Charles Sturt University
Gulbali Institute
Agriculture Water Environment

MOTA Findings Final Report for ACIAR

ACIAR FIS/2018/153

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Human Research Ethics

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Executive Summary

The Motivations and Abilities (MOTA) framework was established to address a planning stage gap, by offering a multi-stakeholder, multi-level approach to evaluate the implementation feasibility (societal adoptability) of plans and policies. MOTA is a stepwise process focusing on the relationship between trigger, motivation, and ability. This study used the Extended MOTA Framework (Figure 1) to provide insights and recommendations into better implementation and institutionalisation of fish passage within SE Asia.

Data collection for the MOTA component of the project took place over two periods. The first round of data collection focussed on understanding fishway decision-making at the policy level across the Mekong and Southeast Asian region. The second round of data collection focussed on eliciting key insights from specific fishway cases and understanding the on-ground realities of fishway implementation. Respondents were purposively selected based on their knowledge and/or experience with fisheries management within each country or in relation to a specific fishway site.

This data was analysed and refined to be presented as five major insights and recommendations in relation to sustainable fishway management (shortened to 'effective fishways' through report) over the life of the structure (~25 years). These recommendations were intended primarily for future programs; however, MOTA insights were also incorporated throughout the FishTech project when analysis of data was able to quickly inform improvements in the program.

The five major recommendations are:

1. **Demonstration Works – Capacity Building Through Research Approach**

   Demonstration using fishways built at key sites is effective in increasing awareness and advocacy for fishways. This is improved when combined with research that shows that the fishways pass fish. Demonstration research fishways should be promoted in areas where fishway advocacy is still needed.

2. **Building Fishways is not an end point to Sustainable Fishway Management**

   Building of fishways is important, and a critical step in effective fishways, but it should not be viewed as the finalisation of the process. Post-build consideration of ownership, operations, and maintenance are essential for fishways to operate efficiently, and should be incorporated into fishway programs to ensure effective fishways over the life of the structure.

3. **Policy/Legislation is not an end point to Sustainable Fishway Management**

   Legislation and Policy are very important factors [triggers] in ensuring that fish passage is implemented, however, it does not guarantee effective fishways. Ineffective fishways are becoming common when policy or legislation is the primary tool to push for fishways.

4. **Fishway Social Dimensions are Dynamic (Fishway Static, Social Dimensions Fluid)**

   Fishways persist within the landscape for decades. In the same time period, communities can go through many changes, even just as a result of generational change. There will likely need to be a continual process of renegotiation and awareness raising with the community to keep a common understanding of the fishway between the community and government.

5. **Business case strengthening to enhance investment by government, donor bodies and emerging green finance investors.**

   Past fishway projects have been largely dependent on donor/lender body investments (i.e. JICAR, WB, ADB). A significant funding gap remains. The business case for investment needs to be more clearly understood and documented, to convince a broader range of potential fishway investors including through green finance and other market-based instruments.

1. Introduction

1.1 Background

Many fisheries in SE Asia are currently under threat from the growing development of irrigation and hydropower infrastructure. Harvesting fish migrations in South East (SE) Asia has long been an integral part of most rural community's livelihood systems. Fish are a main protein source and trade/barter commodity, as well as being a vital source of micronutrients in diets. But the barrier impacts posed by such infrastructure on fish migrations can be significant. Rice is equally as important as fish production for food security and household incomes and is actively farmed in all SE Asian countries. Most rice production occurs in floodplain systems where there is fertile and productive soil. But floodplains have been extensively developed with flood control and irrigation systems (regulators/low head barriers) to improve rice production and prevent crop inundation during seasonal flooding. Although such flood control and irrigation systems are advantageous for rice growing, they block important migration pathways for fish seeking access to critical nursery and feeding habitats. Although these programs may provide river communities with a more stable income from improved rice yields, they risk losing fishing income and an important source of protein and essential nutrients; leading to loss of key livelihood systems, poorer nutrition and social disruption.

The project, referred to as FishTech*: Integrating technical fisheries solutions into river development programs across South-East Asia* (FIS/2018/153), adds to a program of work that progressed from an ACIAR-supported proof of concept study (FIS/2006/183) to a more detailed research and implementation phase (FIS/2009/041), which has demonstrated that fishways can mitigate some of the negative impacts of irrigation development and can also provide lasting economic and social benefits for river communities. Therefore, to facilitate positive, broad scale outcomes, the next phase (FIS/2018/153) focussed on fish passage implementation activities in partnership with line agencies and development banks, to work towards achieving significant livelihood, climate resilience and food security outcomes across South East Asia.

Within FishTech, an important component of the adoption and sustainability of fishways is understanding the motivations and abilities of different implementation partners and what is needed to implement and institutionalise fishways within irrigated floodplains.

1.2 The MOTA Framework

The Motivations and Abilities (MOTA) framework was established to address a planning stage gap, by offering a multi-stakeholder, multi-level approach to evaluate the implementation feasibility (societal adoptability) of plans and policies. MOTA is a stepwise process focusing on the relationship between trigger, motivation, and ability (Phi et al. 2019, Nguyen et al., 2019). This study used the Extended MOTA Framework (Figure 1) as the analytical lens through which the research was conducted. The framework was largely developed through the water management field, addressing the issue that while robust water plans can be developed, it is the implementation of these plans where problems arise. The point of the MOTA Framework is to go beyond the standard benefit-cost analysis approach to implementation and, instead, consider this from societal and institutional perspectives (Phi et al. 2019).

In reviewing the MOTA Framework at the commencement of this project, the limitations of the framework could be seen. While the original MOTA Framework draws on some behavioural theory, broader concepts (such as constructs within the Diffusion of Innovations and Theory of Planned Behaviour theories) could also be incorporated to provide greater insight. The Conallin et. al (2022) paper laid out this 'Extended' MOTA Framework (Figure 1) conceptually. The Bond et. al (2024) paper applied this Extended MOTA Framework to regional level key informant interviews (Phase 1 interviews), and, proceeding that a further paper (under review) then investigated fish passage adoptability within three focus FishTech countries (Cambodia, Laos, Indonesia) (Phase 2 interviews).

This data was analysed and then refined to be presented as five major insights and recommendations under the FishTech platform for future programs. MOTA insights were also incorporated throughout the program when analysis of data was able to quickly inform improvements in the program. The final insights and recommendations are given below in Section 3, followed by a deeper analysis section if readers want to delve deeper into the MOTA elements that formed the five major recommendations.

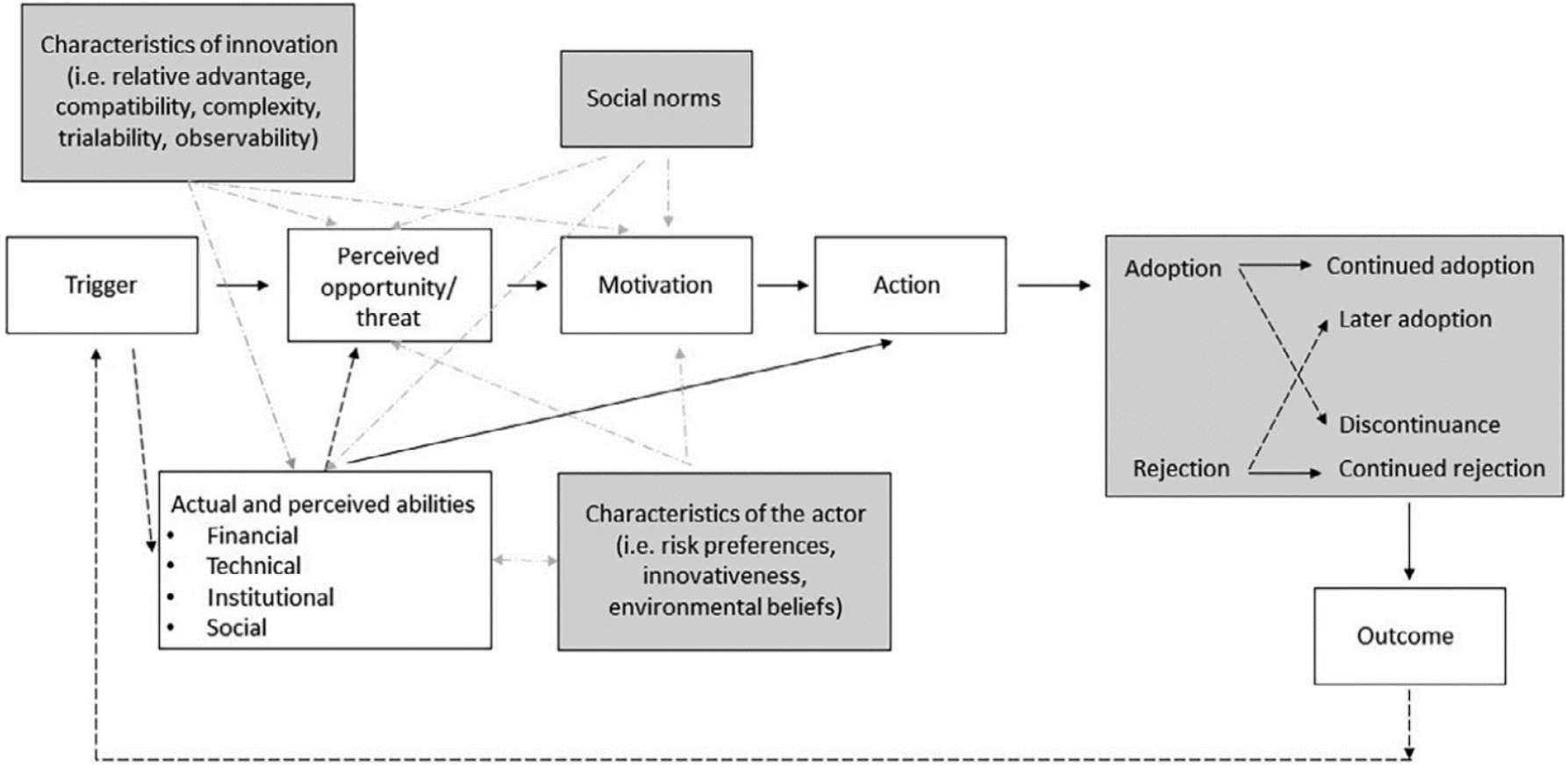

Figure 1.Extended MOTA Framework (Conallin et al., 2022).

Note: The original MOTA framework (white boxes) was expanded (Grey boxes) to include other aspects of social science techniques to provide deeper insight into what would impact a stakeholders motivation and ability to adopt fish passage.

2. Methods

Data collection for the MOTA component of the project took place over two periods. The first round of data collection focussed on understanding fishway decision-making at the policy level across the Mekong and Southeast Asian region. Nineteen key informant interviews were undertaken between February and June 2022 (Table 1). Respondents were purposively selected based on their knowledge and experience in fish-friendly irrigation structures and integrated water management in Southeast Asia.

The second round of data collection focussed on eliciting key insights from specific fishway cases and understanding the on-ground realities of fishway implementation (Figure 2). Data collection was undertaken in September and October 2023 in-country, utilising a mix of interviews and group discussions with a range of respondents (Table 1). Respondents were purposively selected based on their knowledge and/or experience with fisheries management within each country or in relation to a specific fishway site (appendix 1). See appendix 2 for a full list of data collection activities.

