



**Asia-Pacific
Economic Cooperation**

Field Guide: A Three-Tiered Approach to Increasing Sustainable Water and Food Security in the APEC Region

APEC Policy Partnership on Food Security

SOM 1 Workshop

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APEC Project: APEC Workshop on A Three-tiered Approach to Increasing Sustainable Water and Food Security in the APEC Region

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Acronyms

AWD	Alternate Wetting and Drying
ANA	Autoridad Nacional del Agua (Peru)
APEC	Asia-Pacific Economic Cooperation
FAO	Food and Agriculture Organization
FAS	Foreign Agricultural Service
ETS	Emissions Trading Scheme
IOF	Irrigation Operator of the Future
IoT	Internet of Things
PDIA	Problem Driven Iterative Adaptation
PPFS	Policy Partnership on Food Security
SOM	Senior Officials Meeting
WE4F	Water and Energy for Food
U.S.	United States
USAID	United States Agency for International Development
USDA	United States Department of Agriculture

Foreword

Purpose of the Project

The APEC Policy Partnership for Food Security (PPFS) workshop “A Three-Tiered Approach to Increasing Sustainable Water and Food Security in the APEC Region”, took place on February 16th, as part of the Senior Officials Meeting (SOM) 1 events. The workshop focused on current contexts in APEC economies, challenges to agricultural water (and related food) security in the region, and innovative solutions and approaches to the increasing demand for water for agricultural production.

Models suggest that by 2050 more than half the world’s population will be living in water-stressed regions, which will exacerbate existing threats to sustainable agricultural productivity and food security. Sustainable water resources management is an important step towards increasing agricultural productivity to meet future food needs, sustaining human and environmental health, ensuring economic growth.

For this PPFS workshop, economies presented recommendations on constructing policies that will improve and facilitate water efficient farming practices to make APEC food systems more resilient and sustainable. The recommendations are a reference for economies to consider a three-tiered approach to increasing agricultural water security 1) macro level government actions; 2) policies that support and encourage micro level and context relevant on-farm investments in efficient and responsible water use; and 3) collecting and utilizing data to better understand water needs and facilitate precision agriculture. As workshop sponsor, the United States collaborated closely with the PPFS to propose these tiers for the workshop and this associated guide.

About the APEC Policy Partnership for Food Security

The workshop and associated guide are outputs from the PPFS which was launched in 2011 to strengthen APEC’s institutional capacities and public-private cooperation for sustainable food security across the region and world. 1 The current work of PPFS was built upon the Niigata Declaration on APEC Food Security, the first APEC plan for promoting food security in the region; and the Kazan Declaration, the Beijing Declaration, and Piura Declaration, which furthered APEC plan of action on food security.

In 2021, the PPFS forum, in collaboration with the APEC Food Security Ministers, developed the “Food Security Roadmap Towards 2030”. The Roadmap is focused on setting out a path to ensure access to sufficient, safe, affordable, and nutritious food to meet the dietary needs and food preferences for an active and healthy life.² In 2022, the PPFS developed an implementation plan to carry out the Roadmap. In 2023, the PPFS, chaired by the United States during the U.S. APEC host year, focused on APEC 2023 theme “*Creating a Resilient and Sustainable Future for All*, with specific focus on *interconnectedness, innovation and inclusivity*, and the agriculture sub-theme of *Together Achieving Sustainable, Equitable and Resilient Agri-Food Systems*.”

¹ [Policy Partnership on Food Security | APEC](#)

² [Policy Partnership on Food Security | APEC](#)

Introduction

How to Use This Guide

This guide is designed to serve as a technical reference for PPFS member economies and their respective stakeholders to consider in their development, implementation, and monitoring of evidenced-based policies for sustainable agricultural water resources management and food security. The information presented in the guide is derived from a PPFS workshop on February 16, 2023, in Palm Springs, California where experts from across the PPFS economies convened, in-person and virtually, to network and exchange evidence about best practices and successful innovations in policymaking for sustainable agricultural water resources management. This guide aligns with the workshop objectives and agenda; however, it is not an exhaustive report of all the information and evidence generated at the workshop.

The chapters of this guide follow the SOM 1 workshop agenda (Annex 1), by session.

Chapter 1. Opening Remarks

As host economy and workshop sponsor, on behalf of the United States, Allison Thomas, APEC PPFS Chair, and Managing Director of Trade Policy, Foreign Agricultural Service (FAS) at USDA opened the workshop, welcomed the participants, and framed the issue of agricultural water resources management in the context of the PPFS's scope and core workstreams, as well as the United States' priorities for APEC 2023.

Chapter 2. Keynote Address

The Keynote address was delivered by Victor Ibeanusi, Dean of the School of Environment at Florida Agricultural and Mechanical University. Mr. Ibeanusi focused his address on APEC's comparative advantage for positive impact on agricultural water management across the region and the globe. The address highlighted the role of institutions in re-shaping paths to addressing complex environmental challenges; science and technology frameworks for action; and the promotion of a citizen and industry network to lead societal change toward sustainable development. He pointed at PPFS as an example of such a role within APEC, albeit its focus is food security, including associated environmental risks, preparedness, and resilience. The particular processes and applications of this path would allow a truly *disruptive and accelerated transformation* to sustainable development, respecting, amplifying and enabling Sustainable Development Goals.

