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Interventions and pathways to reducing water insecurities in the Mekong region

Insights from SUMERNET 4 All (S4A) research

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Mekong River seen from Phan Khot Saen Khrai Viewpoint Thailand @ Khaing Su Lwin

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1. Executive summary

This report synthesizes insights from 30 projects supported by the SUMERNET 4 All (S4A) program (2018–2024), funded by the Swedish International Development Cooperation Agency (Sida). It aimed to reduce water insecurities through inclusive, evidence-based research and policy engagement in the Mekong region.

Water insecurities in the region are driven not only by environmental pressures but also socio-economic, institutional and governance factors. Exclusion from services, marginalization of communities in decision-making, policy incoherence, and insufficient transboundary cooperation lead to persistent insecurities.

Interventions aimed at reducing water insecurities included: construction of micro-habitats; implementation of rainwater harvesting systems; facilitation of groundwater access and monitoring technologies; establishment of community-based early flood warning systems and management; creation of participatory planning platforms; adoption of adaptive agricultural practices; and utilization of tools such as board games to support and enhance stakeholder learning and engagement. These interventions were co-produced with local communities and embedded gender equality and social inclusion (GESI) principles. Engagement with decision-makers was integrated from the outset to support uptake and relevance.

Key recommendations:

- **Prioritize people-centred infrastructure such as rainwater harvesting, shallow wells, and small-scale irrigation tailored to the needs of marginalized and climate-vulnerable communities.**
- **Support decentralized governance models and capacity building initiatives that empower local communities and authorities to co-manage water systems based on local priorities and knowledge.**
- **Mainstream GESI principles into decision-making processes and enable adaptive planning that connects local experiences with national planning.**
- **Enhance cooperation among Mekong countries through harmonized policies, facilitating transparent data sharing, and fostering meaningful community engagement in water resources management.**
- **Support regional platforms such as SUMERNET to facilitate co-production, policy engagement, and promote the uptake of evidence-based findings and inclusive research approaches.**

2. Background

Water resources underpin socio-economic development, energy generation, and food security in the Mekong region, but the region is prone to water insecurity. This area is host to productive and biodiverse ecosystems like Tonle Sap Lake, cascading hydropower, and expanding agricultural lands. However, due to unsustainable development practices, rising pollution, and intensifying floods and droughts, the region is also prone to water insecurity, which SUMERNET defines as "not having the rights or access to sufficient water of adequate quality or being made increasingly vulnerable to unacceptable levels of water-related risks." It encompasses physical dimensions (e.g. availability, quantity, quality of water), multiple spatial scales (e.g. individual, households, communities, nations), and temporal scales (e.g. seasonal, annual, decades).

The severity of water insecurity is significantly shaped by economic and social factors. For instance, rural and peri-urban residents are increasingly subject to water marginality. This phenomenon happens when rural and peri-urban population, being on the fringe of urban areas, are not connected or are poorly served by formal water infrastructure and services, sometimes having to pay higher prices to transport water (Adeyeye et al., 2020).

In the Mekong region, water insecurities manifest through multiple dimensions such as water-related disasters, hydrometeorological changes in river flows, infrastructure development like hydropower dams or reservoirs and unequal access to water resources. The September 2024 tropical cyclone Yagi and Southwest Monsoon hit Southeast Asia, with Mekong nations including Myanmar, Viet Nam, Thailand, and Lao PDR among the worst affected (AHA Centre, 2024). Floods have become a common phenomenon in these riparian countries with heightened flood risk and increased vulnerability, especially in urban areas (Chitwatkulsiri & Miyamoto, 2023). Meanwhile, most rural and remote areas are still lacking access to adequate water supply and many of the region's major river basins have been polluted (United Nations, 2024). In addition to climate crisis that has exacerbated water insecurities, the region's rapid economic and social development has also contributed to increasing water insecurities (Kirby et al., 2010; Thi et al., 2021), with increasing competition for water resources among key sectors like agriculture, industry and domestic use (Bakker, 2010; Wang et al., 2021).

According to the Asian Water Development Outlook (ADB, 2020), the national water security index of the Mekong nations (except China) lagged behind other countries in Asia and the Pacific region. This index takes into account five dimensions: 1) rural water security; 2) economic water security; 3) urban water security; 4) environmental water security; and 5) water-related disaster security. The report indicated that all five Mekong countries except China have serious constraints on water security for economic development and societal well-being.

The SUMERNET 4 All (S4A) program focused on reducing water insecurities in the Mekong region through bridging research, policy and practice. This work leveraged SUMERNET's extensive network of experts, consisting of individuals from diverse disciplines working on water and development challenges, academic institutions,

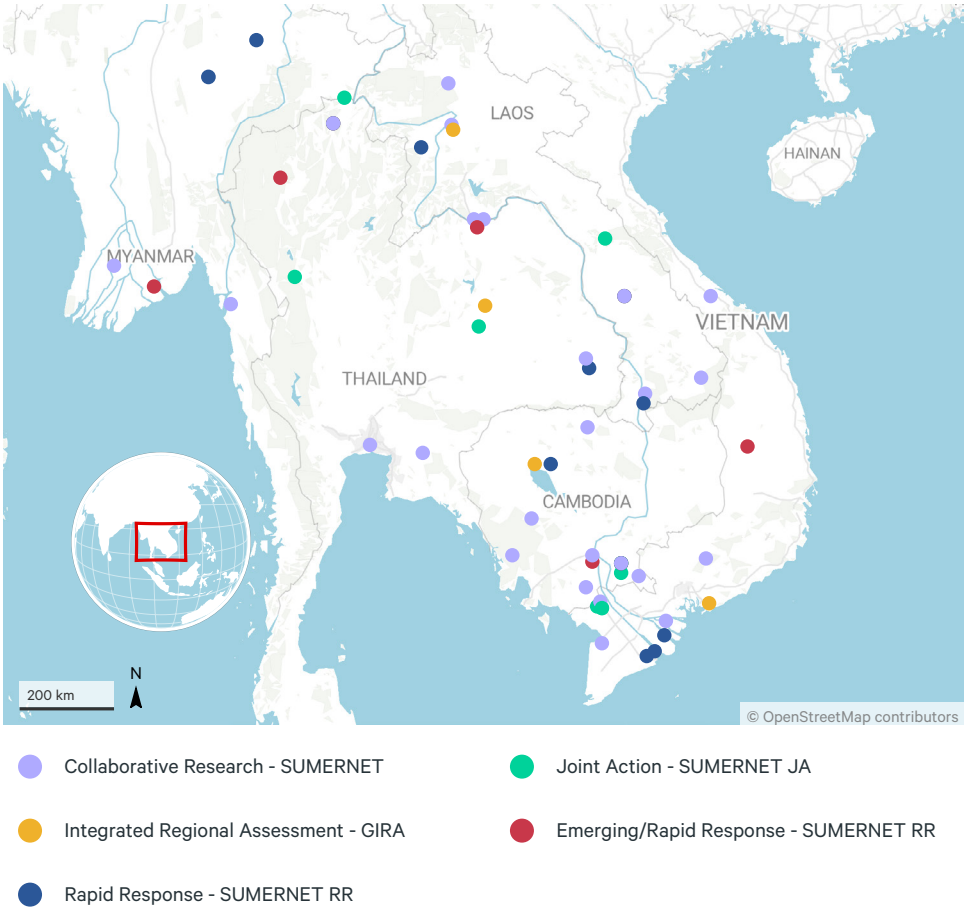
and other civil society organizations in the region. Central to S4A's mission was the recognition of water as a critical resource that underpins sustainable livelihoods, economic development, and environmental sustainability. As the region faces substantial water challenges intensified by development practices, changing climate and weak governance structures, S4A emphasized the need for inclusive and collaborative approaches to address multifaceted water insecurities. By building on SUMERNET's prior achievements such as strengthening participatory river governance, the program aimed to reduce water insecurities and contribute to sustainable development in the Mekong region (SUMERNET, 2018).

