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1 Acknowledgements

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We would like to thank our collaborators in our partner countries Cambodia, Laos, Malaysia, Indonesia, Thailand and Vietnam for their assistance and cooperation in project development. Most importantly we thank them for developing the concept of this project, born out of a need to develop biosecurity initiatives in the SE Asia region. We thank them for their great help in translating many of the necessary project materials, and especially for their cooperation in participating in the baseline surveys and discussion groups that formed such an important part of this project, thus setting the agenda for the phase two projects. This project would not have reached the level of success it has achieved without their drive and commitment to information sharing and collaboration.

This SRA has faced many challenges due to Covid, which has been felt globally. There have been many delays and many times where we have had to pivot, particularly moving from the traditional face-to-face learning activities and meetings to online options instead. So we thank everyone who has participated in this project, provided advice and support.

2 Executive summary

An enhanced capacity in SE Asia for preparedness, monitoring, early detection, and efficacious response to forest pests and diseases will protect the small- and large-scale forest industries that contribute significantly to income and employment in rural, regional, and national economies, as well as to environmental health. This SRA has established the forest biosecurity needs and priorities in partner countries – Cambodia, Indonesia, Lao PDR (Laos), Malaysia, Vietnam, and Thailand. It has also initiated the coordination of two Task Forces – Government and Industry to begin to create a unified network capable of coordinated regional responses to forest pest and disease incursions. This SRA is phase one of a two-phase project. This project gathered the necessary baseline information needed to develop two second-phase projects built on the foundation of phase one, namely the University of the Sunshine Coast-led FST/2020/123 “Building an effective forest biosecurity network in SE Asia” and the University of Tasmania-led FST/2018/179 “Managing risk in SE Asian forest biosecurity”.

This SRA had five primary objectives, key outcomes of which are summarised below.

Determine the current biosecurity capacity, knowledge, and priorities for stakeholders in the SE Asia region

In place of an in-person workshop, online methods were used to determine forest biosecurity capacity, knowledge and needs in the region. An online baseline survey and a WhatsApp discussion forum (also accessible online) were designed to obtain stakeholder feedback.

Eleven common needs emerged regarding training and knowledge across the five countries. These were: early warning systems for forest pests (HRSS), forest pest and disease surveillance (FHS), diagnostics for identification of key pests, knowledge of plant health regulations, pest risk analysis for exports, pest risk analysis for imports, management of risks of importing new quarantine pests, treatments of commodities, emergency response, and creating lists of forestry pests and eradication of new pests. An additional eight common needs emerged regarding skills needs across the five countries. These were: finding technical information when you need it, discussing biosecurity issues with stakeholders, including discussing forest biosecurity issues with smallholder growers and farmers, public sector stakeholders, private sector stakeholders and with your colleagues in other countries. These needs align with the objectives of FST/2020/123 and FST/2018/179.

The discussion forum determined that the gaps in the existing framework for each country are a result of limited training opportunities, poorly equipped laboratory facilities, and a lack of skilled and trained personnel. This is exacerbated by a lack of resources (funding) that are available for forest biosecurity. As a result, this limits people’s ability to conduct their jobs and has limited the forest biosecurity capacity of each country.

Review the regulations laws, trade conventions, and treaties for biosecurity in the SE Asia region

The law review established that whilst each country has a National Biodiversity Strategy Action Plan (NBSAP) under which a forest invasive species action plan falls, there are currently no dedicated biosecurity laws or legislation that focus on the risk and harm associated with forest invasive pests and disease. Therefore, the challenge for governments is to create and implement sustainable policy across relevant departments, institutes, and plant health groups, whilst also developing the capacity of the necessary agencies to implement associated activities (monitoring, surveillance, and PRA) to support the actioned policy. This needs to be actioned at a national level, but also through a regional approach. Biosecurity requires a multi-actor, well-coordinated response to pest incursions and partnerships are key to delivering technical support, including forecasting

and early warning, by enhancing preparedness and implementing preventive measures and outbreak responses.

Understand past and current investment in biosecurity within forestry, horticulture, and agriculture in the SE Asia region (to be used as a baseline for monitoring and evaluation in phase two)

Biosecurity systems rely on expertise in multiple disciplines including risk analysis, contingency planning, surveillance, diagnostics and pest management or eradication methods. Capacity building in these disciplines, particularly in surveillance and diagnostics, has been the major focus of international investment in SE Asian plant biosecurity. Australian agencies, especially DAFF and ACIAR, have contributed to this capacity building in SE Asia, though this has been targeted mainly to diagnostics and surveillance in agricultural and horticultural crops. A concerted effort is therefore needed to integrate forestry into biosecurity networks, building on these prior investments. Including increasing capacity in risk analysis and contingency planning that will feed into policy and justify greater investment in a proactive forest biosecurity system.

Initiate and grow a network delivering coordinated responses and enhanced capability in the region, including bridging the link between forest and agricultural biosecurity institutions

Outline Action Plans were developed regarding monitoring and surveillance of priority pests and for regional collaboration on data, technical and knowledge sharing. High-risk site surveillance is identified as a key network focus as a ‘learning through doing activity’. At the same time, exhibiting the need for collaboration across the other components of a good biosecurity system (e.g. pest risk analysis, preparedness, diagnostics, incursion response), together with a practical outcome to assist in early detection of post-border incursions of forest pests. Preliminary identification of potential risk sites was undertaken for each of the six partner countries and will be refined in the early part of FST/2020/123. Two regional Task Forces (Government and Industry) will drive collaboration between forestry and agricultural biosecurity within partner countries and across the region.

Monitor and evaluate the establishment and spread of the gall wasp parasitoid in the Mekong countries.

Surveys carried out in Laos showed that whilst the numbers of the gall wasp (*Leptocybe invasa*) parasitoid *Selitrichodes neseri* collected from release sites were low, successful recoveries of the parasitoid at 7,14, and 19 months after the initial release demonstrates high potential for it to become established in the field. This is not dissimilar to prior release programs in South Africa and Brazil where numbers were slow to establish. Continued monitoring and release in new locations, as well as at past release sites is recommended to assess and assist in widening the distribution of the wasp in Laos.

3 Introduction

The ability of countries across South East Asia (SE Asia) to respond to invasive forest pests and diseases is variable but generally limited, while risks are intensifying. Improved biosecurity capacity, regional coordination, and response practices within the forestry sector are needed urgently to reduce the risk of harm from invasive pest threats. The need to develop forest biosecurity capacity in the region was driven by discussions with colleagues in Laos, Cambodia, Thailand, and Vietnam working on FST/2012/091 ("Biological control of galling insect pests of eucalypt plantations in the Mekong Region") who highlighted that there was limited knowledge, skills or resources in each country. This gap was further emphasised in the final reviews of FST/2012/091, FST/2011/028 ("Biological control of eucalypt pests overseas and in Australia"), and FST/2014/068 "Management strategies for Acacia plantation diseases in Indonesia and Vietnam"), which recommended enhancing regional capacity in SE Asia to monitor pest threats and respond effectively.

Currently, SE Asia lacks a regional framework to monitor, identify and report existing and emerging forest pests and diseases. Technical capacity within many countries is underdeveloped, and forestry officers and researchers require additional skills and resources to aid industry and smallholders in surveillance, diagnostics, and pest management. Increased trade and a changing climate are amplifying threats, many of which are shared throughout the region. This small research activity was a scoping exercise to better determine the current regional forest biosecurity capacity, and better understand the technical, scientific, policy, and resources need to develop a regional biosecurity network. As it stands, a regional biosecurity network across SE Asia is needed to coordinate responses, upskill biosecurity personnel, and focus technical and social resources to tackle priority biosecurity issues and enhance biosecurity preparedness across the region.

An enhanced regional capacity for preparedness, monitoring, early detection, and efficacious response to forest pests and diseases will protect the small- and large-scale forest industries that contribute significantly to income and employment in rural, regional, and national economies, as well as to environmental health. This project has established what the biosecurity needs and priorities in each partner country are and initiated the coordination of two steering networks – Government and Stakeholder to begin to create a unified network capable of coordinated regional responses to forest pest and disease incursions. This SRA is phase one of a two-phase project. Whereby, phase one gathers the necessary baseline information needed to develop two second-phase projects built on the foundation of phase one. These two projects include the USC-led 'Building an effective forest biosecurity network in SE Asia and the UTAS-led project 'Managing risk in SE Asian forest biosecurity'.

4 Objectives and Deliverables

The goal of the SRA was to lay a foundation for a functional SE Asia regional biosecurity network. To do so, the purpose of this activity was to gather information on current skills, needs, and research priorities to better develop a large-scale research project that targeted necessary research aims, priorities, and activities. Another goal of this project was to develop a stakeholder network made up of industry, growers, government, and other agencies involved in biosecurity and quarantine across the partner countries. Based on previous ACIAR research, projects that are built on strong foundations, good communication, and solid relationships are the most successful. Therefore, actively curating this network in this SRA will set a solid foundation for a sound stakeholder network under phase two.

The objectives of this project were to:

1. Determine the current biosecurity capacity, knowledge, and priorities for stakeholders in the SE Asia region;
2. Review the regulations laws, trade conventions, and treaties for biosecurity in the SE Asia region;
3. Understand past and current investment in biosecurity within forestry, horticulture, and agriculture in the SE Asia region (to be used as a baseline for monitoring and evaluation in phase two); and
4. Initiate and grow a network delivering coordinated responses and enhanced capability in the region, including bridging the gap between forest and agricultural biosecurity institutions.
5. Monitor and evaluate the establishment and spread of the gall wasp parasitoid in the Mekong countries.

Despite several changes to the delivery of activities due to Covid, the team was able to successfully re-align in-person events to online and virtual activities and meet all targets. The outcomes and deliverables are presented below (see table 1).

Table 1. Outcomes and deliverables

Outcome	Deliverables
A unified stakeholder network formed	Agreed roles and responsibilities determined New networks identified. Additional partners identified New co-funding sources identified Research priorities, capacity and technical gaps identified
Steering committee formed and governance structure established	Core commitments defined
Identification of regional priority pests	Action plan for a systematic approach to monitoring and surveillance developed Agreement to coordinate monitoring and surveillance

Working understanding of forest biosecurity laws and regulations within the region, particularly those relating to market access	Paper reviewing legislation and laws
Current working program identified; benefits of current working strategies identified; understanding of past activities that failed all which can provide the framework for the second phase – Diplomacy and Science Baseline data established, to be used for monitoring and evaluation of second phase	Paper reviewing agriculture, horticulture, and forestry biosecurity investment in the SE Asia region
Technical capacity gaps identified and plans to address gaps developed as part of Phase 2	Preliminary/Final proposals for USC and Utas developed
Identification of prevention, emergency preparedness and response requirements and responsibilities	Risk pathways identified
Improved decision making and capacity to implement a regional biosecurity system	Action plan for regional collaboration on data, technical and knowledge sharing developed
Tree growers confident that gall wasp is being controlled and does not negatively impact productivity	Evidence that *S. neseri* is established in Mekong region and overall biological control performance increasing.

5 Stakeholder Input

Initially, a three-day workshop to identify priorities and develop a plan for phase two of this project was to be held in Malaysia in April 2020. The purpose of the three-day workshop was to determine the current biosecurity capacity, knowledge, and priorities for stakeholders in our partner countries. The in-person workshop would have also aided in curating the two networks – stakeholder and Government as part of phase two. However, because of the Covid-19 pandemic, this face-to-face workshop was not possible, and the workshop activities were reassessed and run as a series of online and virtual surveys, questionnaires, and discussions. This was a much better approach to information gathering as it allowed the participation of a much wider audience of people who would not otherwise be able to attend. It also meant that everyone had the opportunity to voice their opinions, both in group settings and anonymously. This meant there was much more open and honest discussion, thoughts, and ideas being presented. This may especially have been the case amongst the more junior staff, who, in face-to-face settings, may be reluctant to express opinions in the presence of their seniors or for others because of cultural norms relating to gender. These surveys and discussions are still online and open to more responses from the organisation and networks of current participants. These online tools have been translated into other languages and will be rolled out to other countries, including Cambodia, Myanmar and the Philippines. This online platform is a format that we will use throughout phase 2 of the project as it has been so successful.

Stakeholder input was gathered in an online baseline survey to develop an understanding of the level of expertise and current capacity in the region, including what future training and capacity building activities participants would like. To better understand current knowledge and needs for stakeholders in the SE Asia region, a series of WhatsApp discussion groups were held in each partner country. These centred on a series of questions, which were also made available online for participants to either re-visit and answer, or for those who preferred a fully anonymous mode of answering. The only identification marker was country and role (researcher, biosecurity/quarantine officer, or other). The baseline and WhatsApp discussion questions can be found in Appendix 1 and 2).

5.1 Baseline Survey on Forest Biosecurity Training and Skill Needs

5.1.1 Introduction

One of the five objectives of this scoping project was to “determine the current biosecurity capacity, knowledge and needs for stakeholders in the SE Asia region”. The original project plan of holding a three-day workshop was modified, with the project team developing a new approach that would utilise a combination of on-line questionnaires and text-based discussion groups to achieve the same outcomes that a face-to-face workshop would have done. Since face-to-face discussions were no longer possible due to COVID-19 travel restrictions, use of online methods became the only viable option. Because internet connectivity is often poor, conducting a single workshop via videoconferencing was seen to be a risky option, and potentially a poor method to generate discussion. Mini-face-to-face -workshops in each partner country were then also considered and planning commenced, but internal movement restrictions in most countries also made this a non-viable option in the short-term, with uncertainty over how long these movement restrictions would be in place. Online options as discussed above were therefore considered to be the best-bet option under the circumstances.

Outcomes of the baseline survey are reported on here and for the WhatsApp group discussions/online text inputs in Section 5.2.

5.1.2 Methods

Topics and questions used came from a baseline survey developed by the Australia-Africa Plant Biosecurity Partnership[1], and adapted for a forest biosecurity focus.

The first question **("How much do you think you would benefit from further training or knowledge in the following areas?**) was designed to elicit participant responses on personal needs for training or knowledge development of various aspects of forest biosecurity, under six sub-themes. These were: **Quarantine pests, detection, and diagnostics**; **Pest risk analysis**; **Horizon scanning and early detection**; **Biosecurity planning; Eradication and control**; and **Market access**. A Likert scale of 1-7 was used to elicit the strength of participants responses, with 1 equating to 'Not really', 4 to 'Maybe' and 7 to 'Very much'.

The second question (**"Which skills you would like to develop further?")** was designed to elicit participant responses on their needs for further skill development, mostly centred around skills required for their interactions with other forest biosecurity stakeholders. Again, a Likert scale of 1-7 was used to elicit the strength of participants responses, with 1 equating to "Not really = My skills are already excellent', 4 to "Maybe = I could use some practice" and 7 "Very much = I really need help with this".

The questionnaire is included here as **Appendix 1**.

Five of the six country partners participated in the survey. There were communication issues with our Cambodian partners which prevented us establishing a representative group to invite as participants. We are current establishing new connections in both the Forestry Administration and Plant Protection Department in Cambodia, so we anticipate we will have this baseline data available before the start of the follow-on FST/2020/123 and FST/2018/179 projects.

Translations of the questionnaires were made available in Pasa Lao, Bahasa Indonesia, Thai, and Vietnamese, as well as in the original English. Translations were either performed or checked by individuals with a background in biosecurity in each country.

Research ethics approval for this part of the project was applied for within the University of the Sunshine Coast and approved under ethics approval number A201420. The Research Project Information Sheet and Consent to Participate form are provided as **Appendix 2** and in this **link to the online form**, which includes the online questionnaire.

Recruitment was via our existing research, regulatory and policy networks in the region. Where we did not have information on suitable candidates for participation in the groups, we sought advice and opinion from experienced local experts in these fields, as well as from other Australian colleagues who have experience in biosecurity in the region previously. Six-10 participants were invited from each country, with as even a split as possible between researchers, those working in biosecurity and from the forest industry, and also considering gender balance as much as possible.

Email invitations were sent to participants in all countries between November 2020 and February 2021. The text of the email invitation is included here as **Appendix 3**. Responses were received between 29/11/2020 and 27/4/2021 and the final data downloaded and anonymised for analysis on 5/5/2021.

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1 https://www.cabi.org/projects/australia-africa-plant-biosecurity-partnership/

5.1.3 Results

Forest Biosecurity Training and Knowledge Needs

Overall Results

Results are summarised for all five countries included in the surveys. There was one response from Singapore, not formally part of the project, and only included in the summary information in Table 1. There were a total of 32 respondents from the six countries as at 5 May 2021, with numbers responding from each country shown in Table 1.

Table 1: Number of survey respondents from each country, by role (Biosecurity, Industry or Researcher).

Role	Indonesia	Laos	Malaysia	Singapore	Thailand	Vietnam
Biosecurity	1	1	2	1	1	1
Industry	3	0	2	0	0	0
Researcher	6	4	2	0	4	4
Total	10	5	6	1	5	5

Responses to each survey question across the five partner countries were analysed using Wizard Version 2 (Miller 2020) and are summarised in Figure 1. Responses were provided on a 1-7 Likert scale, with 1 – 'not really', 4 – 'maybe' and 7 – 'very much'. Needs ratings were defined as 'Very High' (mean score > 6.0), 'High' (mean score 5.5 to < 6.0) and 'Medium High' (> 4 < 5).

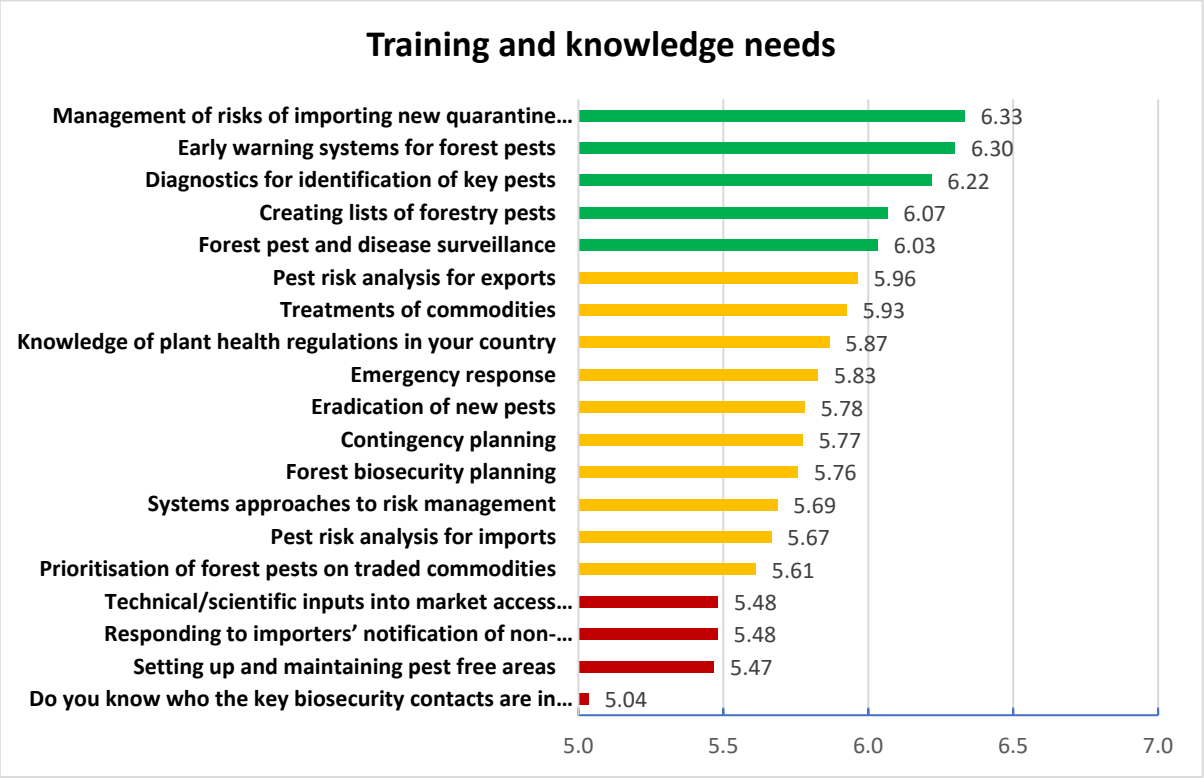


Figure 1: Forest biosecurity security needs for all countries ranked as Very High (green - mean score > 6.0), High (orange - mean score > 5.5 < 6.0) and Medium High (red -mean score > 5 < 5.5)

The top five needs identified were (in descending order): Management of risks of importing new quarantine pests; Early warning systems for forest pests; Diagnostics for identification of key pests; Creating lists of forestry pests; Forest pest and disease surveillance. Analysis of median scores (χ^2; Kruskal Wallace) for each priority by country showed that there were no significant differences between countries in their rating of these needs, indicating a high level of agreement across the region. For further analysis of differences between countries in their survey responses, see the **Need by Country** section. No significant differences were found between roles of respondents, although survey respondents were heavily biased to the researcher role.

Results by Theme

Survey questions were organised under six themes and the results for these themes are shown below.

