infectious disease concerns within biological laboratories, making the base law a guideline for laboratory biosafety.

Animal health is governed by the 79/2015/QH13 Law on Veterinary Medicine, which aims to prevent, treat and fight against animal epidemic diseases, and deals with the quarantine of animal products as well as management of veterinary drugs and practices. Plant health is dealt with under the 41/2013/QH13 Law on Plant Protection and Quarantine, which aims to prevent and control organisms that are harmful to vegetation, plant quarantine and management of pesticides.

Dual-use research of concern and control

Decree 81/2019/ND-CP is for Preventing and Countering Proliferation of Weapons of Mass Destruction. It aims to prevent any research or development that can lead to the potential production of a WMD.

National biosafety regulations

There is no known regulation for national-level biosafety concerns.

Laboratory biosafety regulations

Decree 103/2016/ND-CP, which is based on the 03/2007/QH12 laws, puts more emphasis on the conditions for laboratory requirements and ensuring that business entities performing biological testing activities meet the requirements of the Law on Medical Examination and Treatment.

This decree is supplemented by the Circular 37/2017/TT-BYT, which spells out operational practices to ensure biosafety in laboratories. A second circular 41/2016/TT-BYT codifies the facilities requirements vis-à-vis equipment and conditions for the facilities to be recognised at the corresponding biosafety levels when working with listed pathogens.

Bioterrorism

While there are laws pertaining to counter-terrorism, it does not put emphasis on biological weapons. As such, the decree 81/2019/ND-CP provides specific authorisation to the Ministry of National Defence to work in conjunction with the Ministry of Health to detect, deter, and to take actions against the proliferation of biological weapons.

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[26] "Politburo Resolves on Biotechnology Application to Serve Sustainable Development of the Country." *Vietnam Law & Legal Forum*, May 6, 2023. Accessed 1 August 2025. https://vietnamlawmagazine.vn/politburo-resolves-on-biotechnology-application-to-serve-sustainable-development-of-the-country-70011.html.

[27] United Nations Viet Nam. "Local Experts in Supporting Specialized Content in the Law on Disease Prevention (LDP) with a Focus on Communicable Diseases, including Vaccine Preventable Diseases and Immunization." Accessed 11 July 2025. https://vietnam.un.org/en/297333-local-experts-supporting-specialized-content-law-disease-prevention-ldp-focus-communicable.

A2. Legal Framework Based on Countries (Table)[1]

Country	Types of Regulation	Areas of Concerns	Name of Regulation or Body	Purposes
Brunei Darussalam	Legislation	Biosecurity	Biological Weapons Act 1983	Prevent the development, production, and possession of any biological agent or toxin for non-peaceful purposes. It also provides the power to search and obtain evidence if the magistrate is satisfied by the information provided.
	Legislation	Infection control	Infectious Diseases Act 2003	Provides the power to conduct inspection, surveillance, isolation, and vaccination to prevent and control infectious disease transmission into and within Brunei.
	Legislation	Infection control	Animal (Diseases and Quarantine) Act 2021	Legislate the need for importation and exportation licensing of animal or veterinary biologics, and permission to possess genetically modified organisms. It also authorises the examination, inspection, disposal of diseased animals, and disinfection and destruction of facilities believed to be contaminated.
	Legislation	Bioterrorism	Anti-Terrorism Order 2011	Primary law tackling acts of terrorism, which includes the use of microbial, biological agents or toxins for terrorism purpose and causing harm. It provides extra-territoriality jurisdiction against acts of terrorism.
Cambodia	Legislation	Biosecurity, bioterrorism	Sub-decree on the Organisation and Functioning of the General Secretariat of the National Authority for the Prohibition of Chemical, Nuclear, Biological and Radiological Weapons 2007	Defines the structure and responsibility of the National Authority to provide oversight on CBRN substances.

[1] Compiled by Chan Wai Xin.

