Vietnam Salinity Scoping Study Report

October 2025

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Abstract

Salinity intrusion is becoming one of Vietnam's most critical climate challenges, threatening agriculture, freshwater resources, and rural livelihoods—especially in the Mekong Delta and increasingly in coastal areas of Central and Northern Vietnam.

This Vietnam Salinity Scoping Study, conducted under the Saline Water & Food Systems (SW&FS) Partnership co-led by NFP and NWP, aims to provide an evidence base for long-term cooperation between Vietnam and the Netherlands. The study identifies key trends, policy responses, and opportunities for joint action.

Findings show that while Vietnam's strategies have shifted toward integrated, science-based adaptation (Resolution 120/NQ-CP, 2017 and Resolution 57/NQ-CP, 2024), challenges remain in local implementation, data integration, and early warning. Strengthened public–private–academic collaboration is essential to scale resilient, technology-driven, and market-oriented solutions.

Multiple initiatives are being implemented by government agencies, research institutes, cooperatives, and private actors, yet they remain fragmented and limited in scale. Strengthened public–private–academic collaboration is needed to accelerate technology transfer, mobilize green finance, and scale up successful saline-adaptive farming models.

The scoping study proposes the establishment of a Bilateral Knowledge Hub on Saline Agriculture, a National Program for Food Production in Saline Environments, and enhanced international financing mechanisms to scale effective solutions for sustainable food systems in a saline-affected future with various stakeholders involved in.

Chapter 1: Introduction

The Saline Water & Food Systems (SW&FS) Partnership, convened by the Netherlands Food Partnership (NFP) and the Netherlands Water Partnership (NWP), brings together Dutch and local actors to jointly address salinity-related challenges in low- and middle-income countries. The Partnership is currently advancing a strategic "country approach" in four priority countries: Egypt, Bangladesh, Vietnam, and Senegal. As part of this approach, strategic data collection is undertaken in each country to inform the design of multi-annual action plans.

In Vietnam, salinity intrusion is a critical threat to agriculture, water security, and rural livelihoods, with impacts varying across regions such as the Mekong Delta, central coastal provinces, and the Red River Delta. This isue was reflected during Dutch trade mission 2024 in Vietnam and the Embassy of the Kingdom of the Netherlands (EKN) expressed wish for Impact Cluster on Salinity. The objective of this scoping study is to analyze the salinity challenges in Vietnam, review current responses, and identify key actors and programmes. By consolidating this information, the study provides a foundation for shaping a multi-annual action plan under the SW&FS country approach, ensuring coordinated and effective engagement of Dutch and Vietnamese stakeholders.

With a study methodology of desk review of national policies, donor programs and scientific literature, combined with semi-structured interviews with national and provincial agencies, cooperatives, private sector and research institutes. The scoping is intentionally pragmatic - aimed at identifying implementable farm-level measures and partnerships. The scoping report is aimed at being accessible to a broad, non-technical audience. This scoping report synthesizes current evidence on salinity intrusion across Vietnam with a primary focus on the Mekong Delta and provides recommendations and a practical roadmap prioritized at farm and cooperative levels.

Chapter 2 Context of Vietnam

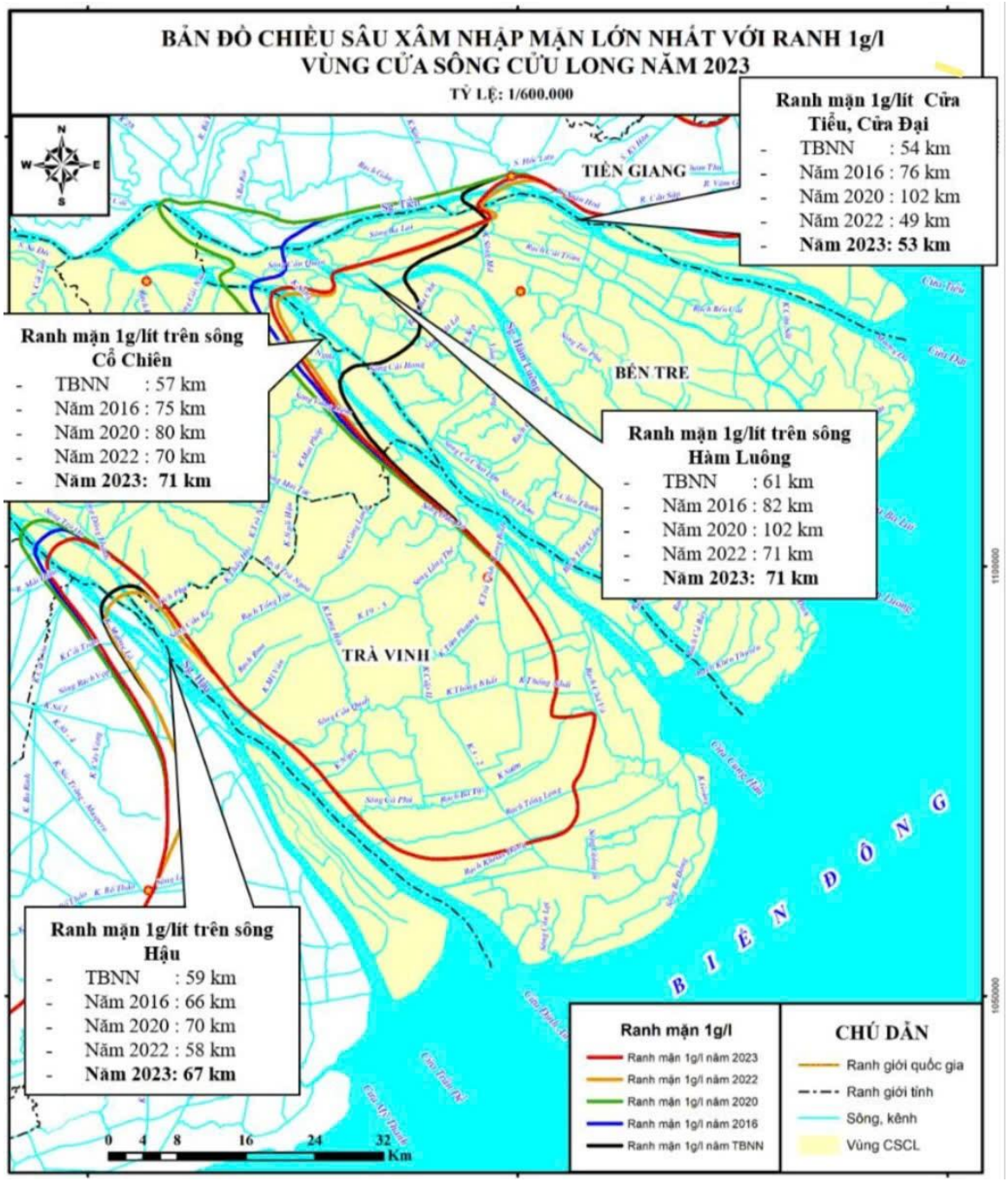
Salinity intrusion has emerged as one of the most critical climate-related challenges for the Mekong Delta, the country's "rice bowl" and a hub for aquaculture and horticulture production. Over the past decade, repeated El Niño events have caused prolonged salinity intrusion, pushing seawater up to 70–100 km inland during severe dry seasons. In 2016, 2020, and again in 2024, salinity intrusion reached record depths, damaging hundreds of thousands of hectares of rice, fruit orchards, and aquaculture ponds, and disrupting domestic water supplies for millions of households. The problem is no longer episodic but systemic, undermining the resilience of food systems and threatening livelihoods.