Chapter 3. The First Tier: How to Consider the Local Context in Water Security Policymaking

The first panel session “The First Tier: How to Consider the Local Context in Water Security Policymaking”, highlighted best practices for macro-level policies in agriculture and water management. The session featured five panelists focused on water management practices in the APEC region.

James Dobrowolski

Panelist James Dobrowolski, National Program Leader, Division of Environmental Systems at USDA, presented on “Agricultural Water Security: Focusing on broad-based, science-led, and local results across multiple sectors to achieve solutions to complex water issues”. In his presentation, James focused on the definition of agricultural water security, the complexity of the issues surrounding agricultural water security, and some of the key challenges, and proposed solutions. James highlighted the relationship between agricultural water security and global food security and the importance of expanding food production for human health and economic prosperity, with an eye on how we use and sustain water.

Adisorn Champathong

The session's third panelist, Adisorn Champathong, Senior Expert on Hydrology at the Thailand Royal Irrigation Department, spoke on “Designing Policies that Support Water Efficient and Sustainable Agriculture Practices in APEC”. The presentation centered on Thailand's policies in response to water shortages while maintaining production of agricultural products, including the Bang Rakam District model, which exemplifies a process of water management and crop adjustment in different (wet and dry) seasons, and the challenges and solutions for

management of sea water intrusion into the lower Chao Phraya River Basin.

Matthew Tan

Associate Professor Matthew Tan, Chair of PPFS Working Group 1, gave a presentation on the “Local Context in Water Security Policymaking Deploying Innovative Solutions”. The presentation showcased Singapore’s water policy, including the local context, implementation of innovative solutions to water shortages, water pollution, and flooding, and a case study related to vertical and urban farming technologies.

Singapore’s water policy has two key tenants: (i) Ensuring water supply for all- under this tenant, Singapore has adopted the “Four National Tap Strategy”, a diversified water strategy that ensures Singaporeans have a robust water supply for the future. The economy had four sources of waters supply including local catchment water, imported water, NEWater, and desalinated water. Ensuring water for all means that Singapore ensures potable water within the international health and safety guidelines for drinking water. NEWater and desalinated water provide sources of drinking water that are weather resilient, mitigating the threat of climate change. (ii) Conserving water resources- under this tenant the economy ensures that water demand does not rise at an unsustainable rate as the population grows. Professor Tan highlighted that a water conservation policy should ideally have two key parts, a communication strategy and a consumer-friendly compliance strategy. In Singapore there is an Account Servicing Team that works with domestic and non-domestic sectors to manage water demand.

Professor Tan also highlighted that children are educated from a young age on the value of water, including community water-use habits and the implications of living in water catchment areas. In Singapore, many water catchment areas are converted into recreational spaces. Some of the main challenges for water conservation in Singapore are the demand for water to double in the next 40 years due to increase in industrial activity along with population growth; uncertain weather patterns caused by climate change; water-wasteful consumer habits; and unrepaired leaks in water appliances, which can lead to tens of thousands of liters of wasted water per year.

Over the last ten years, Singapore has implemented a communications and compliance to reduce the household per capita water consumption from 165 liters per day in 2013 to 141 liters per day in 2019 with a target of reducing to 131 liters per day by 2030. The economy has increased the water catchment area of Singapore from half of the economy to two-thirds of the economy.

Water conservation education and outreach raises awareness in schools, events, conferences, and community centers. The Annual Conservation Awareness Programme includes volunteers visiting households with high water consumption to install water saving devices and share water saving tips. Participating households typically save up to 5% of their monthly water consumption. Singapore highlights monthly usage averages by similar-sized households on their utility bills to show consumers how their water usage changes from month to month and how it compares to other households. Climate-smart technology is a key innovation necessary for Singapore to “grow more with less”. Professor Tan highlighted case studies including GKE the first farm in Singapore that produces vegetables solely using solar energy; a fish farm that reduced overall water consumption by developing a water recycling system, reducing their water usage to one-third of their previous consumption.

Additional innovative solutions to water conservation and consumption issues in Singapore include: NEWater- water that originates from drains and sewers and is treated to surpass World

Health Organization standards for drinking water. The origin of NEWater began in the 1970s, but the technology needed for the required quality was financially prohibitive. In the 1990s and early 2000s, the technology became financially viable, and Singapore commissioned a demonstration plant to produce 10,000 cubic meters daily. After many tests, the water was shown to be safe and sustainable, and NEWater was born. In 2003 NEWater was launched to the public. NEWater isn't primarily used for drinking but also for industrial purposes, cooling, and to fill public reservoirs.

Singapore has set a "30 by 30 goal" to build their agri-food capacity and capability to 30 percent of their nutritional needs locally and in a sustainable manner by 2030. Singapore is historically short of water and short of land. To meet the goal, Singapore is adopting vertical and urban farming technology to increase the production capacity per square meter of land. This technology also used 95% less water than traditional farming methods.