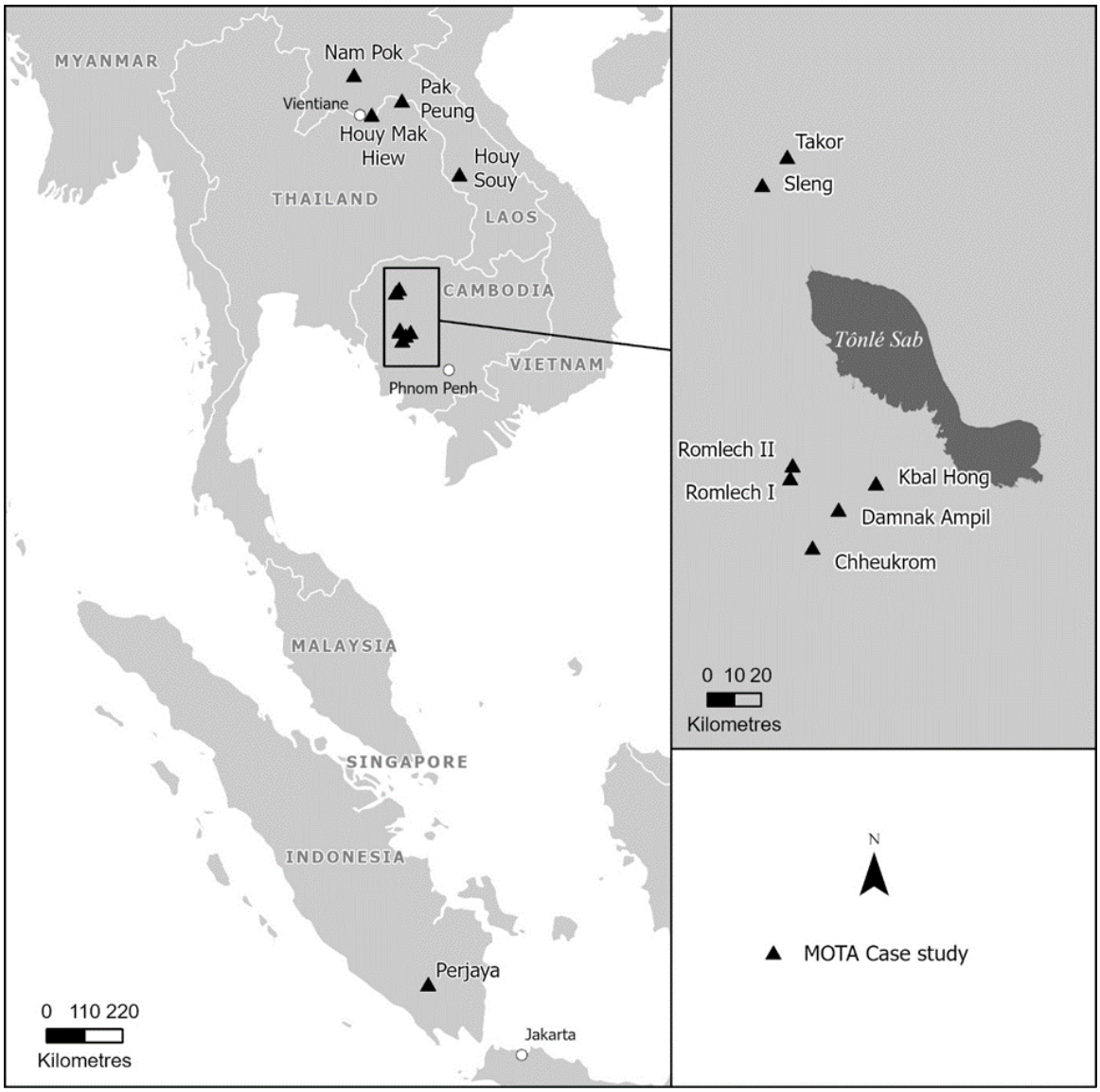

Figure 2. Map of MOTA in-country case study sites

Table 1.Overview of data collection activities

Respondent type	Country	Activity	Number
Regional level	Australia	Interview	8
	Laos	Interview	5
	Thailand	Interview	1
	USA	Interview	3
	Indonesia	Interview	1
	Cambodia	Interview	1
	Total		**19**
In-country	Cambodia	Interview	**17**
		Group discussion	**11**
	Laos	Interview	**13**
		Group discussion	**14**
	Indonesia	Interview	**7**
		Group discussion	**6**
	Total		**68**

For each of the data collection activities, data analysis consisted of multiple rounds of coding, using Nvivo 12, to develop themes. Coding was largely deductive based on the extended MOTA framework and the discussion of findings reflects this approach.

3. Findings

3.1 Triggers

Triggers, as their name suggests, are those events or activities that lead actors to enact a behaviour (Phi et al., 2015). These events may be sudden or gradual and may be perceived as both a threat and an opportunity (Korbee et al., 2019; Phi et al., 2015). To unpack the nuance of triggers, these have been further disaggregated to the social, environmental, economic and political; noting that overlap may occur.

> *"Everybody knows the native fish are feeding a huge number of people... [due to] climate changes as the floods increase, the wetlands are going to expand. Your capture fishery is going to be a much bigger component because you're not going to be able to do anything else in those lower risky flood areas" [IC-L10].*

Social

Regional level respondents acknowledged the importance of fish for communities in terms of livelihood, food security, and culture. Therefore, conceptually, fishways have a social licence which provides a general opportunity for fishway implementation.

> *"I think there is [social acceptability of fishways]… I think it's a net positive. Most people interpret more fish as good. If you highlight the positives and you clarify the negatives, we're not losing your irrigation water. I think most people are completely comfortable with it." [R07]*

"Because people in the community, they are really fighting every day for their livelihood, for the food shortage, for the climate change, many things… if they know that fishway will help for the livelihood improvement… I think may be good" [IC-L7]

Respondents at the community level also saw the value in the concept of a fishway and were generally onboard when it had been explained to them. This social licence is negotiated with communities through community engagement and consultation that ideally begins prior to scoping the fishway location. The research found examples of communities who felt that they had been included in the implementation process, but others who were not. At Kbal Hong, community members stated that

"they [Fisheries department] contact the provincial office only… and they inform the commune, but… don't think the villager were [in] discuss[ions]… they [commune] contact the local people, but… unless the people live nearby, [they] might know about it" [IC-C2]

Similarly, respondents around the Romlech sites felt disrespected as community leaders who had not been informed about the fishway and had to ask the construction labourers what they were doing. They stated:

"they just cut part of the dam to make the fish passage. Even the commune doesn't know anything about the passage. They only inform when they come to actually start the field work." [IC-C6]

Therefore the 'trickle down' approach to community engagement is perhaps not as effective as a more systematic approach. Respondents at the Pak Peung site spoke of how they were presented with a small model of how the fishway would work prior to construction [IC-L27] which helped them understand the process.

The interviews illustrated how the social licence to operate a fishway at the community level needs to be periodically re-negotiated over the lifespan of the structure. For example, Perjaya dam is 30 years old and a different generation of the community are present now. This younger generation weren't part of any community engagement or the development of a social contract at the time of fishway construction and this lack of obligation can be seen in, although is not the only cause of, open fishing within the fishway.

Community respondents at the Nam Pok site spoke of broader benefits and costs they had seen at their site since construction. While some found it more difficult to catch fish because they were migrating upstream [rather than stopping at the barrier where they were easy to catch], generally people were happy because in the process of constructing the fishway, the irrigation channel was cleared of debris and improved so that they can now access water for rice, gardens and fruit trees [IC-L16]. These perceived benefits associated with the fishway construction contribute to a positive view of fishways and reinforce the social licence.

Environmental

The environmental trigger for fishways is relatively clear: barriers restrict fish movement and fishways minimise that impact. These barriers are being driven by investments to support social and economic development through the advancement of hydropower, irrigation farming, road transportation and flood protection infrastructure and their impact on fisheries are increasingly recognised.

Community groups are observing a decline in fish stocks with many farmers reporting that the "can't fish anymore" and questioning why this is happening [IC-C22]. This has been a dramatic shift from previous times in which there had been a belief that "where there is water, there is fish" [IC-C24].

"that's [new hydropower development] a huge barrier... It's definitely changed the hydrology, and I'm hoping that the dam is paying compensation, and is putting in place measures to mitigate those sort of losses to communities" [IC-L3].

"So we try to expand the rice field area to be the irrigated rice field. So we have to build irrigation... we think that maybe this develop will impact on the migration of the aquatic animal and also the block the connectivity between the upper and lower ecosystem" [IC-L1].

"The sorts of dikes that exist to the Mekong Delta are relatively small that they can be opened and closed. They have had a dramatic impact on capture fisheries, a dramatic decline… that mattered a lot because it was the homeless and the poorest members of community depended on capture fisheries" [IC-L9].

"... more and more infrastructure is coming" [IC-C25].

This environmental argument for fishways is strengthened through the consideration of future climate change, which is likely to exacerbate existing challenges to fish passage. In the view of some respondents, however, there is a sense that relative to other environmental concerns such as forestry, freshwater biodiversity is still a neglected area.

Despite the challenge, community advocates for fish passage are optimistic about the future possibilities in which fishways become more common place and fish production and wild stock are "sustaining, not collapsing" [IC-C27].

Economic

A key trigger for fishway implementation in Southeast Asia has been the seed funding in the early 2000s that allowed for the construction of fishway sites. These initial sites have supported the demonstration of the business case for the fishway concept. Fishway structures are expensive and as many countries in Southeast Asia are employing loans to facilitate their implementation, there are opportunity costs that need to be considered. There also seems to be a disconnect in funding of original barriers and funding of the fishway structure. One respondent highlighted how in some cases China funds barriers, Australia funds fishways, noting that "everyone has their own focus" which can be challenging for in-country stakeholders [IC-C1].

Political

In December 2018, a fishway conference was held in Albury, Australia to which many delegates throughout Southeast Asia were invited. This networking event triggered collaboration with Australian researchers and for some, this conference first introduced them to the concept of fish passage, which they then brought back to their home institutions.

> *"the conference in December 201[8], that was the first time when I encountered with the term of the fish passage." [R13]*

Networks with Australian scientists working on fishways, and seed funding from ACIAR were the 'spark' that allowed country governments to see and hear about fishways as a concept and be involved in fishway projects, leading to the strengthening [or opposite] of the 'business case'.

Whether fishways should be made a legal requirement was a key theme of the interviews. Many respondents saw an opportunity that if there is a legislative requirement for fish passage then this could act as a trigger and force projects to incorporate fishways into their structures.

> *"the important thing is the regulation because even though we have a good understanding about the biodiversity and fish behaviour… regulation is important, and it's better to push from the top and then you just following the rules to include fishway and the infrastructure." [IC-I1]*

> *"If it's a box that needs to be ticked, it's a box that needs to be ticked, and they'll tick that box, however they've got to do it. So they'll get the proper people in to design… It's still design issues and all that stuff that need to be overcome, but at least the major hurdle, which is who's paying for it, has already been got out of the way." [R01]*

> *"So if it can be adopted as either laws or implementing rules and regulations, that will facilitate adoption because that's just how it is." [R10]*

However, there was also acknowledgement that if the funding is not provisioned then the legislation will not be enforced in reality, which may result in unfulfilled polices. This can be seen in Indonesia where fishways are explicit in documentation but not mandatory [IC-I1], "they don't have a concern for fishways if they don't have a budget for it" [IC-I6].

Respondents did highlight that if fishways were to be incorporated into legislation then key actors, such as relevant ministers, would need to be made more comfortable with this [IC-C1].

ROLE OF FISH PASSAGE CHAMPIONS

Many respondents strongly endorsed the past efforts of Australian-based fish passage champions and experts in addressing the past tendency for irrigation and hydropower developers to either ignore fish

passage within their projects, or install fishway designs not suited for local conditions or sufficient to sustain adequate fish movement. This influence has been achieved through the provision of technical advice to local ministries and infrastructure operators, the delivery of fish passage masterclasses and other training initiatives, and personal connections and partnerships which have been strengthened over many years.

Given local technical capacity constraints, many local representatives are keen to continue to build and strengthen partnerships with fishtech team. In the view of some local representatives, without this support, it would be "difficult for them to do anything" [IC-L6]. This need for ongoing support is imperative given that, despite the advancements achieved in recent years, fishways are still sometimes regarded as are a relatively new concept or methodology across Cambodia, Laos and Indonesia.

3.2 Motivations & Perceived Threats and Opportunities

A key consideration regarding fishway decision-making and implementation is that of the 'business case' of fishways - and this can pose both opportunities and threats. Flowing from 'triggers' we can see that there are several themes that link to the business case of fishways and can be perceived as either a threat or opportunity. While funding is both an opportunity and threat, we have left this discussion in the previous 'triggers' section to minimise repetition. In this section we incorporate 'characteristics of the innovation' and 'characteristics of the actor' to show these elements as opportunities and threats.

Characteristics of the innovation

- Relative advantage: Fishways enable fish passage without the removal of irrigation barriers, allowing for both environmental and agricultural benefits.
- Compatibility: Fish passage can be implemented on new irrigation structures or retroactively added to existing barriers.
- Complexity: The effectiveness of a fishway is highly contextual and require design based on local requirements such as fish species' characteristics, site ecology and hydrology and ongoing operations and maintenance considerations. Successful fishways require technical expertise, social licence to operate and an ongoing management approach that avoids unnecessary burden on local authorities and communities. Consideration needs to be given to the longevity of structures and what will be done at their end of life. This report provides insight into this complexity.
- Trialability: Given the need for site-specific design and the costs involved, there is limited scope for change once the fishway has been constructed. However, existing fishways offer a demonstration model of the fishway concept.
- Observability: Fishway demonstration is an important part of building the business case for further investment.. A key site for demonstrating the fishway concept is Pak Peung, Laos, which was built to suit local conditions [IC-L24, IC-L27]. While there are suggestions that there needs to be a gate change in the future [IC-L24, IC-L26], and that it doesn't operate at the same level it did at first due to sediment from the Mekong that can't be full cleared despite community cleaning activities [IC-L26], it is generally considered a successful fishway. One respondent stated:

> *"Pak Peung there are many good lessons learned because Pak Peung was funded by ACIAR and they prepare the report and report also, disseminate, or they organize a meeting to disclose about the best practice of Pak Peung. So far, only Pak Peung is the best practice." [R18]*

The need for fishway demonstration sites within Indonesia was clear given the belief amongst some respondents that there are few fishways that are working effectively within the country. If there was, this would make it "easy to communicate to the government" given the ability to demonstrate the contributions to the community and biodiversity [IC-I9]. Within Cambodia, fishway commissioning 'ribbon cutting' events have been used as an opportunity to engage senior government officials, enabling them to see fish passage in action and appreciate the potential economic and social value. Media coverage of these events across local news has further supported the efforts to promote broader community awareness and interest.

