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Biosecurity risk mapping and gap analysis in South East Asia

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ABSTRACT

Introduction: In today's globalized world where travel is commonplace, a threat in one region can easily spread throughout the whole world. It is, therefore, essential for multi-disciplinary risk assessment, risk mitigation, and collaborative strategies to take place among various stakeholders to mitigate this. Any strategic plan to deal with biosecurity, therefore, needs to be a complete loop, top to bottom and bottom to top. This paper describes the results of Project 62, which involved mapping and biosecurity risk assessment in South East Asia.

Materials and methods: The mapping and biosecurity risk assessment activities for the participating partner countries was carried out in two phases. The first phase involved risk assessment by six partner-country bio-experts for their own countries and the second phase involved conducting a joint Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis and risk assessment for the South East Asian region as whole, together with international bio-experts at a workshop.

Results and discussion: The following key recommendations of the project show that biosecurity needs to be addressed through stakeholder engagement at multiple levels starting from the top echelons of the government to the worker who needs to recognize and understand the threats they might face:

1. Systematic analysis of existing information from BWC ISU Article 10, IHR capacities, JEE, UN Security Council Resolution 1540 Action Plan, EU CBRN NAP, and other relevant sources to develop a common understanding of the definition of biosecurity for all stakeholders in the region.
2. Creation of programs for awareness building in biosecurity, not limiting them to laboratory biosecurity but using an all-inclusive approach to include border biosecurity, pandemic response, etc.
3. Creation of a country-specific list of high-risk biological materials.
4. Compulsory standardized biosecurity training, including responsible conduct in biosecurity research.
5. Framework for one-health and security interface addressing biosecurity threats.
6. Framework for ensuring information security in relation to biosecurity.
7. Involvement of local/regional experts in the implementation of EU-CBRN CoE projects.

1. Introduction

The term "biosecurity" has different meanings to different people depending on their field of work. Historically, the term was used to denote the prevention of infectious diseases, including pests, in crops and livestock.[1] In more recent years, it has expanded to include biological terrorism, dual-use research of concern, threats posed to human, animal, and plant health and the environment, even in natural outbreaks and not necessarily limited to intentional release. In addition, the terms "biosafety" and "biosecurity" are often used interchangeably despite the distinct differences between them.[2,3]

In today's globalized world where travel is commonplace, a threat in one region can easily spread throughout the whole world as we saw in the SARS and MERS outbreaks.[2] It is, therefore, essential for various stakeholders to be involved in multi-disciplinary risk assessment, risk mitigation, and collaborative strategies to take place to mitigate this. Biosecurity needs to be approached through dialogue, strategic partnerships, and consultation among the stakeholders.[4] Stakeholders can be at the level of international organizations, regional organizations, nations, regions within nations, institutions, and, while lowest in the hierarchy, the most crucial

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are the workers. While the roles and responsibilities at these different levels and the actions taken at each level are different, participation and two-way communication are required at every level. The best thought-out approach will fail if it is not implementable at the lowest level of workers. Examples include farmers (personal communication) who, instead of culling their pigs infected with the African Swine Fever Virus, may take it across borders to cut their financial losses, thus transmitting the infection to other regions.[5] Similar concerns exist in poultry farming, where the backyard farmer, especially in low-income settings, is not able to adopt measures that may work in larger commercial farms.[6] Another example is laboratory workers who may not fully understand the simple principles of biosafety and may expose themselves to infections with improper work techniques (personal observation). In academic research, researchers are at the forefront of new technology and knowledge and are therefore in the best position to identify potential hazards.[7,8] Any strategic plan to deal with biosecurity, therefore, needs to be a complete loop, top to bottom and bottom to top.

The term "multi-track diplomacy" is used to describe diplomacy at different levels. Track 1 denotes government-to-government dialogue and diplomacy,[9] whereas Track 2 diplomacy refers to dialogue between intermediaries, such as academics, religious leaders, and other citizens who are able to contribute to the dialogue with the aim to create new ideas and problem-solving strategies.[10,11] Track 2 diplomacy offers a non-judgemental and unofficial environment where participants are more likely to have a frank and open discussion. Chigas describes a Track 1½ diplomacy, where unofficial actors such as former government officials, religious leaders, etc., may act on behalf of governments to effect peaceful resolution of conflicts.