The program contributed to reducing water insecurities in the region by promoting solutions and approaches that are both locally responsive and inclusive under three themes: 1) water access, rights & allocation in times of scarcity; 2) governance and management of flood disaster risks; and 3) transboundary interactions between water, energy and food production systems, including the impacts of hydropower dams and irrigation schemes. The significance of these themes was identified by surveying SUMERNET's membership, which currently includes 209 members whose work focuses on water and development challenges across the region.

S4A offered 34 research grants between 2018–2024 through competitive calls focused on addressing critical water insecurity challenges identified via a bottom-up process. Of these, 30 completed projects were analysed for this report (see Figure 1). Research teams – comprising researchers and boundary partners from multiple Mekong countries – collaborated closely, fostering cross-country learning and capacity building, and also had access to the wider SUMERNET membership.

The program aimed to strengthen local researchers' capacity to engage with communities and policymakers throughout the research cycle, ensuring that priorities reflect local needs and voices. S4A has fostered gender equality and social inclusion (GESI), multistakeholder engagement, and co-production of knowledge as core pillars of its approach through project design guidance, capacity building activities, and explicit criteria in research calls. These approaches aimed to support inclusive, evidence-based solutions for more equitable and sustainable water governance in the Mekong region.

Figure 1. Location of research projects.



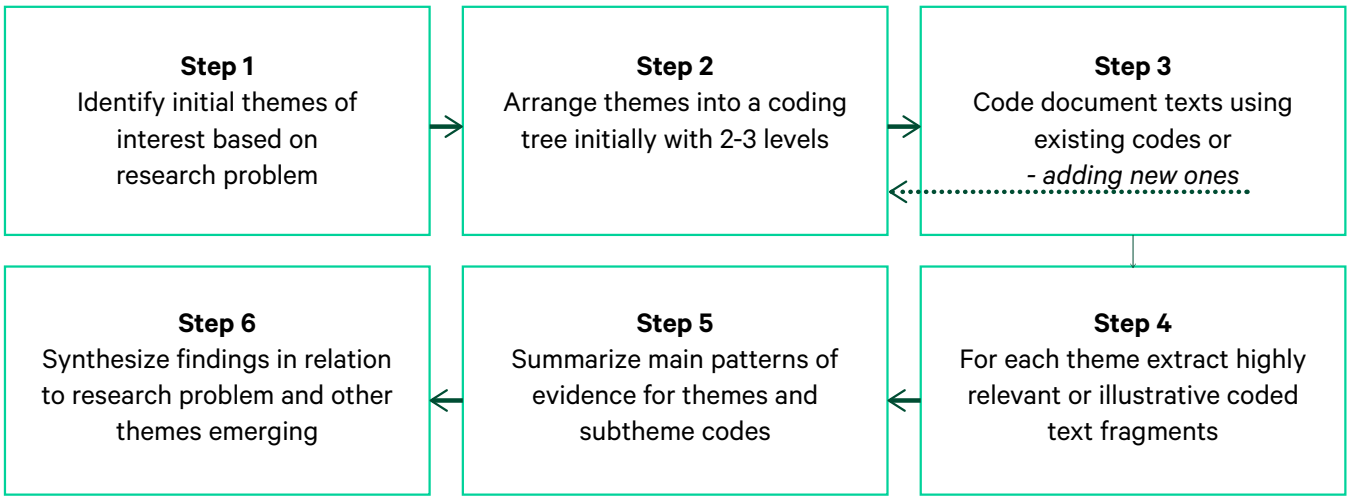
Source: Authors' own.

3. Methodology

This report synthesizes research findings from 30 projects granted by S4A's from 2018–2024, drawing from 159 project outputs (Annex 1). The project outputs analysed include peer-reviewed research articles (41), research manuscripts under review (2) and under preparation (3), mid-term and final project reports (27), project proposals (27), policy briefs (22), and other documents (Annex 1).

Selected projects addressed major water insecurity challenges of the Mekong region. The identification of these research priorities was largely driven by a bottom-up approach, guided by local researchers working directly with local governments and communities to ensure that the projects are grounded in local needs. For several projects, research teams included experts from multiple countries collaborating while creating opportunities for knowledge exchange and cross learning.

Figure 2. The process of synthesizing research outputs in Nvivo.



Source: Authors' own.

Note: "Code" refers to the categories in the code tree – see Annex 2.

The analysis of the project outputs was carried out in NVivo 14 software. A code tree was set up in NVivo (Annex 2) focusing on the following key categories: water insecurities, solutions, challenges, and research approaches. When texts in the documents were relevant to these categories, they were coded for further analysis, following the steps shown in Figure 2. The results were then used to make recommendations for SUMERNET to continue building on transdisciplinary efforts to strengthen inclusivity and sustainability in the region's water management.

3.1 Limitations

Granted projects did not produce the same type, quality or volume of outputs. For example, while some projects produced multiple peer-reviewed papers, others had proposals and mid-term reports, and some of the outputs are still under preparation (Annex 2). Additionally, certain projects made a lesser contribution to the synthesis due to limited documentation.