The Mekong Delta is facing increasing salinity intrusion, reflected in the inland advancement of the 4‰ (NaCl) isohaline and the progressive salinization of coastal aquifers. Key hotspots include the Ca Mau Peninsula, Go Cong (Tien Giang), Northern and Southern Ben Tre, Long Phu – Tiep Nhat, Quan Lo – Phung Hiep, and transition zones in Long An, Tien Giang, and Soc Trang.

The main drivers are a combination of changing Mekong River flows, incomplete and uncoordinated operation of water infrastructure, overexploitation of groundwater, and the impacts of climate change (sea level rise, tidal variability). In coastal areas, shallow aquifers are increasingly saline, while excessive groundwater pumping leads to declining water tables and land subsidence.

Recently, salinity intrusion occurred earlier than usual, beginning on December 16–20, 2022 — about one month earlier than the multi-year average, half a month later than the 2015–2016 dry season, one month later than the 2019–2020 dry season, and half a month earlier than the 2021–2022 dry season.

The salinity intrusion depth in 2023 was higher than both the multi-year average and 2022, but still lower than in 2016 and 2020.



Map of salinity intrusion depth at the Mekong estuary in 2023 (by Dr. Tran Thai Hung)

Recurrent El Niño events, upstream flow changes and sea level rise have intensified salinity intrusion episodes. The 2016, 2020, and 2024 events were among the most severe in recent decades. The 2022–2023 dry season showed early onset and an early peak in some estuaries.

Key comparative points (selected years):

• 2016: One of the deepest intrusion events observed; late peak relative to some other years.

• 2019–2020: Very severe intrusion with deep inland penetration, used as benchmark for recent events.

• 2021–2022: Milder in timing compared with 2022–2023 (2022–23 was earlier).

• 2022–2023: Onset: 16–20 Dec 2022 (≈ 1 month earlier than multi-year average); Peak: 3–7 Mar 2023 (Tieu–Dai: 2–3 Feb). Maximum 1 g/l isohaline intrusion depth in 2023 was higher than the multi-year average and 2022, but lower than 2016 and 2020

Existing tools include hydrodynamic and salinity intrusion models (MIKE, HEC-RAS, SOBEK, VRSAP, DELTA) and scenario-based projections referencing IPCC (2007) and Hoanh et al. (2003). Several Vietnamese research institutes and universities, including Can Tho University, have developed maps and projections under projects such as CLUES.

Academic and research institutions play a critical role: generating scientific evidence, modeling and forecasting, assessing socio-economic and ecological impacts, training and technology transfer, and advising on technical and policy solutions.

The application of mathematical modeling tools, particularly hydrodynamic and salinity intrusion models, is highly effective for analyzing and assessing water dynamics in estuarine and tide-affected regions such as the Mekong Delta. At present, a wide range of hydrodynamic models have been developed and applied both internationally and in Vietnam, including the MIKE model suite from Denmark, HEC-RAS from the United States, SOBEK from the Netherlands, and Vietnam's own VRSAP and DELTA models

While the Mekong Delta remains the most critical hotspot of salinity intrusion in Vietnam, recent studies confirm that the challenge is not confined to the South. In Central Vietnam, particularly in the Vu Gia–Thu Bon river basin and coastal provinces, salinity intrusion has become more frequent and prolonged. Reduced upstream flows, sea level rise have combined to intensify saline water penetration into urban and agricultural areas, threatening irrigation supply for vegetable and fruit production near coastal zones. Similarly, in Northern Vietnam's Red River Delta, evidence shows growing risks of groundwater salinization and the inland migration of the saltwater boundary. Over-extraction of groundwater, sea level rise, and reservoir regulation are identified as key drivers, with model simulations suggesting that future management choices will strongly influence salinity patterns.