When applied to biosecurity (and biosafety), it is not just diplomacy but levels of stakeholder engagement (from the lowest level of the workers to the highest level of the government), that matters. The weakest link in biosecurity lies with the worker who is in direct contact with the material and information and who can knowingly or unknowingly cause a breach of security. For example, the farmer who carries an infected carcass across borders or laboratory workers who have no knowledge (or have very limited knowledge, at best), of biorisk management and, while every law, rule, and regulation is in place, this does not reach the most critical point. Do the workers who handle the biorisk daily recognize it, and do they know how to deal with it?

The European Union-Chemical Biological, Radiological, and Nuclear Centers of Excellence (EU-CBRN CoE)[12] funds projects relevant to CBRN risk mitigation for implementation in the different EU-CBRN CoE regions. Currently, there are eight regions and regional secretariats under the EU-CBRN CoE initiative with a total of sixty-three partner countries (PCs). The EU-CBRN CoE SEA (South East Asia) Region includes the ten countries comprising the Association of Southeast Asian Nations (ASEAN): Brunei Darussalam, Cambodia, Indonesia, Lao Peoples' Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam. To date, twenty-five of the seventy-five EU-CBRN CoE projects implemented have at least one component implemented in the SEA region, and eight of these twenty-five include biosafety/biosecurity/bio-risk management components.[13]

This paper describes the results of Project 62, which involved mapping and biosecurity risk assessment in SEA.

2. Materials and methods

2.1. Project description

The mapping and biosecurity risk assessment activities for participating PCs in SEA were carried out from February to May 2019 under Project 62 of the EU-CBRN CoE initiative, in co-operation with the EU-CBRN CoE Regional Secretariat for SEA and the United Nations Interregional Crime and Justice Research Institute (UNICRI).

Project 62, which involved the mapping and biosecurity risk assessment reported herein, started in February 2018 with the primary objective of enhancing the technical capability of the SEA-Regional Secretariat (On-Site Assistance to the EU-CBRN CoE Regional Secretariat for SEA in Manila) in CBRN risk mitigation. The development of the components of future projects will take into account the results and outcomes of the mapping and biosecurity risk assessment activities carried out under Project 62 and reported herein. The SEA PCs that participated in Project 62 were Cambodia, Indonesia, Lao PDR, Malaysia, Philippines, and Viet Nam. In addition, three regional bio-experts (two from Singapore and one from the Philippines) and a biosecurity expert of UNICRI also participated in the regional workshop. The mapping and biosecurity risk assessment activities done at the national level and the SEA regional level in Project 62 as preparatory activities in the development of the terms of reference for upcoming projects, was the first of such, under the EU-CBRN CoE initiative.

2.2. General objectives

The new approach in the development of EU-CBRN CoE projects for implementation in the PCs involves carrying out risk assessments, as recommended by the European Commission's Court of Auditors (in line with ISO Standard 3100) and supported by the European Commission's Joint Research Centre (JRC) and the European Commission's Directorate for International Cooperation and Development (DG DEVCO).[14] The overall aim of Project 62 was for the PCs and the SEA region as a whole to benefit from the results of this project and to quicken the implementation of future projects. Future projects will then have the information required to design better work packages or components and target gaps and priorities in CBRN risk mitigation (included in the CBRN National Action Plan of PCs) as identified by local experts in the region. Moreover, the information gathered, and the outcomes could be invaluable in the development of a South-East Asia CBRN Regional Response Plan.[15]

2.3. Specific objectives

a. To collect and evaluate all relevant information/data needed to perform a meaningful risk assessment at the national and regional levels. This involves mapping high-risk biological materials and facilities at the national level, which was verified by the CBRN National Team and endorsed by the National Focal Point (NFP).[1]
b. To carry out risk assessments related to biosafety and biosecurity, including transnational border control/security and cybersecurity elements, at national/PC and regional (SEA) levels.
c. To identify gaps and priorities and make recommendations based on the outcomes of this project to guide the development and implementation of work packages/components in upcoming biosecurity projects for SEA.

2.4. Data collection

Data were collected in two phases. The first phase focused on the country level and involved the mapping of current high-risk

[1] The EU-CBRN CoE engages/coordinates with the partner countries through a primary and/or secondary National Focal Point who is supported by a CBRN National Team whose members are representatives of relevant government/private agencies and institutions.