Given the trialability, observability, compatibility and relative advantage of fishways conceptually, there is large scope for their implementation across the landscape. However, in terms of complexity, there are several factors that need to be adequately considered. Specifically, how the fishway is to be managed long term [see Actions to date section] is critical, as is the physical design of the fishway and its associated barrier, and ease of operation. For example, fishways and barriers which require manual operation can be

pose a threat to the operational success of the structure. Respondents from Xyabouli reported that at the Hoi Pin site, it can take up to 5-6 people to open the gate [IC-L22, IC-L23], whereas the community member at Mak Hieu does it alone and only needs to remember which button to push [IC-L19].

Fishway design

The 'characteristics of the innovation' section highlighted the benefit of fishways as being observable and demonstration fishways are a key strategy of developing the business case for fishway decision-making. By observing a fishway in place, bureaucrats and decision-makers can visually see the physical structure, within a real-life socio-ecological system, that they are being asked to make decisions on. This poses both an opportunity and threat. Seeing a functioning fishway lends legitimacy to the implementation of future fishways. Once the concept of fishways has been adopted by decision-makers, there is room for implementation of different and potentially less expensive designs, depending on local conditions, such as using rocks [IC-C1, IC- L14].

However, this visibility of fishways, can also be a threat. When ineffective fishways are implemented, the business case for fishways generally can be diminished. Poor design which doesn't consider local conditions actively works against the business case for fishways as a concept. Fishways imported from overseas.

A key component of appropriate design and management for a specific fishway site is the availability of robust data. Several respondents lamented the general lack of publicly available data. Privately-owned hydropower sites are unlikely, or as yet haven't, disclosed data about how efficiently they operate and other publicly operated fishways often don't have monitoring activities undertaken after construction, often due to funding constraints. This lack of data diminishes the business case of fishways, with some respondents not convinced of their value:

> *"I'm very sceptical, I'm afraid, about fish pass efficacy and its contribution to sustaining fisheries in river systems, extremely sceptical. I think the whole technology and knowledge of fish pass performance and evaluation it's very poorly understood really... There's so much unexplained variance in fish pass performance that I think the argument is we're still at a very early stage of understanding fish pass technology... [Journal article authors] reviewed the fish pass efficacy of studies going back to 1965 and their results are really quite alarming, because they show that most fish passes are only about 20% efficient... My feeling is that, well, they can be effective, but it's the efficiency that worries me and also the return migrations. I mean, is there enough head of water inside flood control schemes during the dry season or the draw-down to get fish back into the river system to complete their life cycle? I don't know" [R16]*

Even within countries, ministries need to account for their spending and justify their decisions in an audit. Within Indonesia, respondents from the Ministry of Public Works stated that it's

> *"about the audit process after he finishing the construction, because if they don't have enough study or understanding about the fish, why he build a fishway?.. and probably if [Public Works] cannot answer and then [we] have to pay back the money… it's big money… so we need a strong reason why the existence of the fishways… but based on scientific data and evidence" [IC-I1]*

Some sites, such as Mak Hieu, have only recently been completed and therefore there is no available data yet [IC-L18]. However, data is not just limited to efficacy of the fishway to pass fish. The business case for fishways in terms of socio-economic benefits also needs to be made.

Whilst many acknowledged the powerful role of existing fishway construction sites in providing an opportunity for stakeholders to observe the benefits from enhanced fish passage in action, it was common for MOTA participants to identify past construction and design failures. These failures typically stemmed from the importation of internationally based designs not suited for local fish. As IC-C25 argued, "We can't simply copy US or Australian designs". These past design failures are still somewhat influential in the minds of some stakeholders and need to be addressed given their role in driving fishway investment opposition.

More broadly, it was also common for key informants to question just how effective, no matter how well designed, fishways can adequately sustain fish passage given the wide variability in sizes and swimming abilities across fish species and that fishways typically represent only a small fraction of total river widths. As one participant considered in relation to a recently constructed fishway that has been designed based on international best practices, "… the results are absolutely not conclusive I understand" [IC-L9]. A concerted

effort is required to address these concerns through further efforts to document and report fishway outcomes across various media channels.

Motivations across key fish passage stakeholder groups

Successful fish passage development and operation across Cambodia, Indonesia and Laos will require support and co-operation a number of domestic and internationally based stakeholders. As our MOTA analysis revealed, while motivations among these stakeholder groups are not always aligned and there can be some opposition to fishway development, there are various positive developments that can shift these perceptions.

SENIOR GOVERNMENT OFFICIALS

Interviewees across all countries acknowledged the significant triggering power that top-down, senior government support could provide for fish passage advancement. Those with experience with dealings at these levels noted that such officials often respond to the "hot issues" of the time and, given their competing interests, require "short, snappy" information on these topics [IC-C13].

Current senior government priorities include the restoration of ecosystems, economic advancement through the establishment of the Mekong as the 'battery of Asia' [IC-L1], and enhancing food security through the promotion of aquaculture and irrigated rice production. Although fish passage is often overlooked in these considerations, respondents identified several ways to motivate government official motivations to consider fish passage by aligning its development with these priorities. Example recommendations to achieve this included:

- Illustrating how fishways can complement commercial fishing activities given their ability to support capture fisheries. As one respondent argued:

  > *"You're getting ripped off buying the fingerlings [to support aquaculture], wasting money, and you're growing something with food you have to buy. Why not just have a nature-based system, food for free?" [IC-L1]*

- Assessing the potential of fishways not only to facilitate fish movement but also to help manage the impact of hydropower dams on water quality by controlling sediment load.

PLANNING AND INVESTMENT MINISTRIES

The important role of planning and investment ministries cannot be overlooked given their role in overseeing government expenditure across fisheries, environment, agriculture and irrigation, transportation and energy ministries. Respondents noted that, consistent with the position of senior government officials, planning and investment ministries are increasingly orientated towards environmental dimensions. Further, as one respondent, noted these ministries have a tendency to focus on "big investments" such as dams and irrigation development [IC-L4].

Whilst planning and investment ministries would be able to support fishway investments if they could see a community benefit, at present, an absence of evidence makes this difficult. Some further raised the concern about the impact of fishway construction on dam safety, particularly in earthquake prone areas. These ministries accordingly require access to further information on the biological and environmental outcomes from the promotion fish passage. Doing so would support the tasks of planning and investment team members in their assessment of how any proposed fishway investments by irrigation, fisheries and other ministries would be in alignment with national economic development plans.

FISHERIES MINISTRIES

Whilst not being directly responsible for the construction and ongoing operation of hydropower dams, irrigation systems and other infrastructure assets which can impede fish migration, fisheries ministries and divisions have an inherent role to play in fish passage. Across our MOTA engagements, we met with many fishways technical officers, managers and senior officials with a strong passion for fishway construction and desire to raise their own fishway expertise and the broader awareness of the nature and benefits of fishways across other ministries.

Notwithstanding their interest in fish passage, where the remit of fisheries ministries included both marine and freshwater fisheries, some felt that the tendency was for these ministries to favour marine advancement.

This reflected the interest of these ministries in supporting the economic advancement of commercially significant of marine fisheries and leveraging opportunities to support blue economy developments [i.e. blue carbon projects through mangrove and seagrass protection, marine debris management]. Such advancements have relatively clear 'multi-plier effects', financial payback period and other economic indicators which are often considered by ministry officials.

Given these insights on the motivations across fisheries ministries, the MOTA respondents noted the need to support fisheries ministries to understand how fishway investment can support the social economic needs of local community members. Senior fisheries managers advocated for a bottom-up approach to gain fishway support, based on "local wisdom" [IC-I13], and validated across broader socio-economic surveys.

AGRICULTURE AND IRRIGATION MINISTRIES

Given the significant investment in irrigation infrastructure to promote rice production, food security motivations are typically regarded as being front and centre within the minds of irrigation and agricultural managers. Relative to the desire to promote food security, some considered that fish are "always number two" and these deep-seated values are regarded as being "hard to change" [IC-L5] with engineers naturally "thinking about engineering overview, not fisheries" [IC-I9].

Whilst there was some recognition that appreciation of the role of fishway construction on freshwater ecosystems across agriculture and irrigation is increasing, opposition nonetheless remains. This opposition to fishways spans four primary dimensions, namely, cost, infrastructure safety, knowledge, and competition for water:

1. Cost: In simple terms, many agricultural and irrigation managers regard fishway construction as a "a cost, and not an investment" [IC-I12], or at least, "difficult to install" [IC-L5] with "uncertain" costs [IC-C13]. Such concerns are despite the own estimates of irrigation engineer estimates that the costs to include a fishway within a new dam development might only add 10% to total dam build costs [IC-I7].
2. Safety: Many irrigation engineers expressed concerns about the impact of fishway construction on the structural integrity of dams:

   > *"… they really worry about the structure of the dam, if they apply the fish lift or fishway…. that if they apply the fishway it'll bother the structure of the dam" [IC-I9].*

   Such concerns are understandable given that detailed structural drawings for existing structures can be difficult to locate in some circumstances. As IC-I9 argued, given these considerations, some irrigation engineers advocated for a focus on fishway construction on newly constructed assets, as opposed to existing structures. Others advocated for a prioritisation of pre-fabrication fishway designs for existing barriers which may alleviate some of the concerns regarding the impact of fishway construction on dam foundations.
3. Knowledge: Some felt that the source of opposition by irrigation managers is a lack of knowledge of the nature and benefits of fishways and the appreciation that migratory species are common across inland fisheries. Beyond technical fishway knowledge, there was also a recognised need to enhance the knowledge of the condition of upstream and downstream ecosystems. In the absence of this knowledge, the overall viability and need for fishway construction will likely be questioned by agriculture and irrigation managers.
4. Competition for water: A number of MOTA participants acknowledge the challenges associated with maintaining fishway operation flows due to the pressure to "hold back" water for rice production [IC-L8]. Such concerns highlight the importance of further work to establish clear rules for environmental water flows.

TRANSPORTATION MINISTRIES

It is important to ensure that the impact of transportation based infrastructure [i.e. roads, bridges, culverts] on fish migration is not overlooked. When it comes to priority design considerations for waterway crossings, road safety is a primary motivation. In this regard, transportation managers identified the need to maintain the natural flow of water to manage the risk of flooding, and manage erosion risks and other factors which may impede infrastructure structural integrity. Some noted the need to evaluate water flows before and after construction to validate this. Where there are concerns about the impact of transportation development on waterflows, pipelines are sometimes used as a mitigation measure.

To raise the motivation of transportation managers to consider fishways within new infrastructure projects, MOTA participations noted the importance of supporting these managers through the provision of relevant information on the status of fisheries impacted by transportation-related barriers. As one participant argued, "they really want to know about the data… about the fish biodiversity in all water" [IC-I9]. Unfortunately this data is not always readily available.

HYDROPOWER INDUSTRY

Consistent with the motivations of agriculture and irrigation ministries, hyrdropower companies often view fishways as being "too expensive" [IC-C25] and can be motivated to hold back water and not divert water through fishways to achieve other means.

> *"Can they also operate the gates to allow the fish through? Or are you just going to keep them blocked and hope every centilitre of water you want to store" [IC-L10]*

There is accordingly a need to raise the profile of fishways across the hydrowerpower industry and further demonstrate how these structures can result in reduced investment risk or enhance the industry's social licence to operate.

INTERNATIONAL DONOR BODIES

Past fishway advancement has been largely dependent on donor body support and further support is required if the gap between what is currently invested in fishways versus what is required is to be addressed. Whilst there have been some acknowledged shortcomings with the performance of past donor backed fishways, some donor backed sites have been put to good use as "demonstration sites and for experimentation" [IC-L8].

Given their motivations to invest in "eye catching" projects [IC-I7] or "practical options" [IC-C25], donor bodies can be inherently motived to invest in infrastructure projects. As IC-L10 put it, donor bodies tend to:

> *"… go for the big projects, the donors love the big projects and the money goes into that".*

Across our interviews, it was acknowledged how donor investment priorities tend to be related to the SDGs. This includes, for instance, a focus on investments which help to address climate-related risks, food security and nutrition, and environmental degradation. It is important therefore to further establish how fishways can be "part of the solution" [IC-C25] in helping to solve these key challenges.