These developments imply that salinity intrusion is a nationwide adaptation challenge, requiring integrated solutions beyond large-scale infrastructure. For horticulture in particular, the risks in Central and Northern coastal areas highlight the need for salt-tolerant varieties, protected cultivation systems, and smart irrigation, technologies where Dutch expertise can make a direct contribution. Extending cooperation pilots beyond the Mekong Delta to selected provinces in Central and Northern Vietnam would demonstrate scalability, strengthen basin-wide data sharing, and ensure that climate-resilient horticulture systems are established across the country, not only in the South.

For Central and Northern coastal areas, many projects are localized and fragmented, making it difficult to address salinity intrusion at a basin-wide scale. Infrastructure,

such as the Thao Long Dam in Hue, suffers from aging and maintenance gaps, reducing effectiveness. Ecosystem-based measures remain small in scale and often conflict with intensive aquaculture or land development. Research findings on groundwater and salinity intrusion are not consistently translated into actionable policy or integrated into local decision-making. Some key lessons from Central and Northern Vietnam mirror those from the Mekong Delta:

Infrastructure must be complemented by ecosystem solutions**.** Hard engineering alone cannot secure long-term resilience without mangrove restoration, watershed protection, and diversified livelihoods.

Maintenance and sustainability matter**.** Even large-scale dams require continuous investment in operation, repair, and adaptive design.

Knowledge must inform in practical way. Studies on aquifers and salinity intrusion should be linked to planning frameworks, groundwater governance, and community-level adaptation.

Integration across scales is essential. Effective salinity management requires aligning local interventions with basin-level water resource planning, particularly in river basins such as the Huong, Cai, and Red Rivers.

In conclusion, Central and Northern Vietnam offer important lessons in balancing engineered infrastructure with ecosystem and community-based approaches. Building on these experiences will be critical for scaling resilient models and ensuring sustainable freshwater security beyond the Mekong Delta.

Chapter 3: Policy framework and programmes

Salinity intrusion has emerged as one of the most pressing climate-related challenges in Vietnam, particularly in the Mekong Delta. Recurrent episodes of early and severe saltwater intrusion- aggravated by upstream hydropower development, sea level rise, and prolonged drought have resulted in significant agricultural losses, drinking water shortages, and long-term threats to livelihoods. In response, the Vietnamese government has gradually built a policy framework that integrates immediate crisis management with longer-term adaptive strategies. The Government of Vietnam has recognized salinity intrusion as a national priority.

A review of key policy documents shows both continuity and evolution in the state's approach. Early instruments such as Directive 09/CT-TTg (2016) and subsequent Notice 47/TB-VPCP (2016) were framed as urgent instructions from the Prime Minister to mobilize resources against severe salinity intrusion events. These documents primarily emphasized emergency measures - water storage, temporary irrigation adjustments, and urgent support to affected households. Similarly, the Prime Minister's Telegram 601 (2020) highlighted short-term responses to combined drought and salinity shocks. The Prime Minister's Official Dispatch No. 04/CD-TTg (2024), directing localities and ministries to respond to the risk of drought, water shortage, and saltwater intrusion in the dry season of 2023-2024 in the Mekong Delta and other regions. The Official Dispatch requires proactive implementation of response solutions, including forecasting and providing information on water resources, developing

effective water use plans, and deploying prevention and control measures appropriate to the actual situation to protect agricultural production and people's lives.

At the strategic level, broader frameworks such as Resolution 120/NQ-CP (2017) on the sustainable development of the Mekong Delta, the Irrigation Law (2017), the Law on Water Resources (2023), and the Water Resources Strategy to 2030 (with Vision to 2050) mark a shift toward long-term resilience. They stress integrated water resource management, infrastructure development, the promotion of salinity- and drought-resilient crops, and livelihood diversification. The Mekong River Basin Planning and bilateral cooperation programs further recognize the regional and transboundary dimensions of salinity intrusion, particularly in terms of upstream dam operation and data sharing.

Across these policies, several consistent measures stand out. First, the state prioritizes infrastructure investments, such as sluice gates and irrigation systems, to control saltwater intrusion. Second, scientific and technological approaches are promoted, including salinity monitoring, forecasting, and the adoption of salt-tolerant rice and aquaculture models. Third, there is growing attention to institutional coordination, through the establishment of regional councils and integrated planning mechanisms.

Nonetheless, the policy framework reveals persistent gaps. Many instruments remain reactive, triggered by crisis years, and heavily reliant on engineering solutions, with limited emphasis on community-based adaptation and ecosystem restoration. While Resolution 120 set out a transformative vision, operational guidelines for linking early warning systems, local governance, and farmer decision-making remain underdeveloped. Moreover, transboundary cooperation, though recognized, continues to face political and practical constraints.

In summary, Vietnam’s policy response to salinity intrusion demonstrates both progress and fragmentation. It has evolved from ad hoc emergency directives toward more integrated and forward-looking strategies, yet practical implementation lags behind. For future resilience, there is a clear need to strengthen monitoring and early warning systems, mainstream livelihood adaptation into policy execution, and enhance coordination between national, provincial, and transboundary actors.