Professor Tan answered a question regarding funding for the case studies he outlined. He mentioned that for innovative farms, a company can submit a proposal for specific farm funding set aside by the Singaporean government. He highlighted the importance of financial modeling to show the cost benefit analysis of these innovations. Another question on the presentation revolved around the management of even a small piece of land to hold vertical farms, given Singapore's available land. Professor Tan explained that many of these vertical or Urban farms are within industrial or private sector sites. He gave the example of a Sushi chain restaurant that is introducing these types of farms at the site of the restaurant. Singapore is looking at using urban spaces for farms, including rooftops for examples.

Ku McMahan

The final panel presentation was delivered by Dr. Ku McMahan, Team Lead, Water, Energy and Food, Exploratory Program and Innovation Competitions, WE4F at USAID. Dr. McMahan spoke about the USAID WE4F project and results, including key metrics on climate change, food insecurity, local-led development, private sector engagement, gender, and access to farming inputs. As an organization, USAID works with USDA, Germany, Norway, Sweden, the Netherlands, and South Africa on international partnerships to help farmers produce more using less water and use energy more sustainably. Dr. McMahan's key takeaway was that it's about food, water, and energy. Dr. McMahan's presentation highlighted activities you can do in your own economy right away using currently available, affordable technologies. The main problem is they are not scaled, and they are not reaching farmers that need them most. Economies can develop policies that make these technologies available and affordable to those who need them.

In two years, the WE4F program has helped SMEs in Asia and Africa to garner more than \$50 million in private sector debt and equity investment, support both climate change adaptation and mitigation efforts, reduce CO2 emissions by more than 50 million tons, and save 6 billion liters of water. Dr. McMahan highlighted that when you engage the private sector, you're able to get results much faster and you get results on the ground. The WE4F program works with farmers on the ground who provide data on results, but also give program feedback on what isn't working. Key questions on the program include how to work on crosscutting issues like water and energy security, inclusivity, and sustainable water management. The program works with around 130 small and medium enterprises and implements farmer interviews to understand income gains, main water uses, and CO2 emissions reductions from alternative technologies. They also monitor challenges in the legal space, including challenges that affect growth and scalability. The program implements an integrated approach focused on locally led sustainable development, working with farmers, working with SMEs, addressing food security needs,

especially during COVID-19, and most importantly focusing on the private sector as a key partner in sustainable scaling of the initiative.

Dr. McMahon stressed the importance of understanding the policy, legal, and regulatory environment, including framework conditions, such as policies and regulations; capacities of individuals, institutions, and organizations and how to include experts outside the public space into conversations while you are having them; access to information and finance to purchase technologies; and opportunities for coordination, cooperation, and networking to ensure a cohesive economy-wide strategy. He highlighted the importance of improving this nexus through: support for businesses to navigate import-export barriers, as many of the innovative technologies are getting stuck at borders and are not making it to the farmers that need them while leading to increased costs; helping industries set up association in the region so they can better coordinate and advocate; enabling policy dialogue amongst decision-makers to better understand challenges; and supporting access to information by making sure data is actually getting out to the farmers and businesses. Dr. McMahon ended with the recommendation for economies to talk to the businesses and producers in their communities and ask what can be done in the public space to help them grow.

Dr. McMahon answered a question from the audience regarding the carbon market, and how offsets could potentially be a source of funding for end-users, saying that most financing is coming in large chunks to large organizations, and not flowing down to SMEs or small-holder farmers. USAID is working on financing schemes with some companies, microfinance institutions, and banks to lower the risk. Carbon benefits can be valued to help offset some of the risk to financing, reducing interest rates and increasing the size of loans. Assistant Professor Tan added to the answer that there are currently carbon credit incubators in the APEC region who will fund agricultural projects if given a part of the carbon credit.

Chapter 4. The Second Tier: Effective Policies for Enhancing the Efficiency of Main Water Systems and Use of Water Resources in Agriculture

The Second-Tier panelists focused on sharing best practices for on-farm investments in agricultural water efficiency.

Robert Kaiwai

Robert Kaiwai, General Manager of New Zealand's Te Tai Tokerau Water Trust started with an overview of agriculture in New Zealand, and its focus on animal-based and horticultural products including meat, dairy, and fruit as their primary exports. Agriculture in New Zealand uses a tremendous amount of water and is the major source of greenhouse gas emissions in the economy. New Zealand's freshwater resources are made up of relatively small catchments. Only about 5% of rain and snowfall is captured each year as water for commercial use. The other approximately 95% remains in the natural water system with most returning to the sea. After 1994 there was a massive shift from sheep and beef to dairy farming. From 2002-2020 there has been a near doubling of New Zealand's irrigated land. The demands on New Zealand agriculture from 1994-2020 led to a near doubling of stock on farms. New Zealand has not had a system of agricultural subsidies for over 30 years.

Today, agriculture continues to be a primary user of water, with 62% of water use going to agriculture. These challenges make it clear that there is a role for central and local government to co-invest with the private sector on new infrastructure. New Zealand is also experiencing consistently warmer years and an increasing number of weather events like cyclones.