Given the recognised nature of donor bodies as 'development' agencies, the clear "economic benefit" [IC-L2] or "benefit to the economy" [IC-C22] from fishway investments must be established. Some participants of the interviews were familiar with the existing efforts to demonstrate these economic outcomes and there was strong support for further research to extend these initial findings. Such work is urgently needed to help donor bodies to understand the return on investment [ROI] from fishway projects.

Further evidence on fishway economic outcomes would support fishway advocates to promote donor motivations to invest in fishways in an equivalent way to which irrigation advocates have been able to secure donor support on the basis of the number of hectares of rice farming advanced [IC-C22]. One respondent in particular, who was familiar with donor body practices, advocated for a scenario modelling approach whereby the overall outcomes from irrigation dam development with [without] fishways were documented.

Enhancing donor support for fishway investments will require a long-term strategy given their work is typically guided by 3-5 year country strategic plans and with the support of local government ministries. As one representative noted, they are not "starting from a blank slate" [IC-I8]. It is important to also acknowledge how, as is the case with Indonesia, country priorities can shift as their relative level of development is advanced.

There have been some efforts made to engage donor body with in fishway training initiatives and site visits and there was strong support to continue these pursuits. Notably, given the belief amongst some donor body staff that fishways are a "costly investment which will drive up the cost of irrigation projects", one respondent recommended a reconsideration of the language use by fishway advocates. Specifically, as opposed to the focus on fishways and fish passage, there was a recommendation to focus on advocating for "fish friendly irrigation"[IC-C13].

Integration of fishways into communities

EMPLOYMENT

Dam and fishway construction are opportunities for providing community members with paid employment, such as at Soui [IC- L20] and Pak Peung [IC-L27]. However, problems can arise when the workers are not paid. In the case of Damnak Ampil, the sub-contractor didn't pay workers for a month and the workers protested to the Provincial Governor, who stepped in and secured some compensation, but the next month the wages weren't paid and the sub-contractor abandoned the project.

> *"They protest it up to the provincial governor. They received some rice, some allowance when they protest but they never received their payment." [IC-C3]*

This was rectified when a new sub-contractor was hired and while this was in relation to construction of the dam rather than the fishway per se, this distinction isn't always clear in the minds of community members. There is a risk that this influences their perceptions of fishways. For the Danmak Chiheu Krom site, respondents reported that the temporary movement of the stream required some villagers to be resettled which caused some challenges and complaints. While on balance the communities saw the benefit of access to water allowing for 2-3 crops/year rather than 1 crop/year, there is potential for discrimination between those who benefit and those who bear the cost of infrastructure development [IC-C5, IC-C11].

TOURISM

Many respondents perceive fishways as places for gathering and tourism, attractions for the community to socialise around. Some sites do have infrastructure for tourists, such as places to sit and food and drink sellers (see photos 1 and 2).

Photo 1. Tourist facilities next to the spillway at Soui, Laos

Photo 2. Tourist facilities next to the spillway at Takor, Cambodia

The provincial leader in Siem Reap "estimate[s] that in the future that will become the tourist site as well. Not just for fish passage, but then it will become tourist site". Addiing:

> "*If we can do good dissemination maybe we can connect it or link it with the international tour package in the future… like the students from Australia, they might be curious about the technology… we also are interested to see such project implemented in neighboring country, like maybe in Laos, Thailand, and other country have... We want to see their technology*" [IC-C10]

Similarly, provincial leaders in Vang Vieng thought that the site at Nam Pok would benefit from good access and people via tourism [IC- L7, IC -L8].

COMMUNITY SAFETY

The communities surrounding Danmak Chiheu Krom were happy with construction of the dam and fishway complex as it provided a bridge, making it easier and safer for the community to move between sides of the river. One example provided by respondents, was that a pregnant woman going into labour one night was able to use the bridge to travel to the healthcare centre, avoiding having to travel by boat.

Community safety is a key issue for communities living around fishway sites. A 12-year-old child was reportedly drowned at the Sleng site in the year prior to data collection, during a period when water was higher than the bollards. The community was insistent that a handrail should be incorporated into the fishway design (see photo 3) so that community members were safe when crossing the spillway[1].

Photo 3. Sleng fishway site without handrail across the spillway

Similarly, the community at the community at Nam Pok have concerns about children drowning in the river by getting caught up in a gate adjacent to the fishway (photo 4) [IC- L16]. Community members at Mak Hieu would like the fishway to be covered with a screen because they think it is too high and dangerous. While there is a sign by the fishway, they don't believe this will protect people fully [IC- L19]. Children have also drowned at Perjaya dam [IC-I1].

[1] *This handrail has been constructed since this data collection period.*

Photo 4. Gate adjacent to fishway which community members are concerned about, Nam Pok, Laos

DAMAGE TO COMMUNITY ASSETS

Another potential threat to the business case of fishways from a community perspective is that of unintended consequences for the areas surrounding the construction. Photo 5 shows bank erosion near the newly constructed fishway at Mak Hieu. Respondents claimed that this wasn't a serious issue because the affected land was not private land, but community land. They understood that the budget didn't extend to bank protection and have sought more funds to rectify this [IC-L19]. Land under tenure regimes other than private ownership also have value. This is seen particularly in relation to the community gathering aspect of other fishway sites. Provincial leaders in Vang Vieng also noted that if the site is too steep and near private land, they should select a different site or different fishway and consult with Naiban to minimise impact to the community [IC- L13]. This was done at Nam Pok, where the side of the river was chosen, at least in part, reportedly due to the other side of the river being private land [IC-L16]. Due consideration of how the fishway construction might impact on the broader area should be considered.

Photo 5. Soil erosion near fishway site impacting community land

Characteristics of the actor

A key factor in raising awareness of fishways throughout Southeast Asia have been 'champions', who have advocated within governments for the concept to be considered. As one respondent stated, it "*depends on person not sector*" [IC-C1]. In order for fishways to be considered for inclusion in major works, key decision-makers need to be aware of them and their benefits because "*if the Director understands fishways we can include it, if not, no fishway*" [IC-C1]. This awareness raising has been 'championed' by key fisheries experts and as key decision-makers become aware of fishways, they take this positive outlook with them as they move throughout government.

> "*The minister move from one [water] to another [agriculture] ministry and he bring along the idea [fishway] to agriculture*" [IC-C7].

These champions have been developed and nurtured through masterclasses.

3.3 Abilities

Within the MOTA framework, abilities are the power, influence and resources stakeholders have available to them and are considered in the dimensions of financial, technical, institutional and social (Phi et al., 2015).

Financial

Funding is a fundamental aspect of decision-making regarding fishway implementation as it is both a trigger (opportunity and threat) and ability. The existence of funding 'triggers' decision-making while access to funding is the ability. This funding is not just for future fishways but also for asset renewal of existing structures.

Respondents spoke of the discrepancies in access to funding between the different sectors involved in fishway projects, highlighting the need to collaborate across sectors.

> *"…there's a definite hierarchy. Fisheries are below irrigation. So the irrigation guys have much more say about things than the fisheries guys." [R01]*

There is also an opportunity cost to Southeast Asian nations for the implementation of fishways, particularly when these are funded by loans which need to be repaid.

> *"it is a lot of money that could otherwise be spent in the Mekong on hospitals or education, things that really are very important. Not that fish passage isn't, but if you're going to spend money, you have to get it right, or there are implications if you don't." [R08]*

Within Laos, the provincial level administration has some degree of ownership over project decision-making and implementation. According to respondents, if a project is under US$200,000 the provincial level administration can allow the project to go ahead. The role of the Department of Irrigation within projects depends on area. If the project is to cover a bigger area then it will generally cost more also [IC- L13]. Although generally the Department of Irrigation would be involved, and need to approve, projects [IC-L24]. This is different from Indonesia, where size of area, rather than monetary value, distinguishes the governmental jurisdiction: less than 1000ha local government, 1000-3000 ha provincial government, 3000+ ha national government [IC-I1].

PROMOTING FINANCIAL ABILITIES THROUGH GREEN FINANCE MARKETS

Given government and donor body funding constraints and the significant gap between what is currently invested in fishways versus what is needed to sustain fish passage, there was a recognised need to broaden out the funding sources for future fishway projects. In this regard, there was strong support for the pursuit of opportunities pursue funding support for fishway projects through green finance markets.

Developments across green finance markets have been typified by a focus on natural capital valuation and enhanced accountability for ESG performance, growth in carbon markets, and the emergence of green debt instruments [i.e. sustainability-linked-loans, green and other environmental-related bond instruments]. Other

developments designed to promote payments for ecosystem services have included a focus on biodiversity credits and offset instruments.

Amongst other green finance instruments options, a number of MOTA participants were enthusiastic about the opportunity to consider biodiversity credits as a means of supporting investments in fishways. As one participant described it, this opportunity "get the credit from conserving the environment" will be an important method of supplementing donor based funding and enable their ministries to utilise resources in the most sustainable manner [IC-C17]. Whilst a relatively new concept, some saw how the opportunity to be the "first in the world" could be viewed in a favourable light by government officials [IC-C24].

Biodiversity credits provide a means of financially incentivising fishway construction through the creation of payments to fishway owners for their demonstrated contributions to inland fishery abundance and diversity. As described by Pollination and Taskforce on Nature Market [2023], in contrast to biodiversity offsets, the objective biodiversity credits is to promote net positive outcomes without directly offsetting biodiversity impacts elsewhere. The intention of these credits is to finance 'real' biodiversity gains that are not connected to negative impacts in other locations (p. 5).

Beyond donor or government backed schemes, demand for biodiversity credits can be stimulated through various channels including CSR-orientated companies, philanthropic organisations, impact investors and other individuals interested in biodiversity promotion (Porras & Steele 2020; Ducros & Steele 2022). For CSR-orientated companies, in particular, investments in biodiversity credits could represent a credible means of demonstrating their environmental commitments as regulatory agencies, investors and other stakeholders increasingly take a dim stance on corporate greenwashing (Hengy 2023).

Collectively, green finance developments are anticipated to enable significant expansion in the South East Asian sustainable economy [projected to reach US$1 Trillion p.a. by 2030] through the facilitation of new growth areas, efficiencies and savings (Hardcastle & Mattios 2020). Compared to many of their international counterparts South East Asian countries have, however, been relatively slow to act on these opportunities (Hardcastle & Mattios 2020).

MOTA participants acknowledged the opportunities to further explore opportunities to support fishway investments through biodiversity credits given the growth in government interest in carbon markets. This includes, for instance, the advancement of:

- blue carbon projects relating to seaweed, mangroves and other initiatives through fisheries divisions,
- forestry based carbon projects, and
- farming based initiatives including soil carbon sequestration and activities designed to reduced emissions from rice production.

Green finance markets are also increasingly focused on by conservation organisations and donor bodies. MOTA participants, for instance, noted examples conservation organisation backed 'natured-based solutions' and biodiversity credit pilot projects. Others identified examples of donor body backed emissions offset projects designed to promote community led, social forestry projects.

Whilst generally supportive of the position that opportunities to promote fishway investment through biodiversity credits, a number of cautions were identified by participants. These typically related to the general lack of understanding of the nature of these green finance instruments. Many had not heard about biodiversity credits before. Others noted the challenges associated with raising the general understanding of the nature of carbon credits. As one participant offered, in the context of carbon credits for rice farmers, "we don't know how this can be for carbon" [IC- L12].

Others emphasised the importance of ensuring the rigor of fishway biodiversity credit schemes. These concerns arouse from past experiences with carbon-based projects, where flawed approaches to establishing valid baselines led to questions about the validity of offsets. As IC-L9 stated, "the idea is to avoid repeating those errors".

In relation to fishway biodiversity credit scheme integrity, some noted the inherent complexities associated with measuring the impact of fishways on fish stocks. The natural comparison was to contrast the challenge associated with measuring fish stocks versus the relative ease of measuring carbon credits generated from tree plantings:

> *"trees don't move around too much, whereas fish do" [IC-L9]*

"When we plant the tree, we can see how many tree and then how big… But if we look at the water, we don't know how many fish. And also they are multi-species and how we can calculate the price of each one? Big fish, small fish?" [IC-L1IC-L1]

"From a practical standpoint, it can be more difficult to monitor fish passage outcomes… This cant be done with satellites" [IC-I13]

Given the complexities, some advocated for a patient approach to the development of any new fishway biodiversity credit schemes. As described by IC-I10, existing green finance schemes relating to carbon offsets have been developed over a number of years. These have started with the establishment of valid proof of concepts, backed by appropriate scientific research, and which have provided an appropriate basis to influence key decision makers and advance regulations. Such an approach will be an important method of "starting to demonstrate the opportunities" IC-C13 and provide a "clear protocol" for these biodiversity credits [IC-L1IC-L1].