The Resolution 120 (2017) and related policies reframed adaptation towards 'living with and adapting to salinity” and multi-sectoral integration. Resolution 57 (2024) advances science, technology and digital transformation as national priorities -creating space for IoT/AI/Big Data interventions in agriculture. It marked a paradigm shift from “fighting salinity” to “living with and adapting to salinity, floods, and droughts,” promoting adaptive agricultural systems and multi-sectoral integration. This change in mindset has opened opportunities for piloting adaptive agricultural models, testing new technologies, and promoting integrated solutions across different regions. Several noteworthy models and initiatives illustrate how adaptation is being pursued in practice. Vietnam’s response to salinity intrusion has increasingly shifted from fragmented emergency actions to large-scale, donor-supported programs that integrate water management, livelihood adaptation, and ecological restoration. A mapping of recent and ongoing initiatives reveals several important trends.

First, World Bank–supported projects such as the *Integrated Climate Resilience and Sustainable Livelihoods Project (WB9)* and the *Mekong Delta Climate Resilience and Integrated Transformation Project (MERIT – WB11)* represent the most comprehensive interventions. These projects prioritize integrated water management, resilient infrastructure, and livelihood diversification across multiple provinces. Their large budgets and wide coverage make them central pillars in building resilience against salinity intrusion.

Second, multi-donor commitments notably the *USD 2.2 billion package from six development banks* and *16 ODA-financed sustainable development projects* underline the recognition of salinity intrusion as a systemic development challenge. These programs focus heavily on transport and water infrastructure, helping to safeguard freshwater supplies and reduce the vulnerability of agriculture to saline shocks.

Third, ecosystem-based and community-oriented initiatives add a critical layer of adaptation. *Mangrove Restoration via Sustainable Shrimp Farming (Germany)*, and *Enhancing Climate Resilience of Coastal Communities (BMZ- German Federal Ministry for Economic Cooperation and Development, Bread for the World, ActionAid)* highlight the role of coastal ecosystems in buffering saline intrusion and protecting vulnerable populations. These projects link biodiversity conservation with livelihood resilience, offering alternatives beyond hard-engineering solutions.

Fourth, knowledge and governance platforms such as the *Mekong Delta Climate Resilience Programme (GIZ)* and the *Sustainable Development Forum 2045 (Can Tho University and partners)* strengthen institutional capacity, coordination, and innovation. They reflect growing recognition that salinity management requires cross-sectoral and cross-provincial collaboration, not isolated local responses.

Besides, some initiatives have been implemented such as:

Salt-tolerant rice varieties and seed systems

Developing and disseminating salt-tolerant rice varieties is one of the most visible adaptation measures. For example, the RVT variety was successfully introduced in the North Central Coast under a project by the Centre for Sustainable Rural Development (SRD), enabling farmers to sustain production in saline soils. In the Mekong Delta, BLR103 and BLR105 varieties have been promoted in Bac Lieu province, showing both high yields and tolerance to brackish water. More recently, the HATRI-200 variety was tested in Ben Tre and Tra Vinh, with resilience up 0.5% salinity. These initiatives illustrate how breeding and seed systems are central to adaptation.

Integrated rice–shrimp and aquaculture systems

Ecological farming models that combine rice and aquaculture are expanding in coastal provinces such as Soc Trang, Ca Mau, and Bac Lieu. These systems make use of seasonal salinity cycles: rice is cultivated during the freshwater season, while shrimp farming takes place when saline water dominates. This model reduces risks of crop loss, diversifies household income, and fits within the Resolution 120 principle of ecological zoning.

Community-based adaptation and farmer-led innovation

UNDP's community-based adaptation programme in Bac Lieu supported farmers to conserve and cultivate local drought- and salinity-tolerant rice varieties. This increased household incomes by 10–12% while strengthening seed sovereignty. Farmers were not only recipients but also innovators, experimenting with cultivation methods under changing conditions.

Monitoring, forecasting, and decision support

Accurate and timely information is critical for adaptation. The Mekong Salt Lab in Tra Vinh integrates hydrological monitoring, soil testing, and farmer training, while also demonstrating hydroponics and water retention techniques for saline-affected agriculture. In the Red River Delta, researchers have applied machine learning with satellite data to predict soil salinity and identify hotspots for intervention. These initiatives show how technology can be linked with practical farmer decision-making.

Nature-based solutions and coastal ecosystem restoration

Mangrove–aquaculture models, piloted by IUCN and WWF in central and southern provinces, combine livelihood support with ecosystem restoration. Restored mangroves buffer saline intrusion, protect coastal infrastructure, and provide habitat for aquaculture. These models represent a long-term adaptation pathway aligned with ecological sustainability.

Infrastructure and water management

Large-scale irrigation systems, sluice gates, and canal operations remain central to government strategy. Recent approaches emphasize flexible operation — closing gates only at peak salinity and allowing brackish flows when beneficial for aquaculture. This reflects the paradigm of "living with salinity" rather than excluding it entirely.

Lessons learned from this portfolio include:

- **Scale matters:** Large infrastructure and water management programs provide critical backbone protection against salinity but require careful integration with local needs.
- **Diversified approaches are essential:** Combining engineering measures with ecosystem restoration (mangroves, coastal habitats) enhances long-term resilience.
- **Institutional capacity remains a bottleneck:** Programs emphasize the need for stronger provincial coordination and consistent integration of scientific forecasts into decision-making.
- **Community engagement is key:** Successful adaptation depends on linking investments to farmer livelihoods and community-driven models, not only on donor-led infrastructure.
- **Georgraphy expansion:** Not only in Mekong Delta, the Central and Northern coastal should be focused.