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biological materials and facilities as comprehensively as possible (subject to the confidentiality clause for the activity[2]). The bio-experts used the Information/Data Gathering Form/Questionnaire/Checklist as a guide, which was developed specifically for this activity by the authors. This was followed by biosecurity risk assessment using the 5 × 5 risk matrix. The gathering of relevant information/-data and the subsequent risk assessment were very important to obtain a primary baseline of the current status of biosecurity in the PCs, the outcomes of which fed into the subsequent regional mapping and biosecurity risk assessment activities in the second phase. The second phase of data collection was conducted at a workshop facilitated by the three regional bio-experts and a UNICRI representative.

2.4.1. Phase 1: Mapping/Information-gathering and risk assessment at the country level by the PC bio-experts

The activities were conducted in two stages: 1) Collecting and evaluating information/data on high-risk biological materials and facilities and preparing a report of the results and outcomes and 2) Conducting biosecurity risk assessments and preparing a report on the results and outcomes.

For the mapping/information gathering process, Project 62 developed a focused and targeted questionnaire. The questionnaire primarily focused on high containment facilities in the country (major cities, provincial levels, and universities). The data and information needed, including the key gaps and priority actions to address these gaps, were obtained by the PC bio-experts through direct communication with stakeholders using the questionnaire provided, interviews, review of available information, reports from previous EU-CoE projects, and relevant elements from the CBRN National Action Plan. The 5 × 5 matrix template for risk assessment[16–18] was provided to the PC bio-experts to determine the level of biosecurity risk.

The bio-experts who conducted the activities had the support of the EU-CBRN CoE NFP and members of the CBRN National Team. The reports on the activities were endorsed by the NFPs and the information/data reported were verified by the CBRN National Team members. Thus, the reports by the bio-experts formed strategic documents relevant to biosecurity at the national level and were handled as confidential documents.

2.4.2. Phase 2: Mapping/Information-gathering and risk assessment at country and regional level by the PC bio-experts and other bio-experts at a workshop held in Cebu in the Philippines on May 22 to 24, 2019

The main activities were as follows:

a. Presentation and discussion of the data/information gathered in phase 1 by the PC bio-experts.
b. Open discussions, information sharing, and exchange of knowledge/experiences on aspects relevant to biosecurity, among actors, experts, and other stakeholders in the SEA region. The discussions included public and animal health, communicable disease outbreaks, legislation and implementation, border-control/monitoring, transport and storage, containment/handling of pathogens and toxins, laboratory protocols, etc.
c. Conducting a SWOT analysis on biosecurity on the SEA region as a whole.
d. Conducting regional biosecurity risk assessment for the SEA Region using the 5 × 5 risk matrix, with a focus on:
    i. Biorisk management systems and their implementation and maintenance.
    ii. Deliberate release of high-risk biological materials through criminal acts and terrorism.
    iii. Pandemic and the capacity of the SEA region to respond effectively as a whole and implement recovery measures.
e. Presentation and analysis of the results of the biosecurity risk assessment and SWOT analysis.
f. Consolidation of the results and outcomes and the key recommendations on priority activities/actions to address the identified gaps in biosecurity in the PCs and in the SEA region as a whole. These key recommendations are expected to guide the development and implementation of work packages/components of the future biosecurity projects for SEA.

The SWOT analysis and risk assessment exercises were guided by the following main sources of information:

a. Results and outcomes from the mapping and risk assessments performed at the national level, including relevant previous data/information from other EU-CBRN CoE projects.
b. Identified gaps and priority actions relevant to biosecurity in the CBRN National Action Plans of PCs.
c. Presentations from the regional bio-experts and the UNICRI bio-expert, all of which were designed to enhance the overall understanding and agreement on the definition of biosecurity and the important elements to be considered in biosecurity risk assessments and risk mitigation.
d. Key outcomes from the open-discussions among the bio-experts who were at the workshop.