Quarantine pests, detection and diagnostics

Results are summarised in Figure 2. This theme contained two of the overall very high needs, namely ***Management of risks of importing new quarantine pests*** and ***Diagnostics for identification of key pests***

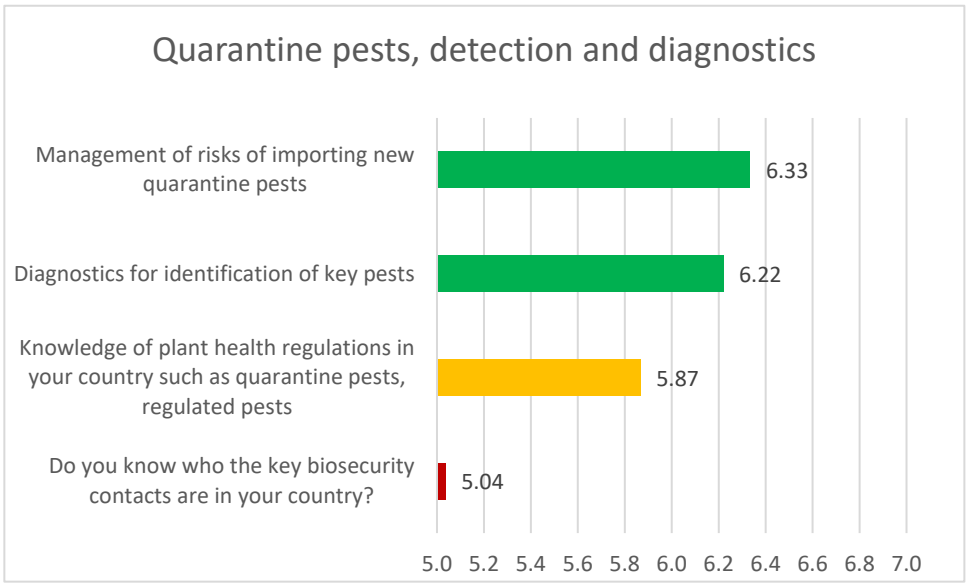


Figure 2: Mean score for forest biosecurity needs under the theme "Quarantine pests, detection and diagnostics". Very High (green - mean score > 6.0), High (orange - mean score > 5.5 < 6.0) and Medium High (red -mean score > 5 < 5.5)

Pest risk analysis

Results are summarised in Figure 3 below. This theme contained two needs rated as high in the overall ratings, namely ***Pest risk analysis for exports*** and ***Pest risk analysis for imports.***

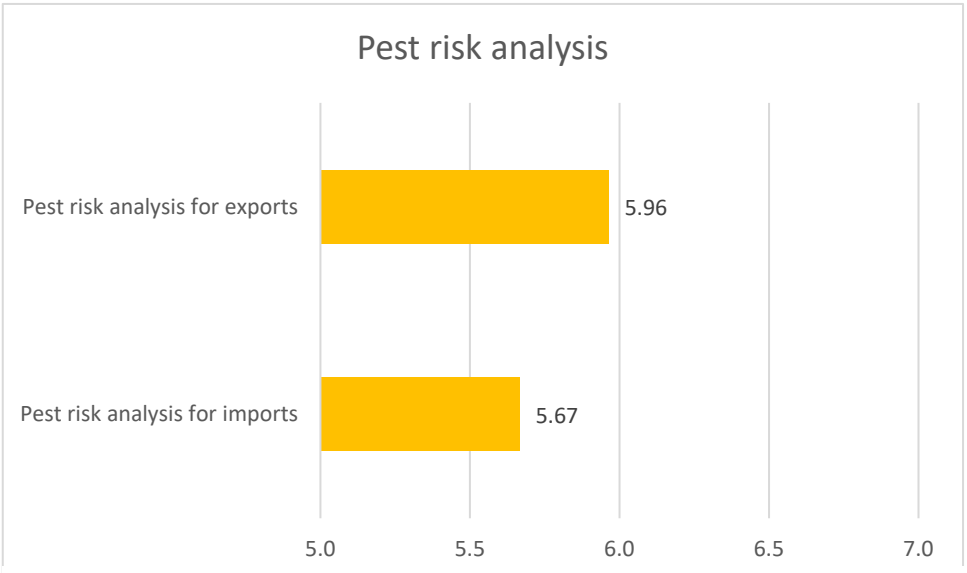


Figure 3: Mean score for forest biosecurity needs under the theme "Pest risk analysis". Very High (green - mean score > 6.0), High (orange - mean score > 5.5 < 6.0) and Medium High (red -mean score > 5 < 5.5)

Horizon scanning and early detection

Results are summarised in Figure 4 below. This theme contained two very high-rated needs**, "*Creating lists of forestry pests"*** and ***"Forest pest and disease surveillance"***, and one Medium high-rated priority, ***Systems approaches to risk management***.

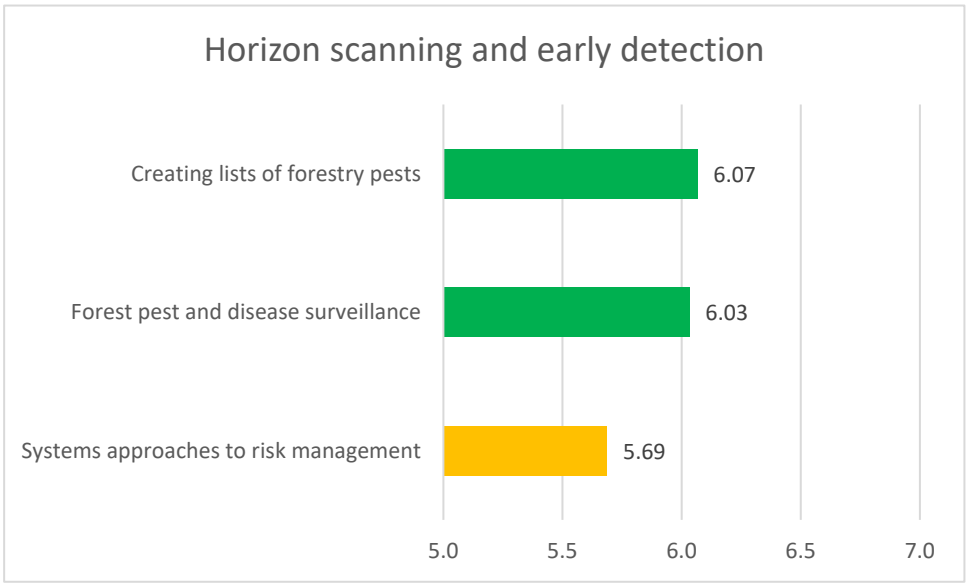


Figure 4: Mean score for forest biosecurity needs under the theme "Horizon scanning and early detection". Very High (green - mean score > 6.0), High (orange - mean score > 5.5 < 6.0).

Biosecurity planning

Results are summarised in Figure 5 below. This theme contained one very high-rated priority**, "*Early warning systems for forest pests"***, two high-rated needs, ***"Emergency response"*** and ***"Forest biosecurity planning***", and one Medium high-rated priority, ***"Setting up and maintaining pest free areas".***

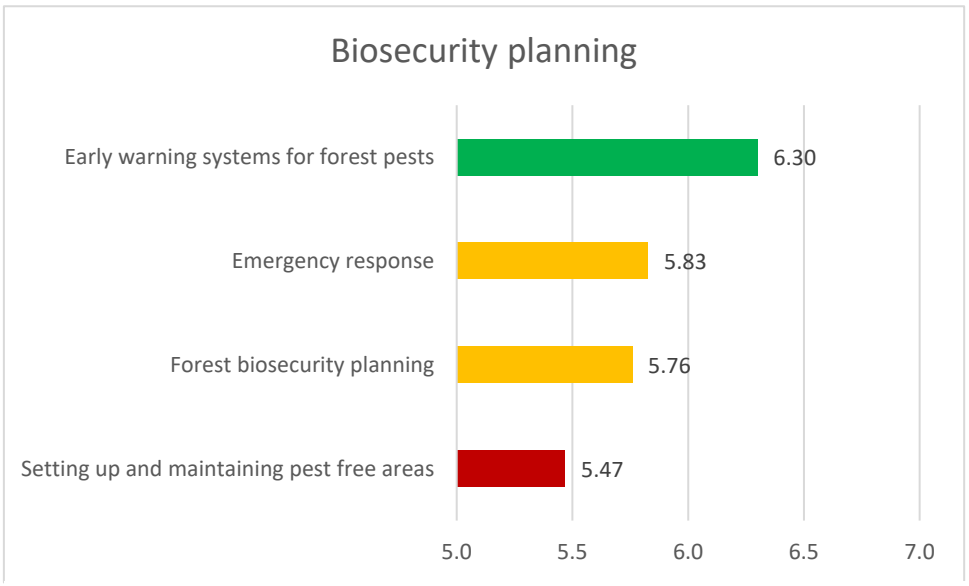


Figure 5: Mean score for forest biosecurity needs under the theme "Biosecurity planning". Very High (green - mean score > 6.0), High (orange - mean score > 5.5 < 6.0 Medium High (red -mean score > 5 < 5.5).

Eradication and control

Results are summarised in Figure 6 below. This theme contained three high-rated needs, **"*Treatments of commodities*", "*Eradication of new pests*"**, and ***"Contingency planning"***.

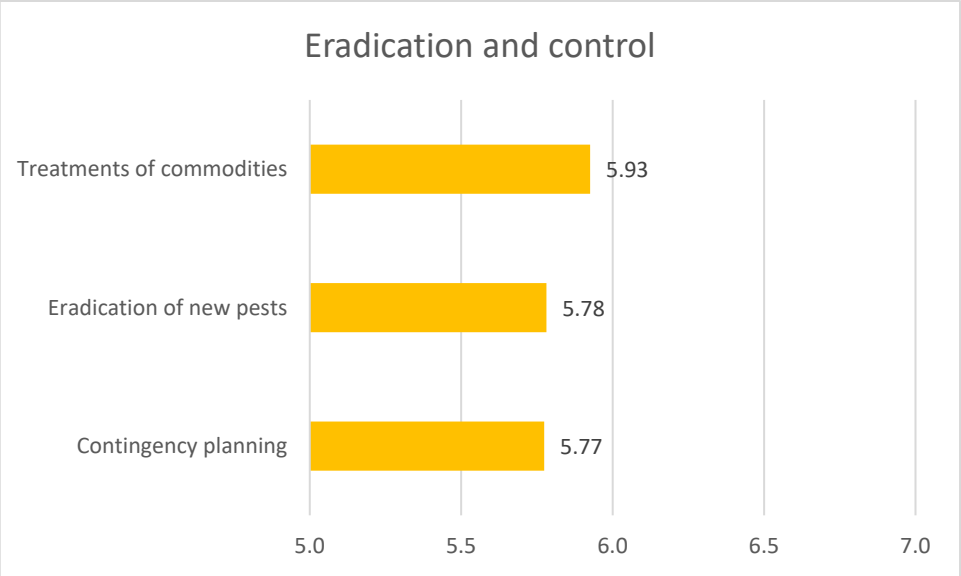


Figure 6: Mean score for forest biosecurity needs under the theme "Eradication and control". High (orange - mean score > 5.5 < 6.0).

Market access

Results are summarised in Figure 7. This theme contained one high-rated priority, "***Prioritisation of forest pests on traded commodities"***, and two Medium high-rated needs, "***Technical/scientific inputs into market access negotiations"*** and **"*Responding to importers' notification of non-compliance"***.

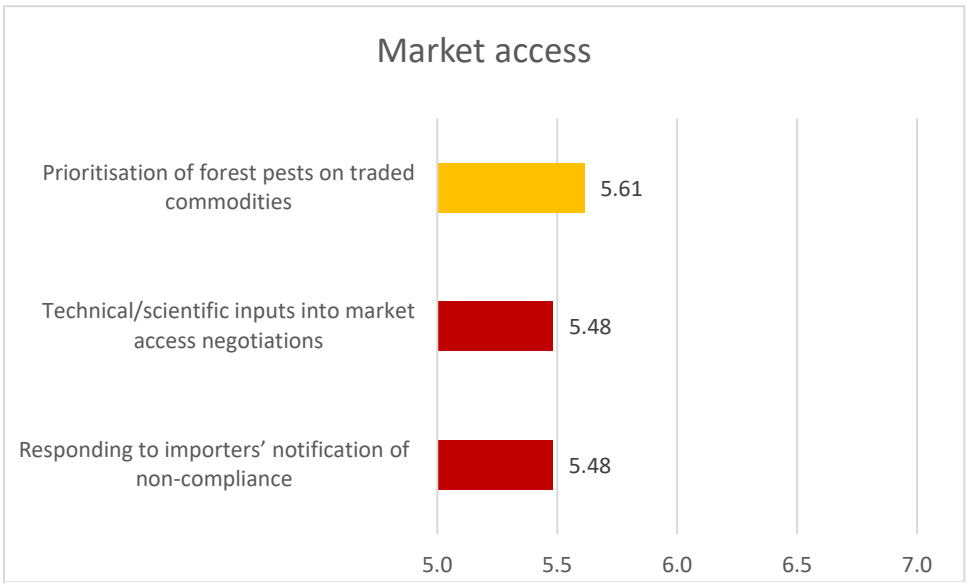


Figure 7: Mean score for forest biosecurity needs under the theme "Eradication and control". Very High (green - mean score > 6.0), High (orange - mean score > 5.5 < 6.0), Medium High (red -mean score > 5 < 5.5)

Forest Biosecurity Training and Knowledge Needs by Country

Laos

Needs for Laos are shown below in Figure 8, with nine listed as very high-priority, three high priority, five as Medium high priority and two as low priority. Of the nine categories listed as very high-priority for Laos, two were in common with the very high-needs across the region: (1) ***Early warning systems for forest pests*** and 8) ***Forest pest and disease surveillance*.**

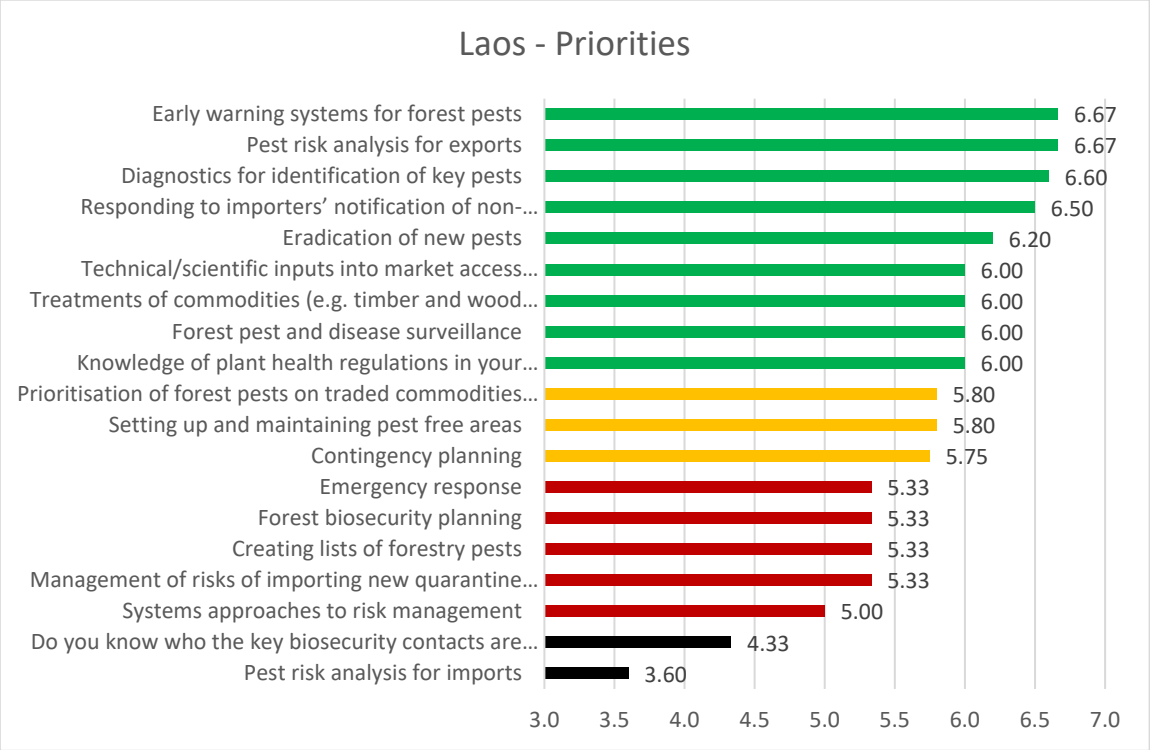


Figure 8: Mean scores for forest biosecurity needs for Laos. Very High (green - mean score > 6.0), High (orange - mean score > 5.5 < 6.0) and Medium High (red - mean score > 5 < 5.5), Low (black - < 5)

Indonesia

Needs for Indonesia are shown below in Figure 9, with **14 listed as very high-need**, **four high need** and **one as low need**. All five of the overall high-rated needs were included in the list of high-needs for Indonesia.

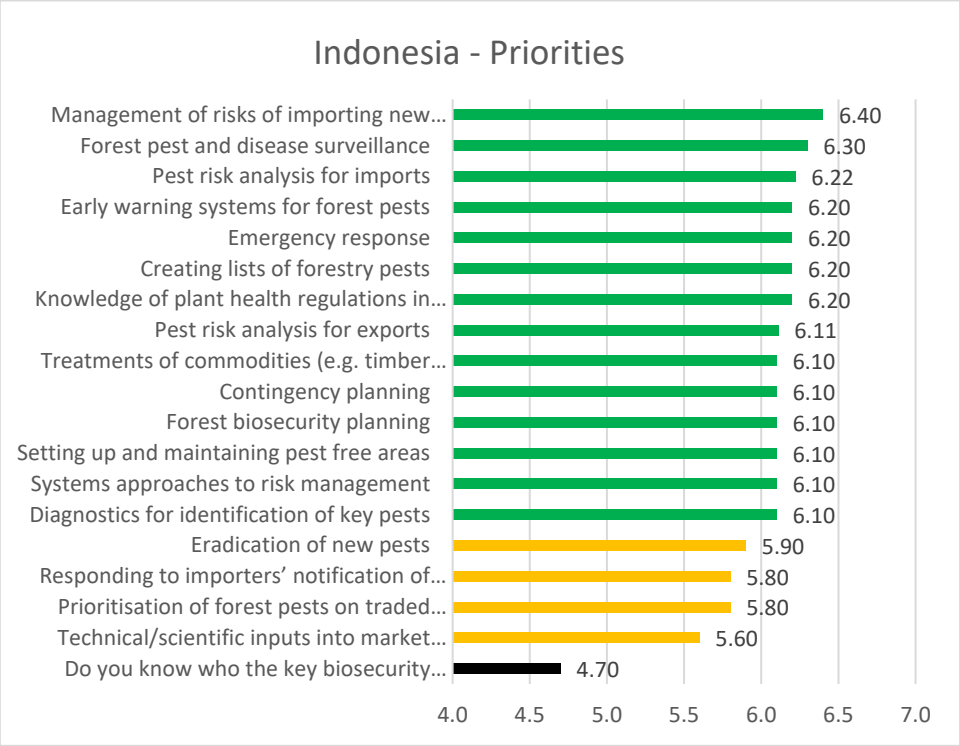


Figure 9: Mean scores for forest biosecurity needs for Indonesia. Very High (green - mean score > 6.0), High (orange - mean score > 5.5 < 6.0) and Low (black - mean score < 5)

Malaysia

Needs for Malaysia are shown in Figure 10, with **7 listed as very high-need**, **six high need, 4 Medium high need and two as low need**. Four of the overall very high-rated needs were included in the list of very high-needs for Malaysia.

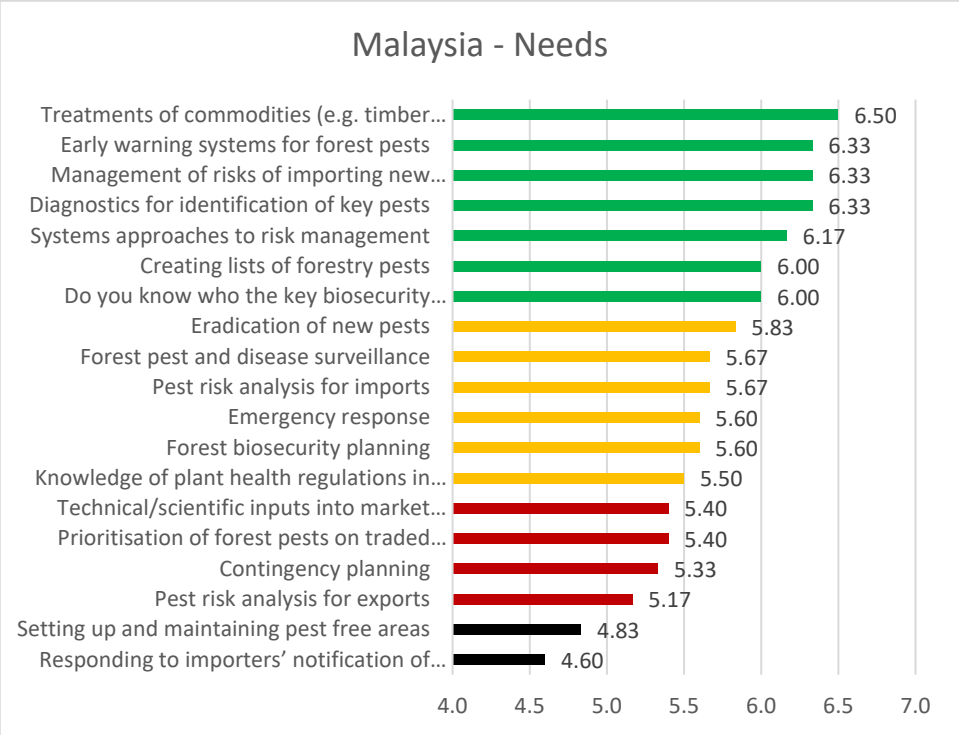


Figure 10: Mean scores for forest biosecurity needs for Malaysia. Very High (green - mean score > 6.0), High (orange - mean score > 5.5 < 6.0), Medium High (red - mean score > 5 < 5.5) and Low (black – mean score < 5))

Vietnam

Needs for Vietnam are shown in Figure 11, with **5 listed as very high-need**, **seven medium high need** and **seven** as **low priority**. Three of the overall high-rated needs were included in the list of high-needs for Vietnam.

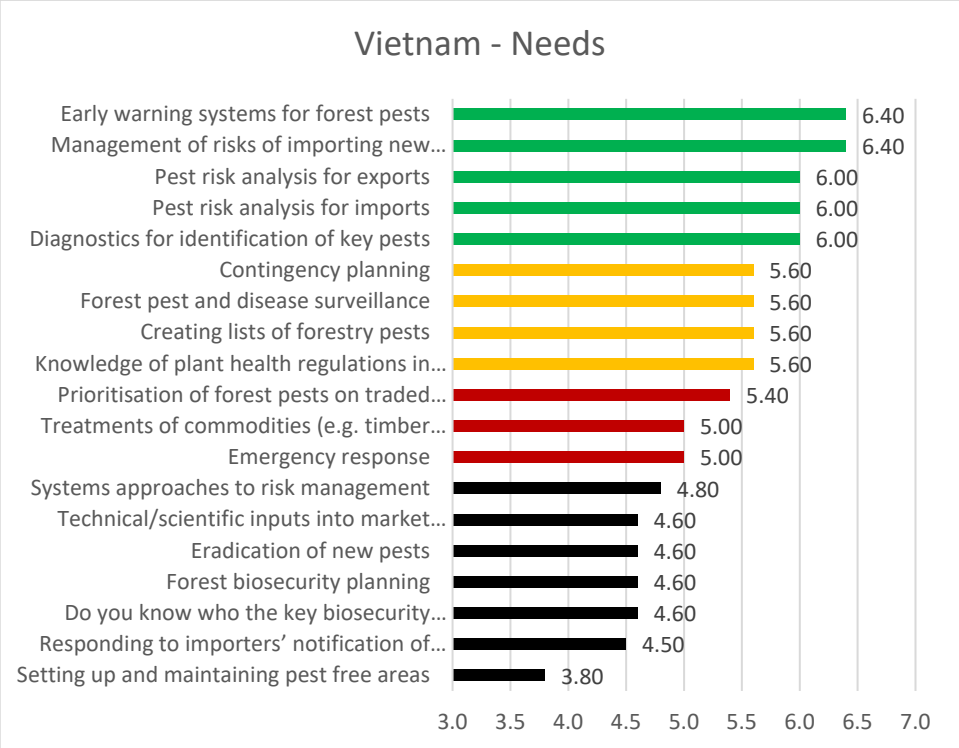


Figure 11: Mean scores for forest biosecurity needs for Vietnam. Very High (green - mean score > 6.0), High (orange - mean score > 5.5 < 6.0), Medium High (red - mean score > 5 < 5.5) and Low (black – mean score < 5)

Thailand

Needs for Thailand are shown in Figure 12, with **12 listed as very high-need**, **six** as **high need and one as medium high need**. All **five** of the **overall very high-rated needs** were included in the list of high-needs for Thailand.