The representation of countries in studies is also inconsistent. For example, the number of projects and studies in Myanmar was relatively low compared to other countries such as Viet Nam or Thailand. These limitations may affect the representation of all projects and comprehensiveness of the analysis.

4. Water insecurities

S4A's research points out that water insecurity in the Mekong region is an intricate challenge, with both environmental variability and governance factors intertwined. Communities across different geographies – upland, lowland, coastal, and peri-urban areas – experience water insecurities through varying interrelated dimensions such as seasonal scarcity, degraded water quality, floods, insufficient infrastructure, and broader issues of socio-economic inequalities and exclusiveness in governance. The following sections outline some of the multi-dimensional ways in which water securities manifest across the Mekong region.

4.1 Environmental and physical dimensions of water insecurities

Seasonal scarcity

Seasonal scarcity, compounded by climate change and saline intrusion, undermines communities' daily lives, affecting water, sanitation and hygiene (WASH) practice, domestic water supply, and livelihoods activities. As observed in Ben Tre province in the Vietnamese Mekong Delta (VMD), Lam et al. (2024) reported that inadequate freshwater and the impacts of saline intrusion during the dry season make it challenging to support and improve the livelihoods of local people, especially the vulnerable people in areas affected by salinity intrusion in the Mekong Delta. A 70-year-old respondent in the project survey shared, "In Ben Tre, many people like me, from children to adults, almost never take a bath with freshwater in the dry season" (Lam et al., 2024).

A relocated farmer in Vinh Chau Town in Soc Trang province in the VMD highlighted the complexity of the issue:

> "Although the state provided free water pipelines, frequent shortages persist, sometimes lasting up to a week, severely affecting hygiene. Sometimes I do not shower for a week, especially during the dry season. Rainwater partially mitigates this during wet months, but contamination from alum and salinity complicates access. Deep drilling for clean water is prohibitively expensive and requires official permits" (CKRWI, 2024).

Upland communities in the Mekong are more vulnerable to seasonal shortages, where seasonal differences in the availability of clean water regularly translate into dry-season crises. In one survey, 49% of households reported that seasonal drought disrupted their water supply, with upland sites affected far more than urban areas (Lebel et al., 2022, 2023). Agriculture in hilly terrains is similarly strained by unpredictable rainfall and prolonged dry-season shortages. As one Khmer upland farmer recounted, "Soil is dry, infertile and difficult to improve. Sometimes, it is abandoned for six months in the dry season" (Huynh et al., 2024). In lowland communities, cooperative schemes owned and managed by residents can buffer scarcity (Tuomala, 2024). As one responded noted, "the water used in rice cultivation is supplied from the water cooperative [...]

farmers have enough water for their crops" (Huynh et al., 2024). These experiences show there can be stark geographical disparities in resilience.

Water quantity and quality

Along the Mekong, communities have observed changes in water quantity with deterioration in quality. Unnatural fluctuations in the river flow were reported with negative consequences on local fishing and riverbank vegetables, as attested in one of the projects: "All they know is the water in the Mekong is already flowing unusually which creates unnatural going up and down of river levels, leading to difficulties in capturing fish and growing riverbank vegetables" (IWMI, 2022b).Where surface water is unavailable or unreliable, communities rely on groundwater. However, a lack of access to pumping infrastructure and limited understanding of groundwater dynamics, such as in Savannakhet, Lao PDR, make this resource uncertain (Sychareun, 2023).

Floods

Flood occurrences, particularly during the rainy season, significantly impact livelihoods in the Mekong region, with people experiencing devastating financial effects from the loss of farms and homes. This is partly due to the lack of coping capacity in communities, which is impeded by the absence of early warning information systems and inclusive plans for flood risk reduction and management (Inmuong et al., n.d.; Khoeun et al., 2022a; *Koh Lat Millionaire Game*, n.d.; Nguyen, 2021; Oo et al., 2024; Sychareun, 2023). Seasonal floods can enrich soils and fisheries, but changing flood regimes due to dams and climate change have become erratic. As noted in one project in Viet Nam, in recent years, floods arrived later than usual and receded quickly, causing fish populations to decline. A local farmer in Nhon Hung commune, Tinh Bien district in lowland Viet Nam said, "in the past few years, after two rice crops, I could earn supplementary income from fishing during the flood season. However, in recent years, the flood has declined in height, and fewer fish are in the canal, so I have not been able to live on fishing in flood season. Instead, I have had to work as hired labor" (Thai et al., 2024a).

4.2 Water access, policy and governance

Underfunded agencies and income disparities limit infrastructure development and make water access challenging for poorer groups (SIWRR, n.d.; Lebel et al., 2022). The issues are further exacerbated by other social inequalities such as the exclusion of ethnic communities, migrant workers, and undocumented individuals from government services, including water. Marginalized communities – often living in remote, informal or peri-urban settlements without required IDs, despite their long-term residence in those places – lack access to water networks and rely on unsafe surface sources like river water (Lebel et al., 2022). Poor families who cannot afford the cost of drilling and equipping deeper wells receive less benefits from using groundwater (Pavelic et al., 2022), highlighting the need to ensure equitable allocation and distribution of water resources (IWMI, 2022a).

Gender and ethnic inequalities also limit participation in water governance. A policy brief from the S4A project focusing on gender and social inclusion in the management of transboundary wetlands management in Mekong Delta stated: “rural poor women in Cambodia’s Mekong Delta are excluded from decision-making structures, leading to the neglect of women's actual needs and their reluctance to participate in conservation efforts. This occurs when development agencies, local governance bodies, conservation organizations, and wealthy business groups impose passive participation, be it intentionally or not in practice” (Thuon, n.d.).

Based on field observations, Thai et al. (2024b) revealed that domestic responsibilities, which are customarily ascribed to women in Kinh and Khmer ethnic communities from a border province in Viet Nam, limit women’s time and capacity to attend meetings and decision-making discussions. While women participate to some degree in household and village-level activities, their representation in commune and district-level management remains significantly low. These imbalances limit inclusivity and reinforce existing inequalities in access to and governance of resources.