Regional councils set limits on water consumption in New Zealand, but there are currently no specific policies to encourage water efficiency in the agricultural sector, and there continues to be poor enforcement of water limits by local authorities. There is an ongoing lack of understanding about farm contaminants and their impact on water resources. There is no requirement to collect environmental information at a domestic level and so there are no domestic-level water data collection tools. Regional councils will use tools within their own region, but they tend to vary. Public utilities and services are delivered, operated, and paid for by many providers, including 67 territorial authorities and thousands of private and community suppliers. Most of these suppliers have relatively small populations that they serve, leading to a critical lack of funding for infrastructure.

New Zealand's three most important water policies include the 1991 National Resource Management Act, putting the responsibility of compliance, monitoring, and enforcement in the hands of regional councils. Under this act, water for drinking and livestock is excluded from monitoring. The National Statement for Freshwater Management, introduced in 2011 and updated and replaced in 2014, and amended in 2017 brought about revised domestic targets for management of nitrogen and phosphorous in lakes and rivers. In July 2020, the Three Waters Reform Program was launched to significantly improve the safety, quality, resilience, and performance of the three types of water entities (drinking, waste, and storm). The plan is for these entities to begin delivering services in July of 2024. The entities will be owned and operated on behalf of the communities they serve. The Emissions Trading Scheme (ETS) puts a price on greenhouse gas emissions and allows businesses and individuals to earn credits for business activities that absorb carbon dioxide. The ETS requires businesses to measure and report on greenhouse gas emissions. Agriculture is not included in the ETS.

There are several current and planned actions that New Zealand is undertaking including the inclusion of agriculture into the Three Waters Reform Program and into the ETS; a nutrient cap placed on nitrogen; plans for wetland restoration; and stock fencing requirements that separate stock from waterways. The Three Waters Program is one of New Zealand's most prominent infrastructure sectors with an estimated replacement value of over \$70 billion. The program is a complex system of shared responsibilities across multiple local and central government agencies. Currently, the system's performance is poor, with under-investment, deteriorating assets, inconsistent enforcement, large debt, and poor compliance with water safety regulations. Investment decisions are made by elected officials in a constrained financial environment in which the main funding and financing schemes are rate paying and council borrowing. Benefits of scaling will include improved access to capital markets, leverage scale for better planning, procurement, and service delivery, better general governance and management, and uniform methods for monitoring compliance and enforcement.

Regarding potential solutions to New Zealand's significant agricultural water challenges, Robert Kaiwai highlighted a project he's currently involved in. The Te Tai Tokerau Water Trust is a series of reservoir developments amongst surrounding soil that has been identified as high value for horticultural use or land conversion. This is land that is currently being used as dairy or pastoral farming. The project was initially funded by the government with a loan of \$68 million. The project was handed to a trust (set up by the government with ex crown ministers as board members) to provide management oversight. The trust used an innovative funding model,

developing three companies in the catchment areas that will be owned through shares held by shareholders. The funding through the shares will pay back the loan. The project is in the northern region, an area of growing concern for droughts. The purpose of the project is to provide the infrastructure needed to support sustainable land use while providing a backup to municipal water supply, which in turn will provide support to local communities. Once complete the project is estimated to provide an additional 7,000 of new horticultural land, leading to substantial gains in GDP, creating approximately 900 jobs, and leading to the transition from dairy and beef to horticultural farming which yields a higher per capita profit per hectare.

Mr. Kawai answered a question from the audience regarding the coordination with indigenous peoples of New Zealand on water projects such as the trust. He highlighted that in order to carry out such a project, organizations or trusts must partner with the indigenous communities in the area for project consultation.

Radtasiri Wachirapunyanont

Radtasiri Wachirapunyanont is the Regional Hub Manager, WE4F at Tetra Tech. The Water Energy for Food (WE4F) program supports entrepreneurs who work at the nexus of water, energy, and food. The program works in 15 economies across South and Southeast Asia. The presentation focused on three key pillars.

The first section concentrated on innovations that currently exist for water sustainability. Innovations include those that focus on water availability, including rainwater harvesting and sustainable irrigation; water efficiency, including tools to minimize water loss and precision agriculture; and crop management including innovations like climate-resilient crops and improved cropping systems and agronomics. The Food and Agriculture Organization (FAO) estimates a considerable rise in droughts in the coming decades, making water even more scarce. At the same time, this drives the need for water efficiency, to ensure that all water is used in the most efficient way. For areas that do face the most extreme drought and climate challenges, crop management technology will be key.

Radtasiri gave three examples of technological innovations for water security stemming from the WE4F program. In Viet Nam, Mimosatek is an innovator that uses technology to enable precision agriculture. The company produces monitors for ground soil moisture and a local weather system that feeds information into their irrigation center. This enables the producers to give the plants the right amount of water and prevents over-watering. Mimosatek's innovations were able to reduce water use by over 131 million liters in 2022.