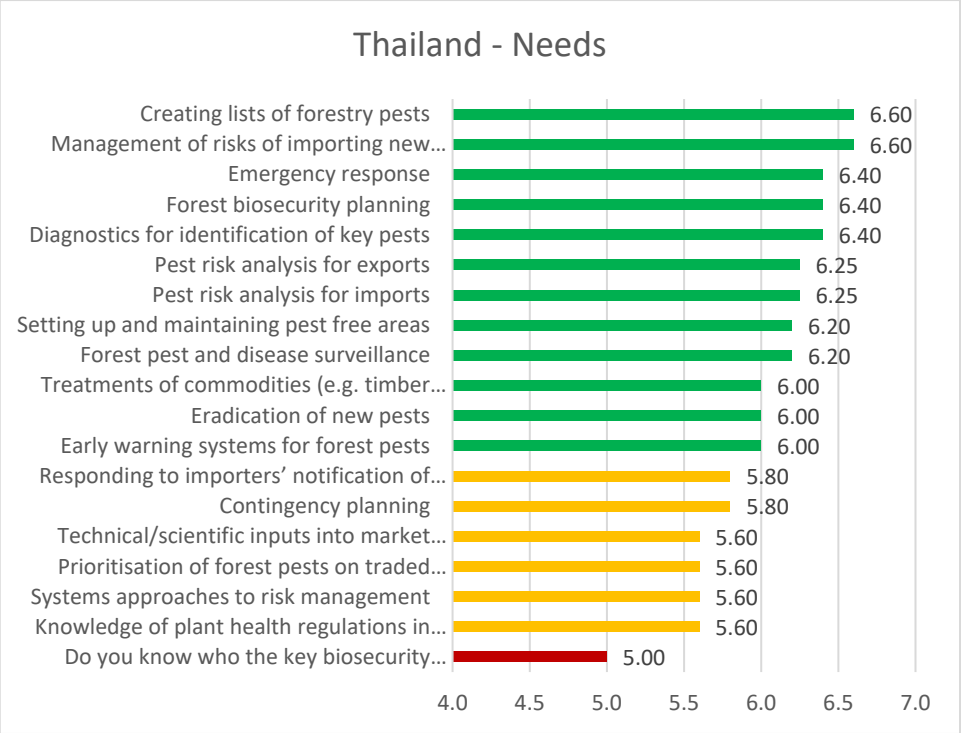


Figure 12: Mean scores for forest biosecurity needs for Thailand. Very High (green - mean score > 6.0), High (orange - mean score > 5.5 < 6.0) and Medium High (red - mean score > 5 < 5.5)

Summary of Needs

Table 2 summarises concordance of needs across the five partner countries included in the baseline survey. In this analysis, if the mean rating of a need was 'very high' in a country it was given a score of 3, 'high as 2 and 'Medium high as 1. Scores were then tallied for each need. Eleven needs had a ranking score of 10 or higher.

Table 2: Summary of needs by country and overall ranking of needs Colour coding indicates a high (green – score 3), medium (orange – score 2) and low (red – score 1) mean needs for each category.

Priority	Laos	Indonesia	Malaysia	Vietnam	Thailand	TOTAL
Diagnostics for identification of key pests	3	3	3	3	3	15
Early warning systems for forest pests	3	3	3	3	3	15
Treatments of commodities	3	3	3	2	3	14
Management of risks of importing new quarantine pests	1	3	3	3	3	13
Pest risk analysis for exports	3	3	1	3	3	13
Forest pest and disease surveillance	3	3	2	2	3	13
Knowledge of plant health regulations	3	3	2	2	2	12
Pest risk analysis for imports	1	3	2	3	3	12
Creating lists of forestry pests	1	3	3	2	3	12
Emergency response	1	3	2	2	3	11
Eradication of new pests	3	2	2	1	3	11
Systems approaches to risk management	1	3	3	1	2	10
Setting up and maintaining pest free areas	2	3	1	1	3	10
Forest biosecurity planning	1	3	2	1	3	10
Contingency planning	2	3	1	2	2	10
Prioritisation of forest pests on traded commodities	2	2	1	2	2	9
Technical/scientific inputs into market access negotiations	3	2	1	1	2	9
Responding to importers' notification of non-compliance	3	2	1	1	2	9
Knowledge of key biosecurity contacts	1	1	3	1	2	8
Country Total	40	51	39	36	50	216

Two needs had complete agreement across all five countries (**score of 15),** namely, '**Diagnostics for identification of key pests'** and '**Early warning systems for forest pests'**. Both these needs were included in the high needs in the Overall Results section The next highest agreement (**score of 14)** was for **'Treatments of commodities'**, with only Vietnam ranking this as a medium need. This need was not classified as a high need in the mean ratings shown in the **Overall Results** section.

Three needs achieved a **score of 13,** being '**Management of risks of importing new quarantine pests'**, **'Pest risk analysis for exports'**, and '**Forest pest and disease surveillance'**. Of these three needs, only **'Pest risk analysis for exports'** was not included in the high needs in the **Overall Results** section. Three more needs had a **score of 12**, namely **'Knowledge of plant health regulations'**, '**Pest risk analysis for imports'**, and **'Creating lists of forestry pests'**. Of these, only the latter was included in the high needs in the **Overall Results** section

Needs with a score of 11 were **'Emergency response'** and **'Eradication of new pests'**. Neither of these were rated as high need in the overall analysis. Needs with a score of 10 or lower were not considered here to be high needs.

5.1.4 Forest Biosecurity Skill Needs

Overall Skill Needs

Results are summarised for all six countries included in the surveys (including one response from Singapore, not formally part of the project) in Figure 13 . As mentioned

before, as of 5 May 2021 there were a total of 32 respondents from the six countries, with numbers responding from each country shown in Table 1.

Mean responses to each survey question are shown. Responses were provided on a 1-7 Likert scale, with 1 equating to 'My skills are already excellent', 4 - 'I could use some practice' and 7 being 'I really need help with this'. In Fig. 13, priority ratings were expressed as 'High' (mean score > 5.5), 'Medium High' (mean score 5 to < 5.5) and 'Low' (> 4.5 < 5).

Figure 13: Forest biosecurity security skills needs for all countries ranked as High (green - mean score > 5.5), Medium (orange - mean score > 5 < 5.5) and Low (red -mean score > 4.5 < 5)

Two skill needs were rated as high, namely **'Negotiating biosecurity issues with trading partners in other countries'** and '**Influencing government regulations and policies'**, with eight needs rated as 'medium' and two as 'low'.

Six of the eight needs skills rated as 'medium' had mean scores above 5.3 and so could be rated as 'medium-high'. These were: **'Influencing your organisation's strategy and operations'**, **'Discussing forest biosecurity issues with public sector stakeholders'**, '**Discussing forest biosecurity issues with private sector stakeholders'**, **'Discussing forest biosecurity issues with smallholder growers and farmers'**, **'Negotiating or discussing biosecurity issues with forest biosecurity professionals'** and **'Discussing forest biosecurity issues from your colleagues in other countries'**.

Forest Biosecurity Skill Needs by Country

Laos

Biosecurity skills needs for Laos are shown below in Figure 14, with seven listed as high-priority, and five medium priority. Of the seven categories listed as high-priority for Laos, two were in common with the high-needs across the region with ***Negotiating biosecurity***

issues with trading partners and ***Influencing government regulations and policies*** ranked equal fifth.

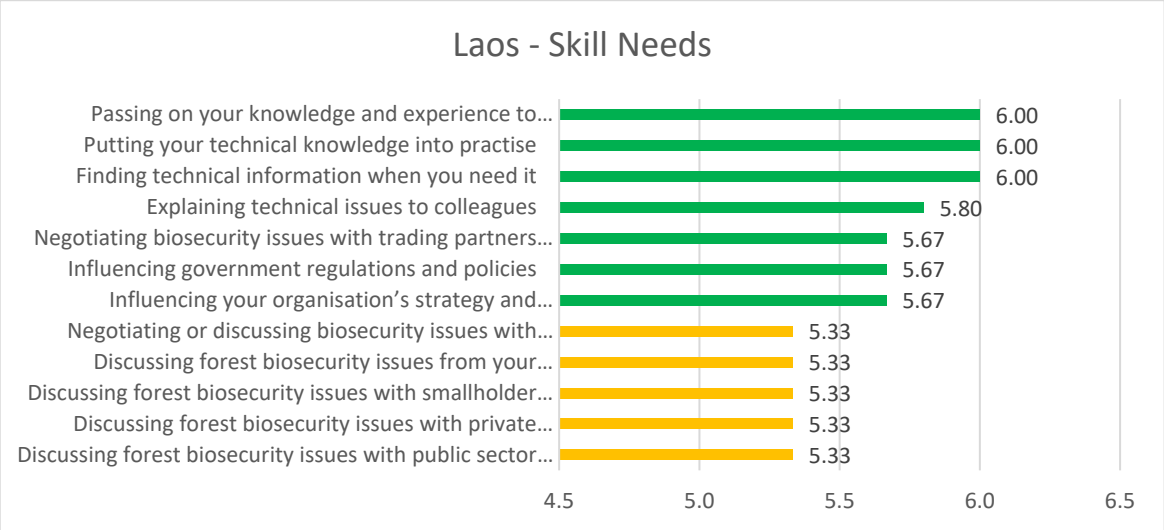


Figure 14: Mean scores for forest biosecurity skills needs for Lao PDR, ranked as High (green - mean score > 5.5), and Medium (orange - mean score > 5 < 5.5)

Indonesia

Biosecurity skills needs for Indonesia are shown below in Figure 15, with seven listed as high-priority and five medium priority. Of the seven categories listed as high-priority for Indonesia, both the high-needs across the region were included, with ***Influencing government regulations and policies*** ranked equal first and ***Negotiating biosecurity issues with trading partners*** equal fourth.

Figure 15: Mean scores for forest biosecurity skills needs for Indonesia, ranked as High (green - mean score > 5.5) and Medium (orange - mean score > 5 < 5.5)

Malaysia

Biosecurity skills needs for Malaysia are shown below in Figure 16, with one listed as high-priority, three medium priority and eight as low priority. The only high-priority for Malaysia, '**Discussing forest biosecurity issues with smallholders'** was not among the two high-needs found for the region. However, this skill issue was among the medium-ranked needs across the region.

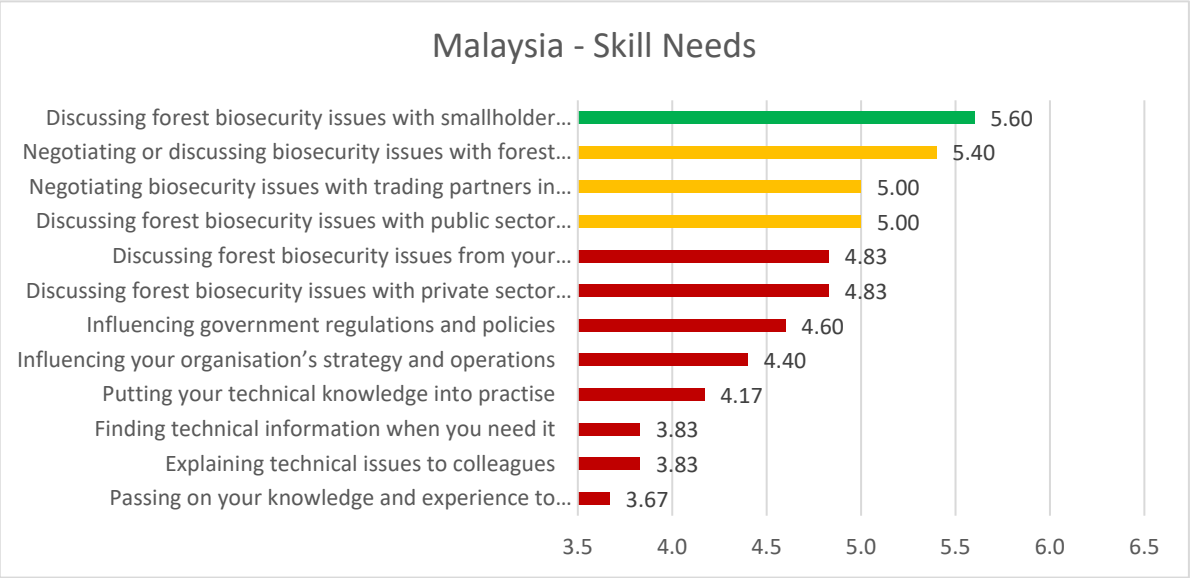


Figure 16: Mean scores for forest biosecurity skills needs for Malaysia, ranked as High (green - mean score > 5.5), Medium (orange - mean score > 5 < 5.5) and Low (red -mean score < 5)

Vietnam

Biosecurity skills needs for Vietnam are shown below in Figure 17, with eight listed as high-priority, two medium priority and two as low priority. Of the eight categories listed as high-priority for Vietnam, both the high-needs across the region were included, with ***Influencing government regulations and policies*** ranked first and ***Negotiating biosecurity issues with trading partners*** equal second.

Figure 17: Mean scores for forest biosecurity skills needs for Vietnam, ranked as High (green - mean score > 5.5), Medium (orange - mean score > 5 < 5.5) and Low (red -mean score < 5)

Thailand

Biosecurity skills needs for Thailand are shown below in Figure 18, with three listed as high-priority, six medium priority and three low priority. The three categories listed as high-priority for Thailand did not include either of the region-wide high-needs, with ***Negotiating biosecurity issues with trading partners*** and ***Influencing government regulations and policies*** ranked equal fourth as a medium priority.

Figure 18: Mean scores for forest biosecurity skills needs for Thailand, ranked as High (green - mean score > 5.5), Medium (orange - mean score > 5 < 5.5) and Low (red -mean score < 5)

Summary of Skills Needs

Table 3 summarises concordance of skills needs across the five partner countries included in the baseline survey. In this analysis, if the mean rating of a need was 'high' in a country it was given a score of 3, 'medium' as 2 and 'low' as 1. Scores were then tallied for each need. Eight skills needs had a ranking score of higher than 10.

Table 3: Summary of skills needs by country and overall ranking of needs. Colour coding indicates a high (green – score 3), medium (orange – score 2) and low (red – score 1) mean skills needs for each priority.

Priority	Laos	Indonesia	Malaysia	Vietnam	Thailand	TOTAL
Negotiating biosecurity issues with trading partners in other countries	3	3	2	3	2	13
Finding technical information when you need it	3	3	1	3	2	12
Influencing your organisation's strategy and operations	3	3	1	3	2	12
Discussing forest biosecurity issues with smallholder growers and farmers	2	2	3	2	3	12
Influencing government regulations and policies	3	3	1	3	2	12
Discussing forest biosecurity issues with public sector stakeholders	2	3	2	3	1	11
Discussing forest biosecurity issues with private sector stakeholders	2	2	1	3	3	11
Discussing forest biosecurity issues with your colleagues in other countries	2	2	1	3	3	11
Passing on your knowledge and experience to colleagues	3	3	1	2	1	10
Putting your technical knowledge into practise	3	3	1	1	2	10
Negotiating or discussing biosecurity issues with forest biosecurity professionals	2	2	2	3	1	10
Explaining technical issues to colleagues	3	2	1	1	2	9
Country Total	31	31	17	30	24	133

The top ranked skill (score of 13) need was **Negotiating biosecurity issues with trading partners in other countries** with Laos, Indonesia and Vietnam ranking this skill need as

high, while Malaysia and Thailand rated it as a medium need. Four other skills needs ranked second (score of 12), being **Finding technical information when you need it**, **Influencing your organisation's strategy and operations**, **Discussing forest biosecurity issues with smallholder growers and farmers**, and **Influencing government regulations and policy**. Agreement across countries was mor variable across these needs, with Malaysia rating 'Finding technical information when you need it', 'Influencing your organisation's strategy and operations and Influencing government regulations and policy lower than other countries.

5.1.5 Conclusions

Forest Biosecurity Training and Knowledge Needs

Eleven common needs emerged in regard to training and knowledge across the five countries participating in the survey. These are grouped under the three relevant primary objectives and associated activities of FST/2020/123 and are shown in Table 4.

Table 4: Common training and knowledge needs in partner countries in relation to FST/2020/123 Objectives.

Forest Biosecurity Training and Knowledge Needs related to Objectives and Activities	
Objective 1: Create a forest biosecurity network in SE Asia	**Activities**
Early warning systems for forest pests (HRSS)	Pilot network of high-risk surveillance sites (HRSS) that drives network activities
Forest pest and disease surveillance (FHS)	Capacity building in FHS and incorporation of remote sensing outputs from FST/2018/179
Objective 2: Develop the science tools needed to support and sustain this network	**Activities**
Diagnostics for identification of key pests	Mobile-based guide and reporting app to aid in diagnostics for key pests Trial of meta-barcoding molecular diagnostics for HRSS trap catches/blitz surveys
Objective 3: Develop coordinated forest biosecurity policies for SE Asia	**Activities**
Knowledge of plant health regulations	Review of regulations completed in this project (SRA FST/2020/102), feeding into further policy development
Pest risk analysis for exports Pest risk analysis for imports	Pest risk analysis training and policy input.

Management of risks of importing new quarantine pests	Using HRSS to promote improved risk management
Treatments of commodities	Policy and capacity development for better understanding of ISPM and other SPS implementation.
Emergency response	HRRS linking to better policies in preparedness and response to incursions.
Creating lists of forestry pests	Pest prioritisation – links to HRSS and PRA activities
Eradication of new pests	Integration with existing policies in Agriculture and new policy development to streamline processes from detection, delimiting surveillance, decision-making on feasibility of eradication, and potential for cost-sharing arrangements.

Two needs (Early warning systems for forest pests (HRSS) and Forest pest and disease surveillance (FHS) aligned with Objective 1 (Create a forest biosecurity network in SE Asia), one need with Objective 2 (Diagnostics for identification of key pests) and eight needs with Objective 3 (Develop coordinated forest biosecurity policies for SE Asia).

Forest Biosecurity Skill Needs

Eight common needs emerged in regard to skills needs across the five countries participating in the survey. These were further consolidated into three thematic areas: Discussing biosecurity with stakeholders; Negotiating and influencing policy and policy makers; Finding and using technical knowledge. These themes were then grouped under the three primary objectives and associated activities of FST/2020/123 and are shown in Table 5.

Table 5: Skill needs in partner countries in relation to FST/2020/123 Objectives and Activities

Forest Biosecurity Skills Needs related to FST/2020/123 Objectives and Activities	
Objective 1: Create a forest biosecurity network in SE Asia	**Activities**
Finding technical information when you need it.	This is a newly identified skill need and will be addressed through general biosecurity training and via the project website where links to relevant technical information will be made available.
Discussing biosecurity issues with stakeholders: Includes: • Discussing forest biosecurity issues with smallholder growers and farmers. • Discussing forest biosecurity issues with public sector stakeholders. • Discussing forest biosecurity issues with private sector stakeholders. • Discussing forest biosecurity issues with your colleagues in other countries.	Discussion of biosecurity issues widely with all stakeholders will form a strong part of the biosecurity network activities. In terms of the establishment of the network, priority needs to be given first to participants being able to discuss biosecurity issues with colleagues from the other partner countries.
Objective 2: Develop the science tools needed to support and sustain this network	**Activities**
No skill needs were identified in relation to this objective.	These concern science tool development activities under FST/2018/179
Objective 3: Develop coordinated forest biosecurity policies for SE Asia	**Activities**
Negotiating and influencing policy and policy makers. Includes: • Negotiating biosecurity issues with trading partners in other countries • Influencing your organisations strategies and operations. • Influencing government regulations and policies	These are higher level needs, which will flow from the broader activities of the biosecurity network as well as from greater integration of forestry and biosecurity agencies.

5.2 WhatsApp Discussions

Responses from each of the countries were very consistent (see table 6 below). Ground crops were the highest priority crops, and every country, except for Thailand, listed a forest species as a priority, demonstrating the importance of forestry as an important cropping commodity. The perceived likelihood that these priorities will change in the future was varied across all responses and countries. For planted and natural forest species, the responses were very similar across the five countries. Largely, the major plantation species were considered important in planted settings, whilst bamboo, *Dipterocarpus* spp., or *Dalbergia cochinchinensis* were considered important for each country in natural forests. Exotic species, climate change, and land-use change were considered major threats to these forestry systems for each of the countries. Malaysia went further in highlighting that online sales are now a high-risk pathway for entry of exotic species that need to be considered in biosecurity plans. It was unclear if Laos have response plans in place, like the other countries. But given that there was a response in place for the recent arrival of fall armyworm, it is likely that the respondents were just unsure or failed to mention such plans.

High risk site surveillance is in place in Malaysia, Thailand, and Vietnam, however, based on the responses, the understanding of what it is and why it is important is limited. What this indicates is that in the next phase of this project, Malaysia, Thailand, and Vietnam can aid in developing the capacity of the other partner countries. For policy and legislation, Indonesia and Malaysia have strong knowledge of plant protection and quarantine laws and will be able to provide support in developing strength in policy development in phase two. Knowledge and understanding of some biosecurity aspects was unclear for some of the respondents. It does not indicate this is the general case for the country but merely that the participants in this discussion may benefit from training and knowledge of these areas of biosecurity.

There is unanimous feeling across the countries that there is a limited ability to deliver on biosecurity activities because of limited funding, limited training opportunities, poorly equipped laboratory facilities, and a lack of skilled and trained personnel. This limits their ability to conduct their jobs and has limited the biosecurity capacity of each country. Whilst governments provide training opportunities in a range of areas from policy, diagnostics, to surveillance and mapping, these opportunities occur only once per year and are often limited in the number of places available. All respondents want more training in diagnostics, surveillance, new technologies, and GIS. Molecular diagnostic capacity ranges from non-existent in Laos, to moderate in the other countries, however, no one has surge capacity due to limited resources – skills, equipment, and personnel. Indonesia and Vietnam highlighted that they would like to see practices and techniques be developed that are in line with global standards, which all partners would benefit from. These resources (funding, training, personnel, etc.) are provided by the government in each country, however, based on the responses, industry could play a significant role here. For instance, in Malaysia, private companies are reluctant to allocate resources to biosecurity yet rely on the government to provide services and advice. Whilst the other countries did not comment on this, it is our observation that this is the case for at least Cambodia (not yet covered in this report, responses to come) and to some extent Laos, and is likely the case in Indonesia, Thailand, and Vietnam. Bringing together stakeholders and government, in this network, will potentially close the gap on this resource issue by highlighting the importance of biosecurity and the value in investing in such activities by industry.