To advance the discussion on the viability of fishway biodiversity green finance opportunities, there was also recommendation to attempt to link these instruments with existing carbon instruments and engage with the ministry which have been active in their advancement.

Finally, some questioned underlying ethics of biodiversity offset projects given how they essentially involve providing a reward for those who have damaged the environment. As IC-L3 argued, if you have done the damage, why should "you get credits for mitigating the damage" [IC-L3].

Role of fish passage masterclasses in promoting abilities

Throughout our MOTA engagement, we had the opportunity to speak with a number of past fish passage masterclass participants. All were very supportive of the value of this training in raising their awareness of the role of fishways in "modern irrigation developments" [IC-C18], priority fishway areas, fishway design options and principles, the value of fisheries and the nature of the migratory behaviours of different species.

"Before I study masterclass I don't know fish need the ladders with the passage to pass up… After we get the training with the professor I know how to that is a importance of this passage for the fish…" [IC-C28].

Participants valued the opportunity to use the masterclasses as an opportunity to test alternative fishway models, select appropriate designs for local conditions. Beyond raising the technical abilities of fisheries and irrigation department staff, there was a recognition that this knowledge would support the ability of these staff to "better inform government and engineers on the important role of fish passage" [IC-C18].

One of the most recognised benefits from the masterclass training was the opportunity to build connections and promote understanding across fisheries and irrigation ministry staff. As some observed, these connections are important given that sustainable fish passage will require both fisheries scientists and irrigation engineers "to work" [IC-I9] or "join together" [IC-C21].

Without connections across fisheries and irrigation staff, it can be difficult for engineers to understand biology and, vice-versa, for fisheries staff to understanding engineering requirements. As one fisheries team member identified the value was in the opportunity to share knowledge across professions. Prior to the masterclass, they had not met any staff from their country's irrigation ministry [IC-C21].

As some past masterclass participants identified, these connections across ministries created through the masterclass have included new friendships. These have been sustained through social media contact and regular discussions and sharing for information and materials.

In an effort to promote female participation in fisheries and irrigation, there has been a focus on advancing female masterclass participation rates. A number of these past female masterclass students expressed a desire to use their experiences to support the efforts to raise the awareness of the nature and benefits of fishways amongst the community and support the efforts to raise aspirations for young women and girls to consider a careers in fisheries or irrigation. These participants further endorsed the proposal to offer women only, GEDSI masterclasses.

Given the above experiences, there was accordingly strong demand for ongoing support to deliver further fish passage training. This includes support to:

- Continue the delivery of introductory fish passage masterclasses for provincial, district and central government irrigation and fisheries staff with a further focus on how these relationships can be sustained.
- Providing the opportunity for past masterclass students to engage in higher level, more specialist training. Some past participants, for instance, displayed a desire for longer training sessions to support their ability to extend their own technical fishway expertise to the level of the Australian-based masterclass facilitators.
- Extend the reach of the masterclasses to other relevant technical ministries including:
    i. Staff from environmental ministries involved in the preparation of environmental impact assessments (EIAs). These staff have an important role to play in the establishment of mitigation requirements for dam and other waterway based infrastructure projects. It is therefore imperative for these staff to "understand or have knowledge of fish passage" [IC-C17].
    ii. Transportation engineers from ministries of public works. At present, these staff tend to have limited skill to "develop fish friendly road infrastructure" [IC-C23].
    iii. Other stakeholders including donor bodies and NGOs involved in conservation activities.
- Extend the consideration of the socio-economic benefits from fishways and how fishways can be designed to maximise these impacts. One participant, for example, noted their desire to consider how fishway projects could be integrated with other community building initiatives such as "community vegetable farming next to the fishway area" [IC-C27]. Others noted the idea to use fishways in conservations zones as site for tourism whereby:

    "... tourists can visit and then buy some feed to feed the fish... then they can provide the restaurants... build community up... community can get the benefit from the fish" [IC-L1].

Should masterclass training be extended to new ministries, it is important to allow appropriate time to prepare formal requests and obtain the necessary support [IC-C16].

Technical

Technical abilities are required across a range of specialist areas. The focus has traditionally been on engineering, hydrology and fish ecology to produce designs that are site-specific and therefore effective, and critically, this knowledge is held in different departments/ministries and stakeholders. For example, a staff member with the Ministry of Public Works and Housing in South Sumatera acknowledged:

> *"[I'm] not focusing on how they design fishway, only for the weir or dam... and also the knowledge about the fish, [I] don't have knowledge." [IC-I1]*

This technical expertise isn't restricted to design and construction, however, as structures might need to be adjusted across their decadal lifespan. This expertise isn't restricted to the engineering, ecological or hydrological components of the fishway project. Key expertise is also required in understanding the socio-economic, institutional and cultural dimensions of the project.

GENERAL TECHNICAL ABILITIES GAPS – FISHWAY PERFORMANCE OUTCOMES

Whilst there has been a number of dedicated efforts to monitor the performance of fishways, there was a strong desire to further strengthen these findings and document how many "fish can pass" [IC-L2]. Fishway performance monitoring efforts are currently constrained a lack of resources. Whether conditions can also present practical challenges given, for instance, the difficulty of "monitoring in high flow conditions" [IC-L8].

A long term approach to the monitoring of fishway performance was advocated for given the tendency for past monitoring efforts to be limited to a relatively narrow window of time. This will help to assure that fish are "still passing" and water is still "actually flowing through the fish passage" [IC-L8]. Doing so will help to understand how fishway performance has been impacted by climatic conditions [IC-L8]. Access to appropriate technologies [i.e. acoustic sensors and fish tagging] will be required to support these efforts.

If the maximum value of any existing and newly captured fishway performance data is to be realised, MOTA participants acknowledged the need for further support to:

- Digitise and the share data and resulting reports across teams and ministries. On this front and in the context of fisheries related data, some acknowledged how they're "not quite there yet" [IC-

L10]. In other contexts such as Cambodia, it can be sometimes difficult to locate past project reports if staff move positions.

- Analyse the data and publish the findings through appropriate communications channels including technical reports, academic journals and websites targeting a broad range of stakeholders.

An enhanced understanding of fishway performance outcomes will be beneficial in at least three key respects. Firstly, it will help with the establishment of "evidenced based" fish passage guidelines as demanded across ministries [IC-C24]. Secondly, it help to address opposition to fishway constructions on the grounds that they do not work. Finally, it will enable fishway developers to refine and optimise their designs to ensure that they are able to:

> *"… meet the needs of a broader range of species and which maintain a higher degree of fish movement" [IC-C25].*

GENERAL TECHNICAL ABILITY GAPS – BARRIER MAPPING AND PRIORITISATION

Whilst good progress has been made, additional training and budgetary support is required to map, measure and prioritise barriers and construct detailed barrier inventories. As Cambodian participants described, there are still "so many" [IC-C26] barriers to map and "much work to do" [IC-C27] with one estimating that perhaps only 5-10% of these barriers having detailed surveys [IC-C20]. These barriers range from larger, sophisticated concrete structures through to simple bamboo structures. Where barrier surveys have been done, often these are regarded as relatively basic given they were conducted through a simple "walk around" [IC-L5]. The issue can extend beyond irrigation and flood management structures to the transport ministry for which there is "no database of fish barriers and no GIS data" [IC-C23].

New technologies such as drones are becoming more commonly used and further support to use these technologies is required. Whilst such technologies can be expensive, they have important safety benefits:

> *"Good technology easy to get more picture. Not cheap. Safe though. People don't need to go to the water. Don't need to use a small boat" [IC-C27].*

Other key technology related, barrier mapping skills gaps related to the limited available skills across fisheries divisions to use geographic information system [GIS] software.

Information of priority barriers for fishways is increasingly demanded by donor bodies who are seeking to understand which fishways will provide the "biggest return" from an economic and social standpoint [IC-C13].

A participatory approach to the development of barrier inventories was recommended. This includes, for example, agricultural and fisheries divisions "working in tandem to develop an inventory of priority barriers and securing funding for fishways" [IC-C15]. Other ministries such as environmental ministries with expertise in land mapping can lend technical GIS expertise. There is also the opportunity to leverage the existing water modelling efforts and coordination powers of the MRC.

GENERAL TECHNICAL ABILITIES GAPS – FISHERIES AND BROADER HABITAT CONDITION

In addition to gaps in the level of understanding of the physical nature of barriers, a number of participants commented on the need for continued support to address gaps in the understanding of the status [abundance and diversity] of fish populations, their swimming abilities and movement. As one participant pointed out in the context of Laos, even global red lists can lack reliability given that "nobody's collecting the data" [IC-L10].

There is also a need to deepen the understanding of the condition of upstream habitats. Underlying questions such as whether flood plains are "still work… degrading… improving" must be continuously monitored [IC-L10]. In simple terms, there is questionable merit in prioritisation the construction of a barrier if we do not know if the fish will "have enough food" [IC-L4] or "have habitat" at their ultimate destinations [IC-L8].

Collectively, addressing these key knowledge gaps regarding the nature and condition of fisheries and the broader habitat will support the identification of not only the priority barriers, but also "priority areas" more broadly [IC-C24].

TECHNICAL UNDERSTANDING OF THE SOCIO-ECONOMIC OUTCOMES FROM FISHWAYS

A number of MOTA participants called for a greater commitment to examining the broader socio-economic outcomes from fishways given the number of community members who depend on fisheries for their livelihoods and nutritional needs. Enhanced clarity on these outcomes will be critical in addressing opposition to fishway constructions on the grounds that fishways are "a cost, and not an investment" [IC-I12]. Put simply, if fishways are "to be accepted, there is a need to understand if it is economical" [IC-L2].

At present, despite its relevance for donor bodies and government officials, data on the socio-economic benefits from fishways can be hard to come by. This reflects the past tendency for fishways researchers to focus narrowly on the impact of fishways on fish movement. As one participant considered, compared to advocates for irrigation infrastructure development who are able to point to the number of rice fields which will be promoted:

> *"… I think that our position is not strong... Because we have insufficient data to show to the government" [IC-L1IC-L1].*

Another respondent similarly compared the current business case for fishway projects in which people "don't understand how much it costs" against opportunities to invest in micro hydropower projects "which is every month, they will provide money to us" [IC-I9].

Some MOTA participants were aware of existing attempts to establish decision support tools which attempt to estimate the financial payback period from fishway projects. There was strong support for further research to strengthen the rigour of these tools. Support is also required to enable local fishway advocates to publish and promote the findings from existing household surveys.

Assessments of the socio-economic outcomes from fishways can provide a good opportunity for engagement across ministries. IC-L3The powerful thing about these assessments is:

> *"… the participation, and bringing people on board to design and value the models themselves, because then you get the different ministries involved, different stakeholders, and they go, 'Oh, I see. Actually, if we start valuing ecosystem services, biodiversity, other things, then we're making better decisions for Lao overall'" [IC-L3].*

A broad approach to evaluating and reporting the co-benefits of fishway investments was recommended, with the MOTA interviewees identifying several potential avenues for consideration. This included, for instance, a further exploration of the potential synergies between fishways and:

- Rice farming. This includes not only assessing the impact of fishways on sustaining fish populations for food and income for farmers but also examining how enhanced fish populations can promote rice yields and help farmers reduce production costs.
- The protection of endangered species such as the Irrawaddy dolphin which can which can be a popular tourism drawcard in some situations.
- The promotion of wild capture fisheries. In the case of Indonesia, this includes species such as the glass eel which are highly sought after given their significant market value. In the case of other countries, fishways can help to sustain the commercial catch of a broad range of native species which can be more valuable than species like carp or tilapia which are a current aquaculture focus.

> *"Before, they don't believe there is a fish in the river. And then when we show that there is a very expensive fish in the river, they realise, 'Oh, okay, it's expensive'. And so we cut their life by building, weir there and then they, 'Oh, okay, we have to change our way to develop this weir'. We start with kind of emotional approach with them" [INO03].*

Institutional

A key challenge of fishway projects is to bring together these various knowledges, which are usually held in siloed departments, i.e. irrigation and fisheries.

> *"a fishway is a combination of engineering and fish science. And if any individual fish scientist goes and does a fishway on their own, the engineering won't be so good, it might fall over. And likewise, engineers can do it to last 100 years, but the fish will never find it." [R09]*

INSTITUTIONAL ABILITIES – ENHANCED FISHWAY REGULATIONS AND EIA PROCESS

Across fishway advocates there was strong support for enhanced environmental regulation to mandate fishway construction on new dams and other barriers and to strengthen EIA processes. As some participants identified:

> *"If the ministry of environment and forestry make it a requirement, it will occur" [IC-I7]*
>
> *"if the EIA says so… departments have no choice" [IC-C25].*
>
> *"… have some regulation or the EIA… [make it] more legalised to push or to force them to build. 'If you don't build, you cannot construct'" [IC-L1IC-L1]*

The role of EIAs in relation to new irrigation, hydropower, road and other projects, in particularly, was regarded as an important consideration given their power to require fish passage mitigation measures across a project's design, construction and operation phases. Final project EIA reports reflect the outcomes of an assessment of the proposed location's socio-economic, biodiversity, water quality and other environment conditions. The processes are intended to be consultative involving participation from across the relevant ministries and community members [IC-C17].