ONergy in India uses solar pumps with drip and sprinkler irrigation systems and are piloting sensor-based automated irrigation systems. Their sister company SwitchON uses rooftop structures to capture rain and feed it back into the ground. While traditionally these companies were focused on technologies promoting the use of water for agricultural production, they are becoming more involved in technologies that focus on the sustainability of that water use. Adaptive Symbiotic Technologies is a company based in the United States and India that uses a technology called Biosure to improve crop resilience. The company procures seeds for crops that grow effectively using 50% less water than traditional crops of the same type. Producers in India saw an average 30% increase in crop yields from the seeds.

Radtasiri highlighted some of the main challenges with this type of innovation. First, there is an issue with scalability, as there is a need for more of this type of technology and more rapidly given the challenges of climate change. Collaboration across sectors is important to ensure we

have the best-fit technology but also ensure it's adopted on the ground, and that the right types of innovations reach those who need them. The program integrates financing to ensure the best technology and access to that technology for those who need it through end-user financing. There is also a need to work on business incentives, including innovative financing or more traditional economy-level financing schemes. There are many actors, but without collaboration and common ground, economies will continue to have unequal growth in this area.

Radtasiri closed with three main recommendations where economies could collaborate to ensure success: (1) R&D support for new water-efficient technologies. With climate change, many economies face new challenges, but public, private, academic collaboration can help ensure there are practical innovations that are usable by farmers. (2) Multi-instrument financing such as blended finance models that use public investment to improve the risk-return profile for water-related agricultural products or end user financing that increases access and affordability at the farm level. (3) Changes at the policy level, which balance incentives for water reduction with enforcement policies for water reduction.

Radtasiri answered a question on which policies he has found most helpful for economies to promote water reduction. He mentioned types of "playgrounds" for researchers and entrepreneurs to come together to ignite innovation, as Singapore has done. This moves research from sitting on a shelf to being implemented in real life. Another way the economy can support innovations at a public level is to bring incentives that promote innovations that may not be profit driven. These types of incentives can help de-risk innovation development.

Nick Brozovic

Dr. Nick Brozovic is the Director of Policy for the Daugherty Water for Global Food Institute. Dr. Brozovic's presentation focused on policies to support best practices for on-farm water investments in the United States. He began the presentation by highlighting the context in the United States, including differences in climate, crop types, agricultural value chains, interaction between urban and rural water users, and water risk. Most consumptive water use in the U.S. (70%) is for agriculture. Across most of the economy, irrigation is the key to food security and thereby support for rural economies. U.S. water policy is mainly made at the state and local (even hyper-local) levels, leading to substantial variability in water policy. Dr. Brozovic highlighted three main points to keep in mind for water policy change. The first is understanding who are the decision makers and who influences them. The second is understanding the importance of data and how to use it in a pre-regulatory environment. The third is evaluating the portfolio of policy options, including how to leverage private sector partnerships in creative ways.

When we hope for a change in on-farm investment, the key is to understand who is making the decisions- who is making on-farm investments and who influences those decisions. Generally, in the U.S. there are many private decision makers making large investment decisions with private money. There is public infrastructure generally surrounding private water infrastructure. This can consist of roads, other utilities, policies, and even research and education that support the water infrastructure. If we want to understand how policy affects on-farm investment, we must understand the interplay between the public and private sectors, including how both large and small enterprises influence decision making on farms. When we think of the range of potential policy tools, we must be much more expansive, including initiatives that de-risk new technology or management practices for participating farmers as a key part of how policy influences on-farm choices. Dr. Brozovic highlighted the business ecosystem surrounding

farmers in his slides, including government actors and other key influences like buyers, equipment manufacturers, agricultural banks, etc.

In the second part of his presentation, Dr. Brozovic highlighted current trends in water for agriculture. Challenges include issues like surface water overallocation in the Colorado River Basin and the introduction of regional groundwater regulation in California. He highlighted that while there are challenges, there is a tendency to catastrophize given the stories that come across related to water. Some of the key lessons from the western U.S. include: (1) Emphasize trust building. Behavioral change is tough and it's a decades- long game. It's important to build trust with those whose livelihoods and families are affected by water security; (2) Data collection is key. The ability to access and use data is becoming better. There is a rush to use data for water research and policy, but the real value of data is to build a shared understanding. (3) There is not one standard policy that works for water security, but a portfolio of approaches that can be valuable, including regulatory, incentive-based, and voluntary approaches. Peer-to-peer learning networks are one approach that is currently successful in building consensus; (4) Enforcement is important and necessary for trust building; (5) Funding is key to good governance. This can include a variety of funding sources such as government funding, grants, and cost share agreements.

Dr. Brozovic addressed a question on how policy influences water rights saying water law in the United States in the east is based on English Common Law and in the west is based on mining law. In California there are five overlapping water rights laws. Water rights are confusing, but even though it's complex in the U.S., it's possible to work around it. In much of the United States agricultural water rights are senior. However, there are well developed mechanisms for transfers including water trading and buyouts for example. These make it possible for constraints around water rights to be reduced.