More recently, Resolution 57 (2024) on science, technology, and digital transformation provides a new momentum to embed innovation, data, and advanced technology into climate-resilient development pathways. Together, these policy frameworks create a strong enabling environment for public–private partnerships and international collaboration.

In conclusion, salinity intrusion is both a pressing challenge and an opportunity. With strong political will from Vietnam and world-leading expertise from the Netherlands, there is a unique window of opportunity to co-create adaptive, technology-enabled, and market-driven food value chains that will strengthen resilience in the Mekong Delta and contribute to global food security.

Chapter 4. Role of research and knowledge institutions

Universities and research institutes in Vietnam play a pivotal role in addressing salinity intrusion through research, impact assessment, technology transfer, and policy support. They provide the scientific basis for understanding salinity dynamics, including mechanisms, drivers such as sea-level rise and river flow changes, and the consequences for soil, water, ecosystems, agriculture, aquaculture, and human health. Their findings help identify vulnerable areas, quantify economic losses, and assess risks, thereby informing both project implementation and long-term planning.

Beyond research, these institutions contribute to training specialized human resources and transferring advanced technologies and solutions to local authorities and communities. Their work provides evidence-based inputs for policymakers in formulating strategies and socio-economic development plans in salinity-affected regions. Based on scientific studies, they also propose technical, management, and community-based adaptation measures ranging from infrastructure and soil improvement to sustainable land-use planning and community awareness raising.

Collaboration among Vietnamese universities and institutes has become an important mechanism for enhancing impact. For example, the CLUES program led by Can Tho University engaged the Southern Institute of Water Resources Research in forecasting, the Mekong Delta Rice Institute in developing salt-tolerant rice, and the Mekong Development Institute in proposing adaptation strategies. Similar cooperative programs - often supported by national and international funding - demonstrate the essential role of academic partnerships in building resilience to salinity intrusion under climate change. The Sustainable Development Mekong Delta Platform - Vision to 2045 (SDMD 2045) is a large-scale initiative founded and hosted by Can Tho University (CTU) under the direction of the Government of Vietnam. The Platform aims to bring together knowledge and experience from all stakeholders, both domestic and international, to analyze the current situation, forecast future developments, and contribute to the formulation of orientations, policies, and solutions for the government, localities, and relevant agencies. It also promotes cooperation in building and implementing practical programs and projects that contribute to the sustainable development of the Mekong Delta (MD). The Forum includes a variety of activities, notably quarterly policy dialogues and an international forum held every two years, with themes focusing on critical, topical, and strategic issues that significantly impact

the sustainable development of the Mekong Delta. However, it seems that lack of research institutions who work in the Central and Northern provinces in Vietnam and still few researches on salinity for the Central and Northern provinces.

Chapter 5. Private sector and international organization engagement

Over the past decade, international organizations and private companies have played an increasingly important role in addressing salinity intrusion in Vietnam, particularly in the Mekong Delta. International research institutes such as IRRI have collaborated with Vietnamese partners to develop and test salt-tolerant rice varieties, while companies including Loc Troi and Vinaseed have invested in breeding and commercialization to bring these varieties to market. These efforts have laid the foundation for more resilient seed systems and have demonstrated the value of science–business partnerships in reducing the vulnerability of smallholder farmers.

In parallel, private technology enterprises have introduced digital and engineering solutions, such as real-time salinity sensors, automated irrigation systems, and data-driven early warning platforms. RYNAN, for example, has pioneered the deployment of IoT-based water monitoring systems that provide timely information for both farmers and local authorities. International NGOs such as SNV, Earth care Foundation in collaboration with Farmers' Union and local unions have complemented these efforts by piloting climate-resilient and low-emission rice value chains, linking smallholders to buyers and certification schemes that reward sustainable practices. Together, these activities represent a growing convergence of technology, markets, and international development support to address the multifaceted challenges of salinity intrusion. For example, Thanh Chi Agricultural Cooperative – A Model of Multi-Stakeholder Linkage for Sustainable Lime Production. The cooperative partners with the Company who can export lime to Europe like The Fruit Republic to supply about 20 tons of lime per month for direct export to Europe, while coordinating with local authorities and agricultural agencies to develop certified growing zones aiming for 400 ha by 2030. The Company has a technial team at the grass root level to support farmers as well as has strong team on monitoring on product's qualifications. The model connects farmers, cooperatives, enterprises, NGOs and local governments through contract farming, technical training, and quality certification (VietGAP, GlobalGAP). It helps farmers increase income, ensures stable export markets, and promotes climate-resilient, sustainable agriculture—offering a replicable model for high-value crop development in the Mekong Delta.

Nevertheless, these initiatives remain fragmented and often limited to project-based interventions. Data generated by private monitoring systems is rarely integrated with public networks, and the high upfront cost of improved seeds or digital technologies constrains adoption among smallholders. Market incentives for resilient production are not yet strong enough to drive large-scale behavioral change, while coordination between agricultural practices, water infrastructure, and coastal protection remains insufficient. These gaps highlight the need for a more coherent approach that bridges public and private efforts.

Looking ahead, proposals to strengthen salinity resilience should focus on four priorities. First, scaling up the diffusion of salt-tolerant varieties through robust seed systems that link research institutes, seed enterprises, and farmer cooperatives. Second, technical support, scientific and technological solutions and knowledge improvement in fruit production and aquaculture to create products of high economic value, meeting export standards and requirements. Third, expanding the deployment of affordable sensor networks and digital platforms, coupled with agreements on data sharing, blended training to inform both farm-level decisions and provincial water management. Forth, creating market and financial mechanisms—such as off-take agreements, blended finance, and certification schemes—that reward farmers for adopting resilient practices. By aligning the strengths of international research with experienced domestic research platforms, private sector innovation, and government coordination, Vietnam can accelerate the transition toward sustainable and salinity-adaptable agricultural systems.