For a full breakdown by country, **see Appendix 4 -** Country discussions report.

Table 6: Summary of discussions by country

	Indonesia	Laos	Malaysia	Thailand	Vietnam
Priority crops	Ground crops, horticulture, oil palm and rubber	Ground crops, horticulture, and rubber	Ground crops, horticulture, oil palm	Ground crops	Hard and softwoods, ground, and horticulture
Changes	50/50-change/stay the same	Will change because of climate change, market demands and new technologies	No change	Unsure	Yes, no, and maybe. Climate and increased pest pressure will be a catalyst
Forest species - planted	Commercial - *Acacia*, *T. grandis*, *Shorea* spp., and *Eucalyptus* spp. Smallholder - *F. moluccana*, Mahogany, *Gmelina jabon* (harwood)	*T. grandis* and *Eucalyptus*	*H. brasiliensis*, *Eucalyptus* spp., *Acacia* spp., *F. moluccana* and *Neolamarckia* spp.	*T. grandis, H. brasiliensis* and *Eucalyptus* spp.	*Acacia*, pine, and *Eucalyptus*
Forest species - natural	Bamboo, *Shorea* spp., and *Dipterocarpus* spp.	Bamboo, *P. macrocarpus*, *P. kesiya, D. conchinchinensis*, A. *xylocarpa* and *B. padak*	*Dipterocarpus* spp.	*T. grandis*, *D. cochinchinensis,* and *Dipterocarpus* spp	Bamboo and *Dipterocarpus* spp.
Threats	Exotic invasive pests, climate change and diseases such as root rot and *Ceratocystis* (forestry focused)	Climate change, human impact (illegal logging), pests and disease	Climate change and the use of online shopping as an avenue for entry of exotic invasive pests	Climate change, land-use change, and pest outbreaks	
Response plans	In place	Unclear	In place	In place	In place
HRSS	Good understanding	No HRSS and limited understanding of	HRSS in place, but limited understanding	HRSS in place, but limited understanding	In place and good understanding
Policy and law	Good understanding	Unclear	Good understanding	Unclear	Limited
Biosecurity roles	Limited	Unclear	Solid understanding	Unclear	Limited
SH engagement	Limited. Local government responsibility	Strong. Extension department	None	None	Strong
Previous training	Limited number of training opportunities (usually one per year) - policy, new diagnostic techniques, surveillance, and mapping	Limited number of training opportunities (usually one per year)	Previous training has been delivered by APFISN	Training does not happen often enough	Infrequent training on policy, diagnostics, and surveillance

Job barriers	Funding, training, skilled personnel, and bureaucracy	Funding and training	Training and equipment	Funding	Funding and training
Training needs	new technology, molecular techniques, and training to develop biosecurity practises in line with global standards, and new diagnostics techniques, specifically: next generation sequencing for diagnostics, other new technologies for diagnostics and surveillance, rapid detection technology such as biosensor and GIS mapping	Molecular diagnostic techniques, surveillance and monitoring, pest prevention techniques, new surveillance techniques, new technologies and GIS	Diagnostics, biosecurity procedures and risk analyses	Molecular techniques and other new technologies	Regional and interregional quarantine techniques. Training in pest and disease diagnostics, IPM, surveillance and monitoring, use of new technology and policy. Molecular diagnostics
Molecular capacity	Molecular diagnostic capacity, no surge capability. Remote diagnostics too	No molecular capacity including no equipment, tools, or training opportunities, therefore there is no surge capacity. Remote diagnostics too	Molecular diagnostic capacity, no surge capability. lacking is facilities, equipment and trained personnel. Remote diagnostics too	Remote diagnostics take place, alongside in-country identification (molecular diagnostics included), and specimens are sent overseas if necessary	Molecular diagnostics, but it is in its infancy. remote diagnostics also occur, and specimens are sent overseas when needed (FABI in South Africa or Murdoch University in Australia). No surge capacity
Resources	Resources for biosecurity are channelled toward agricultural crops. funding available when a problem arrives	lack of human resources and funding, which is major limitation to capacity development	Resources, research priorities, personnel and funding are determined by the government. The private companies are reluctant to allocate resources to biosecurity and rely on the government to provide services and advice	No response	funding, training, and human capacity is provided by the government, yet very limited
Biosecurity plan	Good on ground surveillance activities, strong coordination between agencies which linked with agriculture agencies too	Incorporate the use of new technology to protect the whole forest ecosystem. Better coordination between private companies and the government.	Start with plantations as they consist of exotic species, and would therefore be more likely affected, particularly as they are a tradeable commodity, increasing the chances of bringing in an exotic pest	Unclear	Encompass the whole chain, from farmer to government to ensure it is effective and resilient. It must incorporate good policy, new technology and techniques for diagnostics, including sound surveillance and mapping
Future	Sustain productivity of planted forests, including biodiversity	Sustainable for environmental health, cultural	Include more biosecurity training, well-	Include the use of smart technology,	Balance the demand for economic

	of natural forests whilst contributing rural livelihoods	and traditional significance, and economic value. The sector must include reforestation and conservation practices	equipped/trained personnel, and better equipment	better skilled foresters, and researchers to protect forests from pest and diseases	efficiency whilst minimising environmental degradation. Consider climate change to understand drivers of pest and disease emergence and therefore mitigate risk

6 Reviews

Two reviews were carried out, one to assess biosecurity legislation for the region, whilst the second review assessed past and current regional biosecurity investment.

The law and legislation review examined the existing biosecurity legislation, regulation, and practice in the regional or multilateral conventions or treaties, including trade conventions and private sector standards, and the extent to which such legislation/regulation furthers forest biosecurity interests. In addition, the review considered the processes for regional standard-setting and how this currently addresses forest biosecurity threats, and whether there is further scope to nominate new topics for the development of regional and international standards to improve forest biosecurity.

The biosecurity investment review examined past (10-years) and current Australian, national and international investment in plant biosecurity in the region. The purpose of the review was to allow for a 'rolling-up' or 'summing' of the various successful components that have occurred, such as pre-border activities, surveillance, response, and research and development. This will ensure the inclusiveness of current regional strategies and programs in implementing phase two and avoid duplication of activities. This will aid in curating an effective biosecurity framework that is adequately costed and effectively actioned in the region.

6.1 Law and Legislation

This review examined the existing biosecurity legislation and procedures in the region, including the extent to which such legislation and resourcing accommodate forest biosecurity interests. Relevant trade conventions, private sector standards, and international agreements, conventions, and treaties were also considered, including the forest relevant International Standards for Phytosanitary Measures (ISPM) being implemented and at the challenges that are faced to do so. The review asked three key questions i) are there biosecurity laws or legislation in place that pertain to forestry in the region? ii) If not, what should they be? And lastly iii) How can they be developed and enacted to provide regional protection. Based on the findings, currently, no countries have specific laws, legislation or policy relating to forest biosecurity, rather, reducing risk and harm from invasive species is captured in plant health and protection laws, including in policy regarding the environment, land use, and trade. The challenge, therefore, is for authorities and governments to develop national forest biosecurity in line with the international instruments (Sanitary and Phytosanitary Measures (SPS) agreement, Convention on Biological Diversity (CBD) guidelines) that are applicable at national levels.

Law and legislation development are a complex and often expensive process, requiring a certain level of national capacity (Dahlstrom et al. 2011). Some countries may need to evaluate the capacity of the institutions that will be called upon to enforce biosecurity legislation. One approach may be the lateral spread of existing framework capacity via transfer of knowledge from nations with well-established biosecurity frameworks, such as Australia and New Zealand, to countries that lack sufficient technical, scientific, or policy-based resources (Dahlstrom et al. 2011). Another strategy could be providing support in vertical integration of measures, such as the IPPC aiding individual Members, ASEAN, or the Asia Pacific Economic Cooperation (APEC) as a way forward in developing capacity (Dahlstrom et al. 2011; Campbell et al. 2020). Both strategies would be well placed to develop biosecurity capacity as needed. These strategies could also be actioned at a regional level, with countries sharing resources and training, thereby developing a standardised system. A regional approach to forest biosecurity law and legislation could be another joined up approach, that could be actioned through the formation of a Forest Biosecurity Working Group reporting to the Joint Committee of ASEAN on biosecurity focal points. This group could run as a subcommittee to the ASEAN Forest Products Industry Club (AFPIC) or alongside, to promote interests and global safety in invasive

pests and disease of forest products of the member countries of ASEAN. The strategies put forward for capacity building could potentially be actioned through the Forest Biosecurity Working Group sub-committee to ASEAN.

The full review manuscript is attached as Appendix 5 – Law and Legislation review and will be submitted for possible publication in the *International Forestry Review*

6.2 Biosecurity investment

Biosecurity systems rely on expertise in multiple disciplines including risk analysis, contingency planning, surveillance, diagnostics and pest management or eradication methods. Capacity building in these disciplines, particularly in surveillance and diagnostics has been the major focus of international investment in SE Asian plant biosecurity. Australian agencies, especially DAFF and ACIAR, have contributed to this capacity building in SE Asia, though this has been targeted mainly to diagnostics and surveillance in agricultural and horticultural crops. This may be understandable in countries where lack of food security is a more imminent threat for a significant proportion of the population but overlooks the contribution of forests to poverty alleviation in developing nations as well as the environmental services provided by forests. Even in Australia, plant biosecurity initiatives have, until very recently, focussed almost solely on agricultural and horticultural crops, with poor integration of forestry into the biosecurity system. The situation has changed only within the past decade or so, following the signing of the Emergency Plant Pest Response Deed by the Australian Forest Products Association in December 2012.

Forestry pests and diseases are receiving increased attention globally due to the environmental and economic damage caused by invasive pests such as *Phytophthora ramorum, Fusarium circinatum,* sirex wood wasp and emerald ash borer. Changing climates, land use changes and increased mobility of people and goods all exacerbate the threats to native and planted forests. The global decline of forested areas caused by deforestation and the combined impacts of pest incursions and climatic variability is also an increasing concern for the carbon cycle and its impact on future climate. A concerted effort is needed to better integrate forestry into biosecurity networks in SE Asia and to increase capacity in disciplines including risk analysis and contingency planning that will feed into government policy and justify greater investment in a proactive forest biosecurity system.

This review is included as **Appendix 6** – Biosecurity investment review

7 Priority Pests

To better guide research priorities, training activities (e.g. pest risk analysis) and understand current and potential pests in the region, country regulated quarantine pest lists were reviewed and a priority pest list was compiled (see table 3). The pests are based on their risk of invasion, the host or commodity, and its regional presence or likelihood of arrival. See Appendix 7 – Regulated pest list, for the full list of regulated pests in each country, related to forestry. Here forestry includes native, planted, and some amenity trees.

Table 3 Regional priority insect pest list

Insect	Host	Pathway	Regulated pest list	Regional presence
Apate terebrans	*Acacia, Corymbia (E.) polycarpa, D. sissoo, Tectona grandis*	Movement of timber	Indonesia	
Coptotermes formosanus	*Acer, Citrus, Eucalyptus, Pinus, Fraxinus, Quercus*	Any sizeable material containing cellulose and sufficient moisture. These may include large wooden articles used in shipping, such as crates, pallets or shipping containers, and lumbers, railroad ties (railway sleepers), wooden posts and planting containers holding soil.	Indonesia	
Dendroctronus frontalis	*Pinus, Picea, Tsuga*	Unprocessed pine logs or lumber, crates, pallets and dunnage, containing bark strips.		Intercepted in Australia in low numbers
Dendroctonus ponderosae	*Pinus*	Pathways for human-assisted dispersal include the transport of unprocessed pine logs or lumber, crates, pallets and dunnage, containing bark strips.	Indonesia	Intercepted in Australia in high numbers
Dendroctonus valens	*Pinus*	Wood packaging – with or without bark, live plants		China; high interceptions in China
Euwallacea fornicatus & associated *Fusarium* spp.	58 different plant families, incl. *Acacia* and *Eucalypt*;	Timber and wood packaging material, such as dunnage and crating		China, Thailand, Vietnam
Heteronychus arator	*Pinus, Eucalyptus, Cassia*	Can travel internationally on non-host material as hitchhiker pests; soil		Australia, PNG
Hylotrupes bajulus	Timber; *Abies, Araucaria, Pinus, Quercus*	seeds, wood without bark, plants	Indonesia	China, Australia
Ips typographus, Ips spp.	*Pinus* spp., *Picea* spp.	The transportation of non-debarked wood	Indonesia	China
Lymantria dispar	*Acer, Alnus, Quercus, P. Abies, Pinus, Fagus, Fraxinus, P. menziesii, Salix, Cupressus, Betula*	Females of the Asian strain are capable of flying distances of >1 km. Range expansion of invading populations is primarily facilitated by long-range movement by humans. Egg masses can be laid on cars, trucks, trains or boats, on logs, or containers that are inadvertently moved by humans.	Indonesia	China
Orgyia thyellina	*Pinus*			China

Stromatium barbatum	*Eucalyptus, Pinus, Quercus, Tectona grandis*	Most likely long distance mechanism of dispersal is the movement of eggs, larvae and pupae in woody planting material, such as nursery stock	Indonesia	
Sirex noctilio	*Pinus*	The adults, pupae, larvae and eggs may be carried on solid wood packing material (SWPM), in logs and in saw timber. Another pathway is green, untreated saw timber, especially if this material has large dimensions and the wood does not rapidly dry out. Untreated SWPM has been identified as a high-risk pathway in international trade. Low-quality wood is frequently used for making crates, pallets and other SWPM. The Quarantine Pest Inspection Services have intercepted siricids in SWPM in several countries.	Indonesia	
Tomicus piniperda	*Pinus* spp. (including: *P. sylvestris*, *P. radiata*), *Abies* spp., *Larix* spp., *Picea* spp., *Pseudotsuga* spp.	Solid wood packing material with bark (Pine)		China
Urocerus gigas	Pinaceae	Wood of recently cut, fallen, weakened trees and green timber		China
Pathogen	**Host**	**Pathway**	**Regulated pest list**	**Regional presence**
Amylostereum areolatum	*Pinus*	Bark-bearing and debarked logs, as well as untreated lumber, might carry the fungus, but *Sirex* is necessary for its inoculation into trees.		
Armillaria heimii and *Armillaria* spp.	*Hevea brasiliensis*, *Pinus*, *Tectona grandis*, *Acacia*, *Casuarina*	Bulbs, roots, stems, branches, wood with and without bark	*A. heimeii* Malaysia, Indonesia	*A. ostoyae* China
Austropuccinia psidii	Myrtaceae: *Angophora*, *Corymbia, Eucalyptus, Syncarpia, Syzygium*	wind-dispersed over long distances. Viable spores have been detected on clothing and personal effects following visits to rust-affected plantations and this is a viable pathway for dispersal. Furthermore, there are several instances of (accidental) long-distance movement of A. psidii on diseased plants, both within and between continents.	Vietnam	China, Indonesia
Dothistroma septosporum	*Pinus*, *Picea abies, cedrus, Abies, Pseudotsuga menziesii*	The spread of blight over long distances is not understood, but it is likely that wind, cloud and diseased materials (e.g. nursery stock) are possible transfer mechanisms.	Malaysia	China
Endocronartium harknessii	*Pinus*	Seeds, nursery stock, lumber and wood packaging. There is no risk in the movement of Pinus seeds or pollen. EPPO considered major quarantine pest for Australia.		
Fusarium circinatum	*Pinus*	The fungus may be spread from tree to tree by aerial dispersal of the conidia or through vectors. However, long-range		

		dispersal may be driven by the movement of infected seeds or infected plant material or via vectors associated with logs and other unmanufactured wood articles.		
Leptographium wageneri	*Pinus*	Bark, lumber, sawnwood and packaging -Ips vector	Ips typographus-Indonesia	
Phellinus noxius	*Acacia, Araucaria, Dalbergia, E. guineensis, Eucalyptus, Khaya, Melaleuca, Salix, Syzygium, Ulmus*	bulbs, roots, stem, shots, branches	Thailand	China, Indonesia, Malaysia, Myanmar, Vietnam
Phytophthora pinifolia	*Pinus*	plants for planting, cut branches, cones or soil		China
P. pluvialis	*Pinus*			
P. ramorum	Wide range of trees and shrubs CABI	Plant, water and soil borne.		Vietnam
Nematode	**Host**	**Pathway**	**Regulated pest list**	**Regional presence**
Bursaphelenchus xylophilus	*Pinus, Thuga, Cedrus, Pseudotsuga menziesii, Larix*	Japanese pine sawyer and pinesawyer beetles (vector); containers and packaging, land vehicles, soil, gravel and sand; plants, seedlings, bark and timber.	Indonesia, Laos, Thailand, Vietnam	China, Vietnam - Monochamus spp. present regionally
Paratrichodorus porosus	*Eucalyptus, Pinus, Quercus*, Conifers	Land vehicles, soils, sand and gravel; growing medium, roots and seeds	Indonesia, Thailand	China, Vietnam
Xiphinema americanum	*Tectona grandis*	Land vehicles, soils, sand and gravel; growing medium, roots and seeds	Indonesia	China, Vietnam

8 Outline of major risk pathways in partner countries

A number of common commodity pathways exist through which invasive pests and diseases may enter a country. The most common pathways through which forest pests may enter are via wood packaging, timber, and plants for planting (nursery stock). These pathways are regulated under the International Plant Protection Commission (IPPC) through various international standards (International Standards for Phytosanitary Measures – ISPMs). Those that that are the highest risk pathways for forest pests are shown below in Table 7: IPPC phytosanitary measures of particular relevance to forest biosecurity and their implementation by countries in SE Asia (date of implementation in brackets – many are implemented for export only)

Table 7: International Standards for Phytosanitary Measures with particular relevance to forest pests.

Pathway	ISPM
Wood packaging	ISPM-15: Regulation of wood packaging material in international trade
Wood	ISPM-19: International movement of wood
Nursery stock	ISPM-36: Integrated measures for plants for planting.
Used vehicles	ISPM-41: International movement of used vehicles, machines and equipment

The degree of implementation of these ISPMs varies across countries in the region, as shown is in the review of biosecurity laws and regulations in the region (Section 6).

The importance of these major risk pathways for forest pests is outlined below.

8.1 Wood Packaging (ISPM 15)

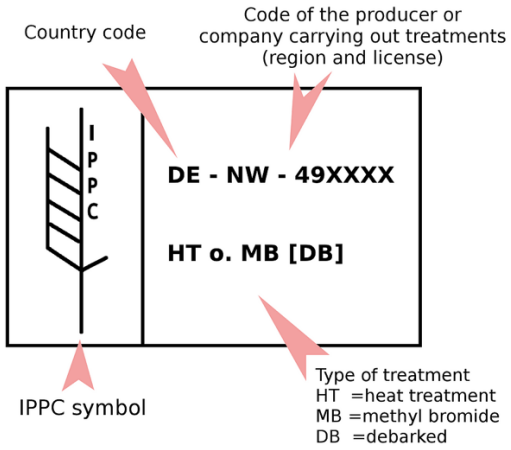
Wood packaging is a ubiquitous part of world trade, and includes wood pallets and dunnage in particular. Pallets and dunnage travel associated with a huge volume and variety of trade in other commodities. For example, much of the goods moved in containers is associated with pallets.

Wood packaging is a high-risk pathway for a number of forest pests, particularly bark and wood boring insects in the families Curculionidae (bark and ambrosia beetles), Cerambycidae (longhorn beetles), Siricidae (wood wasps), Buprestidae (Jewel beetles) and Bostrichidae (auger beetles). These include some of the most destructive forest pests.

Prior to 2002, the way wood packaging was treated as a biosecurity risk material was on an individual basis for countries to decide on what treatments were necessary. Given the huge variation in the ability of countries to manage these issues there was significant impetus to develop an international standard to lower the risk for this material. This resulted in the development and implementation of ISPM 15 in 2002, with revisions in 2006, 2009, together with regular revisions to the annexes that prescribe treatments.

ISPM 15 prescribes three approved treatments for wood packaging, namely: Methyl Bromide, Heat Treatment, or Dielectric Heat. Treated material must be stamped with the

IPPC logo, country of treatment, type of treatment, identifying code for the treatment provider (see example below).



8.2 Wood (ISPM 39)

There is a large volume of trade in wood around the world. Many of the same pests are able to move on this pathway as were noted above for wood packaging, but this pathways also includes a wider- range of pests that may, for example, be associated with bark (e.g. moth eggs) or incidentally associated with these products (hitchhikers) and that may not only be restricted to pests of forests but of agriculture as well. A greater range of pathogens can also be associated with wood. Under ISPM 39, the term 'wood' includes round wood, sawn wood, wood materials produced from mechanical processing of wood (excluding sawing), wood chips, wood residue, sawdust and wood wool.

Phytosanitary measures listed in ISPM 39 used to prevent movement of pests include, removal of bark (especially for round wood), chemical treatments (e.g. methyl bromide or its replacement fumigants), and chipping (physical destruction). There is greater flexibility for individual countries to require these treatments under ISPM 39 than under ISPM 15 for wood packaging. I.e. countries can mandate specific treatments for particular products prior to export.

8.3 Nursery Stock (ISPM 36)

Nursery plants are one of the highest risk materials for invasive forest pests, although the risk profile is somewhat different in that wood and bark borers do not generally move on this pathway (with the exception of bonsai plants, which have been known to harbour wood borers). Countries again vary widely in their treatment of this commodity, with Australia and New Zealand for example either prohibiting the import of some plants, or, for permitted plants, requiring these plants to undergo lengthy post-entry quarantine. ISPM 36 applies a systems approach to reduce the risk of pests spreading on this material.

8.4 Used vehicles (ISPM 41)

Used vehicles (e.g. motor vehicles or heavy machinery) can be a risk pathway for a number of forest pests and diseases. For example, motor vehicles (new and used) can act as substrates for oviposition by insects such as the Asian Gypsy Moth, while used heavy machinery can carry substantial amounts of soil in which there may be present soil-borne pathogens (e.g. *Phytophthora* root diseases) or insects such as ants (e.g. Red Imported Fire Ant, *Solenopsis invicta*).

8.5 Risk Sites for Entry of Pests

Risk sites can be classified as primary, secondary and tertiary according the to the level of risk and volume associated with them.

- **Primary risk sites** include airports, seaports, and land border crossing points.
- **Secondary risk sites** may be properties where containers and goods are moved following entry into the country (in Australia these are called 'Approved Arrangement' sites), pallet depots and distribution facilities for various high-risk goods.
- **Tertiary risk sites** are locations such as botanic gardens (where there is a wide range of potential host tree species) and tourist hotspots.

Below we outline the risk sites for partner countries in SE Asia, namely Cambodia, Indonesia, Laos, Malaysia, Thailand and Vietnam.