Policy incoherence across sectors – referring to conflicting priorities, lack of coordination, and fragmented mandates between government agencies – further aggravates these challenges. At the sub-national level, different sectors often pursue competing objectives for groundwater use, with limited integration between water resource management and economic development planning. For example, in Khon Kaen province, the drive for industrial groundwater extraction conflicts with conservation mandates, leading to over-extraction that drains hand-pump wells relied on by poorer households (Muenratch & Nguyen, 2022). This can have implications for communities that primarily rely on agricultural activities for their livelihoods. Declining groundwater level due to extraction, along with limited recharge potential because of erratic rainfall patterns, make shallow hand pumps ineffective and limit water access for poor communities who rely on those pumps (IWMI, 2022a).

4.3 Transboundary impacts and water governance

S4A researchers have looked closely at the transboundary issues in the region. The emerging indicators surrounding the issues include transboundary aquifer governance, institutional disjuncture, policy gaps (at the local, national, and regional levels), and power asymmetries in hydropower decision-making.

Transboundary aquifers in the Lower Mekong River basin have become an essential supplementary resource due to frequent surface water shortages but they remain unregulated, leading to declining water levels, quality issues, and seawater intrusion in delta areas. Despite recognition from regional organizations such as the Mekong River Commission (MRC), groundwater governance is often overlooked and is rendered ineffective (Gupta et al., 2022). The Cambodia–Viet Nam transboundary aquifer illustrates the governance challenges that arise when countries have divergent laws, priorities, and capacity levels. Cambodia’s groundwater policies remain fragmented and not fully implemented, while Viet Nam faces limited groundwater monitoring and weak stakeholder participation. The absence of bilateral agreements means each country continues to manage its portion independently (Upadhyay et al., 2024a).

Research conducted under S4A on transboundary wetland management between Cambodia and Viet Nam highlights the lack of collaboration in wetlands governance, noting that "there is not at present evidence of close interaction between practitioners or researchers addressing the problems facing the Mekong Delta wetlands between these two countries" (Nha, 2023).

The formal consultation process for addressing hydropower impacts is largely procedural, as indicated by stakeholder interviews in the research project concerning stakeholder participation in transboundary hydropower development at the Pak Beng Dam in Lao PDR. As a villager from Thongngam put it: "During the meeting, the company and relevant government ministry would mainly inform villagers about the dam design and its technical features. We villagers could only listen because we lack technical knowledge to join the discussion." This view was confirmed by an MRC official that was interviewed: "MRC PNPCA is designed mainly as a means for the company and the relevant government to present the planned hydropower dam development in terms of its overall design, how this can be improved to mitigate environmental impacts (e.g., ship lock for navigation, fish passage), and less on facilitating discussion with local community" (Suhardiman & Geheb, 2022).

These interlocking environmental stresses and governance failures show that water insecurities in the Mekong are multifaceted challenges. The intersections of geographical constraints and socio-economic inequalities amplify vulnerability, resulting in disparities of adaptative capacity and resilience.

4.4 COVID-19 and water insecurity

The COVID-19 pandemic caused widespread economic disruptions across the Mekong region. Lockdowns, mobility restrictions, and market closures led to reduced incomes, employment losses, and higher agricultural input costs, especially for smallholder and farm-based households (Lebel et al., 2023; Tun Oo et al., 2024a).

With respect to water insecurities, the pandemic further exacerbated existing water access challenges. Hygiene campaigns increased the need for clean water, yet many vulnerable communities – particularly informal settlements and rural areas – lacked adequate infrastructure. Restrictions on movement, high water prices, and seasonal shortages pushed vulnerable households to rely on unsafe sources (Lebel et al., 2023). These conditions underline the urgent need for improved household-level water infrastructure in peri-urban, informal settlements, rural and remote areas alongside integrated planning that addresses both health and water access in crisis contexts.

Some S4A projects intended to investigate COVID-19's effects on water insecurities and injustice, particularly through co-creation approaches. However, the complex nature of the pandemic and other contextual factors may have contributed to limited or less explicit articulation of these linkages in the results (IWCAN, 2022; CKRWI, 2024).

5. Interventions for reducing water insecurities in the Mekong region

Addressing water insecurities necessitates a multifaceted approach involving infrastructure development, technical advancements, increased hydrogeological knowledge, and strengthened policy and governance mechanisms tailored to region's specific needs. This section synthesizes implemented or proposed interventions identified across S4A-supported research across these areas.

5.1 Infrastructure development for water insecure areas

Numerous studies emphasized the need to invest in and expand infrastructure – such as water supply networks, rainwater harvesting, wells, and irrigation networks – to reduce water insecurities for remote and vulnerable communities.

In Viet Nam's uplands, communities respond to droughts and water shortages by constructing wells and ponds:

"Residents drill wells, build storage ponds, and save water for domestic uses, sharing when they must. Governments and residents agree that further investments in drilling groundwater wells, rainwater harvesting structures, enhancing storage, and watershed conservation are needed" (Lebel et al., 2022).

Similarly, research in a coastal province of the Lower Mekong Delta in Viet Nam has reinforced the recommendations to support poor communities with water storage and distribution infrastructure, rainwater harvesting tanks, water treatment plants, piped water, and building dike systems for water storage. It emphasizes the need to address varying levels and types of vulnerability, such as those affecting pregnant women and the elderly (Lam et al. 2024).

In Myanmar's coastal area, dikes and embankments are recommended as a significant adaptation strategy, to be implemented together with crop diversification for building communities' resilience to climate change (Tun Oo et al., 2024b). In regions of Lao PDR and Cambodia with limited access to electricity, the use of solar-powered pumping for irrigation is proposed as a cost-effective alternative to fuel-based pumping methods. This approach was integrated with crop diversification to enhance climate resilience or enhance incomes (Pavelic et al., 2022).

Beyond water supply infrastructure, in upland areas of Lao PDR and Cambodia, the S4A research project has implemented micro-habitats built with concrete and bamboo. The structures were designed to store water and create habitats for aquatic resources, thereby, enhancing food security. Communities were actively involved in the design, site selection and construction processes (Phouthavong, 2021).

However, financial constraints at the community and local authority levels impede the development of infrastructure. Without proper investments in remote upland or coastal regions, communities remain vulnerable to water insecurity. Some projects suggested

certain strategies to help bridge financial gaps – such as linking water management projects to broader WASH programs and aligning them with targets for SDG 6 (Lebel et al., 2022) and encouraging private sector investment (SIWRR, n.d.). These examples highlight that interventions must be tailored, adequately resourced, and designed with local ownership in mind to ensure long-term functionality.