Chapter 6. Gaps, Farm-Level Needs and Recommendations:

At the farm level, monitoring and information systems remain fragmented. While indicators such as salinity and flow are collected, the data rarely reach farmers in a form they can act upon. Provincial and central models are often not integrated into local advisory channels, leaving a gap between analysis and practice. Moreover, most observation sensors are placed at the basin scale, while farms lack cooperative-level monitoring nodes that could provide localized salinity readings to guide irrigation and crop decisions. Access to Early Warning Systems (EWS) also remains limited, as many farmers do not receive mobile-based alerts or lack trusted advisory intermediaries who could interpret and communicate the information effectively.

From an agronomic and technological perspective, progress has been uneven. Salt-tolerant horticultural varieties and rootstocks for fruit trees are still not widely available or distributed. Adoption of protected cultivation, smart irrigation, and soilless systems is low, primarily due to high capital costs and the absence of suitable financing options. In addition, post-harvest infrastructure at the cooperative level- such as cold storage and processing facilities - remains inadequate, which exacerbates losses when salinity reduces product quality.

Institutional and service-related challenges further compound the problem. Agricultural extension services continue to be under-resourced, often providing general rather than location-specific salinity advice. Coordination between sluice and gate operations and on-farm water use is weak, with local farmers not always informed of operational decisions that directly affect salinity flows. At the same time, opportunities to integrate private aggrotech services into public extension channels remain limited.

Market and finance gaps also persist. Smallholder farmers are highly fragmented and lack strong linkages to premium markets, with only a few certification schemes recognizing “salinity-resilient” products. Access to tailored financial instruments such as blended loans or leasing schemes for greenhouses, sensors, and processing equipment is still constrained. Insurance mechanisms for agricultural production including salinity-related risks are only in their early stages and have yet to reach scale.

Finally, there are significant social and capacity gaps. Digital literacy remains low among older farmers, underscoring the need for training and demonstration platforms to facilitate technology uptake. Current pilot programs also do not consistently ensure equitable access for women and young farmers who have entrepreneurial skills, limiting their participation in new adaptation initiatives.

In conclusion, salinity intrusion is reshaping Vietnam's agricultural landscape from South to North. Horticulture represents a high-value sector where Vietnam and the Netherlands can co-create climate-resilient value chains.

Chapter 7. Potential collaboration between Vietnam and the Netherlands

A potential area for cooperation with Dutch enterprises lies in jointly identifying where their capacities whether in technology, knowledge, finance, or product offtake can best support Vietnamese farmers in adapting to salinity intrusion and water scarcity. This requires more structured dialogue and information exchange on what specific Dutch enterprises can offer and how these can be linked to ongoing programs in Vietnam.

First, collaboration between two groups, foreign enterprises or international funds, and Vietnamese research institutions or domestic companies will be essential to design appropriate science-based programs. Building on past and ongoing projects, such collaboration should focus on defining research priorities and tailored solutions for different regions and agro-ecological sub-zones. These could cover a wide range of production systems, such as brackish-water aquaculture, freshwater aquaculture, large-scale rice, high-quality rice with low emissions, and export-oriented fruit. The ultimate goal is to enable farmers to adapt production under conditions of declining water availability and increasing salinity, while at the same time improving water-use efficiency, especially during the dry season, to better support socio-economic development.

Second, a more integrated "three-party" partnership bringing together foreign enterprises, Vietnamese enterprises or research institutions, and farmer cooperatives or farmer unions (with the direct involvement of farming households) is required. Each actor brings a complementary role:

Foreign enterprises can provide advanced technologies and transfer modern scientific knowledge into practice. They can invest in state-of-the-art equipment and services to support production, such as soil and water quality testing tools, high-tech meteorological forecasting systems, crop and livestock disease monitoring, and post-harvest quality control equipment that ensures products are free from harmful residues.

Vietnamese enterprises or research institutions serve as the intermediary, receiving and adapting these technologies and knowledge for local contexts. With support and advice from foreign partners, they can guide farmers in structured production practices—regular soil and water quality checks, informed decisions on water intake during periods of salinity, improved cultivation and harvesting methods, and proper product handling to meet food safety, appearance, and market standards for both domestic consumption and export.

Cooperatives or Farmers' Unions act as the organizing platform to ensure farmers participate in training and knowledge transfer activities. They facilitate adoption of new technologies and, at the same time, provide feedback loops to both foreign and domestic partners. This allows issues encountered during production to be addressed quickly, supports continuous improvement, and provides lessons for scaling up future projects across other sub-regions of the Mekong Delta.

Such a coordinated approach ensures that knowledge transfer, technology adoption, and production support reach the farmer level effectively, while also creating mechanisms for continuous feedback and adaptation. In the longer term, it strengthens resilience, enhances productivity, and opens pathways for replicating successful models across the Delta.