Dr. Amal Talbi Jordan

Dr. Amal Talbi Jordan is a Senior Water Supply and Sanitation Specialist for the World Bank. Dr. Talbi Jordan presented on The Irrigation Operator of the Future (IOF) Toolkit, a World Bank toolkit that is currently being tested in some economies. Currently irrigation operators are expected to deliver a better service with less water, declining infrastructure conditions, and reduced financial resources. The toolkit is inspired by the utilities of the future and a report by the World Bank "Governance in Irrigation and Drainage: Concepts, Cases, and Action-Oriented Approaches- A Practitioner's Resource". The report highlights the key challenges to irrigation, including population growth, dietary changes, and climate change. The report focused on how to break the build-neglect-rehabilitate cycle. Approaches include identifying the specific problems with irrigation systems and identifying the best solution for the specific economy context and undertaking a Search-frame Analysis and Planning Approach, which focuses on the Problem-Driven Iterative Adaptation (PDIA) technique to identify and solve local institutional problems in complex systems in an inclusive way. The Search Framework can be broken down further into five stages: Map out solutions to identified problems; develop focal points or milestones; conduct periodic reviews with stakeholders; adjust the action plan and revise future focal points; and proceed to implement in line with the revised plan. The resource book describes practical ways of engaging with irrigation-related water management processes.

The toolkit flowed naturally from the World Bank report. It supports operators to assess, reset their vision, and take action to perform in a dynamic reality. Irrigation is a service provided by operators to farmers as the customer. The toolkit is aimed at developing economies' state or private sector operators for medium or large areas of land. These operators are often faced with

aspects of a system beyond their control, such as laws and policies around water in their economies. As one of the tools, the operator participates in a series of facilitated engagements that focus on: identification of problems and assessment of performance; visioning goals and defining action; and option analysis and costing and strategic planning. For the first stage, the toolkit provides practical indicators that can be used to measure performance. For the visioning stage, there is information on 117 topics across operational and functional areas and the external environment. This is the stage during which the operator will participate in facilitated discussions aimed at analyzing the performance issues that come up during stage 1 and identify solutions that will move their vision forward. During the third stage, the actions are prioritized by impact, effort, and cost. The toolkit is available publicly at: [The Irrigation Operator of the Future: A Toolkit \(worldbank.org\)](http://www.worldbank.org).

In response to a question, Dr. Talbi Jordan explained that one of the focuses of the toolkit is to help the operators better understand the different farmers in their jurisdictions, including what they are willing to pay for what level of water access or guarantee.

Chapter 5. The Third Tier: Collecting Data to Better Understand Water Needs and Facilitate Precision Agriculture

The Third-Tier panel centered on best practices for collection and analysis of data for evidence-based policymaking on sustainable agriculture and water.

Dr. Nicole Bernax

Dr. Nicole Bernax, Senior Professor of Geography and Environment for CIGA Pontificia Universidad Católica del Perú's presentation on "Peru: The Power of Data to Build Integrated Water Resource Management Policies and Increase Water Security" focused on five major sections including: the Peru economy context; policy framework; the power of data; successful lessons; and key challenges.

Peru Economy Context: Peru is one of the most biodiverse economies in the world, but faces asymmetry between water supply and population distribution, with 60% of Peru's population located in the Pacific Slope, with access to only 1.8% of the water resource. 34% of the population lives on the Atlantic Slope with access to 97.7% of Peru's water. The most important drivers that are impacting sustainability of water in Peru include climate change, increasing water demand, dramatic rise of urbanization, land use challenges, and ecosystem degradation. Due to the impact of climate change, 14 million Peruvians are experiencing food insecurity while 2.6 million are impacted by droughts. In 2009, the World Economic Forum highlighted water security as a global risk. Activities to promote water security must be holistic and integrated, but behind each action, technology, data, and monitoring is needed. While Peru has made significant progress in investment in economic infrastructure in recent years, not even half of farmers own the title to their land and only 36% of agricultural surface space is under irrigation. An integrated data approach is required to tackle water problems, as it can show the important link between chronic malnutrition rates, hectares of cultivated land, and land with irrigation technology. It's important to use data science to provide policy-relevant guidelines for water management.

Policy Framework: Dr. Bernax gave an overview of the policy timeline from 2000-2022 in Peru related to food, agrarian, water, and related policies to show there is really an impetus in Peru on finding enlightening policies related to these issue areas, and especially related to water. Since 2008, the Peruvian water authority, Autoridad Nacional del Agua (ANA), has been tasked with development of policies and strategy for water management. While several actors are involved at the government level in water management in Peru, the absence of the ministries such as Education, Ministry of Economy and Finance, and Ministry of Foreign Affairs who have a role to play in water policy as well. The Peruvian Domestic Agreement Forum provides an important space that includes actors from the public, private and civil society sectors in dialogue. State Policy 33 was approved in 2012 and references the five pillars of integrated water resource management: investment, information, infrastructure, institution, and integration. There have been several Peruvian water strategies released, but now Peru is focused on a multi-sectoral approach that is rolled out in four stages: design; formulation; implementation; and monitoring and evaluation. The design phase must accurately identify the public problem and its direct and indirect causes. Peru is trying to tackle different time frames in their policy making, including short- and long-term goals through the Peru Development Strategic Plan 2050. Each new step of policy making relies on data analysis and communication, but information availability and accuracy continues to be a challenge. To address this, ANA is strengthening its integrated spatial data infrastructure. Infrastructure examples include speed cameras installed in rivers to measure the flow of the current, installation and commissioning of aquifers, and installation of automatic hydrological system stations.