2.4.3. SWOT analysis[3]

[4]The SWOT analysis is a common tool in organizations/institutions, as well as in project management. SWOT stands for Strengths, Weaknesses, Opportunities, and Threats and is a method used by organisations to identify and understand their strengths and vulnerability and strategize their action plan using the results of the analysis. Typically, Strengths and Weaknesses are internal factors and Opportunities and Threats are external factors.[19,20]

In this study, a SWOT analysis was performed in groups, with the regional bio-experts facilitating and guiding the activities. The SEA region's strengths were examined relevant to biosecurity (including relevant existing mechanisms). Opportunities present in the region from other donor-countries/organizations abroad, to enhance the capacities of PCs and therefore the region, in the area of biosecurity, were also examined. Furthermore, the bio-experts identified the weaknesses in the SEA region as a whole and the most likely threats to the region related to biosecurity, whether externally or internally. The bio-experts identified common gaps and needs in the PCs that affect the regional capability to handle biosecurity-related events and recommended priority actions to address these regional gaps.

2.4.4. 5 × 5 matrix risk assessment

Matrix risk assessment is a qualitative method of assessing and ranking the risk of an outcome, usually negative. It is done by considering the likelihood of an event occurring against the severity of

[2] The sensitive nature of the information/data gathered warranted a confidentiality clause to re-assure bio-experts and country-stakeholders that they can choose which information/data can be shared, and that the reports are treated as confidential documents.

[3] Biological Weapons Convention Implementation Support Unit https://bwc1972.org/home/the-biological-weapons-convention/isu/.

[4] *The use of SWOT in Biosafety and Biosecurity was first observed by one of the authors during the Lao Country Partners Exchange Conference (Vientiane, Lao-PDR, March 2019), organised by the United States Defense Threat Reduction Agency, Biological Threat Reduction Program (US-DTRA, BTRP) under Ms. Laura Marsh.*

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the consequences if it did occur and by regarding the product of the ranks given to the two as the risk. In a 5 × 5 matrix, the ranks can range from 1 to 5, 1 being the lowest and 5 being the highest level of likelihood, severity of consequence, and, therefore, risk. This method, while it has its limitations, is a simple method that can be easily performed and can provide visibility of potential risks, thus assisting in informed decision making by organizations and governments.[16–18,21]

Risk assessment was performed in groups with each group working on one of the following topics:

a. Examine the level of implementation of biorisk management systems and existing gaps.
b. Examine the deliberate release of high-risk biological materials by criminals/through acts of terrorism and the economic impact for the country and region.
c. Examine the capacity of SEA to prevent, detect, respond, and implement recovery measures in case of pandemics, taking into consideration existing regional mechanisms.

3. Results

3.1. Phase 1: Mapping/information-gathering and risk assessment at the country level by the PC Bio-experts

The types of institutions surveyed during the information gathering included Government Public Health/Epidemiology Institutions, Government Hospital Laboratories, Government Research Institutions, Government Veterinary Research Institutions, National Animal Health Laboratories, Government Biosafety Enforcement Agencies, Research Universities and University Health Services, Academy of Sciences, Biosafety and Biosecurity Associations/Organizations, Diagnostic Laboratories, Tuberculosis Centers, National Blood Service Centers, Microbiology Laboratories, National Standards Reference Laboratories, Biotechnology and Ecology Institutes, Department of Environment and Natural Resources, Department of Agriculture, Bureau of Fire and National Police Laboratory, National and Regional Vaccine Institutes, Animal Health Regional Laboratory, Public Health Regional Center, private institutions, and industries, including members of CBRN National Team/Working Groups. The general outcomes from the mapping/information-gathering activities are presented below:

a. One participating PC had a national list of high-risk biological materials, another PC was in the draft-phase and the rest identified the development of this list as a priority action.
b. Types/classifications of biomaterials within the PCs were mostly risk groups 1 & 2 with some high-containment facilities for risk groups 3 & 4.[22]
c. Legislations and implementing mechanisms for the Biological Weapons and Toxins Conventions (BWTC) were in the draft phase for some PCs, while others had existing relevant legislations covering biological materials of concern.
d. Standard operating procedures (SOPs) in handling/storage/waste disposal/transport of high-risk biological materials were in place at high-containment facilities, but at very different levels and standards at other facilities.
e. Biorisk communication protocols were implemented at varying degrees among the PCs.
f. Laboratory peer review programs have started to be implemented in several participating PCs.
g. Biosecurity self-assessment and monitoring checklist were recently developed in one PC, which could be shared with the other PCs in the region.
h. The concept of "one-health" was not a common approach for PCs.
i. One PC had developed and was currently in the process of disseminating its Code of Conduct for Biosecurity nationally and this could be shared with other PCs in the region.
j. Emergency Response Plans (ERP) at the institutional levels were in place for all PCs (with varying standards) and at various developmental stages at the national level, except for three countries, which had these fully implemented.