Findings from desk research and stakeholder interviews indicate several general gaps in:

- Still **lack of the collective research** among research institutions, universities and government agencies for salinity and practical wanrings or information for farmers and local authorities in the Central and Northern part.
- **Monitoring and early warning**: Local authorities and farmers still lack timely, accurate, and accessible salinity forecasts. Existing monitoring networks are fragmented and often not connected to decision-support systems.
- **On-farm adaptation**: While salt-tolerant rice, fruit and aquaculture practices exist, scaling remains limited due to limited access to the technology. Farmers need affordable IoT tools, advisory services, and climate-smart production models.
- **Small scale of agricultural production:** Small and medium-scale agricultural production areas face increasing risks from saline-contaminated water supplies, threatening both product quality and compliance with export standards.
- **Value chain integration:** Farmers and cooperatives remain poorly connected to high-value markets. There is limited branding or certification for climate-resilient products, which could help capture premium prices in European, Dutch markets or the premium domestic market.

Over the past decade, Dutch government agencies, research institutes, and private companies have worked with Vietnam to address pressing challenges. Examples include the Mekong Delta Agricultural Transformation agreement**,** which provides a policy framework for sustainable agricultural transition; the Mekong Salt Lab**,** which pilots saline farming solutions, freshwater retention, and farmer training in Tra Vinh; and joint capacity-building programs on saline agriculture and water governance delivered through the Netherlands Water Partnership and Partners for Water. Dutch companies have also introduced greenhouse systems, precision irrigation, hydroponics, soil testing and sensor-based monitoring**,** helping to modernize Vietnam's horticultural sector. Collaborative research programs, such as Rise and Fall project- collaboration among Can Tho University (CTU), Southern Institute of Water Resources Research, the Federation of Hydrogeology, and the Faculty of Geosciences – Utrecht University

have generated evidence on salinity intrusion, land subsidence, and groundwater management to inform regional planning. To maximize impact, future initiatives could adopt pilot-based approaches in selected provinces, supported by public–private partnerships that share risks and investment between Vietnamese stakeholders and Dutch companies. Knowledge hubs and blended training programs would ensure local capacity to maintain and replicate solutions.

Dutch–Vietnamese cooperation has already produced tangible pilots and policy frameworks. *The next step is to consolidate these achievements and scale them into integrated, region-wide solutions for water, agriculture, and salinity resilience, with Dutch government agencies providing strategic guidance and Dutch enterprises delivering technology and innovation.* Besides, the collective research programmes like Rise and Fall project should be carried out for the Central and Northern. And for the value chain approach, the Netherlands can be a good gate for Vietnamese agricultural products to enter the Europe through Rotterdam port, Netherland and vice versa for Dutch products to Vietnam.

The Netherlands and Vietnam have built a long-standing strategic partnership in water management, agriculture, and climate adaptation. This partnership is grounded in the Netherlands' expertise in integrated water resources management, saline agriculture, and high-tech horticulture, combined with Vietnam's urgent needs in the Mekong Delta and other vulnerable regions.

Chapter 8. Recommendations

1. Bundle expertise and focus on action

Establish a bilateral Vietnamese-Netherlands knowledge hub on 'food production in a saline environment' with a strong focus on implementation and action. In such a platform the expertise of the private sector, the government, universities/institutes and financial institutions can be bundled to support agricultural transition. Exchange of practical experiences between Vietnam and Netherlands would be very valuable. Development partners and investors should be closely involved to ensure coordination and synergies with current programs. Within this model, Dutch technology providers and food companies can work directly with Vietnamese cooperatives and enterprises, under government engagement and Farmers' Union facilitation to co-design pilots and build scalable solutions. A knowledge hub could also coordinate capacity building and provide technical training.

2. Develop a nationwide program on saline agriculture

Develop a the long- term program on 'food production in a saline environment' not only for Mekong Delta provinces but for the Central and Northern provinces. Although the cause of salinity can vary (saltwater intrusion, seepage of saline groundwater, irrigation and evaporation) solutions can be similar.

3. Pro-actively anticipate on international funding opportunities

Pro-actively approach leading programs and donors such as Aus4Adaptation, MERIT (WorldBank) and Green Climate Fund to anticipate on their priorities related to climate

adaptation, water issues and agricultural development. Dutch innovations and technology, customized for the situation in Vietnam could fit with the objectives of these international opportunities.

4. **Develop mechanisms to tackle the impact of land fragmentation**

Dutch expertise on land use consolidation could be valuable to support mechanism to tackle the impact of land fragmentation. Cluster-based land use consolidation through cooperatives could be the private version of a government intervention. Agricultural cooperatives already have a legal and institutional foundation in Vietnam. By consolidating adjacent smallholder plots into cooperative-managed clusters, farmers can adopt uniform production practices, apply standardized irrigation, salinity management, digital systems, and collectively ensure compliance with export standards. Importantly, land use right remains with individual farmers, while cooperatives coordinate production and quality control.

Modern cooperatives, managed in a professional way, are supposed to be able to take the lead in land use consolidation. Programs to guide cooperatives are important. Agriterra could be partner to support cooperatives in a business-driven approach.

Contract farming could be part of the model, to ensure the link with the off takers.

5. **Optimize Vietnamese loan and subsidy facilities**

Various Vietnamese facilities can support farmers and cooperatives to invest in interventions that enhance their resilience. Optimizing Funds for Supporting Farmers (operated by Vietnam Farmers' Union), Policy Bank or Agriculture Bank and subsidy schemes at provincial levels, could enable farmers to invest in the right responses related to salinity and other climate change related challenges. Involvement of VNFU and its provincial Farmers' Unions can be supportive to discuss this kind of facilities at national and local level.

6. **Introduce suitable technology and services**

Foster adoption of beneficial and suitable technologies and services, offered by Dutch companies, by anticipating on the needs of the farmers and considering the specific climate and soil conditions of various agro-ecological zones in Vietnam.