	Legislation	Biosecurity, bioterrorism	Law on the Ban of Nuclear, Chemical, Biological and Radiological Weapons 2009	Prohibits manufacturing, processing, receiving, transferring, storing, transporting and use of chemical weapons, nuclear weapons, biological weapons, and radiological weapons and other chemical substances related to the production of weapons in the Kingdom of Cambodia.
	Legislation	Infection control	Law on Measures to Prevent the Spread of COVID-19 and Other Deadly Infectious Diseases 2021	Provides authorities rights to impose administrative measures to isolate and contain areas with high infection rates.
	Legislation	Biosafety	Code on Environment and Natural Resources 2023	Primary objectives are to implement a precautionary approach towards biosafety, and prevent the adverse impact to biodiversity caused by transboundary movement, development, and release of living modified organisms (LMOs). The emphasis on biosafety in the law puts emphasis on environmental concerns and biodiversity protection.
	Guidelines	Bioterrorism	CBRN National Action Plan (NAP) 2017	Provides the national vision for CBRN risk mitigation and capacity building.
Indonesia	Legislation	Biosecurity, infection control, biosafety, DURC	Health Law No. 17/2023	Provides an overarching legislation towards preventing the spread of disease-causing agents (Article 399), conducting disease surveillance, isolation, and quarantine measures (Articles 371–378), and ensuring risk management standards (Article 397), ethical research and the weighing of cost and benefits (Articles 335, 336).
	Regulation	Infection control	Minister of Health Regulation 27/2017 on Infection Prevention and Control in Health Service Facilities	Aims to reduce and prevent acquired infections from healthcare facilities.

	Legislation	Infection control	Law on the Quarantine of Animals, Fish, and Plants 21/2019	Provides for the supervision and quarantine of animals, fish, plants, their genetic resources, the safety of their derived food products, and genetically engineered products (PRGs).
	Guidelines	Biosafety	Laboratory Biorisk Management Quality Guidelines (SNI 8340:2016)	Provide operating guidance for laboratories to meet their biosafety requirements. The guidelines also provide some aspects to address biosecurity concerns.
	Guidelines	Biosafety	Institution Biorisk Laboratory Manual 2019	Provide operating guidance for laboratories to meet their biosafety requirements. The guidelines also provide some aspects to address biosecurity concerns.
	Regulation	Biosafety	Governmental Regulation No. 21/2005	Provides guidelines for the use of genetically modified agricultural biotechnology products that must be formally approved by the Commission for Biological Safety of PRG (KKH). This includes animal, fish, plant, microorganisms, and their derived products.
	Legislation	Bioterrorism	Law No. 5 of 2018	Recognises the use of biological weapons to create mass casualties as an act of terrorism, and the unlawful importation and possession of biological weapons or pathogens for the intent of terrorism being punishable with imprisonment.
Laos	Legislation	Biosecurity, biosafety	National Biosafety Regulation 2019	Focuses on laboratory biosafety practices to prevent laboratory-acquired infections. To a certain extent, it provides certain safeguards in the aspect of biosecurity.
	Legislation	Biosafety	Biotechnology Safety Law 2014	On the management and monitoring of biotechnological safety with

				regards to the research, development, handling, movement, and use of GMOs, which may result in negative consequences on biodiversity and environmental conservation.
	Legislation	Infection control	Law on Prevention and Control of Communicable Diseases 2017	Focuses on any disease that can be transmissible to humans. It classifies communicable diseases by severity and states the corresponding actions required in terms of surveillance, detection, and reporting to prevent and contain the transmission.
	Legislation	Infection control	Law on Animal Husbandry and Veterinary Medicine 2016	Detect and monitor the diseases to provide timely advice and implementation of control measures. It also requires the Ministry of Agriculture and Forestry to have veterinary checkpoints to conduct animal product inspections.
Malaysia	Guidelines	Biosecurity, biosafety, DURC	Malaysia Laboratory Biosafety and Biosecurity Policy and Guideline 2015	Covers some of the administrative and engineering controls for biosecurity. Requires the formation of institutional biosafety and biosecurity committees (IBBCs), which will oversee that all activities related to infectious agents and toxins follow legal frameworks, with controls in place. Provides a checklist and control recommendations to ensure facilities comply with the required biosafety level.
	Expert Recommendation	Biosecurity, biosafety	Malaysian Biosafety and Biosecurity Association (MBBA)	Actively promoting biosafety and biosecurity practices through training and networking with similar regional and international associations.