Below are five common gaps identified by the PC bio-experts in Phase 1:

a. Inadequate legislation for addressing biosecurity.
b. Poor biosecurity awareness across all levels of stakeholders.
c. Poor implementation of the biorisk management system. The lack of SOPs developed locally and implemented locally was mentioned as a gap by three PCs.
d. Inadequate mapping of existing high-risk facilities/laboratories and associated inventory control of infective agents that are held at these facilities/laboratories.
e. Lack of a national list of biological agents of concern specific to each of the countries. The bio-experts felt that a list must be developed for each country, as the types of high-risk biological materials are different from country to country.

In addition, the following gaps were reported, but not across all PCs:

a. There is a general need to enhance the legal framework to address border control/monitoring, including law enforcement/implementation at the national level, storage, transport, and waste management of high-risk biological materials.
b. Although most PCs had biosecurity management systems in place at the institutional level (especially for high-containment facilities), there is still a need to enhance capabilities in physical and information security. There was a need to implement periodic vetting of personnel working with high risk biological material (to take into account any changes in personal and financial circumstances of key staff, which could make them vulnerable to bribery, coercion, or in committing acts of revenge/vendetta in their workplaces).
c. Nationwide awareness building on biosecurity, ensuring a common standard and understanding of risks (going beyond biosafety and the laboratory setting).
d. Updating of SOPs, ERP, and relevant protocols (including risk communication procedures at a national level) in line with current good practices in the biorisk management system.
e. Enhancing the capability of PCs in the fast-detection of pathogens and toxins using advanced instrumentation technologies, as well as in the area of biosecurity forensics.
f. Effectively addressing the threat of misuse of high-risk biological agents/toxins, which could be smuggled through PC borders or obtained through an insider, as well as visitors to the countries harboring highly communicable diseases and/or illegally bringing in animals and plants, which could threaten both public and animal health and indigenous species.
g. Prioritizing the capacity to rapidly detect emerging zoonotic diseases in rural areas because of the prevalence of zoonotic diseases (for example, Ebola Reston, H5N1, H5N6, anthrax) with high-risk of transmission from animals to humans, specifically in one PC (which has the potential to spread rapidly in the region if not contained), which affects not only public and animal health but also has a high impact on the economy (specifically on the agricultural and tourism sectors).

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These identified gaps were further discussed and elaborated during the second phase of the gap analysis during the regional workshop.

3.2. Phase 2: Mapping/information-gathering and risk assessment at the country level by the PC bio-experts and other bio-experts at the workshop

The results and outcomes from the SWOT analysis and risk assessment activities using the Risk-Vulnerability Tool and the 5 × 5 Risk Matrix are presented below. The key outcomes from the discussions are also included.

3.3. Results and outcomes of the SWOT analysis and risk assessment

There was considerable overlap in the discussion during the two exercises, even though the topics were different. The key outcomes of the SWOT analysis are given in Table 1 and those of the risk assessment in Fig. 1.

During the workshop, all the information gathered was discussed by the participants and the bio-experts. The key biosecurity gaps (from both the SWOT analysis and the risk assessment) that were collectively identified and agreed upon were as follows:

a. The need for a systematic analysis of existing information from BWC ISU[3] Article 10, IHR capacities,[5] JEE,[6] UN[7] Security Council 1540 Committee National Implementation Action Plan, EU CBRN NAP, and other relevant sources for use by the SEA countries.
b. Possibility of developing a SEA specific biorisk management system that draws upon all these existing documents but is fully implementable in SEA.
c. No common understanding of the definition of biosecurity among all stakeholders leading to a lack of awareness about in biosecurity, including microbial forensics, border control, tools specific for ASEAN countries in response to pandemics, and creating a list of country-based high-risk biological materials. This point was emphasised by all the participants repeatedly.
d. Lack of compulsory standardized biosecurity training with the possibility of developing training on responsible conduct of research for biosecurity. One participant talked about the outreach program developed in their country by engaging all facilities, laboratories, and institutions that handle infective or other biological material.[23]
e. Lack of a one-health approach, with human, animal, and plant health always being addressed individually. Participants discussed the possibility of establishing a framework for triggering one-health issues and intelligence and for training (table-top exercises on information-sharing) to adopt a one-health approach.
f. No framework to ensure information and personnel security.
g. Insufficient involvement of local/regional experts in the implementation of EU- CBRN CoE projects.
h. No standardization of infrastructure such as physical buildings, standard operating procedures, inventory management, with wide variation existing among countries and within countries. Participants mentioned the "cut and paste" method, which was not useful or applicable to the local situation and this could pose a risk.