- *Providing the system on monitoring and early warning***:** Capacity building for local authorities and farmers for timely, accurate, and accessible salinity forecasts, building up the monitoring networks to be connected to decision-support systems.
- *Seed and breeding expertise* to develop salt-tolerant vegetable and fruit varieties.

- *Protected cultivation systems* (greenhouses, net-houses, hydroponics that are right technology and accessible for farmers in Mekong Delta) adapted to salinity-prone coastal areas.
- *Technological solutions of freshwater storage systems* (lake, pond, cannel) in the area of household groups, each farm/ orchard to irrigate for fruit trees adapting to extreme drought and salinity conditions.
- *Smart irrigation and water management* technologies that integrate drip irrigation, sensors, and digital advisory tools.
- *Post-harvest and processing solutions* (cold chain, controlled atmosphere storage, packaging, frozen, drying, and juicing) to reduce losses and meet EU standards.
- *Digital traceability and branding systems* to position Vietnamese horticulture as "climate-resilient," enhancing access to premium markets.

7. Enabling national policies are necessary to foster innovation

Many policies on technology and digital transformation have been issued. Then, to realize them at the grassroot level is to help some meaningful innovations are to implement. Currently aquifer recharge faces issues due to the quality of infiltration water. Collection and sharing of data is crucial to anticipate on the opportunities of digitalization. Close collaboration with the national government is recommended to tackle these kinds of issues.

Annexes to Scoping Report: Salinity Intrusion and Farm-Level Responses in Vietnam

Annex A: Detailed Salinity Trend Data & Maps (2016, 2020, 2022–2024)

This annex provides detailed seasonal data on salinity intrusion in the Mekong Delta and selected coastal provinces.

• 2016: Severe intrusion; inland penetration up to >90 km in some estuaries; late peak observed in March–April.

• 2020: One of the most severe recent events; ranh 4‰ ClNa penetrated 60–80 km inland in key rivers; major crop losses reported.

• 2022: Moderate year; intrusion onset later than average; impacts localized but still affected horticulture.

• 2022–2023: Early onset (16–20 Dec 2022); peak 3–7 Mar 2023 (2–3 Feb at Tieu–Dai); depth higher than multi-year average and 2022, but lower than 2016 and 2020.

• 2024: Preliminary reports suggest elevated salinity linked with El Niño; data collection ongoing.

Maps: Isohaline 4‰ (2016–2020) and CLUES projections (2013) included as figures.

Annex B: Full List of Donor Programs and Project Details

This annex compiles key donor-supported initiatives relevant to salinity management and climate adaptation in the Mekong Delta:

• World Bank: Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project (WB9); MERIT Project.

• GIZ: Mekong Climate Resilience Programme (MCRP).

• USAID: Climate Resilient Agriculture in the Mekong Delta.

• EU: SUPA project on sustainable aquaculture and value chains.

• Dutch–Vietnam Cooperation: Delta planning, water infrastructure, monitoring systems, capacity building.

• FAO and IFAD programs on farmer capacity and water-smart agriculture.

Each project includes components on monitoring, infrastructure, salinity-adapted crops, extension, or market linkages.

Annex C: Stakeholder Interview List and Anonymized Quotes

Key stakeholders consulted for this scoping study:

• National ministries (MARD, MONRE).

• Provincial DARDs (Ben Tre, Tien Giang, Tra Vinh, Soc Trang).

• Farmer cooperatives (horticulture, rice–shrimp integrated systems).

• Enterprises in fruit export and aquaculture value chains.

• Universities and research institutes (Can Tho University, SIWRR, IMHEN).

• Civil society organizations (Farmers' Union, IUCN, WWF).

Sample anonymized quotes:

"We receive salinity data from the province, but it arrives too late to guide our irrigation decisions." (Cooperative leader)

"Smallholders are interested in protected cultivation, but lack finance and technical support." (Enterprise representative)

"Monitoring networks are fragmented; integration with local decision support is missing." (Researcher)

Annex D: Technical Specifications for Sensor Kits, Greenhouse Packages, and Cold Chain Equipment

Sensor Kits:

• Conductivity-based salinity sensors with accuracy ±0.1 mS/cm.

• Solar-powered data loggers with GSM/LoRa connectivity; cost ≈ USD 300–500 per node.

• Dashboard software (open-source or proprietary) with API integration for SMS/USSD/app alerts.

Greenhouse Packages:

• Low-cost net-houses (500–1,000 m^2) for leafy vegetables; cost ≈ USD 5–7/m^2.

• Modular greenhouses with drip irrigation and fertigation kits; cost ≈ USD 20–25/m^2.

Cold Chain Equipment:

• Pre-cooling units (2–5 tons/day capacity).

• Cold storage rooms (10–50 tons capacity; temperature range 0–10°C).

• Small-scale processing units for drying/juicing; cost range USD 20,000–50,000.

Annex E: Detailed Roadmap with Resource Estimates and Implementation Schedule

Short-term (2025–2026): Pilot phase.

• Resource needs: USD 1–2 million per province for 3–5 cooperative clusters.

• Cost breakdown: sensor network (USD 150k), green-houses (USD 500k), training (USD 200k), finance facility design (USD 150k).

Medium-term (2027–2029): Scaling phase.

• Resource needs: USD 5–10 million per province to expand to 10–20 clusters.

• Cost breakdown: post-harvest hubs (USD 2–3 million each), expanded monitoring, insurance pilots.

Long-term (2030+): Institutionalization phase.

• Resource needs: USD 50+ million region-wide for integration into national programs.

• Focus: mainstreaming salinity-smart practices, manufacturing local equipment, scaling certification and market linkages.