Successes: There have been many successes in Peru, including the Ministry of Agriculture's water planting and harvesting program, which includes an integrated approach to data collection and analysis across many categories including understanding plant cover, ecosystem services, aquifers, water practices and customs, and economic contributions. Another example is the Water, Climate, and Development program in the Santa Eulalia Basin, which works at the nexus of water, environment, and food. The program employs an integrated and participative methodology highlighting the importance of knowledge and awareness. As a final example, Dr. Bernax presented on ANA from 2008-2023. In 15 years, ANA has become a privileged space for knowledge sharing and building, technology, and big data. Data has increased public awareness of sustainable water management and has opened up water culture.

Challenges: Dr. Bernax highlighted that while there are many successful case studies in Peruvian water resource management, challenges remain. The main challenge is public service gaps including education inequality and unemployment. While its important to ensure education and skills building, it's also important to continue the cycle of science, build bridges between science and public policy, and understand the interplay between domestic, local, and regional levels to understand how to educate, create water culture, and communicate to forward goals of integrated water resource management.

Dr. Bernax answered a question on examples of new ways of educating people in rural areas or areas on the outskirts of cities. Dr. Bernax stressed the importance of interdisciplinary approaches to education and the importance of strengthening governance, due to its direct effects on education. Communication, trust building, and dialogue are also of key importance when working to educate people from all backgrounds and in all geographies. She also noted the importance of working together so that education is not only interdisciplinary but works with

human interconnection necessary in situations where new technology and policies affect many different people.

Chusak Chuenprayoth

Chusak Chuenprayoth is an Agricultural and Food Promotion Officer for the Department of Agriculture and Food for the Thai Chamber of Commerce and Board of Trade Thailand. The Thai Chamber of Commerce and Board of Trade is a nonprofit organization that strengthens the public private relationship between the private sector and Government of Thailand. Mr. Chuenprayoth's presentation focused on implementation of policy and research. Communication is extremely important to successful implementation. Mr. Chuenprayoth presented two case studies- sugar cane and rice- to demonstrate how water management affects these commodities and the farmers who produce them.

The first case study focused on Mittr Phol Group's sustainable water management. The company is one of the largest sugar cane producers in Thailand. The company uses the waste from sugar cane production for biomass energy, fertilizer, and wood substitution. As a large producer they are concerned with farmer competitiveness and human resource development. Mittr Phol has over 35,000 contract farmers covering 836,000 acres of sugar cane. While some farmers cover a large area of acreage and primarily use machines for farming to save time and effort, Mittr Phol also contracts small farmers. Given the diversity in size of the farms, Mittr Phol developed a consolidation model to combine parcels of small holder land together to create larger plots where it makes sense to use machinery. The company has expanded the government's water distribution network, investing around \$3.2 million to develop a mega water reservoir- the Oasis Project. Through water management and land combining, they have doubled their sugar cane yield. They are also supporting farmers to develop their own water resources, such as ponds, wells, and water from solar cell technology.

The second case study presented was on water efficient and sustainable agricultural practices in the Sakon Nakhon Province. This area of Thailand experiences droughts related to climate change, and USAID Mekong Adaptation and Resilience to Climate Change Vulnerability Assessment Report estimated that the Northeast will experience more severe droughts in the coming years. The water crisis currently means there is no water for the second crop of rice, drastically affecting the quality of life for farmers receiving income from this crop in the Sakon Nakhon Province. The local community asked themselves if there were any appropriate solutions to alleviate the negative effects of the droughts. The community set up a committee to work on this problem, including the local governor, the Chamber of Commerce, the Rotary Club, and a local academy. The committee agreed to three projects, ongoing since 2016, including Groundwater Banking for water conservation; Family Forest to increase green area in private land; and a project focused on growing rice with less water. The groundwater banking project relied on best practices from existing water banking examples, including open and closed system banking. The water banking led to faster growing trees through subsurface irrigation. The Family Forest project supported the local community to plant 100 acres of new trees from 2016 through 2022. In addition to increasing green space, the project generated community income from natural foods, herbal medicines, and high-quality charcoal, in addition to opportunities to claim carbon credits. The third project that focused on growing aerobic rice with less water, partnered the community with a local academy to find rice that could be grown in more arid conditions so the farmers could again grow two crops. Foodtech Solutions partnered

with the project to grow climate friendly rice as a pilot in 2020, which is popular in European markets. The rice uses less water, helping the farmer, but also produces less methane and can be considered more environmentally friendly than the rice traditionally grown in this area.

Mr. Chuenprayoth answered a question regarding challenges faced with the consolidation of plots and persuasion of farmers to do this. He highlighted that communication of the benefits of consolidation to the farmers in terms of revenue was key.