Table 1
Results of SWOT analysis.

	Positive	Negative
Internal	**Strengths** 1. Good, well-developed expertise and networks across the regions 2. Well-established joint epidemiological and criminal investigations capabilities 3. Well-established ASEAN/bilateral co-operation in response to threats/events 4. Existence of ASEAN Humanitarian Assistance (AHA), which could encompass biosecurity 5. CBRN National Action Plan developed by some countries with possibility of future regional action plans through AHA	**Weakness** 1. Inadequate legislation to address biosecurity 2. Poor biosecurity awareness 3. Poor implementation of biosecurity practices on the ground 4. Poor cross-disciplinary communication 5. Lack of political will/ commitment
External	**Opportunities** 1. Database of research capabilities in case of new agents/ technology 2. Strengthen existing dual use research concern framework 3. Formal and informal information sharing 4. Collaboration within the region and internationally	**Threats** 1. Social and economic threats due to biosecurity events 2. Lack of awareness and education about biosecurity 3. Lack of legal framework to deal with threats and events 4. Advances in science and technology posing biosecurity threats 5. Cross border security inadequately addressed 6. Poor ability to deal with natural outbreaks

i. Participants discussed what would be a good approach to get buy-in from workers and governments to ensure participation at all levels. A discussion also ensued on how to prioritize the threats, considering that resources are limited and not all areas could be addressed at the same time. The participants discussed what the next steps should be and what areas should be addressed (this is discussed under the Conclusions section of this paper).
j. Lack of tools specific for ASEAN countries in response to pandemics, and a list of country-specific high-risk biological materials with the potential to be weaponized.

4. Discussion of results

The results of this project show that biosecurity remains a challenge in the SEA region as seen from the vast differences in awareness and capabilities among the PCs as well as in various regions within each PC. While larger cities may have better-developed biorisk management systems, this is severely lacking in rural areas. This risk-mapping project was funded by the EU-CBRN CoE; other organizations fund projects in SEA with similar objectives.[4,23] While the region and culture are different, the biosecurity lessons are the same and it is important to share the findings so that other projects may start with the pre-existing knowledge and be able to move to the next level. Malaysia[23] has an outreach program to bring awareness about biosecurity to the individual workers and such outreach programs are very important to ensure that national and international initiatives, such as legislation, are truly implementable and reach down to the workplace. Projects and initiatives need to reach the level of the actual worker to be effective.

This project was an example of the Track 2 level of diplomacy and one of the most discussed needs was awareness building and

[5] International Health Regulations https://www.who.int/ihr/en/.
[6] Joint External Evaluations – World Health Organizations (https://www.who.int/ihr/procedures/joint-external-evaluations/en/).
[7] United Nations (https://www.un.org/en/sc/1540/national-implementation/national-implementation-plans.shtml).