5.2 Technological tools, adaptive practices and capacity building

Adaptive agricultural practices, groundwater monitoring, and remote sensing offer opportunities to improve water efficiency and planning. These technologies – ranging from satellite-based groundwater tracking to restoring canal irrigation and flood early warning systems – can significantly enhance communities' adaptation capacity (IWMI, 2022a; Phy et al., 2022; Upadhyay et al., 2024b). However, their success depends on paired investments in training, data literacy, and local co-financing.

For instance, a trial of adaptive agricultural practices – alternative wet and dry technique (AWD) in a coastal province in Viet Nam – has demonstrated its potential as an effective water conservation measure, but noted replicating or scaling requires peer learning, leadership skills, technical training and institutional backing (Huynh et al., 2024; Out-Scaling Water, 2023; Pham, n.d.).

In flood-prone areas of Lao PDR, adopting climate-resilient crop varieties such as flood-tolerance rice has been demonstrated. While the advantages of such varieties are evident, adoption is still limited. Research in Lao PDR proposed measures to increase the uptake of climate-resilient rice varieties, recommending increasing awareness and technical training for farmers and policymakers as well as facilitating peer-to-peer knowledge transfer (SEED-UP, 2023).

5.3 Building knowledge of hydrogeological systems

Understanding the intricate hydrogeological aspects of an aquifer or watershed is often the first step towards managing water resources and reducing water insecurity. Authorities in Mekong countries lack sufficient technical and human resources to conduct activities in key ecosystems, and S4A has undertaken research to increase understanding of hydrogeological systems. The findings of these technical studies are instrumental in establishing foundational strategies and management frameworks.

In flood-prone areas in Cambodia, researchers conducted multiple studies including assessing watershed health (Ka et al., 2022), flood hazard and management (Khoeun et al., 2022b; Phy et al., 2022), and climate change impacts on hydrological regimes (Sok et al., 2022). The findings from these studies can inform decision-making and support the development of long-term policies. For example, the assessment of groundwater usage and management in transboundary aquifers in the lower Mekong region of Cambodia, Lao PDR and Thailand can be useful to inform transboundary groundwater governance (Dhungana et al., 2024; Upadhyay et al., 2024a).

The direct contribution of the results from these studies are hard to trace, as long-term impact goes beyond the scope of the project and timeline. However, research findings from the groundwater system in Cambodia have already contributed to the development of a groundwater management framework that is the first of its kind (Gupta et al., 2021).

5.4 Strengthening local governance and community-based approaches

S4A research consistently emphasizes inclusive governance and community-based approaches to address water insecurities. Top-down policies often fail to fully consider the specific needs and context of local communities, particularly those affected by seasonal variations and resource scarcity.

Villages in Lao PDR coped with floods and droughts by applying Indigenous solutions and generational knowledge of observing water levels along with monitoring weather forecast news, often in the absence of formal support (Sychareun, 2023). This suggests a benefit in strengthening those existing community mechanisms. In Thailand, community-agreed rules for fair water allocation between upstream and downstream users in the mountain regions have proven effective during the COVID-19 outbreak. (Lebel et al., 2022). Similar approaches in the remote areas of Lao PDR, Cambodia and Thailand recommend decentralizing water management to the basin or Sub-watershed Committee, where communities can oversee local systems such as swamps, ponds, and groundwater with clearer roles and responsibilities (SIWRR, n.d.; Muenratch et al., 2022; Promphakping, 2021; Thuon, 2023).

A case study in Bangkachao, a small urban island surrounded by canals near Bangkok, highlighted the value of participatory research and bottom-up approaches. Stakeholder consultations conducted by the research team enabled community input in the management of the main water gate, improving flood control and water flow. The process facilitated continuous collaboration and led to the establishment of the Bangkachao Water User Organization (WUO), a registered community body that articulates local needs to governmental authorities (Kittiprapas & Daniere, 2025).

However, governance fragmentation and social exclusion pose significant challenges (Thuon, n.d.). A wetland governance study in Cambodia and research in Viet Nam recommended stronger coordination across institutions and greater inclusion of marginalized groups in decision-making processes (Huynh et al., 2024; Thuon et al., 2023).

5.5 Improved transboundary water governance and policies

S4A research emphasizes the need for inclusive, multi-level approaches to improve transboundary water governance in the Mekong region. In the context of transboundary aquifers, there is a strong emphasis on the need to have dialogues to build consensus and to make decisions collaboratively. S4A projects have identified a

need to form an institutional organization as a Coordinating Council or a Multi-Country Consultative Body, together with enhancing stakeholder capacity and developing shared data systems for aquifer management (Gupta et al., 2022).

Transboundary governance in the Mekong region is not only about improving national and regional policy. S4A research has shown reinforcing local actors such as inter-village networks, civil society organizations (CSOs), and non-governmental organizations (NGOs) can be a pathway to more equitable and transparent governance, amplifying community voices in transboundary settings (Suhardiman et al., 2022). For instance, in Thailand, local CSOs and the Mekong People's Forum have successfully mobilized communities to challenge transboundary dam projects through legal and policy mechanisms, ensuring that local knowledge and concerns are recognized. As a villager from Huai Luek noted a 2020 interview, "We have a lot of people working together as a network, from the north and the northeast regions, many provinces. We can identify our clear goals, what to achieve, do and act. The forum will be a place where people can communicate ideas, concerns and problems and where we can share information" (Suhardiman et al., 2022).

However, the research noted that in Lao PDR, the absence of strong social movements and the prevalence of inter-village competition have weakened collective bargaining power (IWMI, 2022b; Suhardiman et al., 2021). Unlike in Thailand, projects like Pak Beng in Lao PDR are perceived as driven by the state, leaving little room for contestation by community members or groups (Suhardiman et al., 2022).

In any case, a key pathway to improved transboundary governance can still be strengthening grassroots actions that can collectively negotiate with developers and policymakers. Simplifying technical information, promoting participatory research, and enhancing local participation in governance processes such as public consultations are essential to address existing power asymmetries and enable informed community engagement (IWMI, 2022b).

6. Policy recommendations from SUMERNET research

As water insecurities in the Mekong region persist, various actors – such as local, national and regional decision-makers, international organizations, NGOs, CSOs and other regional networks – can adopt a multifaceted approach to strengthen resilience and foster sustainable and inclusive water management. In line with SUMERNET's core principles, these recommendations emphasize the importance of inclusivity and bottom-up approaches, recognizing that sustainable solutions must be grounded in the experiences, knowledge and leadership of marginalized communities, women, youth, Indigenous groups and vulnerable communities.

The following recommendations draw from the challenges and findings previously discussed, focusing on strengthening and building on approaches that promote inclusive, adaptive and context-specific water management.