8.5.1 Cambodia

Land crossings

Road transport is the largest transport subsector in Cambodia, with a share of more than 90% for passenger and freight. About 20 companies, including the biggest fleet owners, own about 2,000 trucks and focus almost exclusively on international container freight business[2]. In comparison, railway transport for passengers and freight is negligible.

There are 15 international land border crossings in Cambodia: six with Thailand, eight with Vietnam and one with Laos. These are listed by country below, and shown graphically in Fig.1[3].

Thailand

- Aranyaprathet - Thailand/Poipet - Cambodia (Most direct access to Siem Reap)
- Hat Lek - Thailand/Koh Kong - Cambodia (Cham Yeam Checkpoint - most direct access to Sihanoukville)
- Chong Jom - Thailand/O'Smach, Oddar Meanchey - Cambodia
- Chong Sa Ngam - Thailand/Anlong Veng, Oddar Meanchey - Cambodia
- Ban Pakard, Chantaburi - Thailand/Phsar Prom Pailin - Cambodia
- Ban Laem, Chantaburi, Thailand/Daung Lem, Battambang - Cambodia

Vietnam

- Bavet Checkpoint: Moc Bai - Vietnam/Bavet, Svay Rieng - Cambodia (To/from Phnom Penh)
- Ving Xuong - Vietnam/Kaam Samnor, Kandal - Cambodia (To/from Phnom Penh)
- Tinh Bien - Vietnam/Phnom Den, Takeo - Cambodia (To/from Phnom Penh or Kampot/Kep)
- Trapeang Phlong Border Pass: Xa Mat - Vietnam/Trapeang Phlong, Kampong Cham - Cambodia
- Xa Xia - Vietnam/Prek Chak - Cambodia (To/from Kampot/Kep) Newly opened international border crossing.
- Le Tanh, Gia Lai Province - Vietnam/O'Yadaw, Ratanakiri - Cambodia - Newly opened international border crossing.

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2 Cambodia Transport Sector Assessment, Strategy, and Road Map. Asian Development Bank https://www.adb.org/sites/default/files/institutional-document/529231/cambodia-transport-assessment-strategy-road-map.pdf

3 https://www.canbypublications.com/cambodia/overland.htm

- Trapeang Srer International Border Checkpoint, Kratie Province
- Banteay Chakrey International Border Checkpoint, Prey Veng Province

Laos

- Veun Kam - Laos/Dom Kralor - Cambodia

Figure 19: Locations of Cambodia's land border crossings with Laos, Vietnam and Thailand.

International Airports:

There are three international airports in Cambodia. These are ranked below according to passenger traffic. In 2017, these airports together handled about 9 million passengers and recorded about 90,000 aircraft movements. Freight traffic was insignificant at 65,000 tons in 2017. Driven mainly by growth in tourist travel from China, passenger traffic was likely to have grown beyond 10 million by 2020.

- **Phnom Penh International Airport** [4]
  Phnom Penh International Airport processed 6 million passengers in 2019
- **Siem Reap International Airport** [5]
  Siem Reap International Airport can host up to 5 million passengers per year
- **Sihanouk International Airport** [6]
  Sihanoukville International Airport can host up to 0.5 million passengers per year

4 https://en.wikipedia.org/wiki/Phnom_Penh_International_Airport

5 https://en.wikipedia.org/wiki/Siem_Reap_International_Airport

6 https://en.wikipedia.org/wiki/Sihanouk_International_Airport

Major Seaports:

Cambodia has three main seaports in Sihanoukville, Phnom Penh and Koh Kong[7]. Trade volumes quoted below come from the Asian Development Bank report [8].

- **Sihanoukville**
  Sihanoukville is the main deep-sea port of Cambodia. It is situated in the Bay of Kompong Som on the Gulf of Siam, and is the principal and only deep-water maritime port of Cambodia. The capacity in its present condition is estimated at about 950,000 tonnes per year. The port is served by National Highway No. 4 (NH4) (226 km to Phnom Penh, the main link between Phnom Penh and the coast), and a railway line which takes a more southerly route via Kampot. In 2018, the import–export volume through this port amounted to 5,196,399 tons and 537,107 twenty-foot equivalent units (TEU) while the volume through the PPAP amounted to 12,899,000 tons and 205,000 TEU.

- **Phnom Penh**
  Phnom Penh depends on access via the Mekong through the delta area of Vietnam. The Phnom Penh port is the country's traditional river port, accessible to vessels from the South China Sea through Vietnam. In 2018 the volume through this port amounted to 12,899,000 tons and 205,000 TEU containers. There are two terminals—the original city terminal and a new container terminal 30 km southeast of Phnom Penh along the Mekong River and National Road 1.

- **Koh Kong** (provincial port)

  Vessels entering Cambodia from Singapore, Malaysia or Thailand call first at Paklong, on the Gulf of Siam about 15 km from the Thai border, for customs clearance and other formalities. Up to 300-tonne capacity boats can be accepted, or 500 tonnes at anchorage. The 300-tonne boats can then proceed across the bay to Koh Kong town for unloading or transhipment to smaller vessels if required. Important for the import of goods, especially construction materials from Thailand.

7 http://www.business-in-asia.com/cambodia/cambodia_ports.html

8 Cambodia Transport Sector Assessment, Strategy, and Road Map. Asian Development Bank https://www.adb.org/sites/default/files/institutional-document/529231/cambodia-transport-assessment-strategy-road-map.pdf

Potential Priority Pest Risk Sites for Cambodia

Phnom Penh

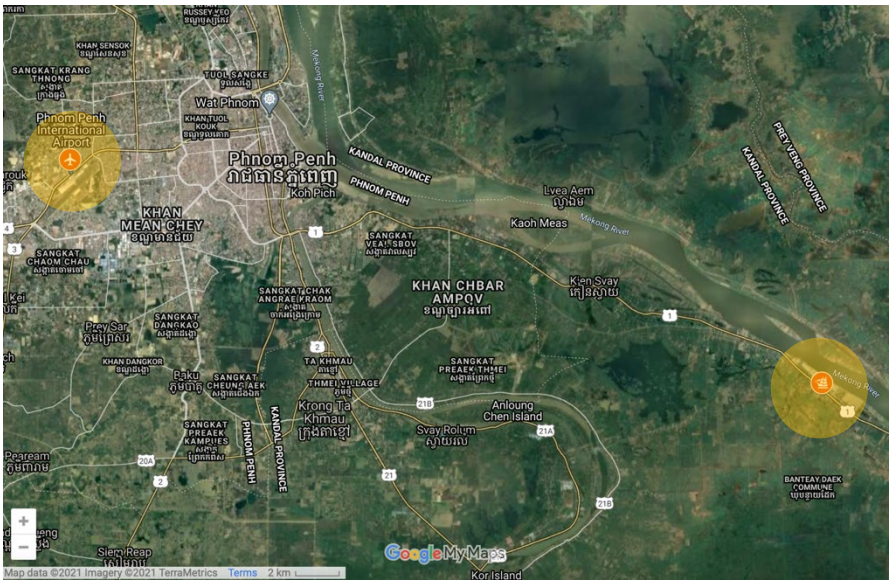

Figure 20: Phnom Penh International Airport and Container Port. Airport to Container Port is approx. 35 km

Sihanoukville

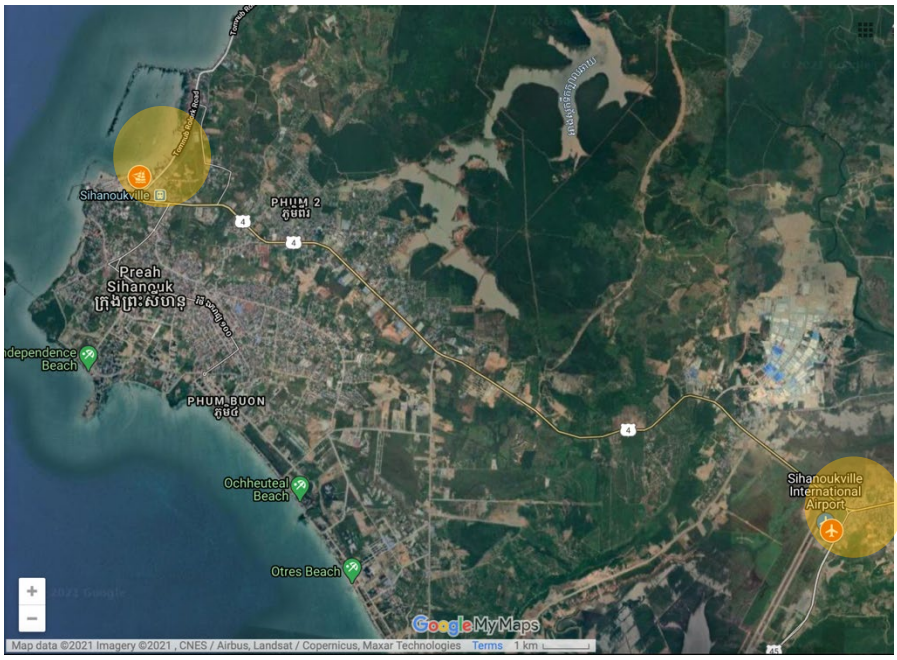

Figure 21: Sihanoukville international airport and container port. Distance is approximately 25 km.

Siem Reap

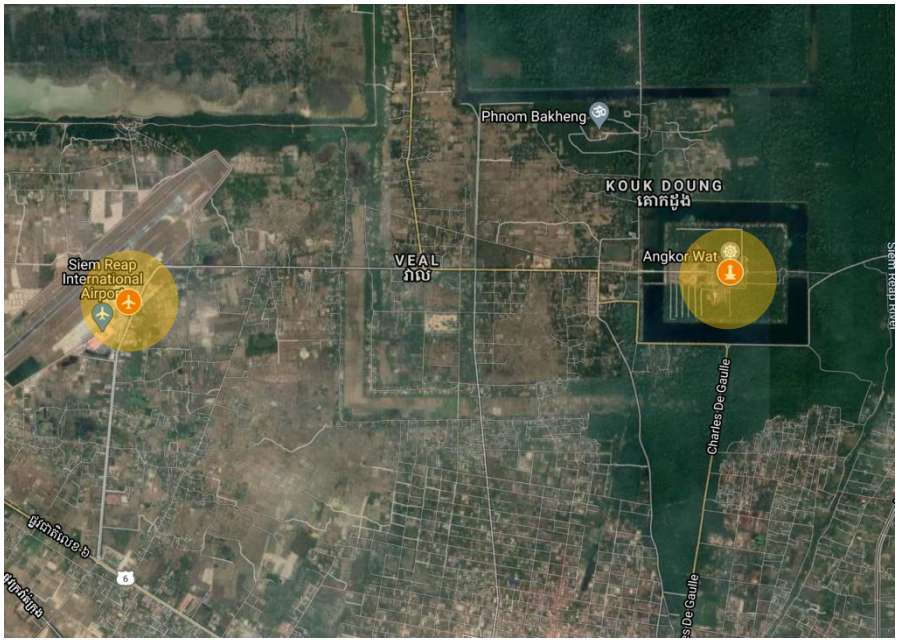

Figure 22: Siem Reap International Airport and Angkor Wat tourist site. Distance is approx. 5 km between sites.

8.5.2 Indonesia

Indonesia comprises 13,466 islands in Southeast Asia and shares land borders with Papua New Guinea, East Timor, and Malaysia.

Land Crossings

Given that Indonesia consists of a huge island archipelago it is not surprising that it is has relatively few land borders with other countries. There are land borders with Papua New Guinea (1 crossing), Malaysian Borneo (3 crossings) and with Timor Leste (2 crossings). Individual crossings are listed below.

Papua New Guinea

There is one official land crossing between Papua province in Indonesia and Papua New Guinea[9].

- Vanimo – PNG/Jayapura – Indonesia

Malaysia

There are three land crossings between Kalimantan, Indonesia, and Sarawak, Malaysia

- Tebedu, Sarawak – Malaysia/Entikong, West Kalimantan, - Indonesia
- Biawak, Sarawak – Malaysia/Aruk, West Kalimantan - Indonesia
- Lubok Antu, Sarawak – Malaysia/ Badau, West Kalimantan – Indonesia

Timor Leste

There are two land crossings between Indonesia and Timor Leste.

9 https://www.indonesiaevisas.com/news/indonesian-border-crossing

- Terpadu Mota'ain border crossing (Indonesian side)
- Motamasin border crossing (Indonesian side)

International Airports

There are 31 listed International Airports in Indonesia (Table 8). Most of these airports serve purely domestic routes or domestic plus regional routes. A few of these also service seasonal or charter flights to Jeddah and Medina in Saudi Arabia for the annual Hajj pilgrimage. Only two of these airports (those at Jakarta and Denpasar - listed in **bold** below) serve numerous international destinations beyond the immediate region, while some others service limited international flights, primarily through regional hubs such as Singapore.

Table 8: International airports in Indonesia.

Java	*Kalimantan*
• Husein Sastranegara International Airport (Bandung) • Banyuwangi International Airport (Banyuwangi Regency) • Halim Perdanakusuma International Airport (Jakarta) • **Soekarno–Hatta International Airport (Jakarta)** • Kertajati International Airport (Majalengka Regency) • General Ahmad Yani International Airport (Semarang) • **Juanda International Airport (Sidoarjo Regency)** • Adisumarmo International Airport (Boyolali Regency) • Adisucipto International Airport (Sleman Regency) • Yogyakarta International Airport (Kulon Progo Regency)	• Sultan Aji Muhammad Sulaiman Sepinggan International Airport (Balikpapan) • Syamsudin Noor International Airport (Banjarmasin) • Aji Pangeran Tumenggung Pranoto International Airport (Samarinda) • Juwata International Airport (Tarakan) *Sulawesi* • Sultan Hasanuddin International Airport (Makassar) • Sam Ratulangi International Airport (Manado) *Lesser Sunda Islands* • **Ngurah Rai International Airport (Denpasar)** • Zainuddin Abdul Madjid International Airport (Mataram)
Sumatra	*Papua*
• Sultan Iskandar Muda International Airport (Aceh Besar Regency) • Radin Inten II International Airport (Bandar Lampung) • Hang Nadim International Airport (Batam) • Kualanamu International Airport (Deli Serdang Regency) • Minangkabau International Airport (Padang) • Sultan Mahmud Badaruddin II International Airport (Palembang)	• Frans Kaisiepo International Airport (Biak) • Sentani International Airport (Jayapura) • Mopah International Airport (Merauke)

• Sultan Syarif Kasim II International Airport (Pekanbaru) • Sisingamangaraja XII International Airport (Siborong-Borong) • H.A.S. Hanandjoeddin International Airport (Tanjung Pandan) • Raja Haji Fisabilillah International Airport (Tanjung Pinang)	

International Seaports

Over 90% of freight entering and exiting Indonesia is carried via ships[10]. There are 40 major seaports in Indonesia (listed below, Table 9)[11], with hundreds of additional smaller ports (1,700 or so). Of these, 111 are commercial ports while only 11 are container ports.

The busiest and most advanced of these is the Port of Tanjung Priok in Jakarta[12], which is the main international gateway and the major gateway for domestic trade. The port is located at Tanjung Priok, North Jakarta, and is operated by the Indonesian state-owned PT Pelindo II. The port loaded and unloaded 7.8 million TEUs of cargo in 2018, out of a total capacity of about 8 million TEUs. The container port ranked as 22nd busiest in the world by Lloyd's One Hundred Ports 2019. An extension to this port (New Priok) is under construction and which will triple capacity in 2023 to 18 million TEUs. Six other big ports are also undergoing upgrades, namely: Belawan in Medan, Batam near the Singapore border, Tanjung Priok in Jakarta on the island of Java, Tanjung Perak in Surabaya, Makassar in South Sulawesi and Sorong in West Papua[13].

Table 9: Seaports in Indonesia. Major ports are in bold.

Java	*Sumatra*
• Port of Cirebon, Cirebon, West Java • Port of Merak, Banten • **Port of Tanjung Priok, Jakarta** • Ciwandan, Banten • Sunda Kelapa, Jakarta • Port of Patimban, Subang Regency, West Java • Port of Pramuka, Garut Regency, West Java • **Port of Tanjung Perak, Surabaya, East Java** • Port of Tanjung Emas, Semarang, Central Java • Tanjung Intan, Cilacap, Central Java	• Port of Kuala Tanjung, Batubara Regency, North Sumatra • Port of Bakauheni, Lampung • Ulèë Lheuë, Aceh • Port of Belawan, Medan, North Sumatra • Sibolga • Palembang, South Sumatra • Teluk Bayur, West Sumatra • Jambi, Jambi • Bengkulu, Bengkulu • Panjang, Lampung • Pangkal Balam, Bangka-Belitung • Tanjung Pandan, Bangka-Belitung • Sungai Pakning, Dumai, Riau

10 https://www.transport-exhibitions.com/Market-Insights/Indonesia/Ports-in-Indonesia-ready-to-expand

11 https://en.wikipedia.org/wiki/List_of_ports_in_Indonesia

12 https://en.wikipedia.org/wiki/Port_of_Tanjung_Priok

13 https://www.transport-exhibitions.com/Market-Insights/Indonesia/Ports-in-Indonesia-ready-to-expand

• Port of Ketapan, Banyuwangi, East Java • Kalianget, Madura	• Port of Tanjung Pinang, Tanjung Pinang, Riau Islands • Krueng Geukueh, Aceh • Gunung Kijang, Bintan
Kalimantan	*Sulawesi*
• Port of Trisakti, Banjarmasin, South Kalimantan • Pontianak, West Kalimantan • Balikpapan, East Kalimantan • Sampit, Central Kalimantan • Palaran Container Terminal, Samarinda, East Kalimantan • Port of Tanjungpura, Mempawah Regency, West Kalimantan • Tarakan, North Kalimanta	• Port of Makassar, Makassar, South Sulawesi • Malili, South Sulawesi • Parepare, South Sulawesi • Port of Bitung, Bitung, North Sulawesi • Gorontalo, Gorontalo

Potential Priority Risk sites for Indonesia

Jakarta

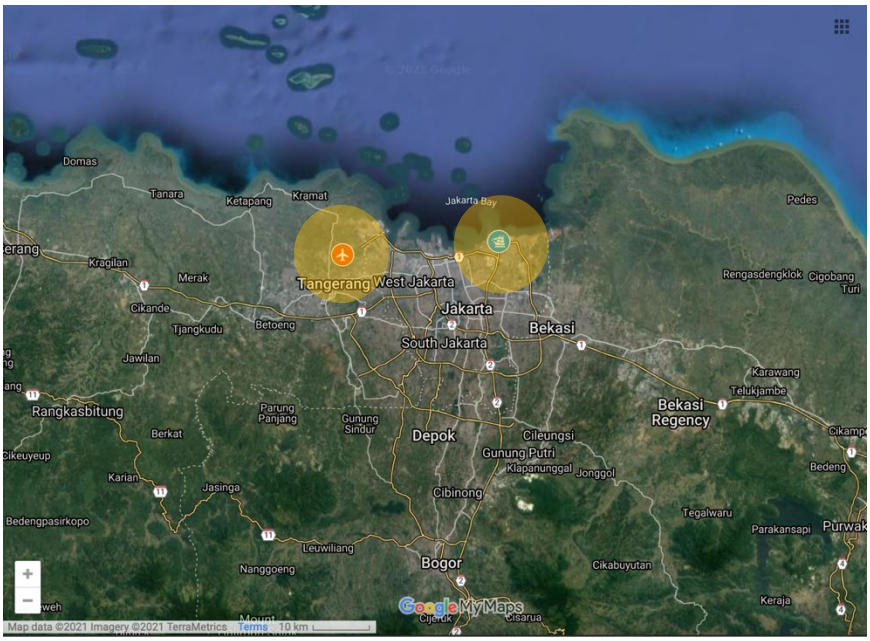

Figure 23: Jakarta international airport and container port. Distance approx. 26 km.

Denpasar

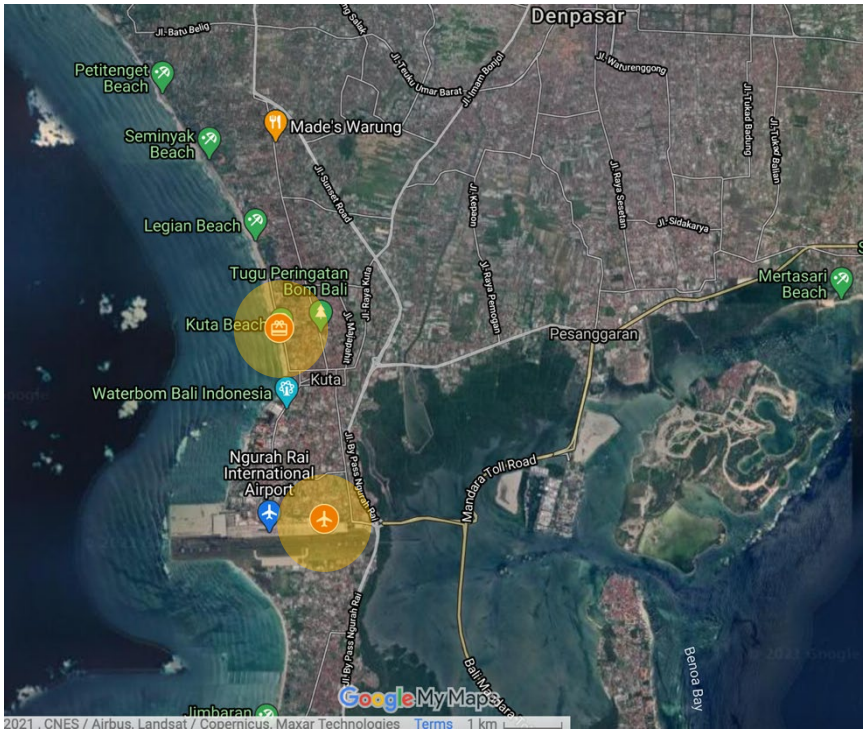

Figure 24: Denpasar international airport and tourist area. Distance approx. 5 km.