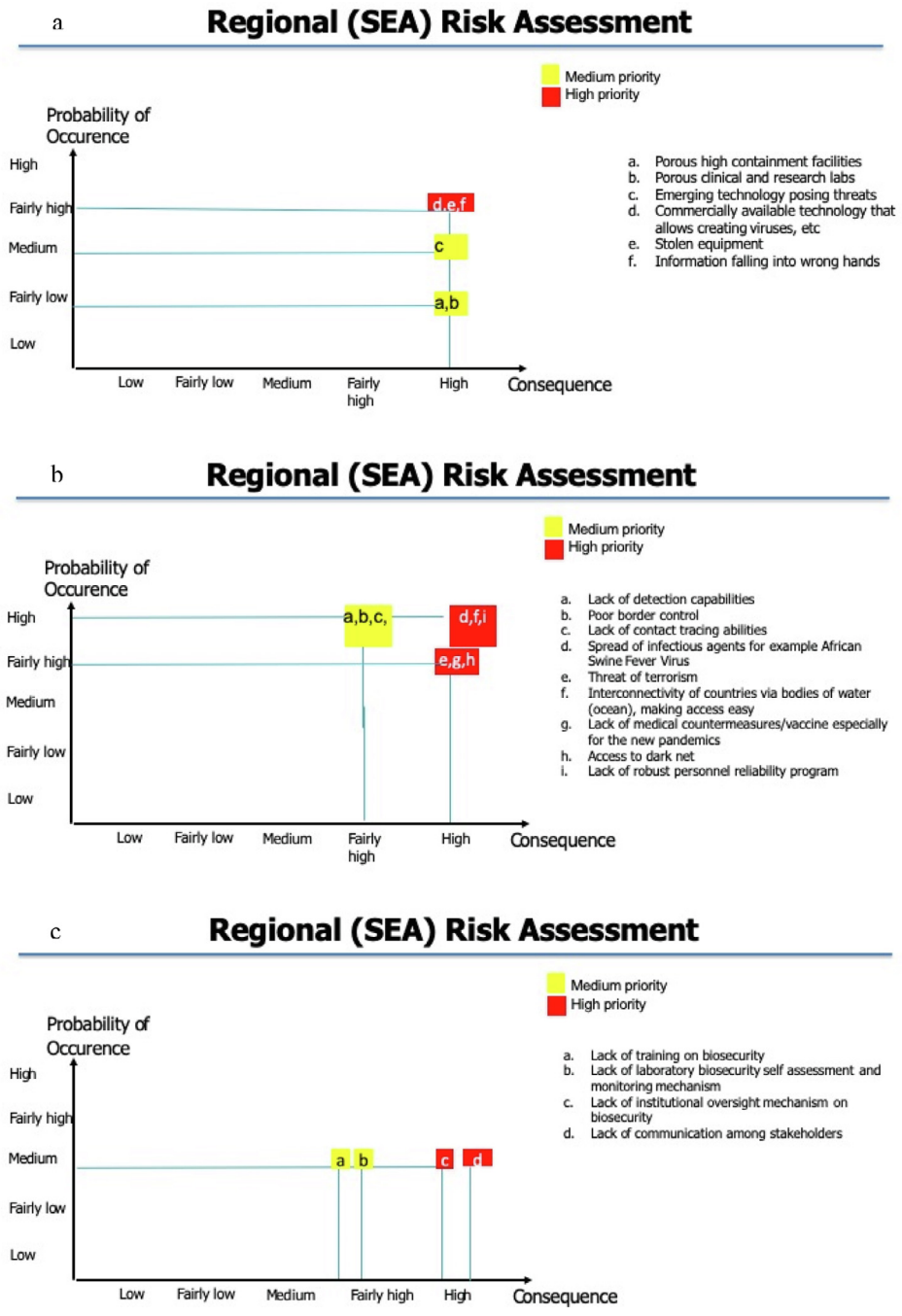

Fig. 1. Shows the results of the risk assessment. 1a shows risk values for factors such as awareness, training, communication, oversight at institutional level; 1b shows facility and information related risk factors; and 1c shows access and connectivity related risk factors.

standardised biorisk management systems. These are on-the-ground strategies that need in-depth engagement with the workers and simply addressing it at the higher levels will defeat the purpose of these projects. Therefore, the authors suggest using the term "Stakeholder Engagement Tracks 1–3" to augment the term "multi-track diplomacy," such that the classification of roles can cover the entire spectrum of actors that are needed to ensure that biosecurity is understood and comprehensively fulfilled at all levels (Fig. 2). It is, therefore, essential to engage the entire spectrum of stakeholders, albeit at different forums and meetings, to ensure that the implementation of strategies to address biosecurity is communicated not only vertically but also laterally as wide as possible.

The organization of events and the activities during the regional workshop were designed to gather and share the necessary information and use the identified gaps in biosecurity within PCs to further assess the regional situation. This was particularly in areas of biosecurity such as legislation, law enforcement, and border-control/monitoring of high-risk biological materials, deliberate use of biological weapons by individuals (terrorists, non-state actors, lone wolves, etc.), and disease outbreaks resulting in a pandemic. These aspects were chosen because the SEA region is most vulnerable to highly communicable diseases, including zoonoses, with recurring outbreaks and known cases of animal-to-human transmissions, not to mention diseases after natural disasters such as earthquakes, storms, flood, tsunamis, etc. as evident from the