6.1 Empower community-led and decentralized water resources management

Drawing on the earlier discussion on community-led initiatives, it is critical to empower local communities to take an active role in water governance and decision-making (IWCAN, 2022; Sychareun, 2023). This is particularly necessary in remote villages where there is disconnection from and limited outreach by government or local authorities. These empowerments must be accompanied by necessary tools and education, and should be supported by appropriate policies and practical programs that focus on disadvantaged communities (Huynh et al., 2024). Additionally, national governments and policymakers can support decentralized governance models that enable local actors to better manage resources, addressing specific local challenges like seasonal scarcity and groundwater extraction. To further these efforts, SUMERNET can continue building on participatory research and capacity building programs for researchers and community leaders.

6.2 Invest in people-centred, community-based water infrastructure and technical innovations

For vulnerable local communities in rural and remote areas and water-scarce regions, national governments should prioritize investing in community-based solutions such as household groundwater wells, rainwater harvesting systems, and expanded irrigation pumping stations. These solutions should be coupled with setting up monitoring network and data infrastructure for groundwater and water quality monitoring for sustainable water management.

Policy frameworks should encourage public-private partnerships, especially in financing these infrastructures, while aligning projects with SDG 6 targets for water access and sanitation. International organizations and NGOs can contribute technical and financial assistance to these projects. They can also facilitate the transfer of

technologies and promote investment by supporting the integration of infrastructure projects with broader development initiatives, such as rural development and climate resilience programs.

6.3 Strengthen policy engagement initiatives to address gaps in governance and enhance inclusivity

To address the challenges identified around governance gaps and community involvement, strengthening policy engagement through multistakeholder engagement approach is essential. As projects have shown working closely with local authorities and policymakers early in the research process, SUMERNET can facilitate the integration of local needs into policy agenda (Inmuong et al., 2024; Thuon, n.d.). This approach can lead to more locally responsive and adaptative policies that are translated from the realities on the ground.

International organizations should work with national governments to strengthen local governance structures through technical support, knowledge-sharing platforms, and resources for community-led water management initiatives. They should also advocate for the inclusion of marginalized groups, such as women and Indigenous communities, in governance processes. By adopting a bottom-up approach, where local communities – particularly women, ethnic communities, youth and economically disadvantaged groups – are actively involved in governance, SUMERNET can contribute towards policies that are more reflective of diverse needs.

6.4 Improve multi-level governance for transboundary water management

To improve governance of transboundary water resources, national governments and regional bodies like the Mekong River Commission (MRC) should support the establishment of dedicated coordinating bodies – such as bi-national or multi-national councils – for specific aquifers. These bodies should enable transparent groundwater use, facilitate regular data sharing, and align with sustainability goals.

Stakeholder engagement in transboundary hydropower consultations must also be strengthened to ensure meaningful participation by affected communities. In parallel, harmonizing national water policies is critical to address conflicts between development objectives and resource management.

6.5 Expand collaborative knowledge-sharing and learning platforms

As noted in previous sections, co-production of knowledge is a powerful approach in enabling local communities influence in decision-making and resource governance. Strengthening and expanding collaborative knowledge sharing and learning platforms can deepen engagement with diverse stakeholders, including local communities, CSOs, researchers, Indigenous communities, and policymakers. These platforms should focus

on shared learning, ensuring the context-specific solutions are co-created and adapted to the needs of local communities. National governments and regional organizations such as MRC can put more effort into hosting and facilitating those platforms, while development partners can also finance the establishment of such platforms. Regional networks like SUMERNET should consider establishing thematic groups or communities of practice that can enhance the interactions with concepts like co-production and GESI, building the capacity of researchers in the Mekong region.

Boxes 1–3 expand further on the beneficial role of GESI, knowledge co-creation, and multistakeholder engagement in decision-making.

BOX 1. GENDER EQUALITY AND SOCIAL INCLUSION (GESI) AS A FRAMEWORK FOR INCLUSIVE DECISION-MAKING

The gender equality and social inclusion (GESI) framework promotes meaningful inclusion of diverse and commonly excluded groups in natural resource management. Across S4A's projects, this framework has helped highlight disparities in water access, governance, and decision-making power for women, ethnic minorities and other marginalized groups. For example, the use of a GESI framework in the Vietnamese Mekong Delta–Cambodia border helped show that while Khmer women had more say in decision-making at the household level compared to Kinh women, both groups lacked decision-making power in wetland management at the commune level (Thai et al. 2024a).

Beyond highlighting shortfalls, S4A has also enhanced stakeholder awareness, as an wetland management stakeholder interviewee in Viet Nam reported increased attention to women's participation: "[...] I am more aware of the importance of increasing women's participation in water and wetland management so I will include it in my works and share with my colleagues about its importance" (Nha, 2023).

BOX 2. CO-PRODUCTION OF KNOWLEDGE

S4A emphasizes co-learning and co-design by actively involving communities and local authorities throughout the research process to address water insecurities. As noted by one study, "Knowledge is power, and this project aims to address underlying power imbalances through building knowledge from the grassroots" (IWCAN, 2022).

Successful examples include participatory flood risk management in Thailand, where researchers, municipal officials, and communities co-created flood risk maps and an early warning system (Inmuong et al., 2024). Innovative tools like serious games have also supported inclusive learning and planning by simulating wetland–development–climate interactions (Koh Lat Millionaire Game, n.d.). While co-production improved engagement and relevance, further work is needed to assess their long-term impact on governance and institutional change.

BOX 3. MULTISTAKEHOLDER ENGAGEMENT

Multistakeholder engagement helps resolve conflicts, build trust and facilitate open communications among diverse water users (Langsdale & Cardwell, 2022). If designed effectively, it strengthens the links between community feedback, technical knowledge, and policy decisions.

S4A's projects demonstrated this in practice. In Khon Kaen, Thailand, a participatory research project on flood management has led to a significant step, stating "[...] the national decision maker at the Office of The National Water Resources, Thailand (ONWR) initiated a substantial push toward proposing a large-scale flood mitigation project, exceeding the project's initial expectations" (Inmuong et al., 2024). Another study emphasized that close collaboration with local authorities and water providers can influence how adaptation priorities are integrated into water infrastructure investments and planning (Lam, 2021).

7. Future priorities for SUMERNET and other regional networks

While the S4A research program has significantly advanced understanding of water insecurities across the Mekong region, some critical gaps remain. Future studies should deepen analysis of transboundary groundwater and wetland governance, focusing not only on hydropower but also on neglected areas like agricultural drainage, fisheries management, and emerging contaminants. Furthermore, better integration of land-water -climate linkages is needed to understand cumulative impacts at basin and sub-basin levels.