Surabaya

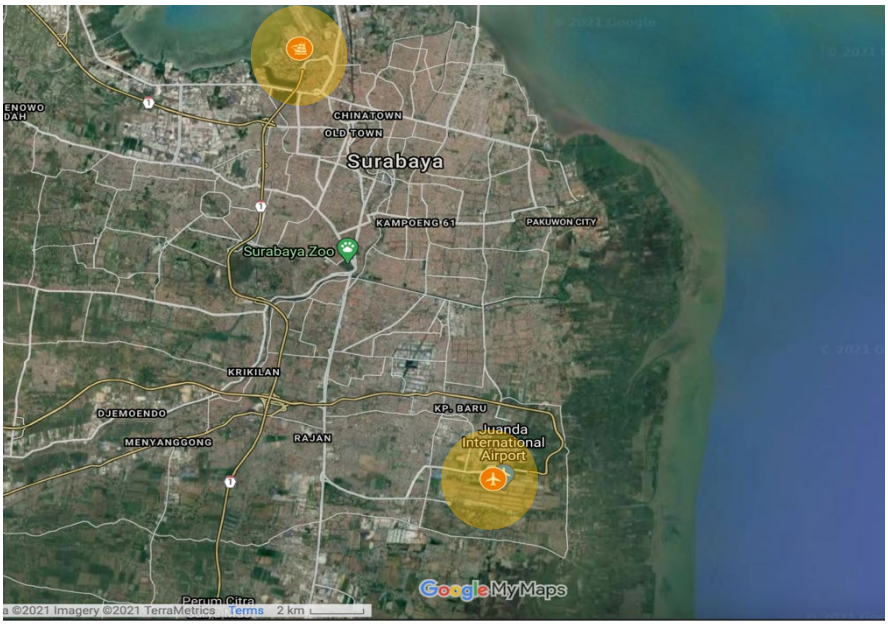

Figure 25: Surabaya International Airport and Surabaya Container Terminal. Distance approx. 19 km. Surabaya is approx. 300 km from Yogyakarta

8.5.3 Laos

Land crossings

Laos has land borders with five other countries, namely China, Vietnam, Cambodia, Thailand and Myanmar. There are 24 official land border crossings: China (2); Vietnam (8); Cambodia (1); Thailand (11); Myanmar (2) (28 int borders)[14] (Table 10).

Table 10: Land crossings in Laos. Major crossings in bold.

China • Lantui checkpoint in Phongsaly Province • **Boten checkpoint in Luang Namtha Province** *Cambodia* • **Veunkham checkpoint in Champasak Province** *Thailand* • Friendship bridge IV checkpoint in Bokeo Province • Samliemkham checkpoint in Bokeo Province • **Friendship bridge I checkpoint in Vientiane Province** • Tanalaeng checkpoint in Vientiane Province • Pakxan checkpoint in Bolikhamxay Province • **Friendship bridge III checkpoint in Khammouane Province15** • **Friendship bridge II checkpoint in Savannakhet Province** • Vang tao checkpoint in Champasak Province • Nam Ngeun checkpoint in Xayabouly Province • Namheuang checkpoint in Xayabouly Province • Phoudou checkpoint in Xayabouly Province	*Vietnam* • Panghok checkpoint in Phongsaly Province • Nonghaed checkpoint in Xieng khouang Province • Nam phao checkpoint in Bolikhamxay Province • Na pao checkpoint in Khammouane Province • **Dansavan checkpoint in Savannakhet Province** • Nam soy checkpoint in Houaphanh Province • Phoukeua checkpoint in Eutapeu Province • Lalai checkpoint in Salavan Province *Myanmar* • Meuang Mom checkpoint in Bokeo Province • Samliemkham checkpoint in Bokeo Province

14 https://www.visalaos.com/border-crossing-points/

15 https://www.vientianetimes.org.la/freeContent/FreeConten_State_114.php

Rail linkage

There is currently one international connection by rail in Laos. This is the line between Thanaleng in Laos and Nong Khai in Thailand. This link will be greatly expanded as part of the Kunming-Singapore line This railway will stretch 427 kilometres , from the Laos-China borderline at Boten in Phongsaly Province to Vientiane. The rail will be connected with a new railway bridge spanning the Mekong between Vientiane and Nong Khai .

The Boten–Vientiane railway (often referred to as the China–Laos railway) is a 414 kilometres, standard gauge electrified railway under construction in Laos, between the capital Vientiane and the small town of Boten on the border with China. In the north the line will be connected to the Chinese rail system in Mohan, through the Yuxi–Mohan railway[16]. The line is expected to open in December 2021[17]

This is part of the Kunming-Singapore multi-country rail network (or “Pan-Asia Railway”).

Figure 26: Route of the Boten-Vientiane and associated railways

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16 https://en.wikipedia.org/wiki/Boten–Vientiane_railway

17 https://www.scmp.com/news/china/diplomacy/article/3123306/china-laos-railway-may-be-badly-needed-good-news-beijing-and

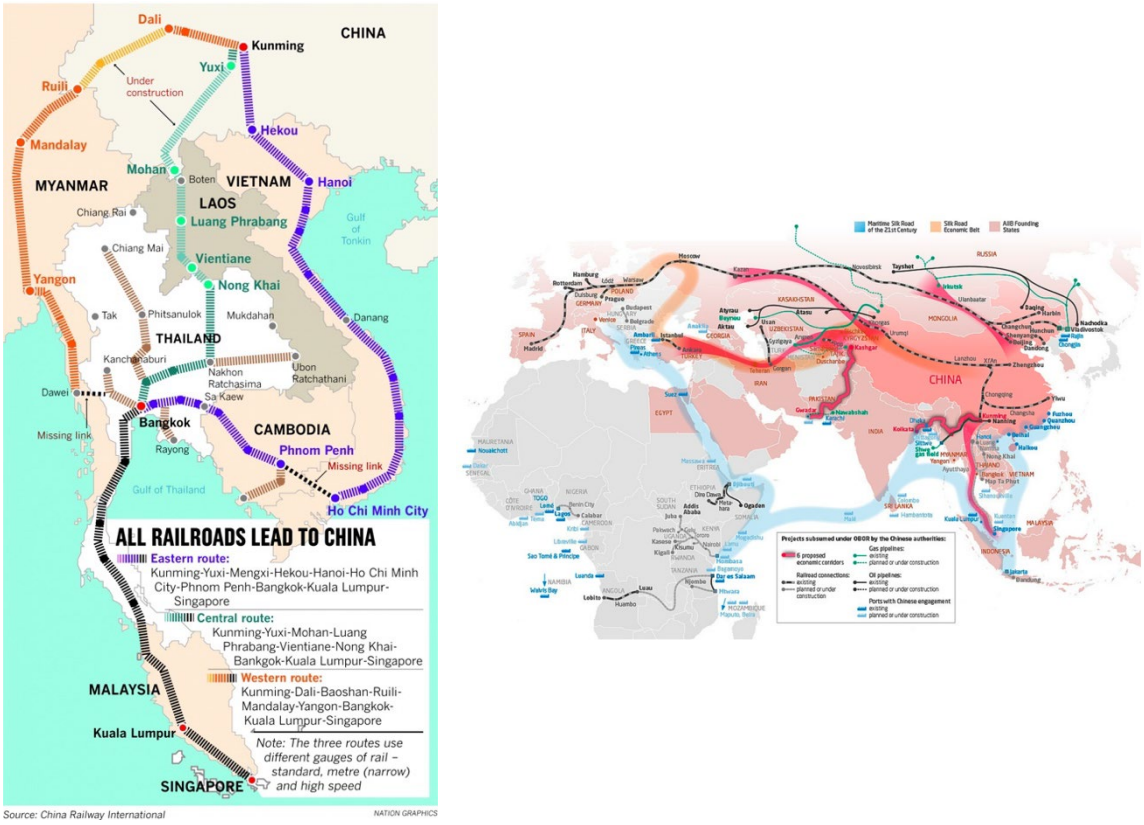

Figure 27: Eastern, Central and Western routes, and Global extent of the planned One Belt One Road initiative

Airports:

Laos has four airports that serve international flights.

- Wattay International Airport (Vientiane)
- Luang Prabang International Airport
- Savannakhet Airport
- Pakse International Airport

Wattay airport in Vientiane is the country's main international gateway, with most flights linking within the region, with some others direct from China, Korea and Japan[18]. The airport in Luang Prabang is the second busiest airport and is mostly centred on tourism, with direct flights outside the region from China, Japan and Korea. Pakse airport services flights that connect Thailand, Vietnam, and Cambodia, while Savannakhet airport services flights to Thailand.

River Ports:

As a landlocked country Laos has no direct sea access, but there is extensive trade along the Mekong river with the other six countries (China, Thailand, Myanmar, Vietnam and Cambodia) through which it flows. There are 29 ports located along the Mekong river in Laos, with a few additional ports located along tributaries such as Nam Ou, Nam Ngum, Nam Kading and Xe Bang Fai. The main port is the Laos-Japan friendship port, Lak Si port in Vientiane. An 'Agreement on Commercial Navigation on Lancang-Mekong River'

18 https://en.wikipedia.org/wiki/Wattay_International_Airport

among China, Laos, Myanmar and Thailand governs international transport in the northern region.

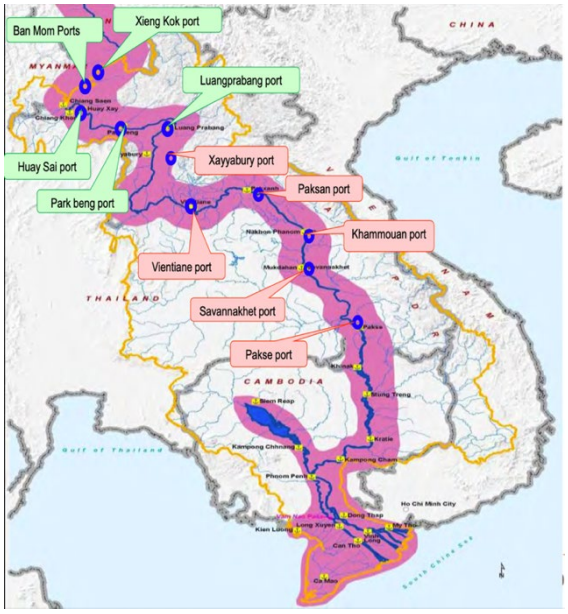

Figure 28: Main ports in Laos along the Mekong River.

Potential Priority Risk sites for Laos

Vientiane

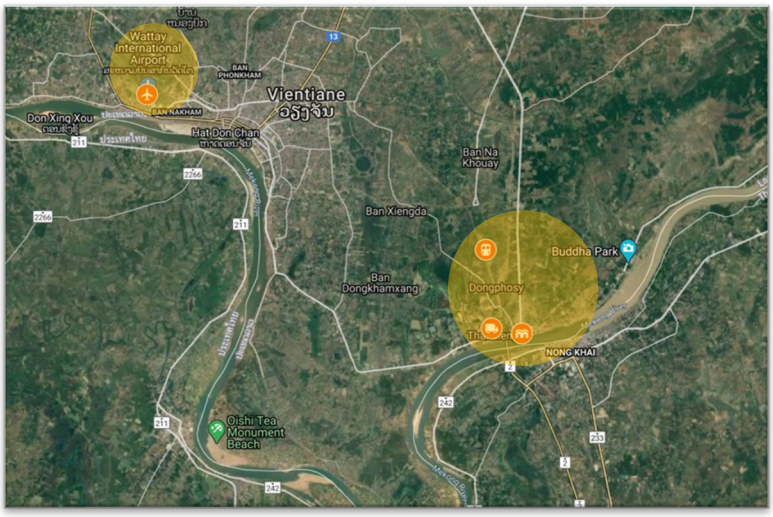

Figure 29: Vientiane International Airport, Thanaleng border crossing (Thai – Lao Friendship Bridge), Thanaleng Warehouse and Thanaleng rail container depot. Distance approx. 18 km from Wattay airport to the Thanaleng road/rail complex.

Luang Prabang

Figure 30: Luang Prabang International Airport and proximity to tourist sites and forested land

Savannakhet

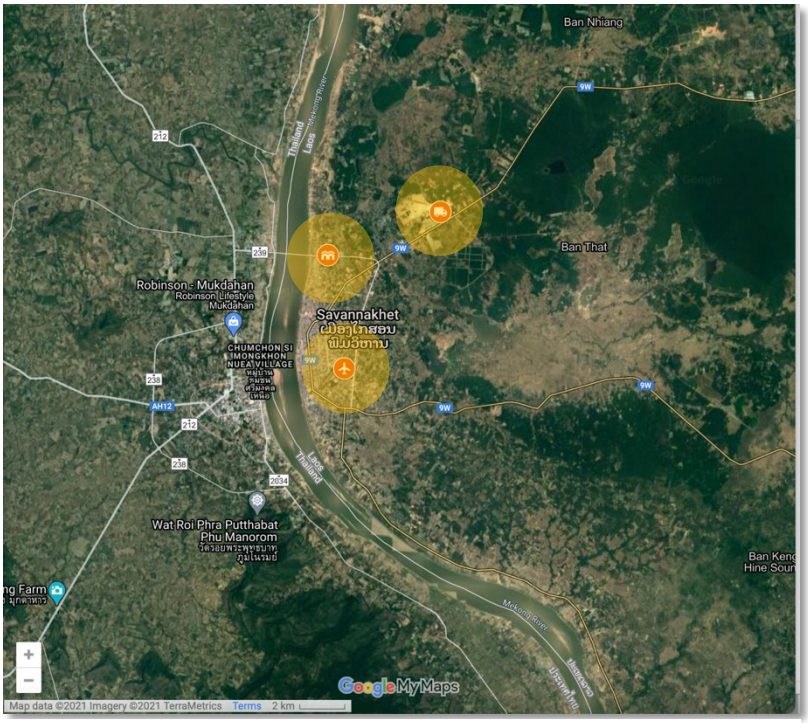

Figure 31: Savannakhet airport, Thai border checkpoint (Friendship Bridge 2) and container depot.

Pakse

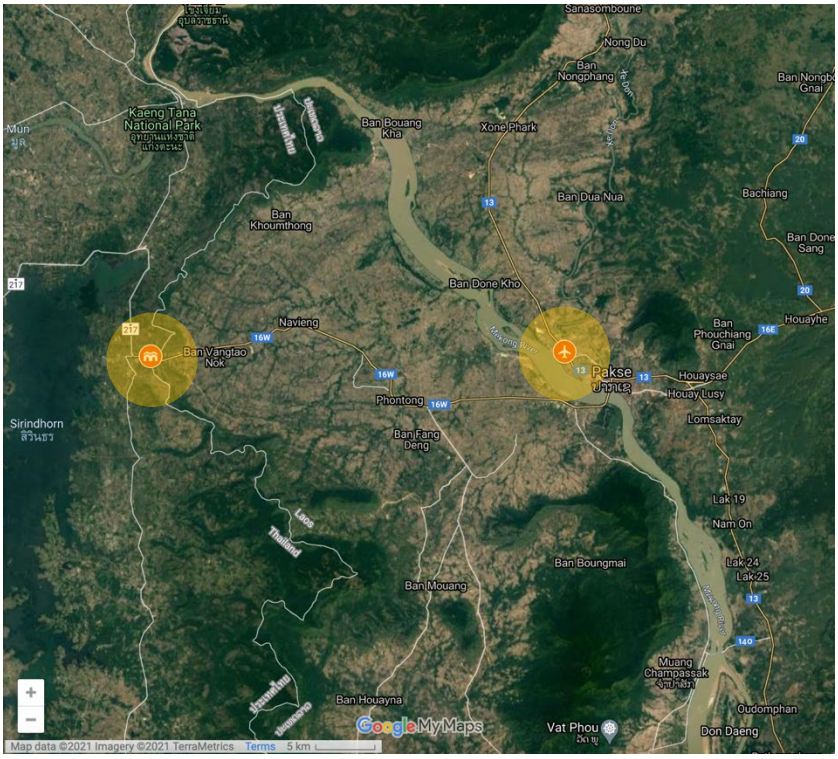

Figure 32: Pakse Airport and Chong Mek border crossing with Thailand.

Boten

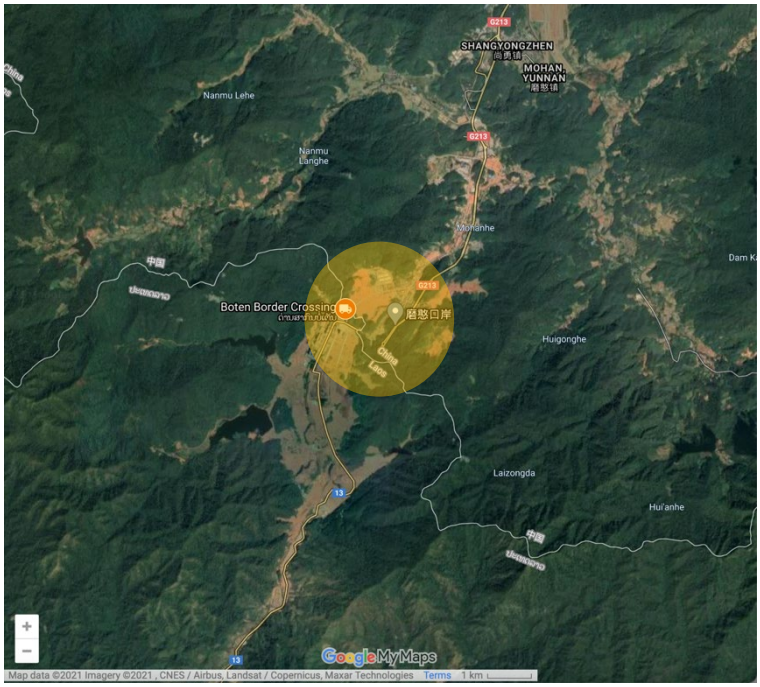

Figure 33: Boten border crossing with China. This will be the start of the Boten – Vientiane railway when it opens.

Dansavan

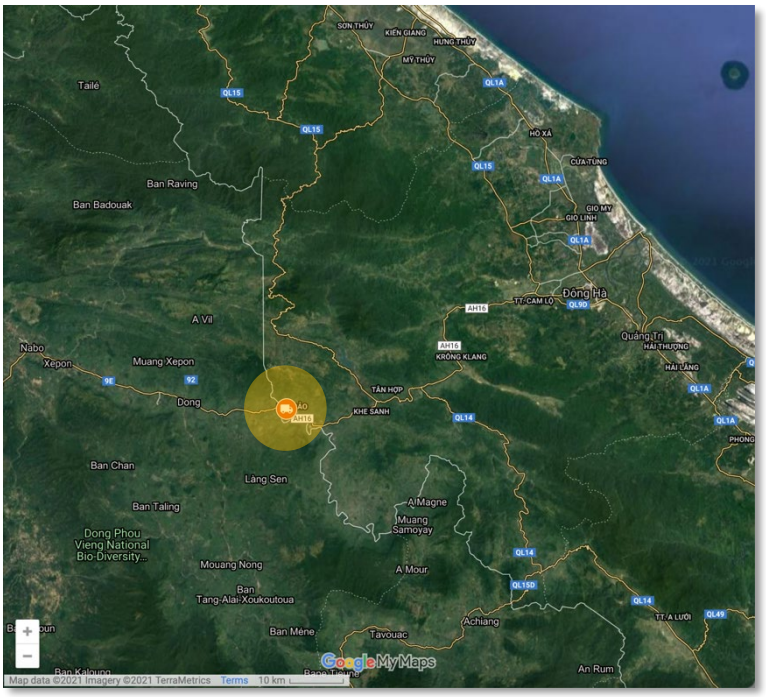

Figure 34: Lao Bao border crossing with Vietnam at Dansavan. Connects to Dong Ha and the main North-South highway. Da Nang port in Vietnam is 485 km's from Savannakhet.

Nam Phao

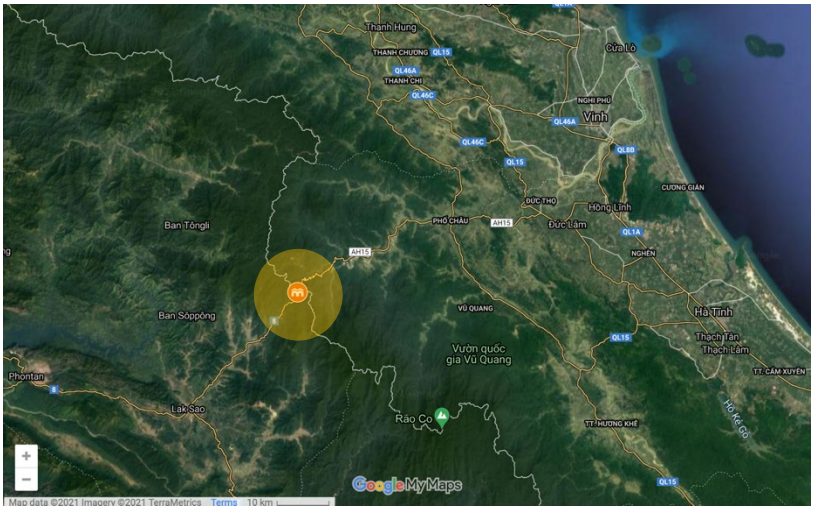

Figure 35: Nam Phao border crossing with Vietnam

Veun Kham

Figure 36: Veun Kham border crossing with Cambodia

8.5.4 Malaysia

Land crossings

Malaysia has land crossings with Singapore, Thailand, Indonesia and Brunei. Those for Indonesia are covered in the land crossing section for Indonesia above, while those for Singapore, Thailand and Brunei are listed below.

Singapore

There are two land border crossings with Singapore

- Johor–Singapore Causeway
  To the north of Singapore, the busiest border checkpoint in the world with 350,000 travellers daily, supporting road and rail transport
- Malaysia–Singapore Second Link
  To the west of Singapore, known officially as Tuas Second Link in Singapore or *Linkedua* Malaysia.

Thailand

There are seven land border crossings with Thailand.

- Wang Kelian, Perlis
- Padang Besar, Perlis
- Bukit Kayu Hitam
- Kota Putra (Durian Burung)
- Bukit Berapit, Pengkalan Hulu, Perak
- Bukit Bunga, Kelantan
- Rantau Panjang, Kelantan

Brunei

There are four land border crossings with Brunei

- Sungai Tujuh Miri
- Tedungan Immigration Post
- Pandaruan
- Mengkalap

Airports

- Kuala Lumpur International Airport
- Kota Kinabalu International Airport
- Penang International Airport
- Langkawi International Airport
- Kuching International Airport
- Senai International Airport
- Miri Airport
- Sultan Abdul Halim Airport *

* Seasonal flights to Jeddah and Medina, Saudi Arabia.

Seaports

Malaysia has a total of seven major Federal ports namely:

- Port Klang
- Johor Port
- Port of Tanjung Pelepas
- Kuantan Port
- Penang Port

- Bintulu Port
- Kemaman Port.