	Legislation	Infection control	Prevention and Control of Infectious Diseases Act 1988 Act 342	Allows the authority to declare that an area has been infected by communicable disease, conduct surveillance, and isolate and quarantine potentially infected persons. The authority may also order for the disinfection of vehicles and premises. The law also requires individuals who are aware of the existence of infectious disease to report to the health office.
	Legislation	Infection control	Animals Act 1953 Act 647	Specifies the requirements for animal importers, control of the slaughter of animals, prevention of cruelty, and preventing the introduction and spread of animal diseases within Malaysia.
	Legislation	Infection control	Plant Quarantine Act 1976 Act 167	Aims to control, prevent, and eradicate agricultural pests, noxious plants and plant diseases within Malaysia, and during plant movement for the purposes of international trade.
	Legislation	DURC	Strategic Trade Act 2010 Act 708	Restrict the technical assistance, exportation, transhipment, brokering of biological material that may be used for the development of WMDs.
	Legislation	Biosafety	Biosafety Act 2007 Act 678	Primarily governs activities related to GMOs. This includes the importation and exportation, usage, and release of such organisms. The law also requires an emergency response plan stipulating the safety measures and procedures required to prevent unintended consequences.
	Legislation	Bioterrorism	Penal Code Act 574	Primary law that defines the act of terrorism. It includes biological weapons as a lethal device in such an act. It also

				considers providing, training and receiving training related to the use of biological weapons for acts of terrorism as an offence.
Myanmar	Legislation	Infection control	Animal Health and Livestock Development Law 2020	Prevent infectious and zoonotic diseases, and to provide for systematic response and control measures during an outbreak.
	Legislation	Infection control	Plant Pest Quarantine Law 2000	Control the importation of plant and plant-related materials, and provide officials the authority to inspect, seize, and destroy such material, where necessary.
	Legislation	Infection control	Prevention and Control of Communicable Diseases Law 2011	Empowers the Department of Health to carry out surveillance, prevention, and control of communicable diseases, and provides a legal basis for the restriction of movements of affected individuals.
	Guidelines	Infection control	National Action Plan for Health Security	Aims to raise public health security in line with International Health Regulations 2005 (IHR) by promptly detecting, preventing, and reducing the likelihood of outbreaks to save lives.
	Legislation	Bioterrorism	Counter Terrorism Law 2014	Prevent acts of terrorism and covers the usage of chemical, nuclear and biological weapons in an act of terrorism.
The Philippines	Legislation	Infection control	Mandatory Reporting of Notifiable Diseases and Health Events of Public Health Concern Act (Republic Act 11332)	Allows the Department of Health to conduct disease surveillance to provide timely response. It also requires organisations and healthcare professionals to accurately and timely report notifiable diseases.

	Legislation	DURC	Strategic Trade Management Act (STMA) (Republic Act 10697)	Provides governance over the export and transhipment of strategic technologies that can contribute towards the development of WMDs, which includes biological agents and toxins.
	Guidelines	Biosafety	National Biosafety Framework (Executive Order 514)	Enhanced the National Committee on Biosafety of the Philippines by giving it the authority to guide the conduct of all other governmental departments and agencies in the matters of biosafety and biotechnology.
	Guidelines	Biosafety	Philippines Biosafety Guidelines for Contained Use of Genetically Modified Organisms (GMOs) 2014	Provides guidance on the requirements for the different biosafety levels. It also advises the formation of institutional biosafety committees (IBCs) to provide oversight and categorise pathogens and toxins by risk levels.
	Guidelines	Biosafety	Philippines Biosafety Guidelines for Containment of Transgenic Arthropods 2014	Documents the biosafety guidelines related to experiments on genetically modified insects.
	Guidelines	Biosafety	Manual of Laboratory Biosafety and Biosecurity Standards 2023	Provides a more concise document to guide facilities in implementing the core requirements to achieve biosafety.
	Legislation	Bioterrorism	Anti-Terrorism Act of 2020 (Republic Act 11479)	Recognises biological weapons as WMDs and aims to prevent the development, possession, and usage of such weapons for acts of terrorism.
Singapore	Legislation	Biosecurity, biosafety	Biological Agents and Toxins Act 2005 (BATA)	Governs the possession, importation and transfer of biological agents and toxins. Categorises toxins and biological agents by risk group.
	Legislation	Biosecurity	Strategic Goods (Control) Act 2002 (SGCA)	Governs the exportation of biological agents reasonably believed to be for weaponisation.