Expanding interventions for reducing water insecurities

Addressing water security requires a broader portfolio of interventions beyond infrastructure. Future actions should emphasize ecosystem-based adaptation approaches (e.g. wetland restoration, agroecology), decentralized water systems for vulnerable communities, and integrated early warning systems that are accessible to marginalized populations. Strengthening the evidence base on low-cost, expandable, and community-driven water management options would support more inclusive adaptation pathways.

Continuing engagement and participation of youth

Youth groups represent critical actors for driving innovation, mobilizing grassroots movements, and sustaining long-term resilience strategies. SUMERNET should continue and strengthen the participation of youth in not only research projects, but also regional dialogues. Future projects should embed youth leadership training (e.g. on negotiation, advocacy) in addition to current participatory research opportunities (e.g. fellowships, fieldwork). They should also co-design spaces where young people can contribute to water interventions at community, national and transboundary levels through partnerships with other regional youth networks or program.

Private sector roles in reducing water insecurities

There is little engagement with private sector actors in research itself across the reviewed projects – this is despite their increasing influence on water resources through agriculture, hydropower or manufacturing. Future research and interventions should explore mechanisms for private sector accountability, incentives for sustainable water use, and public-private partnerships that promote climate resilience and water stewardship. Aligning private investments with water security goals could unlock critical resources and innovation.

Research on transboundary cooperation and multi-level governance

While transboundary governance for major river basins has been a focus area for studies, research remains limited for smaller river basins and aquifers.Some studies are conducted in a transboundary basin, but the delineation of the study area itself is only within a single country, for example in Thailand (Pinsri et al., 2022). A study in Viet Nam–Cambodia border wetlands was limited in its engagement with transboundary cooperations as the study found there was extremely limited or no collaboration or coordination between the countries (Nha, 2023). These limitations highlight the need for more effort in studying transboundary interactions in smaller river basins, wetlands and groundwater aquifers.

While transboundary governance has been a focus area, particularly around hydropower and groundwater, gaps remain in multi-level coordination, especially across local, sub-national and national scales. Strengthening institutional linkages, promoting inclusive cross-border dialogue platforms, and clarifying roles and responsibilities among ministries and agencies are critical to improving governance effectiveness. SUMERNET should also continue to facilitate mechanisms to ensure marginalized voices such as women, ethnic minorities, and river-dependent communities are systematically included in decision-making.

Disability inclusion, Indigenous groups, and local wisdom

Documentation of the needs and contributions of people with disabilities and Indigenous Peoples remains sparse. Future research should explicitly integrate disability-inclusive approaches in water and climate adaptation strategies, ensuring that early warning systems, infrastructure, and consultation processes are accessible to all. Furthermore, greater recognition and incorporation of local wisdom – such as Indigenous flood management practices and traditional groundwater knowledge – would strengthen resilience strategies and foster more culturally grounded solutions.

Inclusion of action research and pilot demonstrations

Future SUMERNET and regional network initiatives should prioritize action research and pilot demonstrations. These approaches enable testing of community-driven solutions in real-world settings while generating practical evidence for policy and scaling. Embedding action research strengthens the relevance of findings, ensuring adaptive strategies are grounded in the realities of marginalized communities most affected by water challenges.

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Annex 1. Number of documents according to reference type

No	Project Title	Title Abbreviation	No. of project outputs by type											
			Journal paper				Policy brief	Conference paper	Project reports		Media article	Thesis	Field note	Proposal
			Published	Under review	Abstract	Under preparation			Midterm	Final				
1	**Strengthening pathways for rights-based approaches in Mekong hydropower: Towards inclusive and sustainable growth**	Pathways for rights-based approaches in Mekong hydropower	3		1					1	2			1
2	**Bringing more than food to the table: precipitating meaningful change in gender and social equity-focused participation in transboundary Mekong Delta wetlands management**	BRIMOFOT	2				2	1		1		1		1
3	**Enhancing Aquatic Habitats in Upland Environments**	ENAHA							1					1
4	**Collaborating Water Management for Small-Scale Hydropower Dams in Viet Nam, Laos and Cambodia**	VICA	3						1					1
5	**The role of wetlands in water security for the Mekong region**	Wetlands for Water Security	1	1				1	1	1				1
6	**Enhancing the Preparedness of Rice Production to Water Scarcity in the Lower Mekong Basin: A Transdisciplinary Approach**	HCE&RAC	5				2		1	1				1
7	**Atmospheric deposition to large river basins and potential effects on the water environment (DEPOSITION)**	DEPOSITION	2				1			1				1
8	**Strengthening the Adaptive Capacity and Resilience of Agriculture and Aquaculture-dependent Livelihoods: Case Studies of Selected Disaster Prone Villages in Vietnam and Myanmar**	AA-Adapt	2				2		1	1				1
9	**Identifying barriers to sustainable and inclusive groundwater use for marginalized rural communities in the Mekong region**	Sustainable and inclusive groundwater use for agriculture in the Mekong (Groundwater Agri)	1			1	2	1		1		1		1
10	**Integrated assessment of domestic water accessibility for vulnerable communities in the Lower Mekong Basin**	IODA-LMB		1			3		1				2	1
11	**Strengthening Groundwater Governance in Rapidly Urbanizing Areas of the Lower Mekong Region**	Groundwater Governance in Lower Mekong Region (GIRA)	6					7	1		2			1
12	**Out-scaling Water Saving Innovations to Reduce Water Insecurity Conditions of Poor and Marginalised Communities in Vietnam's Upper Mekong Delta**	Water Savings Innovations & Water Insecurity Reduction – Vietnam Mekong Delta	2				1			1	2			1