Some felt that whilst EIA processes might consider the status of fish stocks in the local area, there can be a tendency to overlook the need for fishways and the importance of maintaining migration [IC-I7]. This was attributed to limited awareness across environmental ministry staff who tend not to have a detailed understanding of fisheries [IC-C25]. Others noted the practical challenges associated with conducting thorough EIAs for all proposed projects, particularly smaller barriers which would entail significant costs in hiring consultants, report preparation and potentially stymieing development [IC-C17].

A number of MOTA participants acknowledged the influential role of key players such as the MRC and ADB have had in promoting fishway requirements who have both established guidelines recommending fishways for new projects. The establishment of these and other fishway guidelines were recognised as an important reference point for both infrastructure developers and also staff involved in conducting EIAs.

There was a recognition that effective EIA processes require environmental ministry officials to "go into the field" and carefully scrutinise and "double-check" the claims of developers [IC-L10]. Others noted the need to ensure that all community members, including women and those with disabilities, are able to access the consultation procedures [IC- L11].

External consultants often play a key role in EIA processes. Some have recognised the need to strengthen the abilities of irrigation engineers and other barrier developers to evaluate the rigour of the assessments prepared by these external specialists [IC-I7].

When it comes to the potential introduction of new fish passage regulations, it is important to recognise the challenges associated with navigating an already crowded regulatory landscape. IC-I11There are "so many regulations" and it can be difficult for ministries to understand which one they need to consider [IC-I11]. In these contexts, it is important to provide these ministries with the appropriate support to help them to identify the relevant regulations for their projects.

INSTITUTIONAL ABILITIES – BUREAUCRATIC CHALLENGES AND PROMOTION OF COOPERATION ACROSS MINISTRIES

Throughout our MOTA engagement, it become very clear how fishway advancement will require participation and support across many technical ministries. This includes, for instance, reaching agreement between staff from:

- Fisheries divisions responsible for managing the sustainability of inland fisheries.
- Agricultural divisions with responsibilities for the construction and operation of irrigation barriers.
- Transportation divisions with responsibilities for construction and maintenance of road based barriers.
- Energy divisions with the responsibility for the hydropower operations.
- Environmental divisions with the responsibility to conduct EIAs.
- Investment and planning divisions with the responsibility of overseeing investment and expenditures across the technical ministries.

These responsibilities can be further split across central and provisional government agencies depending of the scale of the area covered.

At present, those involved in fisheries often remark that they have had little to do with other ministries who are responsible for managing barriers and how it can be difficult to reach agreement across ministries. Some put these types of conflicts down to "sectoral ego" [IC-I9]. These tensions can existing even when related technical divisions are located within an single ministry:

> *"We have the ministry of agriculture and forestry, so one is to protect the forest and protected areas. The other one has an agenda on agriculture and it also conflict each other" [IC-L9]*

At times progress on fishways can be slow given the need to follow traditional formal communication processes across ministries. In the case of Cambodia, investments in ICT are expected to enhanced the efficiency of these government processes [IC-C18].

In relation to Indonesia, it will be important to consider the role of ministries such as the Coordinating Ministry for Maritime and Investment Affairs in helping to promote fishway partnerships and support across relevant and influential ministries [IC-I10]. In other contexts including Cambodia, there was some optimism about future, strengthened between relevant fishways ministries given the cooperation leadership style of the key ministers [IC-C24].

To complement existing efforts to promote ministry collaboration through the fish passage masterclass training, some Cambodian participants further advocated for the establishment of a "working group across many different sectors and ministries" [IC-C22]. This could be led by fisheries staff and involve an initial collaborate workshop and high level meetings on fish passage. This could be subsequently extended across other Mekong countries and leverage the outcomes from previously successful fish passage conferences [IC-C15].

Beyond the promotion of partnerships across relevant ministries, our MOTA engagements with key NGOs and IGOs uncovered a number of opportunities to share relevant project outcomes and data and build synergistic fishway partnerships given our joint interests in:

- Strengthening environmental reforms and capacity building across government ministries
- The promotion of ecosystem services markets and nature-based solutions
- Supporting community livelihoods
- Conservation zone establishment and protection

A long-term strategy will be required given the need to align new fishway partnerships with the longer-term planning cycles of NGOs and IGOs.

SOCIO-INSTITUTIONAL ABILITIES

Masterclasses have been undertaken to bridge these silos and build social networks for stakeholders to make connections across sectors, districts and even countries. As highlighted earlier, funding is key for implementing fishways, but it is also key for institutional strengthening to support the implementation and ongoing management of fishways. These institutional relationships are not just across sectors but also vertical bringing national level policies into community-level management of the completed structure. While communities have institutions in place around water and other natural resources [see social norms section], local authorities are interested in knowing how to manage the structure with the community and the rules that should be implemented to maintain fish migration [IC-L14]. Some respondents suggested that future masterclasses could include more people from provincial and district level as well as communities to further raise awareness of the role of fishways [IC-L14]. This is insightful as the provincial and district levels become more aware of fishways and potentially take on more ownership of the process.

Within the fishway decision-making context, there are institutional considerations, such as safeguards.

> *"It [fish passage] has to satisfy what ADB [Asian Development Bank] call their safeguards, their environmental safeguards and the social safeguards. Which includes ensuring there's no adverse impacts on ethnic groups and so on. So there's the safeguard perspective". [R15]*

> *"I think there would be a lot of interest from donors because there's so much development of the floodplain… If you could come up with some technology to mitigate*

any impacts or to ameliorate any existing impacts, then I'm sure that would be very welcome". [R16]

Funding for institutional development around fishways and funding of fishway infrastructure seems to come from different sources.

INSTITUTIONAL ABILITIES – FISHWAY OPERATIONAL CHALLENGES

Whilst optimising the design and construction of fishways for local conditions is an obvious priority, it is also important to consider the long-term operational performance of fishways. As one response put it:

> *"… we all know building the structure is one thing and proving it works is one thing, but getting the operators to operate it properly" [IC-L9].*

> *Throughout our MOTA interviews, numerous examples of operational challenges with fishways were uncovered. These included those related to ongoing physical operational and maintenance challenges:*

> *"This is the story of irrigation development all over the globe. Engineers are keen to make, donors are keen to invest, and as soon as it's done, it's left behind and you go back in five years, the gates are broken and things" [IC-L10].*

> *"[the fishway] Operated in the past year. Now already blocked…. Blocked by steel trap. It have a large steel trap, use electric. And use a human to lift up…. Yeah, now it's broken [IC-C26].*

Successful fishway operations will require clear assignment of responsibilities and clear operational and maintenance manuals. In some circumstances, there can be some uncertainty regarding these responsibilities and whether it is the responsibility of the irrigation or fisheries departments. In others, local farmer groups sometimes being left to operate and maintain fishway operations.

To maximise the long-term operational performance of fishways, one respondent advocated for a bottom-up approach to the establishment of fishways. Doing so can be more efficient given the time required to get government support and help to promote community buy-in:

> *"Our conclusion is it's better that the government doesn't build them, the irrigation department shouldn't. People should build them themselves with the local district irrigation departments and maintain them themselves, and they should manage the water. So we're a bottom-up focus project because no, the government, the top down approach, you need a good government budget and plenty of staff. And that's our big challenge at the moment" [IC-L10].*

Fishway operational issues can also be associated with a pressure to hold back water to conserve water for farming cultivation purposes [IC-L12]. This reflects how, in some circumstances, irrigation is still the "number one priority" [IC-L5].

A further key issue that is challenging the ongoing operational performance of fishways relates to the issue of fishing in fishways. For some, it can be viewed as "'easy' to catch fish in fishways" [IC-L6]. As one person put it, "if there are fish, people will fish there for 72 hrs a day" with instances of netting across fishways reported [IC-L2].

Fishing in fishways can be difficult to overcome given deep seated values that "fish is for everybody" [IC-L1]. Others acknowledged how many fish in fishways out of necessity, to "fill their stomachs" [IC-C24].

To manage fishing in fishways, some advocated for an extension to existing closed fishing or conservation zone protection rules, "not allowing the fishermen go fishing inside" [IC-C27]. This could involve enforcement through fishway rangers [IC-C24]. Notwithstanding the benefits, setting up fish conversation zones as a basis of managing fishing in fishways can be time consuming and costly:

> *"… you've got to consult with and brief all the other villages have to be on board with the regulations. So that's a lot of upfront costs, I guess, and then if there's issues, you have to mediate that" [IC-L3].*

In contrast to a heavy-handed approach to preventing fishing in fishways, some advocated for a more flexible approach. This included, for instance, the establishment of community led fishway protection rules. As IC-L3 argued, "all the other villages have to be on board with the regulations". Such an approach might

result in fishway protection rules which reflect local customers and allow for fishing in fishways on certainly culturally significant events:

> *"… certain ceremonies, so that if they want to have a big thing once a year or so, they go in and they put in a net, and they say within 20 minutes they can feed the whole village" [IC-L3].*

Community education will also need to play a key role in managing fishing in fishways. This could include, for instance, providing community members with information on fish spawning times [IC-C27] and government announcements regarding and fishway rules [IC-L5]. These education efforts should be extended to community leaders:

> "… talk with the leader of the community. That important. We have to protect this area, not catch the fish before they have to move" [IC-L7].

Those involved in fishway monitoring activities reported a desire from community members to understand the nature of their work and wondering if their purpose is to "catch fish". They question "why fish need the ladder… they don't believe" [IC-C28]. There is optimism, however, that when "people understand the value of fish passage, people will get involved" [IC-C21].

In light of these considerations, IC-C21 called for a broader communication strategy designed to inform the community of the broader of the value of fishways. This could involve social media posts related to fishway site vists and general information as platforms such as Facebook and TikTok are increasingly utilised.

Given the underlying socio-economic drivers of fishing in fishways to support community nutritional needs, there was a recommendation that fishway advocates should work closely with NGOs to support community members to identify alternative sources of income [CAM 12]. This could include, for example, supporting farmers to engage in eco-tourism such as fishing tours, or setup new, small home-based businesses [IC-C14].

Social norms

Fishways are physical, static structures that become embedded in dynamic socio-ecological systems. This section presents the social dimension of this integrated system.

SOCIO-CULTURAL CONTEXT

Key social dimensions for consideration in relation to fishway decision-making and implementation are gender and culture. Interviews and observation show that males and females interact with fish, fishways and fishing differently. Generally, women tended to fish earlier in the day and/or during the day, using lift nets, and were the person in the household who sold fish (where this was done). In contrast, men were more likely to use hook and line, cast nets and gillnets, fish during the day and into the night, and achieve a greater catch [IC-L23]. Photos 6a and b show this gendered division of gear use. How a fishway (and associated buffer zone of fishing ban) might impact on women's and men's daily livelihood activities differently.

Photos 6. a. Men fishing with catch nets in the spillway; and b. Women fishing with lift nets on the riverbank, Soui, Laos

Similarly, different ethnic groups might interact with the river, fishway and fishing differently. In the communities near Danmak Ampil, Cham people living in the town, seasonally moved out to the riverside during the fishing season (approx. September-October) to fish. This seasonal access should not be overlooked in community consultations.

Other cultural dimensions of fisheries and water management, specific to each location, need to be considered when scoping the site for fishway implementation. Respondents in Takor spoke of drownings in the past – one man and two children – in their conservation lake. Respondents spoke of the spiritual dimension of these incidents:

> *"It's kind of weird for the kid. It's not that they come and play in the water. It's just like suicide or something, just walk in and disappeared…There's no sound. There's no swimming or playing, or nothing… From perspective of superstition, it's like they've been lured by some kind of spirit or something." [C16]*

More formal religious factors should also be considered as many respondents claimed that they do not fish on special Buddhist days or in lakes next to a Pagoda [IC-L25]. Similarly, in Indonesia the fisheries authorities draw on 'local wisdom' and activities to support sustainable fisheries management, such as auctioning access and fishing rights to small areas of water [IC-I6]. Existing cultural practices should be understood and may provide avenues for engaging communities in sustainable fishway management.

SOCIO-ECONOMIC CONTEXT

The communities' incentives to manage the fishway for optimal fish passage can be impinged by their reliance on fish for food security and livelihoods. In-country interviews identified that local residents comprehended the purpose of the fishway, and generally supported the concept of fish migration through the structures.