Potential Priority Risk sites for Malaysia

Kuala Lumpur

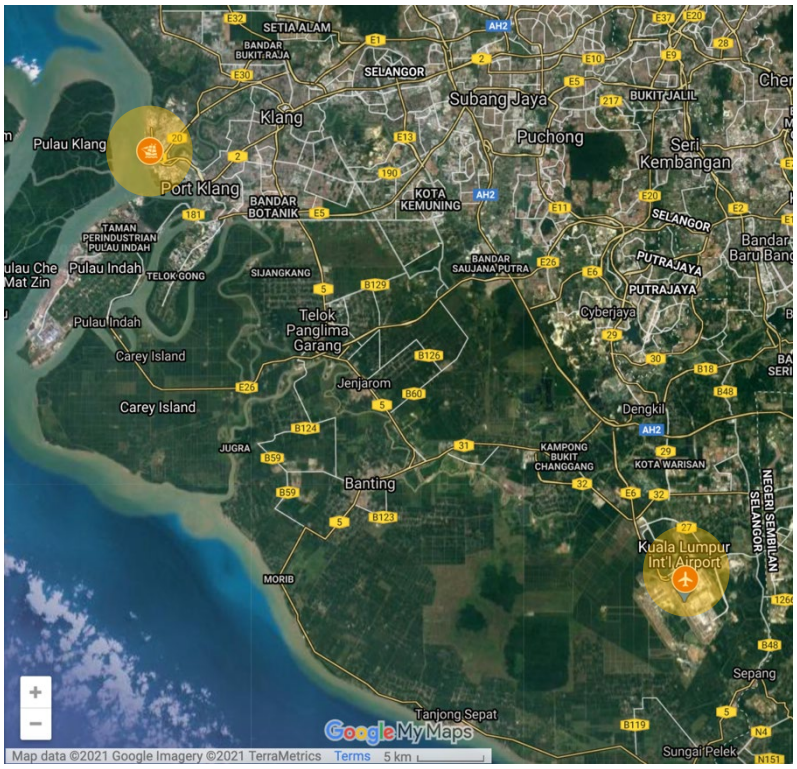

Figure 37: Kuala Lumpur International Airport and Port Klang. Distance is approx. 50 km.

Johore

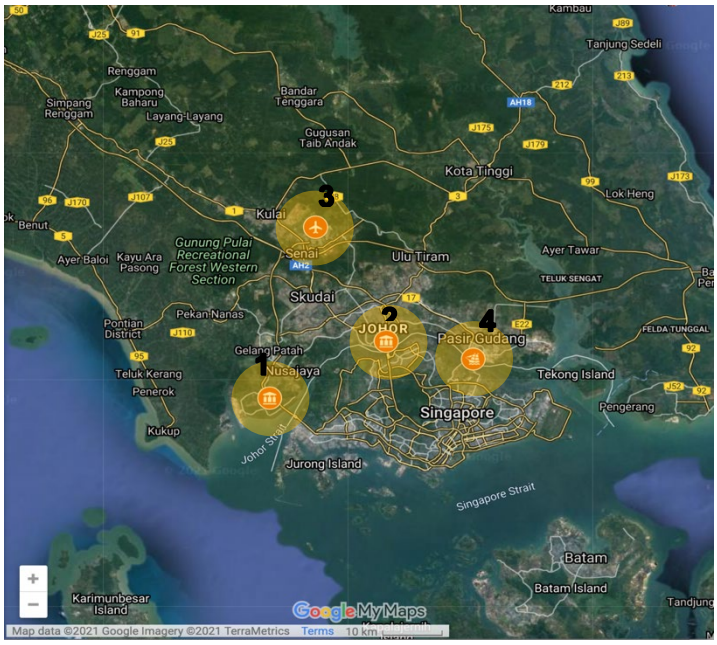

Figure 38: Two land crossings (1. Malaysia–Singapore Second Link and 2. Johore-Singapore Causeway), 3. Senai International Airport and 4. Johor Container Port. Distance between airport and container port is approx. 34 km.

8.5.5 Thailand

Land border crossings

Thailand has land borders with Malaysia, Laos, Myanmar, and Cambodia. The border crossings for Malaysia, Cambodia and Laos have been covered in the land border sections for each of those three countries, above.

There are four land-crossings between Myanmar and Thailand (Fig. 39 below):

- Mae Sai/Tachileik
- Mae Sot/Myawaddy
- Ranong/Kawthaung
- Phunaron/Htee Kee

Seaports

There are four major container ports in Thailand. Two are located at Bangkok Port, one at Laem Chabang (Pattaya), and a much smaller one at Songkhla in the south.

International Airports

Thailand has 11 airports that handle international traffic. Of these, Suvarnabhumi Airport and Don Mueang International Airport in Bangkok area major regional hubs (in **bold**, below), with capacity for 45 and 18.5[19] million passengers annually, respectively. Suvarnabhumi handled 60 million passengers in 2017[20,] and is the 17th busiest airport in

19 https://en.wikipedia.org/wiki/Don_Mueang_International_Airport

20 https://en.wikipedia.org/wiki/Suvarnabhumi_Airport

the world, eleventh busiest in Asia, and is also a major air cargo hub, with a total of 95 airlines.

- **Suvarnabhumi Airport, Bangkok**
- **Don Mueang International Airport, Bangkok**
- Chiang Mai International Airport, Chiang Mai
- Mae Fah Luang Chiang Rai International Airport, Chiang Rai
- Hat Yai International Airport, Songkhla
- Phuket International Airport, Phuket
- Samui International Airport, Ko Samui
- Krabi International Airport, Krabi
- Surat Thani International Airport, Surat Thani
- U-Tapao International Airport, Pattaya
- Udon Thani International Airport, Udon Thani

Potential Priority Risk sites for Thailand

Land crossings

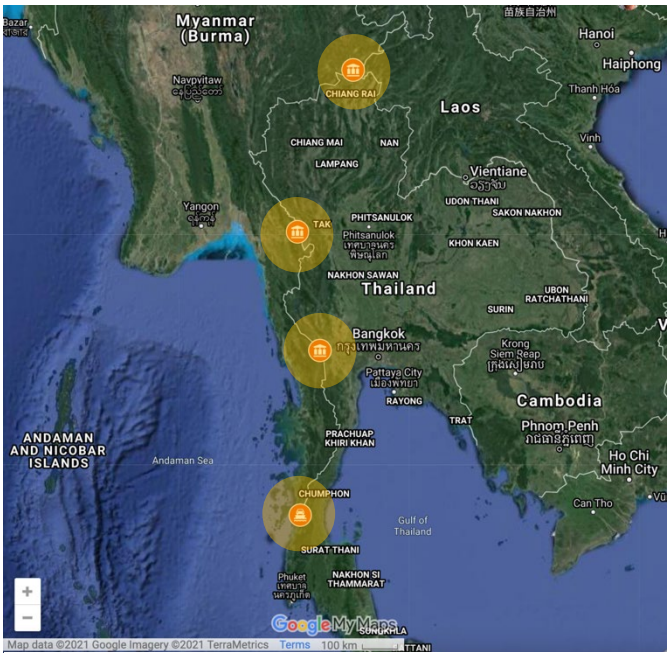

Figure 39: Major land crossing points in Thailand

Bangkok

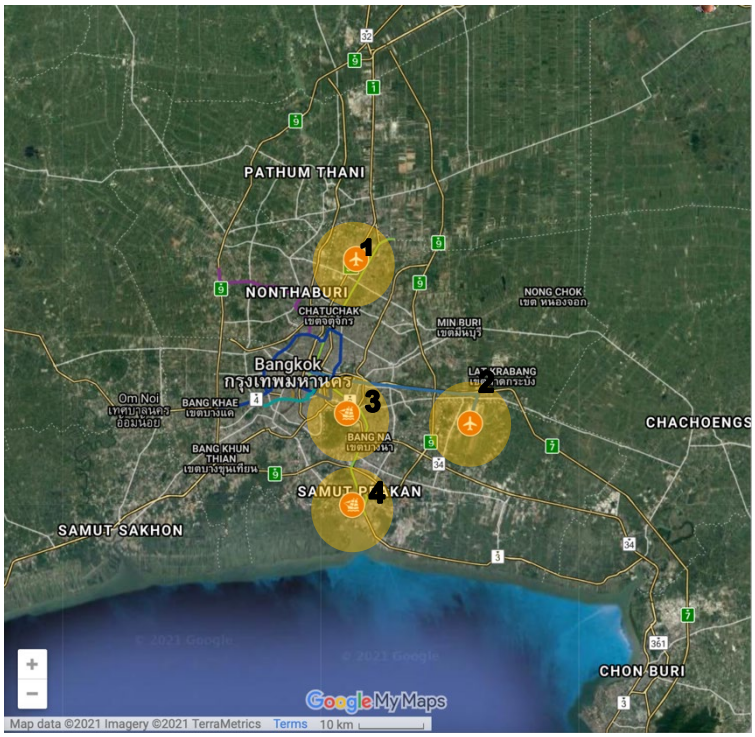

Figure 40: High-risk sites around Bangkok. 1 Suvarnabhumi airport. 2. Don Meuang International Airport. 3 Bangkok Container terminal 2. 4. Bangkok Container terminal 1. Distance from 1 to 2 is approx. 30 km, from 1 to 3 approx. 23 km, from 1 to 4 approx. 36 km.

Pattaya

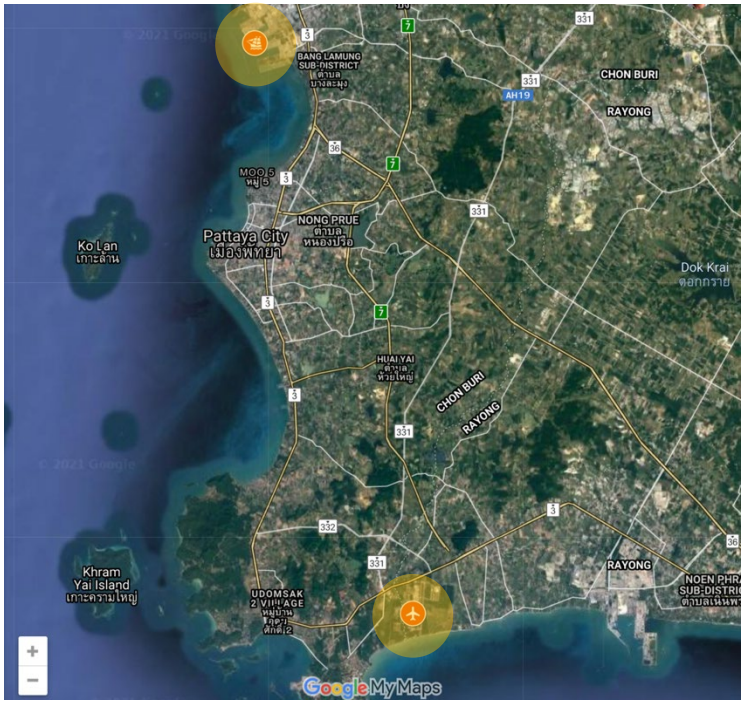

Figure 41: U-Tapao International Airport Pattaya (bottom) and Laem Chabang Container Port (top). Distance is approx. 45 km.

8.5.6 Vietnam

Land border crossings

Vietnam has land borders with China, Laos and Cambodia. Those border crossings with Laos and Cambodia have been covered in the sections on those countries above. There are three main land border crossings with China.

- Mong Cai – Dong Hung (2 crossings)
- Dong Dang – Ping Xian
- Lao Cai – Hekou

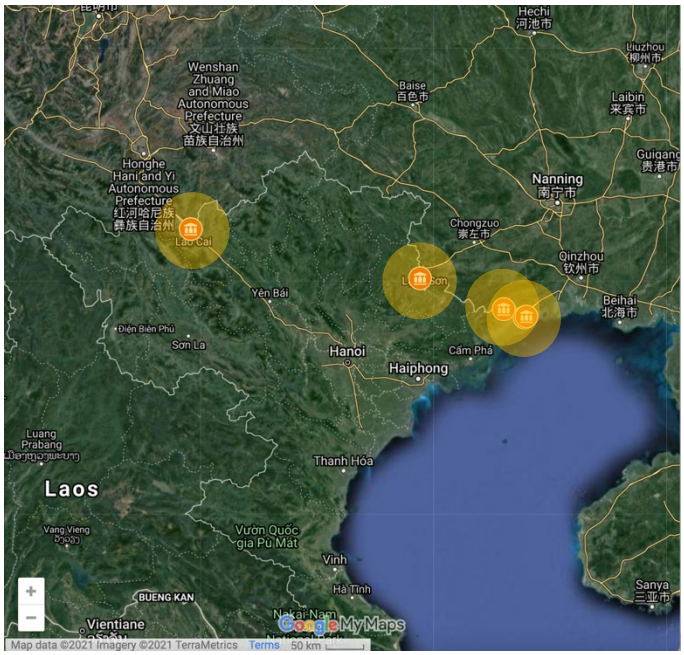

Figure 42: Vietnam land border crossings with China.

Seaports

There are six main large container ports in Vietnam[21]. These are:

- **Hai Phong port**

Serves as the port for Hanoi and is the most modern container port in the North of Vietnam.

- **Cat Lai Port (Saigon Port)**

Is one of the biggest and most modern container terminals in Vietnam, situated in Ho Chi Minh City's port area

- **Vung Tau Port**

Serves as a port for Ho Chi Minh City and southern Vietnam.

- **Danang port**

Serves as the main port of Da Nang and central Vietnam and handles the majority of the traffic in the central region, which links Vietnam to Myanmar, Thailand, and Laos.

- **Quy Nhon port**

Mostly used for transporting goods from Mekong Delta and western Vietnam, along with transhipping goods heading for Cambodia.

- **Cai Mep Port**

Around 80 km south of Ho Chi Minh City, mostly handles goods for Dong Nai and Binh Duong, which are major production centres in the region

21 https://www.vietnam-briefing.com/news/port-infrastructure-vietnam-3-hubs-for-importers-exporters.html/

Airports

Vietnam has five main international airports:

- **Noi Bai (Hanoi)**

Is the largest airport in the country for cargo transport and the second busiest airport for passenger traffic[22].

- **Tan Son Nhat (Ho Chi Minh)**

Is the busiest airport in Vietnam with 32.5 million passengers in 2016 and 38.5 million passengers in 2018. Official capacity is 25 million passengers[23].

- **Danang (Danang)**

It is the third international airport in the country, besides Noi Bai International Airport (Hanoi) and Tan Son Nhat International Airport (Ho Chi Minh City), and is an important gateway to access central Vietnam[24].

- **Cam Ranh (Nha Trang)**

This airport handled almost 10 million passengers in 2019, making it the fourth busiest airport in Vietnam, after those in Ho Chi Minh City, Hanoi and Da Nang, and one of the fastest growing airports in the country[25].

- **Phu Quoc (Phu Quoc Island)**

This airport facilitates the arrival of international tourists who are attracted to the island's beaches[26].

22 https://en.wikipedia.org/wiki/Noi_Bai_International_Airport
23 https://en.wikipedia.org/wiki/Tan_Son_Nhat_International_Airport
24 https://en.wikipedia.org/wiki/Da_Nang_International_Airport
25 https://en.wikipedia.org/wiki/Cam_Ranh_International_Airport
26 https://en.wikipedia.org/wiki/Phu_Quoc_International_Airport

Potential High Risk Sites Vietnam.

Hanoi

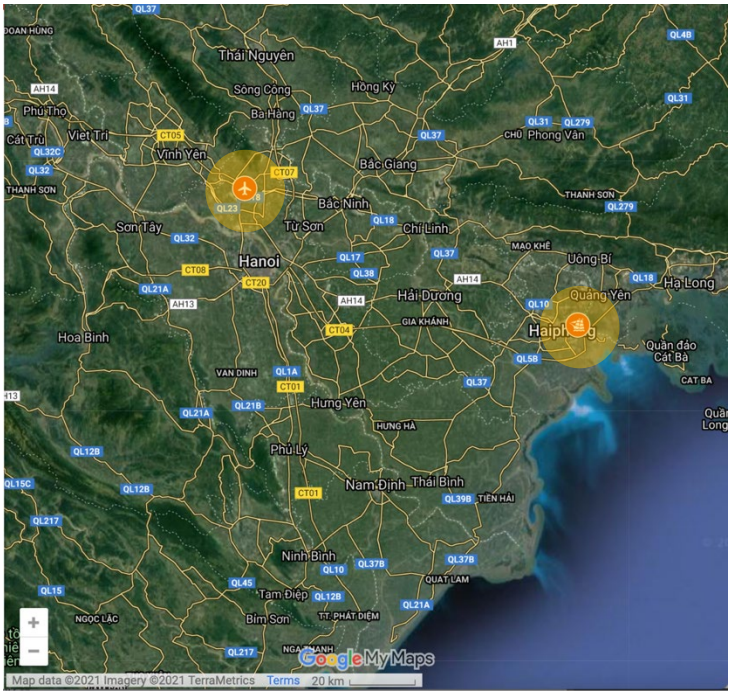

Figure 43: Noi Bai International Airport and Haiphong Port. Distance is approximately 110 km.

Ho Chi Minh

Figure 44: (1)Tan Son Nhat Airport, (2) Cat Lai Container Port, (3) Cai Mep Container Port and (4) Vung Trau Port. Distance between the (1) and (2) is approx.. 16 km, between (1) and (3) approx. 50 km and between (1) and (4) approx. 60 km.

Danang

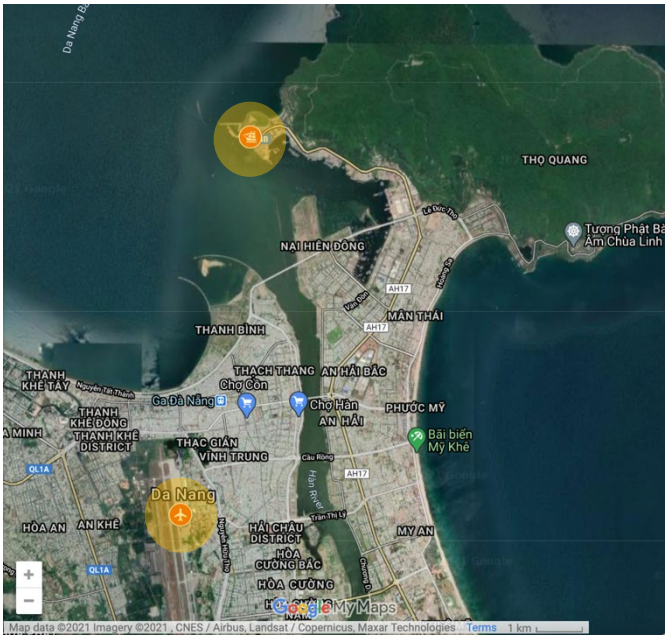

Figure 45: Da Nang international airport and container port. Distance is approx. 8 km.

8.5.7 Conclusions

For forest pests and diseases, five major risk pathways are of importance, these being wood packaging, wood, live plants (particularly nursery stock), and vehicles. A number of ISPM's have been developed to reduce the risk of pests moving on these pathways, but these tools are not 100% effective for reasons, such as ineffective treatments or non-compliance, and so pests still do move on these pathways. In addition, levels of implementation vary widely across countries (see Section 6) potentially increasing risk. Thus it is still very important to focus effort on reducing the risk of entry/establishment at high-risk entry sites, such as airports, seaports, land border crossings and river ports.

The six countries covered in this analysis display a wide variation in risk pathways, from Laos, which is landlocked, to Indonesia, which consists of a huge archipelago of islands. Thus, a one-size fits all approach to identifying the major risk pathways and risk sites is not applicable. We identified potential risk sites in each of the six countries and suggested priority sites that could be targeted for the HRSS pilot network in FST/2020/102. This was done without access to detailed statistics on volumes of trade at each site or location in proximity to host trees etc., but this refinement will be incorporated as an activity in the early phases of FST/2020/123. Below we summarise the potential priority risk sites for each country.

Cambodia:

Three potential priority pest risk sites were identified for Cambodia, in Phnom Penh, Sihanoukville, and Siem Reap.

Phnom Penh: Two sites were identified in Phnom Penh, the international airport and the container port on the Mekong River (Fig. 2). The airport is the busiest in Cambodia and the container port handles the largest import/export volume by tonne and is second in container volume to Sihanoukville. The sites are approximately 35km from each other. In terms of logistics (e.g. ease of access, closeness to laboratory facilities, transport costs etc.), these sites are the most easily accessible by our partners in Cambodia, with both

the Plant Protection Department and Forest Administration headquartered in Phnom Penh.

Sihanoukville: Sihanoukville has an international airport as well as the largest container port in Cambodia (Fig 3). These sites are approx. 25 km distant. However, Sihanoukville is a 230 km (5 hrs) drive by road from Phnom Penh and so logistically difficult for our partners based in Phnom Penh to service HRSS traps and carry out surveillance efficiently.

Siem Reap: As a major tourist destination, Siem Reap has a high throughput of people through its international airport (up to 5 million passenger per year). The tourist site of Angkor Wat is just 5km from the airport and is surrounded by a forested area (Fig. 4). Siem reap is approx. 320km and a 5.5hr drive from Phnom Penh. As above for Sihanoukville, for logistical reasons this does not make it a suitable HRSS pilot site.

Indonesia

Forming a large archipelago, a large number of risk sites were identified for Indonesia. However, only three of these were selected as potential high-risk sites, based on volume of people and cargo.

Jakarta: has the busiest international airport in Indonesia and a large container port, situated around 26km apart, making it the highest risk site in Indonesia (Fig. 5). Prioritisation of the Jakarta sites for inclusion in the HRSS pilot network will depend on identifying partners located in Jakarta so that it is logistically efficient to service traps and send catches to a diagnostic laboratory. One of our partners (Centre for Forest Biotechnology and Tree Improvement) is based in Yogyakarta, which is a 7.5 hr drive to Jakarta and a 5 hr drive to Surabaya (see below), and which makes it logistically difficult for them to service traps at either location. These arrangements will need to be decided in the early phase of FST/2020/123.

Surabaya: has the third busiest airport in Indonesia and a large container port, currently undergoing expansion (Fig 7). As noted above for Jakarta, there are some logistical issues with selecting Surabaya as the HRSS pilot site, and which would need to be decided in the early stage of FST/2020/123.

Denpasar: has the second busiest international airport in Indonesia, but no large associated container port (Fig 6). The greatest risk in Denpasar (as for Siem Riep) is therefore via the large number of international tourists who may inadvertently carry pests into the surrounding countryside. Denpasar's location also poses issues with logistics.

Laos

Laos has only two international airports (Vientiane and Luang Prabang) that service large volumes of passengers. As a landlocked country it has many land borders with its five neighbouring countries (China, Cambodia, Thailand, Vietnam and Myanmar), as well as trade along the Mekong River and its tributaries.

Vientiane: has the busiest airport in the country and the largest volume of trade with Thailand across the Friendship Bridge (Fig. 8). In addition, the China- Laos railway is nearing completion and will open up a major risk route, with the terminus in Vientiane. Both Laos partners (NAFRI and Plant Quarantine Division) are based in Vientiane. Therefore from both risk and logistical perspectives, Vientiane is the preferred HRSS pilot site in Laos.

Luang Prabang: has the second busiest international airport in Laos. However, there are no other major risk sites (Fig. 9), and from this perspective and from a logistical point of view, is not a good site for a HRSS pilot site in Laos.

Savannakhet: has three associated risk sites, the airport (with limited international connection), a border crossing with Thailand (Friendship Bridge 2) and a large logistics

facility along Route 9 which links to the Lao Bao crossing with Vietnam (Fig. 10), and then through to the port of DaNang. Savannakhet could potentially act as a trial site away from the capital city. There are project staff located in Savannakhet, as well as a lab where triaging of samples could take place.