No	Project Title	Title Abbreviation	No. of project outputs by type											
			Journal paper				Policy brief	Conference paper	Project reports		Media article	Thesis	Field note	Proposal
			Published	Under review	Abstract	Under preparation			Midterm	Final				
13	**Assessment of Groundwater Sustainability in the Special Economic Zone of Thailand for Operational Groundwater Management**	Groundwater Infrastructure Sustainability Assessment (GISA)	1				1	1						1
14	**Evaluating Social and Environmental Impacts of Intensive Rice Production and Pesticide Use on Water Quality in the Lower Mekong Region: Case Studies of An Giang, Vietnam and Chiang Rai, Thailand**	SERUWA							1					1
15	**Participatory Flood Risk Management: A Case for Policy Implication from Ban Phai Municipality Thailand**	PFRM-Ban Phai					1	1		1				1
16	**Reaching more farmers to better cope with climate change: A practical approach to scaling up flood-tolerant seed variety in Lao PDR**	SEED-Up								1				1
17	**Strengthening flood risk management induced by climate change in Stung Sen River Basin, Cambodia**	Flood Cam	5			2	4	6		1		5		1
18	**Listening to voices on the margins: lessons from the COVID-19 crisis for improving access to clean water for drinking and hygiene in the Mekong Region**	VOICES	3							1				1
19	**Co-creating Knowledge to Enhance Women's Leadership for Inclusive River Governance and Livelihood Resilience in the Mekong Region**	Co-creating Knowledge to Enhance Women's Leadership in the Mekong Region (CKEWL)								1				1
20	**Towards mainstreaming the Ecosystem-based Adaptations for Sustainable Groundwater Resources Management in the Transboundary Cambodia-Viet Nam Mekong Delta Aquifer, Lower Mekong Region**	GEBA	1				2	1				1		1
21	**Co-creation of Knowledges as a process to respond to water injustices of marginalized communities in Mekong Region Water Politics**	Co-creation to respond to water justice in Mekong Region (CKRWI)					1			1	1			1
22	**The Pulses of the Mekong River Basin: Sayyabouly Province (Laos) and Hau River (Vietnam), the Livelihoods of Farmers and Fishermen on the rivers**	Pulse of the Mekong river and Fisherman Livelihood (PMFL)	1							1				1
23	**Water security vulnerability and adaptation (V&A) assessment due to water-related disasters Lao PDR**	VAWI	1						1	1				1

No	Project Title	Title Abbreviation	No. of project outputs by type											
			Journal paper				Policy brief	Conference paper	Project reports		Media article	Thesis	Field note	Proposal
			Published	Under review	Abstract	Under preparation			Midterm	Final				
24	**Enhance community resilience to climate change-modified water hazards in the Vietnamese Mekong Delta coastal zone (CoRe)**													1
25	**A straw fermentation model for buffalo fattening to adapt to under water scarcity in Giang Thanh district for Khmer women.**													1
26	**Leveraging Small-Scale Local Water Management Strategies in the Lower Mekong River: Kalasin,Thailand**									1				1
27	**10 years changes of livelihoods in flood-prone areas in the Mekong Delta of Vietnam**									1				1
28	**Multi-stakeholder dialogue in addressing community-based water management problems in Bangkajao greenspace**		1											
29	**Rethink the Hydropower Development Policies and Socio-Economic Rights of Affected Communities in Cambodia through Human Rights-Based Approaches**													
30	**S4A PhD project**		1											
			41	**2**	**1**	**3**	**22**	**19**	**9**	**18**	**7**	**8**	**2**	**27**
													Total	**159**

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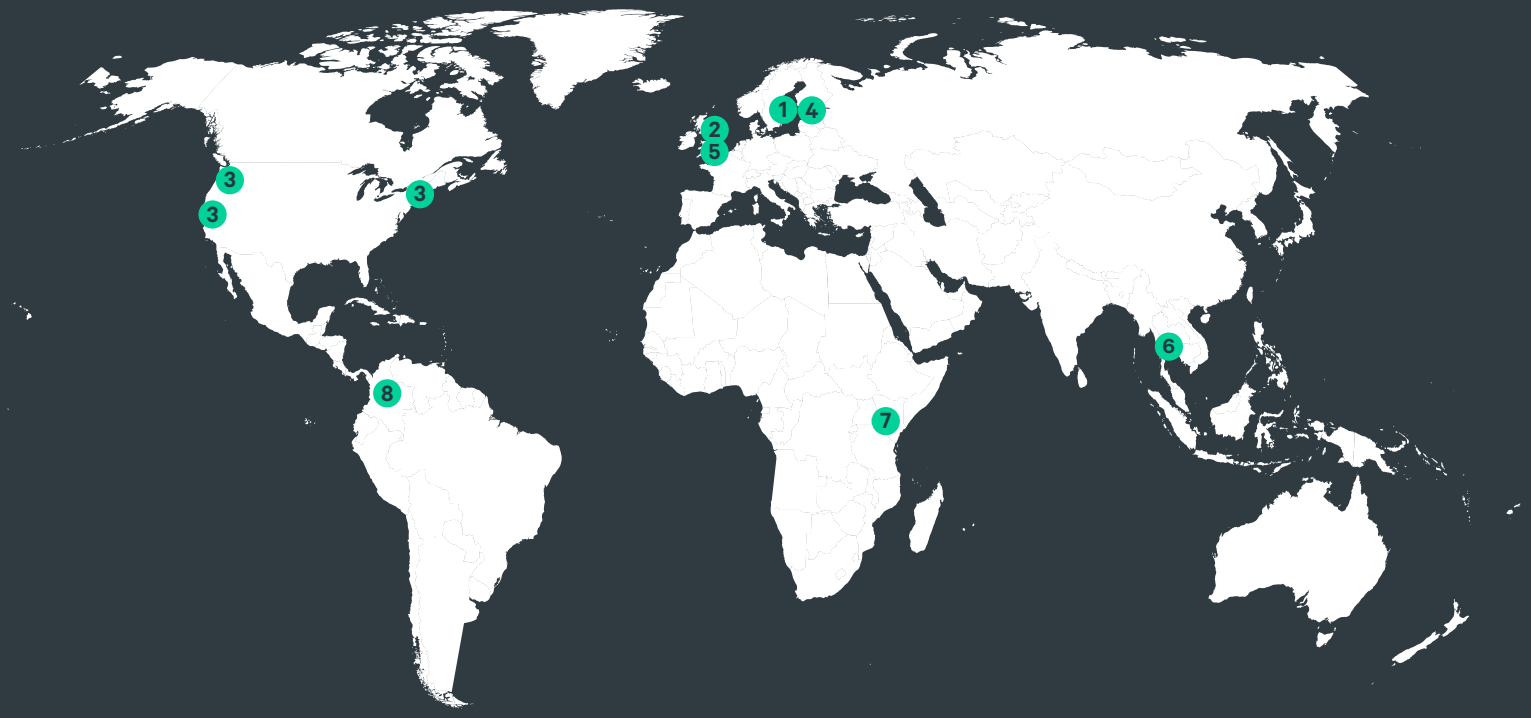

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