In some regions, the fishway is operating well – from a community perspective. Respondents in Sumatera stated that the Perjaya fishway is "is operating very well to facilitate fish movement… according to the residents there" [IC-I1]. While there is no data available yet, community respondents at Nam Pok were satisfied that the fishway was aiding fish migration and were confident that no one was fishing within the fishway and attributed this to social pressure, where anyone fishing in the fishway would be visible to everyone [IC-L10]. However, the provincial authorities claimed there was some fishing in the fishway [IC-L8]. The community at Nam Pok did concede that illegal fishing had been a general problem in the area though [IC-L10]. However, throughout Laos there are clear rules and sanctions for illegal activity, often a fine, although each village can have input into what values these fines have [IC-L18 IC-20]. At Mak Hieu there were previously problems with interference with gates and illegal fishing, where people from other villages

would use sticks to prop the gate open and catch fish passing but that has stopped since construction of the fishway and according to community members factored into the site location of the fishway where it was closer to the village and easier to protect [IC-L19]. Respondents at district authorities in Champone reported that there was some illegal fishing in the Soui fishways as it was easier to catch fish there [IC-L20]. In contrast fishers at Soui claimed that people don't fish in the fishway because it is a cone structure which makes it difficult to use their gear in there [IC-L21].

At Damnak Ampil there were previous reports of occasional fishing in the fishway but these people stopped once they were told to. There was some level of allowance of fishing in the fishway because "those are starving people, they don't have a boat" [IC-C3]. The fishway at Damnak Ampil now has netting over the top which stops people from fishing within the fishway. This was remarked on by respondents near Kbal Hong, who stated that they have a harder time stopping people from fishing in the fishway as the sometime-gate operator stated "I don't have authority" and while police ban people, this only works when they come with orders "from the top". When fishing in the fishway, people "make the net like the same size as the fish ladder and collect the fish from that ladder". When outsiders come and they try to stop them fishing the fishway, they just say "what is your authority?" [IC-C2].

Given the illegality of fishing in the fishway it is likely to be underreported. However, the Perjaya fishway presents an interesting case where illegal fishing in the fishway is visible and organised. Groups of fishers (based along familial lines) have developed a program of access to the fishway, restricted to their broader group, which outlines a timetable of sorts for different groups at different times/day and different baffles [IC-I4].

> *"during the peak season of fish migration, they catch fish the whole day. So like they have a shift. So there are several groups of fishers that, so this time is for this group and then another. 24 hours." [IC-I3]*

> *"The fishers are the local people… and every box of the fish way is already defined, who's the owner… they negotiate, themselves… they have many groups, one on this baffle, and the next baffle… since a long time ago.. maybe ten families…it's specific only for particular persons, and it's inter-generational. So from 1990, the father, and then it's continued by his son. Or probably if someone didn't want to continue, they could just add another from his close relatives, or something like that. But it's not for the outsiders, it's still in the circle." [IC-I4]*

Respondents stated that the reason this was not stopped was due to the families involved having no alternative livelihood, "it's their main occupation and they really rely on this source of income" [IC-I4]. One informant stated "they [local residents] think fishway is good for their economy, not for the fish. That is how it works" [IC-I1]. Some respondents rationalised that because the particular community members involved were from a location that did not access water from the dam, their agricultural and aquacultural alternative livelihood options were diminished. Therefore, access to fish within the fishway was seen as reasonable. This view was not universal however, with other respondents claiming these people were too 'lazy' to pursue legal alternative livelihood options such as aquaculture which requires more investment and work [IC-I2]. A fisher respondent claimed to invest the money he earned through fishing into corn production [IC-I5], although this requires land. Within the context of Perjaya is it important to note the activities occurring in the broader region which might influence the relationships between people, the fishway and the fish. Respondents spoke of pressure on the Komering river due to pollution throughout the broader catchment system, such as coal mining, sand mining, oil palm plantations and factories, where local residents are wary of food safety and tend to purchase live fish [IC-I6].

The livelihood context of communities living near fishways is also relevant in Cambodia and Laos. Many communities have had significant numbers migrate for work.... The remaining households are reliant on agriculture, particularly rice, but this may be challenged by poor soils [C16], flooding [IC-L23]. Many households near the fishways fish for own consumption with a minority of households fishing for market. Particularly in Laos, respondents spoke of how dams upstream have altered the water levels in the river system which impacts on their fishing ability [IC-L23]. Although in some areas such as Champone, respondents claimed that the majority of fisherman sell to market rather than own consumption only and numbers of people fishing was increasing [IC-L20].

SOCIO-INSTITUTIONAL CONTEXT

As mentioned earlier community engagement is critical to the integration of fishways within communities. This integration is critical because the fishways need to be managed and maintained beyond construction

and this largely falls to local authorities and communities. This management looks different at different fishway sites due to the different types of barriers the fishways are integrated into and the type and scale of the fishways themselves. However, this also looks different based on the socio-institutional context within which the fishway is constructed.

Earlier sections of the report have highlighted the environmental and social licence of fishways due to their benefits for fish, which communities rely on for culture, livelihoods and food security. Earlier sections have also highlighted that for many households living nearby fishways, farming (and specifically rice production) is their main livelihood strategy with fishing undertaken for their own consumption. Fewer households (but this varies by location) are completely dependent on fishing for income and food, and these households tend to not have farmland or alternative livelihood options. Particularly within Cambodia, community structures and institutions tend to be assembled around water use and access for irrigation for farming. In Laos, there is a precedent of community-based fisheries management, largely associated with Fish Conservation Zones (FCZ) which could provide the institutional frameworks through which fishway management is undertaken. At Perjaya, local authorities operate the gates themselves [IC-I1].

At the Danmak Chiheu Krom site, the gatekeeper is a contracted officer of MOWRAM who has been trained on various management aspects of the site including measuring water level, when to check water levels, knowing when to release water, and how to operate the gates (mechanical site with cameras). This gatekeeper checks the water level regularly and has the authority to stop people fishing in the fishway. There are established water user groups in the region and households can become registered members, paying $10/ha to access water, which covers maintenance costs. These institutional structures provide a framework for the ongoing management of the water distribution and fishway and formal mechanisms for managing the water and distributing throughout the four canal systems. However, there are still challenges faced by these groups: there are some exceptions for poor households in paying the fee, a local elite asked them to not charge some households prior to the latest election, the committees weren't too insistent on collecting fees during the COVID 19 pandemic, some maintenance work is beyond the budget of the committees and requires MOWRAM funding, some people steal water with hand-made equipment. Despite these challenges, there are formal mechanisms for distributing water and sanctioning wrong doers [IC-C5].

In comparison, respondents at the Kbal Hong site claimed to have no water user group or fisheries group. The local person who has been operating the gates and cages at the site undertook this on an informal basis, being contacted via Telegram (messaging app) and paid sometimes but not via a formal salary. Respondents stated that the area couldn't get any volunteers to be on a water committee, so the authorities manage this. As for a fishway committee if someone volunteers to lead that "that person will be cursed!", people don't want to volunteer because it's a lot of work. However, the community are keen to be involved in the management of the fishway and irrigation with village chief and local authorities in collaboration, and think a combined water and fishway group would be more manageable [IC-C2]. However, it is critical to have the right people involved in these committees, as respondents stated that in a nearby village

> *"they then have the people that shock, electrocute the fish…and those are also the like, community policing… those people [volunteer community police] are the one that do the fish electrocution… so we do need to be careful on who is to be in the committee" [IC-C2]*

The Romlech sites also have gatekeepers and water user groups, but the arrangements are more informal. Instead of requiring a letter to officially request water distribution (such as at Danmak Chiheu Krom), people from outside villages come to the gatekeeper and argue with him to release water, or release the water themselves by breaking the padlock. Without a rest area near the gates, multiple gates, and no salary, it is difficult for the gatekeeper to manage the sites. Respondents stated:

> *"Sometimes we see people come to release water by themselves. This could not happen in other places -they need to have the request letter to the community. But here, it's so easy, anybody can come and just open the gate. That's why there is the report. We do report to the Communal District about such problems. But even then, there is no solution. The report is just a report, nothing happens. It seems like this place has a loose rule… Even if we don't open the gate, people from downstream come and open by themselves. That's why there is a conflict… one or two, or sometimes 12:30am, some people come and open and close at night time. There's a name of manager, but they don't dare to take any action. It all sounds like it gets out of control… And sometimes people come with equipment that they create by themselves, they can open silently without nobody here. So, they come with creative material to silently open it. So, people can just walk in, open, close as they wish… See, this road, it's in a flood. So, more challenging in terms of*

infrastructure. And even protection, prevention, anything also challenging. We sometimes get information from the villagers around the community policing that inform us, but there are many places where people mobilize. So, we depend a lot on the people who live close to the dam to report to us… here, there's a lot of gangsters, and they chop each other. So, even if there's guard, he wouldn't dare to stop them. And he said that nobody's afraid of anybody. Even the guard who's there, even some authority, but the outsiders just come, and they gonna make argument if they try to stop them." [IC-C6]

An engineer also confirmed that in Romlech, "They have the community for water but doesn't really function" [IC-C7]. However, he recognised the key role the communities play in the ongoing management of the fishways, as once they are constructed, they are essentially handed over to the community to manage.

"..mobilize the water usage community. It need to be mobilized whenever we build any construction to hold the water, we do need community. The process go a long time. You need to do construction and you need to have a package for the budget for community mobilization alongside together… So when the construction finish, you can have the handover so that… community to take responsibility" [IC-C7]

Acknowledging the difficulties communities near Romlech have with patrolling, the engineer explained that the budget does in fact allow for remunerated management activities, the difficulty is that the communities have difficulty accessing these funds.

"So actually, from the original design the community is supposed to receive 80% of the operation budget from government. But the Ministry of Economy and Finance never approve that. That's why they [community] never have the money." [IC-C7]

It is common across fishway sites for management activities (water user groups, fish conservation zones) to be undertaken when there is financial support, such as through a project funded by an NGO, but once this funding ceases, activities stop [IC-C7, IC-C8, IC-C9, C16, IC-L21, IC-L23, IC-I1], unless the community pools their resources, such as each household donating rice which is sold to buy equipment for security [IC-L21]. However, there is potential for these dormant community-based organisations to be reinvigorated for the management of fishways. For example, the community around Sleng had an active fisheries management group, supported by a funded project, with a clear management structure, resources and outputs. This existing structure could be remobilised for fishway management, if funding were made available.

The management relationship seems to be clearer in Laos, perhaps a reflection of the length of time fishways have been present. The District Agriculture and Forestry Office works with communities (specifically the Naiban and other relevant committee members) to operate gates and when there are any issues (i.e. breakdown), the community members inform the district level authorities who in turn inform the provincial level authorities [IC-L3]. While there are no committees for managing the fishway, the water committees and fish committees can manage the rules [IC- L14]. However, this management relationship seems to have changed over time in Pak Peung. After construction the irrigation committee of the community were managing the opening and closing of the gates, but in more recent times this has transitioned back to DAFO [IC-L26].

5. Discussion and Recommendations

The findings show a range of opportunities and threats for fishway decision-making and implementation throughout Southeast Asia. We can see that these opportunities and threats need to be considered: 1) in terms of the incentives different stakeholders have within the fishway complex, and 2) across the whole process of fishway decision-making and implementation (scoping, design, construction, management).

The five major findings are:

1. Demonstration works – Capacity Building through Research Approach.

Demonstration using fishways built at key sites is effective in increasing awareness and advocacy for fishways. This is improved when combined with research that shows that the fishways pass fish. Focussing on designing and building demonstration fishways allowed for the FishTech program to centre itself on an

actual location and then explore through partnerships, the social, ecological and technological components that a fishway brings to a certain location. This included awareness and advocacy events such as fishway openings study tours aimed, conferences aimed at networking and showcasing the demonstration fishways. In addition, classroom type training such as masterclasses, and a Graduate Certificate, and on-site training activities such as M&E to provide data on fish using fishways was integrated into the demonstration areas. This focussed on build capacity within young and mid-level professionals from departments such as irrigation, fisheries, environment and universities. While the individual activities are working, the program could be improved by using a foundational capacity building model where all the activities are linked to the outcome – in-country experts. A focus on advocacy and awareness at the high ministry level and building the technical capacity of young and mid-level professionals. Demonstration research fishways should be promoted in areas where fishway advocacy is still needed.

2. Building Fishways is not an end point to Sustainable Fishway Management.

Building of fishways is important, and a critical step in effective fishways, but it should not be viewed as the finalisation of the process. Earlier programs of fish passage concentrated on technical design of fishways to be fit for purpose under SE Asian fish conditions, as well as the actors needed in the process to ensure the design and construction of fishways at irrigation infrastructure is effective, and relationships between fisheries and irrigation is developed. This approach was essential in devising designs and builds that would produce effective fishways. Less emphasis has been spent on post build and ensuring that the fishways operate effectively and efficiently over the lifetime of the build (often 20+ years). Other fishways built in SE Asia that are not operating effectively and efficiently have given us insight into the why, and much of it comes down to the disconnect between the owner, operators, maintenance, and local community input. Challenges exist such as gate operations and factors such as difficulties in raising gates (so gates are often not raised, or partially raised, leaving the fishway ineffective). Post-build consideration of ownership, operations, and maintenance are essential for fishways to operate efficiently, and should be incorporated into fishway programs to ensure effective fishways over the life of the structure.