Pakse: has two associated risk sites, the airport (which serves limited international flights) and a land crossing with Thailand at Chong Mek (Fig. 11). This is thus not a high-risk location compared to Vientiane, and there are also logistical issues in servicing traps etc.

Malaysia

Malaysia has two high-risk locations that have multiple risk pathways, namely Kuala Lumpur and Johore.

Kuala Lumpur: has two high-risk sites, the international airport and the container port at Port Klang (Fig. 16). The airport is one of the busiest hubs in the region. and the world's 23rd busiest airport by numbers of passengers, while the container port is the 11th busiest in the world. These risk sites are separated by approximately 50 km. Our partners in the Forest Research Institute Malaysia and the Plant Biosecurity Division, Department of Agriculture, are both headquartered in Kuala Lumpur, and so logistics would be covered.

Johore: due to its geographical proximity to Singapore, has extensive trade and people links across two causeways. In addition it has an international airport and large container port (Fig. 17). These sites are all in reasonably close proximity. However, there are logistical issues with our partners being based in Kuala Lumpur.

Thailand

Thailand has two locations with concentrations of high-risk sites, Bangkok and Pattaya, including several land crossings with Malaysia, Myanmar, Laos and Cambodia (Fig. 18).

Bangkok: has the greatest concentration of risk sites, with two international airports and two container ports (Fig. 19). Project partners are located in Bangkok and so in terms of risk and logistics this would be the most efficient site to locate traps for the HRSS network.

Pattaya: as a major tourist gateway, Pattaya has a relatively high-volume airport and also a container port. However, for logistical reasons (project partners are located in Bangkok) Pattaya would not be an efficient site to include in the HRSS network

Vietnam

Vietnam has three potential high-risk sites Hanoi-Haiphong, Ho Chi Minh city and Danang.

Hanoi- Haiphong: The two risk sites here are Noi Bai international airport in Hanoi and the Port of Haiphong. Our project partners are located in Hanoi, so can easily service the airport. However, the airport and seaport are separated by approximately 110 km, which may pose some logistical issues servicing traps. This will need to be discussed with partners to decide whether both sites could be covered logistically.

Ho Chi Minh City: There are four risk sites within or nearby Ho Chi Minh city, namely; Tan Son Nhat International Airport and Cat Lai Container Port within greater Ho Chi Minh city, and Cai Mep Container Port and Vung Trau Port on the coast, about 50-60 km from Ho Chi Minh city. It would be relatively easy to establish a pilot high risk site trapping at the Ho Ch Minh city sites, however our Vietnam partners are based in Hanoi, meaning that it would be logistically difficult to service sites in Ho Ch Minh city.

Danang: is the major air and sea hub for central Vietnam, with a busy international tourism-related airport and a large container port. It also has road linkages to the two southern regional centres of Savannakhet and Pakse in Laos. As above for Ho Chi Minh city, Danang may pose some logistical issues with servicing traps at a pilot high risk site.

9 Action Plan for a systematic approach to monitoring and surveillance of priority pests

9.1 Introduction

A central component of the work of FST/2020/123 is to establish a pilot network of high-risk site surveillance (HRSS) across our partner countries to (a) give the forest biosecurity network a focus as a 'learning through doing activity', at the same time drawing in all other components of a good biosecurity system, and (b) to assist in early detection of post-border incursions. Identification of potential risk sites is outlined for each of the partner countries in section 8.

9.1.1 Priority Pests

Current listed priority pests in the region are summarised in Table 3, Section 7.

While relatively extensive, the list shows that work will need to be done in the early stages of FST/2020/123 to more comprehensively cover both exotic pest threats to forests in the region and to currently established pests under management (particularly for acacias and eucalypts) and then prioritise these for inclusion in country and regional lists. For the prioritisation process, tools have been developed by Plant Health Australia and the Department of Agriculture, Water and Environment to assist in prioritisation of pests of agriculture, horticulture and forestry, and environmental pests, respectively. These tools could be utilised in FST/2020/123 to provide a rigorous prioritisation process across the region.

9.1.2 Surveillance and Monitoring

While the priority pest list can potentially be improved upon, the current list still illustrates the best approach to develop systematic monitoring and surveillance for these pests. In the list, 13 of the 15 priority insect pests can be trapped using attractants, pheromones or a combination of both. Thus, a high proportion of SE Asia's current priority forest insect pests can be trapped and are amenable to being detected using HRSS.

For pathogens, trapping is generally ineffective (spore trapping is possible, but diagnostics are difficult) so pathogen surveillance needs to be based on external tree symptoms. These surveys will be carried out as targeted 'blitz surveys' on woody vegetation near HRSS sites.

9.2 High-risk site surveillance tasks

9.2.1 Site selection

While a preliminary analysis of risk sites has been carried out in this project (Section 8), a more detailed analysis will be required at the beginning of FST/2020/123 evaluating volumes and types of trade at each site, as well as utilising local knowledge on the best locations within a high risk site to establish traps and carry out blitz surveys, and to assess site accessibility. Some of this work can be carried out remotely using Google Maps and street view (when available).

9.2.2 Purchase of Traps and Lures

Each country is funded to purchase traps and lures over the life of the project. USC staff will assist in purchasing when required and to assist in ensuring all are using the same traps and lures from a single supplier.

9.2.3 Training in trap maintenance and servicing

Videos will be produced to familiarise participants in all aspects of choosing locations, assembling traps, setting traps, and in trap maintenance and servicing (changing lures and taking trap catches). This will be followed up with in-country training if possible when Covid travel restrictions lift.

9.2.4 Sorting, Triage and Diagnostics

Again, videos will be produced to show participants how to sort trap catches to morphospecies and triaging of priority pests. Training in basic diagnostics will be given online and participants provided with links to online diagnostic resources and information on how and where to send specimens for identification if required.

9.2.5 Data management

A standardised data management system for trap catches will be established and made available to participating countries. Online training sessions will be used to train participants in the use of the system and how to maintain data security.

9.2.6 Reporting

To be useful, data collected in the trapping program needs to be appropriately reported and shared. Discussions will be held with all partners early in the project to assess the degree of data sharing they are comfortable with.

9.2.7 Preparedness and Response

Simulations will be developed for each country partner to test the degree to which they are prepared to respond to a forest pest incursion detected at a high risk site. Learnings from these simulations will be then fed into improvements that can be made in response arrangements and the policy and legislation needed to support this.

9.3 General Forest Health Surveillance Tasks

An outcome of FST/2012/091 “Biological control of galling insect pests of eucalypt plantations in the Mekong Region” was a desire from plantation companies in Laos to develop a standardised and systematic general forest health surveillance methodology. Although developed initially for Laos, we anticipate that these tools could be used by plantation companies elsewhere, especially in Cambodia which has similar issues and is also at an early stage of plantation development. Industrial-scale plantation companies, such as those operating in Indonesia, already tend to have well-developed surveillance and monitoring systems in place.

9.3.1 Understanding current practices and adapting surveillance methods

Companies in Laos already have in place systems such as permanent monitoring plots, which are visited regularly in the early stages of plantation establishment to assess mortality and growth rates. Discussions will be held with companies in Laos through the Lao Plantation Forestry Group early in FST/2020/123 to discuss how these existing practices can be modified to include systematic surveillance.

9.3.2 Data gathering and reporting

From the outcomes of discussions outlined above, standard surveillance protocols will be produced and online training developed to familiarise managers and field staff with them and surveillance more generally. Through collaboration with Plant Health Australia and the Australian plantation industry, FST/2020/123 will participate in the development of a

'MyPestGuide Forestry' App and associated 'MyPestGuide Reporter'[27]. The former will be an App-based guide to common pests and diseases of forestry in the region, as well as those of biosecurity significance, and links directly to the Reporter App. Online (and field-based if possible) training will be used to coach managers and field staff in their use.

9.3.3 Data sharing

As above for HRSS, it is important that data derived from FHS surveys be shared so that maximum benefit is obtained for the region. As in 9.2.6 above, discussions will be held with industry project partners on the level and detail of sharing they are prepared to accept given commercial sensitivities. Although the App will be available to all, filters may be applied to sensitive data such that only anonymised data is shared.

10 Action plan for regional collaboration on data, technical and knowledge sharing

Data, technical and knowledge sharing is a key component of the forest biosecurity network. Data sharing will be the most difficult of these, at both the Government and private plantation company levels, with technical and knowledge sharing being easier tasks and equally important to the success of the network.

10.1 Data-sharing

There are two Task- Forces (TFs) to be set up in FST/2020/123, one Government and one Industry. At their first meetings following project inception, data-sharing will be a priority agenda item, and each TF will report back to the project steering committee (PSC) on what mechanisms and strategies partner countries and companies can utilise and develop to enable data sharing, and what safeguards need to be put into place regarding data management to assist. Data-sharing will be an agenda item at all subsequent TF meetings so that progress is regularly monitored and evaluated, and emerging issues discussed. A paper outlining the benefits of data-sharing will be developed and circulated by the project team prior to the first TF and PSC meetings to make clear these benefits and provide incentive for implementation.

The project team will provide progress reports to the TFs and SC on the development of data-management systems, including the mobile field guide and reporting Apps development. Filtering of sensitive data (e.g. plantation ownership details) is possible using the App, and the project team will discuss with PHA how these systems have been put in place in the AUSPestCheck system (https://www.planthealthaustralia.com.au/resources/auspestcheck/) currently being rolled out in Australia, and which utilises a two-tier permission system of data access for sensitive data.

10.2 Technical and knowledge sharing

Technical and knowledge sharing will be achieved through both formal training and as part of the routine functioning of the network.

In regards to formal training, eleven common training and knowledge needs emerged from the baseline survey (Section 5. 1. 5) as well as eight common skill needs. These will be the early targets for training to increase knowledge across the network, particularly in

[27] *https://www.agric.wa.gov.au/pests-weeds-diseases/mypestguide*

relation to establishment of the HRSS network and associated challenges such as diagnostics and incursion response.

Apart from the Australian project team, middle income country partners such as Vietnam Malaysia, Thailand and Indonesia have substantial technical knowledge and skills in some of these areas and can assist in sharing.

Again, the TFs will have a large role to play in sharing of knowledge, and identifying training needs in each country and across the region. This will be an agenda item for all meetings.

11 Biological Control Surveys

As part of FST/2012/091, the first release of the parasitoid *Selitrichodes neseri* took place at the Horticulture Research Centre (HRC) in a K7 hedge in early December 2019. This initial release was followed by subsequent releases at 2-year-old K7 plantings at the Nabong Site of Burapha Agroforestry (see table 11). In early 2020, eight sites around the Sun Paper plantation were chosen for further release of the parasitoid wasp. As the rearing and testing of *S. neseri* were so difficult (see FST/2012/091 final report for further details), the monitoring and assessment of its release were undertaken as an on-ground activity in this SRA.

Table 11: *Selitrichodes neseri* release points (December 2019 and February 2020)

Village	District	Province	Released
Haddokeo	Hadxayfong	Vientiane Capital	*S. neseri* (30 ♀: 15 ♂)
Nabong	Hadxayfong	Vientiane Capital	*S. neseri* (40 ♀: 16 ♂)
Senoudome	Xaithany	Vientiane Capital	*S. neseri* (10 ♀: 4 ♂)
Sivilai	Champhone	Savannakhet	*S. neseri* (10 ♀: 4 ♂)
Lak 35	Champhone	Savannakhet	*S. neseri* (10 ♀: 4 ♂) *Q. mendeli* 10 ♀
Oumnamkhong	Songkhone	Savannakhet	*Q. mendeli* 10 ♀
Sang	Nong	Savannakhet	*S. neseri* (10 ♀: 4 ♂) *Q. mendeli* 10 ♀
Vangbouangkang	Sepon	Savannakhet	*S. neseri* (10 ♀: 4 ♂) *Q. mendeli* 10 ♀
Vangkung	Sepon	Savannakhet	*S. neseri* (10 ♀: 4 ♂) *Q. mendeli* 10 ♀
Konghin	Sepon	Savannakhet	*S. neseri* (10 ♀: 4 ♂) *Q. mendeli* 10 ♀
Labokang	Sepon	Savannakhet	*S. neseri* (10 ♀: 4 ♂)

Since its release, three surveys have taken place to monitor *S. neseri* and ascertain its establishment. The first survey after release took place in July 2020, covering the Nabong release sites and those in Savannakhet. Only one female was collected on this survey, from Savannakhet, however, there was an (2 ♀: 4 ♂) increase in recovered S*. neseri* in the second survey trip in February 2021, to the same release locations. The most recent monitoring survey (July 2021) covered the release sites at HRC, but also the central provinces of Xayabouly, Xeingkhouang, and Bolikhamxay (see figure 46). There were 249 samples collected across the provinces, with HRC the only release site collected from, recovering very few *S. neseri* (2 ♂). It would be far too presumptuous to say this decline in *L. invasa* is a result of the combination of *S. neseri* and *Q. mendeli*. However, the

numbers have been declining since the first survey- July 2020, 32 *L. invasa* and 145 *Q. mendeli*, February 2021, 4 *L. invasa* and 163 *Q. mendeli*, and July 2021, 0 *L. invasa* and 20 *Q. mendeli*. Whilst, these numbers are low it does indicate that the parasitoid has established itself in K7 plantations in Sepon and at HRC.

There is one more survey planned as part of this SRA, during which subsequent releases of *S. neseri* will also take place. Due to Covid, the team has had to work around country and district lockdowns.

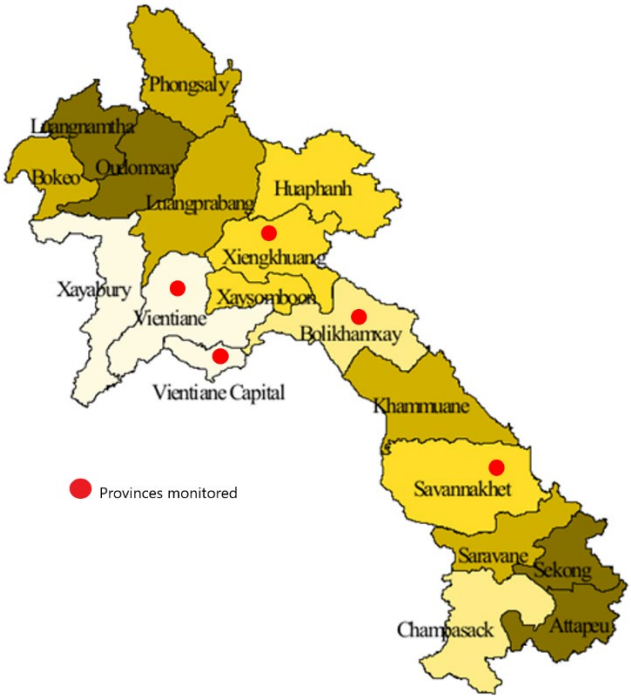

Figure 46: Provinces monitored for *Selitrichodes neseri* establishment

12 Conclusions and recommendations

Considering the delays and constraints that came with Covid, this SRA was delivered to an extremely high standard as a result of the hard work of the entire team across all countries. Moving the information gathering and workshop activities online was in fact a positive move. It meant we were able to collect far more in depth data, responses, opinions, and information than if we held the traditional face-to-face workshop. This is because we were constrained in the number of people we could support to attend a face-to-face workshop, and junior staff felt more comfortable expressing opinions anonymously.

Based on the outcomes, we have determined that there is a large gap in the existing biosecurity framework, for each country, to protect natural and planted forests from invasive pests (insects and weeds) and diseases. To close this gap, we recommend initiating phase two of this project to develop a regional biosecurity network in SE Asia and develop the capacity of our partners to reduce the potential impact of invasive species and increase their preparedness.

12.1 Conclusions

12.1.1 Baseline survey and What's App discussions

The discussion forum determined that the gap in the existing framework, for each country, is a result of limited training opportunities, poorly equipped laboratory facilities, and a lack of skilled and trained personnel. This is exacerbated by a lack of resources (funding) that are available for forest biosecurity. As a result, this limits people's ability to conduct their jobs and has limited the forest biosecurity capacity of each country.

The baseline survey identified 11 common needs in regard to training and knowledge and a further eight needs in regard to skills. These identified needs showed good correspondence with the objectives of FST/2020/123 and FST/2018/179 and will be used to prioritise training and capacity building activities in these phase 2 projects. In particular, a number of training and knowledge needs were directly associated with surveillance (both high risk site and general forest surveillance), such as creating pest lists, diagnostics, pest risk analysis, emergency response and eradication, which support the learning through doing approach in FST/2020/123 that is centred on a HRSS network for the region.

12.1.2 Law and Investment Reviews

The law review determined that whilst each country has a National Biodiversity Strategy Action Plan (NBSAP) under which a forest invasive species action plan falls, there are currently no dedicated biosecurity laws or legislation that focus on the risk and harm associated with forest invasive pests and disease. Therefore, the challenge for governments is to create and implement sustainable policy across relevant departments, institutes, and plant health groups, whilst also developing the capacity of the necessary agencies and organisations to implement associated activities (monitoring, surveillance, and PRA) to support the actioned policy. This needs to be actioned at a national level, but also through a regional approach. Biosecurity requires a multi-actor, well-coordinated response to pest incursions and partnerships are key to delivering technical support, including forecasting and early warning, by enhancing preparedness and implementing preventive measures and outbreak responses.

12.1.3 Major risk sites outline

Major risk sites were identified and prioritised for each partner country based primarily on presence of major international airports and container ports associated with large

population centres in each country. The risk profile differed between countries in the number and types of risk sites, with many land border crossings in countries such as land-locked Laos and many seaports in the Indonesian archipelago, both of which provide challenges for pest surveillance. The establishment of the pilot HRSS network will thus need to focus on a small subset of these identified sites.

12.1.4 Action Plan for a systematic approach to monitoring and surveillance of priority pests

A series of actions were identified to initiate both a HRSS pilot network and more standardised forest heath surveillance for plantation growers, based on the regional priority pest list identified in Section 7 (which will also need review and refinement). The pest list confirmed that a high proportion of the priority insect pests are amenable to trapping at high-risk sites using pheromones, attractants or a combination of these. For plantation surveillance, an app-based field guide to pests and diseases together with a linked reporting app will be developed and deployed in partner countries.

12.1.5 Action plan for regional collaboration on data, technical and knowledge sharing

The government and industry task-forces to be established as part of FST/2020/123 will be instrumental in developing strategies and mechanisms to implement forest biosecurity data sharing in particular. These TFs will also guide the prioritisation of knowledge and skill sharing, informed by the knowledge and skills needs identified in Section 5.1.

12.1.6 Biocontrol

Whilst the numbers of *S. neseri* collected from release sites are low, the successful recovery of the parasitoid (at 7, 14, and 19 months) after the initial release shows the potential to become established in the field in Laos. This is not dissimilar to the release programs in South Africa and Brazil where numbers were slow to establish.

12.2 Recommendations

12.2.1 Baseline survey and What's App discussions

There is a need for better coordination between departments (agriculture, forestry, plant protection, etc.), and stakeholder groups (farmers and industry) to streamline the approach to forest biosecurity across the partner countries. This would include better linkage with agricultural agencies which often receive a higher allocation of resources for biosecurity activities. Indonesia suggested establishing a collaborative effort with international agencies to further develop coordination and capacity. Both suggestions feed directly into the aims and objectives of the forest biosecurity network in the second phase of this project and will be actioned accordingly. In addition, industry could contribute resources to aid in reducing some of the burden, particularly around funding, placed on governments. Potentially, bringing together private industry and government, in this network, will close the gap on this resource issue by highlighting the importance of biosecurity and the value of investing in such activities by industry.

12.2.2 Law and Investment Reviews

Based on the law review, we put forward three recommendations to aid in developing biosecurity law and legislation. There needs to be an emphasis on good governance to ensure alignment between sectors, whilst engagement on a regional scale will harmonise protocols to better safeguard SE Asian forests and ensure local scale and scope. Stronger collaborative efforts among countries, state, and non-state actors in SE Asia is the key to significantly reducing pest threats to planted and native forests. A significant outcome of

such an approach would see greater regional preparedness to reduce the likelihood of pest invasion and better preparedness to respond in the event of forest biosecurity issues ranging from local to large national- and regional-scale pest threats. From a regional perspective, the ASEAN trading community would benefit from the development of a biosecurity framework to develop and coordinate policy and direct on-ground activities in a regional and collaborative context. countries.

12.2.3 Major risk sites outline

Further work needs to be done early in FST/202/123 to refine the risk site selection for each country. In particular there is a need to obtain more recent (pre-Covid) data on passenger and container volumes for all identified high priority risk sites, as well as to identify potential sites for the trapping/blitz surveys. Local knowledge is crucial for obtaining this data and in identifying accessible, secure sites for the trapping and blitz surveys. This will be an early priority activity for our partners in each country and for discussion with the Australian project team.

12.2.4 Action Plan for a systematic approach to monitoring and surveillance of priority pests

A high priority should be placed on the early establishment of the two Task Forces, and particularly on the composition of these such that those nominated have the background knowledge, skills and passion to be champions for forest biosecurity in their own countries and for the region.

12.2.5 Action plan for regional collaboration on data, technical and knowledge sharing

These collaborations form the major activities of the forest biosecurity network and will require long-term relationships and trust to be built within and between the two Task Forces. It is therefore a priority that these TFs be established quickly and meet early and then regularly thereafter, and with tight integration with the Project Steering Committee meetings.

12.2.6 Biocontrol

It is necessary to continue to monitor and release in new locations as well as at past release sites. It is recommended that additional ‘top-ups’ are sent from South Africa or Brazil, to ensure strength of the colony through introduction of additional genetic material.

13 References

13.1 References cited in report

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List of publications produced by project

Healey MA and Lawson SA (in preparation) Forest biosecurity laws and legislation in South East Asia: A review. Target journal: International Forestry Review.

Healey MA, Lawson SA, Bounneuang et al. (in preparation) Geographical distribution of the blue gum chalcid (Leptocybe invasa) associated parasitoid Quadrastichus mendeli Kim & La Salle in the Mekong Region – Lao PDR, Thailand, Vietnam and Cambodia.

14 Appendixes

14.1 Appendix 1:

See attached file “Appendix 1 Baseline questions”

14.2 Appendix 2:

See attached file “Appendix 2 General Questions for Whatsapp”

14.3 Appendix 3:

See attached file “Appendix 3 Email Invitation to Participate”

14.4 Appendix 4

See attached file “Appendix 4 Country discussions”

14.5 Appendix 5:

See attached file “Appendix 5 Law and Legislation review”

14.6 Appendix 6

See attached file “Appendix 6 Forest Biosecurity Investment in SE Asia review”

14.7 Appendix 7

See attached file “Appendix 7 Regulated pest list”