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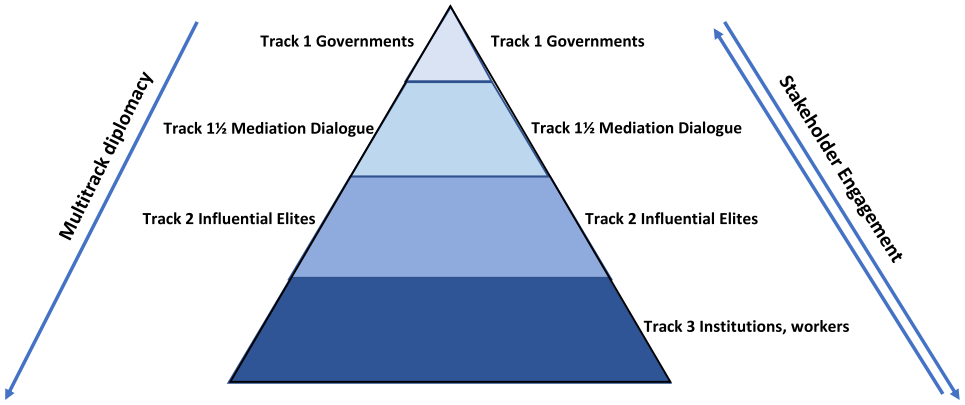

Fig. 2. Shows the pyramid with the different tracks of diplomacy and corresponding tracks in Stakeholder Engagement. (Adopted from https://www.beyondintractability.org/essay/track2_diplomacy). The stakeholders form a complete spectrum of those who have a role to play in biosecurity. In the tracks described, while it is not common for track 3 stakeholders to have direct dialogue with track 1 stakeholders, it is definitely possible for stakeholders in adjacent tracks to have dialogues with each other, thus effectively facilitating top-to-bottom and bottom-to-top dialogues.

outcomes of the PC bio-experts' risk assessments at the national level. In addition, there is the emergence of terrorist groups in the region, with access to funds and advanced technology, and cases of attempted use of CBR materials have been documented in some PCs in the region (personal communication). The geographical nature of the region, which includes very porous shared borders (including the Mekong River) and wild forests in the landlocked areas and vast coastlines, for the archipelagoes, including major trade routes, numerous ports, and busy international airports, makes the whole region very susceptible to illegal entry of contrabands and high-risk biological materials (issues of concern identified by PC bio-experts in their risk assessments), in addition to animals and plants harboring diseases and pests, not to mention the prevalence of undocumented workers moving through the porous borders.[4]

This project had some limitations, which include the general tendency for the PC bio-experts to focus on their own areas of expertise (for example, biosafety or biosecurity; public health; animal health; defence/security aspects; or laboratory biosecurity). Due to administrative and time constraints, there was no prior training/workshop for the PC bio-experts on conducting the mapping/information gathering and risk assessments, which would have helped to focus the activities and gain a more standardised and comprehensive outcome. In addition, due to confidentiality of information, the facilities and high-risk biological materials were classified, although some PCs included the names of facilities and the types of organisms contained in these facilities in their reports. Participants were not fully knowledgeable about how to perform risk assessment at a national level because many of them were predominantly laboratory-based experts. A few participants had extensive knowledge outside of biological laboratories and were able to discuss biosecurity in a broad sense at the conference. However, the PCs must look at issues beyond laboratories in their countries.

5. Conclusions

The key outcomes/recommendations from the activities above were as follows:

a. Consolidation and systematic analysis of existing information from BWC ISU Article 10, IHR capacities, JEE, UN Security Council Resolution 1540 Action Plan, EU CBRN NAP, and other relevant sources to develop a standardized and common understanding of the definition of biosecurity for all stakeholders.
b. Creation of programs for awareness-raising in biosecurity, including microbial forensics, border control, specific tools for ASEAN countries in response to pandemics, and creation of a list of country-specific high-risk biological materials of concern.
c. Compulsory standardized biosecurity training, including responsible conducting of research for biosecurity and table-top exercises for sharing information.
d. Creation of a framework for one-health concepts to be included in biosecurity strategies.
e. Creation of a framework for ensuring information security in relation to biosecurity.
f. Involvement of local/regional experts in the implementation of EU-CBRN CoE projects.

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Conflicts of interest

There is no conflcit of interest for the authors in this submission.

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