3. Policy/Legislation is not an end point to Sustainable Fishway Management.

Legislation and Policy are very important factors (triggers) in ensuring that fish passage is implemented, however it does not guarantee effective fishways. Ineffective fishways are becoming common when policy or legislation is the primary tool to push for fishways. There are many examples already in SE Asia where fish passage has been ignored in infrastructure builds and refurbishments, even when clearly stated that it is needed. In addition, fishways have been built, but using ineffective designs for SE fish, or have never been operated, or are partially effective when operated (e.g. incorrect gate operations). Similar to building of fishways is not an endpoint for effective fishways, it is the people side of the infrastructure that needs to be incorporated to have sustainable fishways over the lifetime of the structure. Strengthening and devising of appropriate policy and legislation for fishways is lacking and needed in SE Asia, however it should be created as a supporting mechanism to effective fishways, not an endpoint in itself.

4. Fishway Social Dimensions are Dynamic (Fishway static, social dimensions fluid).

Fishways persist within the landscape for decades. In the same time period, communities can go through many changes, even just as a result of generational change. A technocratic view of fishway sites might see them as the physical structure set within a natural and physical environment. However, as these sites are also situated within socio-cultural and institutional environments that are enacted by communities through their everyday interactions with each other, their surroundings and the fishway site, communities might see these areas as more than just ‘sites’. We use the term fishway ‘places’ to highlight the meaning-making and emotional connections that communities may undertake/have with fishway spaces. There will likely need to be a continual process of renegotiation and awareness raising with the community to keep a common understanding of the fishway between the community and government.

5. Business case strengthening to enhance investment by government, donor bodies and emerging green finance investors.

Past fishway projects have been largely dependent on donor/lender body investments (i.e. JICAR, WB, ADB). Throughout our MOTA engagement, a key theme across fisheries and irrigation ministry representatives a-like was the lack of available funding (i.e. financial ability) to support fishway construction. Any bids by fisheries or irrigation departments to secure internal government funding will ultimately require support through the relevant internal investment/planning ministry. A significant gap remains in terms of the business case for investment needs to be more clearly understood and documented to convince government funders, lenders, and the broader investment uptake such as green financing, or other market-based

financing. Improving the understanding of the Return on Investment (ROI), payback and other socio-economic indicators from fishway investments, while considering emerging investment opportunities through green finance markets is needed for continuing uptake of fishway technologies.

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Appendix 1. Fishway sites included in the in-country case studies

Table 2. Overview of fishways sites included in the in-country case studies

Country	Site name - co-ordinates	River-Catchment	Closest major centre	Lateral-Longitudional	Selection Process1	Donor	Funder	Owner	Type	Cost (USD)	Operator	Maintenance
Cambodia	Sleng Weir (342052E, 1498320N)-Built	Stung Phlang	Siem Reap	Longitudional	CSU-IFREDI	ACIAR-research, design	FishTech	MoWRAM-Provincial-Irrigation Dept	Vertical Slot	100k	No gate, so no operator	Provincial Irrigation Dept
Cambodia	Greenfield site-Takor	Stung Sreng	Siem Reap	Longitudional	CSU-IFREDI	ACIAR-research, design	FishTech	MoWRAM-Provincial-Irrigation Dept	Proposed Rock ramp	~60k	No gate, so no operator	Provincial Irrigation Dept
Cambodia	Kbal Hong Weir (382869E, 1387425N)-Built	Stung Pursat	Pursat	Longitudional	Priorisation process-AFPS-IFREDI-USAID	USAID-Donor, AFPS Designer	USAID	MoWRAM-Provincial-Irrigation Dept	Cone	80k	Gated structure - Provincial Irrigation Dept	Provincial Irrigation Dept
Cambodia	Damnak Ampil	Stung Pursat	Pursat									

	Romlech I	Svay Doun Keo	Pursat	Longitudional	Priorisation process-AFPS-IFREDI-USAID	USAID-Donor, AFPS Designer	USAID	MoWRAM-Provincial-Irrigation Dept	Dual Cone	70k	Gated structure - Provincial Irrigation Dept	Provincial Irrigation Dept
Cambodia	Romlech II	Svay Doun Keo	Pursat	Longitudional	Priorisation process-AFPS-IFREDI-USAID	USAID-Donor, AFPS Designer	USAID	MoWRAM-Provincial-Irrigation Dept	Cone	50k	Gated structure - Provincial Irrigation Dept	Provincial Irrigation Dept
Cambodia	Damnak Chiheu Krom Weir (ADB)	Stung Pursat-Damnak Chheukrom Irrigation Scheme	Pursat	Longitudional	Original design was from MOWRAM-Consultants, redesigned and finalised by CSU Fish Passage team	Design in-kind from CSU FP Team	ADB	MoWRAM-Provincial-Irrigation Dept	Vertical Slot	350k	Gated structure - Provincial Irrigation Dept	Provincial Irrigation Dept
Laos	Pak Peung fishway (362253E, 2029253N)	Houy Nongpung (Peung)	Pak San	Lateral	CSU team selection	ACIAR-research, design	ACIAR build	Provincial irrgation	Cone bypass around structure	130k	Provincial irrigation	Provincial irrigation
Laos	Maki Houy (278514E, 1991463N)			Lateral	CSU team selection	ACIAR-research, irrigation design	ADB-Netherlands	Provincial irrgation	Vertical Slot	430k	Provincial irrigation	Provincial irrigation

Laos	Nam Pok (18o58’45.03” N, 102o26’57.73 ” E)	Nam Pok		Longitudional	CSU team selection	ACIAR-research, irrigation design	FishTech	Provincial irrgation	Vertical Slot	115k	Provincial irrigation	Provincial irrigation
Laos	Houy Souy (520675E, 1826346N)	Houy Souy	Savannakhet	Longitudional	Prioritisation Process - Champhone prioritisation	ACIAR-research, design	WB	Provincial irrgation	Dual Cone	50k	No gate, so no operator	Provincial irrigation
Indonesia	Perjaya	Komering	South Jakarta, Palembang	Longitudional	Government construction company (PT. PP)	ACIAR-Research	JICA	Governme nt ministry	Pool Passes	~170K	Governme nt ministry	Government ministry

Appendix 2. Overview of data collection activities

Data collection was undertaken in two rounds:

- Phase 1: Regional level key informant interviews via Zoom (Table 3)
- Phase 2: In-country face-to-face interviews and group discussions (Table 4)

Table 3. Overview of regional level respondents

No.	Area of expertise	Stakeholder type	Country	Code
1	Fishway design	Consultant	Australia	R01
2	Fishway implementation	University	Lao PDR	R02
3	Fishway implementation	University	Australia	R03
4	Research funding	Funder	Australia	R04
5	Research funding	Funder	Australia	R05
6	Fishway implementation	University	Australia	R06
7	Fisheries specialist	International Organisation	Thailand	R07
8	Fishway design	University	Australia	R08
9	Fishway design	Consultant	Australia	R09
10	Research funding	Funder	Lao PDR	R10
11	Fisheries specialist	International Organisation	USA	R11
12	Socio-economic specialist	University	Australia	R12
13	Fishway implementation	Government	Indonesia	R13
14	Fisheries specialist	Regional Organisation	Lao PDR	R14
15	Infrastructure project management	Consultant	Lao PDR	R15
16	Fisheries specialist	Consultant	USA	R16
17	Fisheries specialist	Government	Cambodia	R17

18	Irrigation specialist	Government	Lao PDR	R18
19	Fisheries specialist	Development Bank	USA	R19

Table 4. Overview of in-country respondents

Number	Country	Format	Respondent type	
1	Cambodia	Interview	Irrigation manager	IC-C1
2	Cambodia	Group discussion	Kbal Hong Community members	IC-C2
3	Cambodia	Group discussion	Damnak Ampil fishers	IC-C3
4	Cambodia	Group discussion	Damnak Ampil key informants	IC-C4
5	Cambodia	Group discussion	Danmak Chiheu Krom key informants	IC-C5
6	Cambodia	Group discussion	Romlech community	IC-C6
7	Cambodia	Interview	Provincial leader	IC-C7
8	Cambodia	Group discussion	Sambour community	IC-C8
9	Cambodia	Group discussion	Sleng community	IC-C9
10	Cambodia	Interview	District Governor	IC-10
11	Cambodia	Group discussion	District administration	IC-11
12	Cambodia	Group discussion	Takor community	IC-12
13	Cambodia	Interview	Senior country leader - IGO	IC-13
14	Cambodia	Interview	Senior fisheries manager	IC-14
15	Cambodia	Interview	Senior fisheries official	IC-15
16	Cambodia	Interview	Technical environmental expert	IC-C16
17	Cambodia	Group discussion	Technical fisheries team	IC-C17
18	Cambodia	Interview	Masterclass student – irrigation engineer	IC-C18

19	Cambodia	Interview	Senior fisheries official	IC-C19
20	Cambodia	Interview	Technical Expert - IGO	IC-C20
21	Cambodia	Interview	Masterclass student – fisheries	IC-C21
22	Cambodia	Interview	Senior fisheries official	IC-C22
23	Cambodia	Interview	Senior transportation manager	IC-C23
24	Cambodia	Interview	Senior fisheries official	IC-C24
25	Cambodia	Interview	Senior country manager - NGO	IC-C25
26	Cambodia	Interview	Fisheries manager	IC-C26
27	Cambodia	Group discussion	Technical fisheries team	IC-C27
28	Cambodia	Interview	Masterclass student - fisheries	IC-C28
29	Laos	Interview	Senior fisheries Official	IC-L1
30	Laos	Group discussion	Senior country representative and Technical Team - IGO	IC-L2
31	Laos	Interview	Senior country manager - IGO	IC-L3
32	Laos	Group discussion	Senior planning managers	IC-L4
33	Laos	Group discussion	Senior provincial irrigation managers	IC-L5
34	Laos	Group discussion	Senior provincial irrigation managers	IC-L6
35	Laos	Interview	Senior women’s representative	IC-L7
36	Laos	Group discussion	Senior research officials	IC-L8
37	Laos	Group discussion	Senior managers - NGO	IC-L9
38	Laos	Group discussion	Senior country managers - IGO	IC-L10
39	Laos	Interview	Senior manager - NGO	IC-L11
40	Laos	Interview	Senior agricultural manager	IC-L12
41	Laos	Interview	Provincial irrigation Vang Vieng	IC-L13
42	Laos	Interview	Provincial Livestock & Fisheries Vang Vieng	IC-L14

43	Laos	Group discussion	District Agriculture Vang Vieng	IC-L15
44	Laos	Group discussion	Nam Pok community leaders	IC-L16
45	Laos	Interview	Provincial irrigation Vientiane	IC-L17
46	Laos	Interview	Provincial Livestock & Fisheries Vientiane	IC-L18
47	Laos	Group discussion	Makhieo key informants	IC-L19
48	Laos	Interview	District Agriculture Champone	IC-L20
49	Laos	Group discussion	Soui community leaders and fishers	IC-L21
50	Laos	Interview	District Agriculture Xyabouli	IC-L22
51	Laos	Group discussion	Hoi Pin community leaders and fishers	IC-L23
52	Laos	Interview	Provincial irrigation Bolikhamxay	IC-L24
53	Laos	Interview	Provincial Livestock & Fisheries Bolikhamxay	IC-L25
54	Laos	Group discussion	District Agriculture Pak San	IC-L26
55	Laos	Group discussion	Pak Peung community	IC-L27
56	Indonesia	Group discussion	South Sumatra Public Works	IC-I1
57	Indonesia	Group discussion	Fisheries extension	IC-I2
58	Indonesia	Group discussion	Perjaya dam operators	IC-I3
59	Indonesia	Interview	Village head Perjaya dam region	IC-I4
60	Indonesia	Interview	Fisherman Perjaya dam region	IC-I4
61	Indonesia	Interview	South Sumatera Provincial Fisheries	IC-I6
62	Indonesia	Group discussion	Senior central and provincial irrigation managers	IC-I7
63	Indonesia	Interview	Senior country manager – foreign development organisation	IC-I8

64	Indonesia	Group discussion	Senior managers and technical team – IGO	IC-I9
65	Indonesia	Interview	Senior planning official	IC-I10
66	Indonesia	Group discussion	Senior country managers – Foreign development organisation	IC-I11
67	Indonesia	Interview	Senior research official	IC-I12
68	Indonesia	Interview	Senior fisheries official	IC-I13