	Legislation	Biosecurity	Infrastructure Protection Act 2017 (IPA)	Stipulates the personnel screening requirements for protected infrastructure.
	Expert Recommendation	Biosecurity, DURC	Genetic Modification Advisory Committee (GMAC)	Providing non-legal-binding guidelines for researchers and businesses to adhere with regards to genetic modification technology.
	Guidelines	Biosafety	Biorisk Management Standard For Large-Scale Work With Biological Agents – Feb 2025	Ministry of Health guidelines for organisations engaged in large-scale production or large-scale manipulation of pathogenic or potentially pathogenic biological agents for purposes, including vaccine research, development, manufacturing or any other related activities.
	Guidelines	Biosafety	Singapore Standard – Biorisk Management for Laboratories and Other Related Organisations (SS ISO 35001:2021+A1:2024)	Enterprise Singapore guidelines to identify, assess, control, and monitor the risks associated with hazardous biological materials to meet biosafety and biosecurity objectives.
	Legislation	Bioterrorism	Terrorism (Suppression of Bombings) Act 2007	To suppress terrorist bombings through punitive measures and compel disclosure from individuals with knowledge of terrorist activities.
	Legislation	Infection control	Animals and Birds Act 1965	Prevents the introduction and spreading, within Singapore, of diseases of animals, birds, or fish.
	Legislation	Infection control	Infectious Disease Act 1976	For the controlling and prevention of infectious disease transmission to human beings. It empowers the corresponding officers to impose isolation and quarantine, surveillance, and detection of diseases.
	Legislation	Infection control	Communicable Diseases Agency Act 2025	Formation of the coordination agency responsible for the research, surveillance, and the development of technical

				expertise for the prevention, management and control of infectious disease in Singapore.
	Guidelines	Biosafety, DURC	Singapore Biorisk Code of Conduct for the Life Sciences Industry and Professionals	Promote a culture of responsibility and awareness of the dual-use implication of research among professionals.
Thailand	Legislation	Biosecurity, biosafety	Pathogens and Animal Toxins Act 2015 (PATA)	Serves as the primary law related to biological activities, it is largely a biosafety-centric guidelines. It classifies the categories of pathogens and toxins by their risk levels, and stipulates the corresponding licensing requirements for the production, possession, importation, exportation, sales, and transit of such agents.
	Legislation	Biosecurity, DURC	Control of Item in Relation to the Proliferation of Weapons of Mass Destruction Act 2019	Provides high-level regulatory oversight over any material that can be used to design and develop WMDs, and the exportation and transhipment of such material. This control also applies to biological weapons and items that are potentially for dual-use.
	Legislation	Biosecurity	National Biodiversity Act (Draft)	Target is to regulate genome editing for the agricultural and aquaculture industries. Once it has been passed, the law will serve as the national focal point for the Convention on Biological Diversity (CBD) and the Cartagena Protocol on Biosafety.
	Legislation	Infection control	Communicable Diseases Act 2015	Prevention and control of infectious diseases that are transmissible to human.
	Legislation	Infection control	Animal Epidemics Act 2015	Focuses on the prevention and control of communicable diseases in animals.
	Legislation	Infection control	Plant Quarantine Act 2008	Control of importation of plants into Thailand.

	Guidelines	Infection control	Ministerial Regulation of Public Health on the Disposal of Infectious Waste 2021	For the proper accounting of infectious waste management.
Vietnam	Legislation	Infection control	03/2007/QH12 Laws on the Prevention of Infectious Diseases 2007	Allows health agencies to impose quarantine, and conduct surveillance to prevent the transmission of infectious diseases in humans.
	Decree	Infection control	Decree 92/2010/ND-CP	Details the infectious disease concerns within biological laboratories.
	Legislation	Infection control	79/2015/QH13 Law on Veterinary Medicine	Aims to prevent, treat and fight against animal epidemic diseases, and deals with the quarantine of animal products and management of veterinary drugs and practices.
	Legislation	Infection control	41/2013/QH13 Law on Plant Protection and Quarantine	Prevent and control organisms that are harmful to vegetation, and deals with plant quarantine and the management of pesticides.
	Decree	DURC, bioterrorism	81/2019/ND-CP Preventing and Countering Proliferation of Weapons of Mass Destruction	Prevent any research or development that can lead to the potential production of a WMD. Provides specific authorisation to the Ministry of National Defence to work in conjunction with the Ministry of Health to detect, deter, and to take actions against the proliferation of biological weapons.
	Decree	Biosafety	Decree 103/2016/ND-CP	More emphasis on the conditions for laboratory requirements and ensuring that business entities performing biological testing activities meet the requirements of the Law on Medical Examination and Treatment.
	Circular	Biosafety	37/2017/TT-BYT	Spells out operational practices to ensure biosafety in laboratories.

	Circular	Biosafety	41/2016/TT-BYT	Codifies the facilities requirements vis-à-vis equipment and conditions for the facilities to be recognised at the corresponding biosafety levels when working with listed pathogens.

Abbreviation: GMO: genetically modified organism