Dr. Chien-Hui Syu

Dr. Chien-Hui Syu, Associate Researcher, Agricultural Chemistry Division, Taiwan Agricultural Research Institute, Council of Agriculture, opened the Third Tier Part 2 session. Dr. Syu is an Associate Researcher for the Agricultural Chemistry Division, Taiwan Agricultural Research Institute, Council of Agriculture in Chinese Taipei. His presentation focused on “The Practices for Collection and Analysis of Data for Evidence-based Policymaking on Agricultural Water Allocation.” Agriculture accounts for 72% of water use, with irrigation accounting for 66% in Chinese Taipei. Domestic and industrial sectors account for 28% of economy water use. Most of the water used for irrigation is taken from rivers, thus agriculture is dependent in large part on rainwater flowing into rivers. Regarding climate change trends over the last century, Chinese Taipei has experienced increasing temperatures, with a notable increase in the last ten years. The economy also experiences a greater number of dry days, time and spatial differences in precipitation and increased precipitation intensity.

The presentation highlighted the severe drought in Chinese Taipei that took place from 2020-2021, drastically affecting agriculture during that period. To mitigate the effects of this drought, Chinese Taipei developed solutions in the irrigated areas, including rotation irrigation, use of regenerated water, activation of backup wells, and pond regulation and storage. In addition, they ceased irrigation of 74,000 hectares of land, notifying and compensating farmers. In order to decide where to stop irrigation, Chinese Taipei collected and analyzed geospatial data on rice planting time, rice yield, landcover, and soil properties. For traditionally non-irrigated areas, the economy subsidized water-saving irrigation equipment for farmers.

At a regional level, Chinese Taipei looked at the different water requirements for crops such as corn, at different stages of growth and determined the total water required per hectare of the crop. In addition, they collected data on the timing of the different stages of growth. Other parameters were established in these areas surrounding storage capacity of farm ponds, monthly average precipitation, spatial distribution of irrigation canals, monthly average temperatures, and irrigation weights determined by soil profile texture. This data allowed for a simulation of water requirements during each stage of growth under different precipitation scenarios.

To enhance water efficiency, Chinese Taipei undertook several activities. One relied on Internet of Things (IoT)-based devices to control irrigation systems and intelligent sensors to conduct Alternate Wetting and Drying (AWD) treatment during rice planting to effectively reduce water consumption by 30%. Another activity, soil laser leveling, was used to decrease the difference in levels of soil, making it a more uniform surface, and thereby decreasing water needs by over 20%. Crop rotation modifications were used as another solution to decrease the risk of water shortages during key planting seasons. Finally, Chinese Taipei utilized spatial information to accurately calculate irrigation requirements at different spatial scales.

Dr. Syu summarized that under climate change conditions, food security must be maintained through efficient and accurate allocation of agricultural water resources. To mitigate risk during the most severe drought of the century, Chinese Taipei used scientific data as the basis for policymaking to reduce farmer losses. In order to achieve the goal of sustainable precision agriculture, water-saving and monitoring technologies at different spatial scales are being continuously developed.

Ronald Sofo

Ronald is a Research Manager, Economic Policy Research Program at the Papua New Guinea APEC Study Centre. Ronald's presentation highlighted the Papua New Guinea economy context, including challenges and opportunities. Papua New Guinea is rich in water resources, including substantial rainfall. The economy is primarily based on agriculture, with 87% of the population based in rural areas. The 30-year Papua New Guinea Strategic Development Plan is the framework guiding agricultural and water policy in the economy. The plan is based on the United Nations Global Development Goals, including those centered on water and food security. Papua New Guinea also has a National Agricultural Policy and National Food Security Policy. There are also opportunities for the private sector to engage in water security in Papua New Guinea.

In Papua New Guinea, one of the greatest challenges to water security is the land ownership issue, which constrains commercial farming and water catchment. Inclusiveness is another challenge that Papua New Guinea is facing, as well as challenges related to climate change. Data driven reform is another challenge, as good policies exist, but implementation is often an issue. Finally, Mr. Sofo mentioned infrastructure needs and noted that the government will need to prioritize water access and efficiency more now than in the past given climate change issues and engage the private sector in solutions.

Chapter 6: Workshop Summary & Closing Remarks

The closing remarks highlighted a summary of key recommendations, taken from the workshop's presentations. These include:

1. A comprehensive stakeholder analysis and meaningful, inclusive engagement is critical to design and deploy interventions for sustainable agricultural water resources.
2. Water and food security policies should be complementary, and informed by environmental, economic, and social data that can be broadly shared, discussed, and understood among key stakeholders.
3. Ongoing investments in research, development, and education for sustainable agricultural water resources management must continue and compliment efforts to scale up and disseminate existing technologies that are currently unavailable or are unaffordable to producers and other land users.
4. In each context and within the respective policy jurisdiction, policymakers and key stakeholders should continue to identify and monitor water security priorities and, where practical, ensure tangible incentives for agricultural water storage and efficiency interventions among agricultural producers and other land users.
5. Consider opportunities for use-inspired research and ensure that local businesses, agricultural producers, and other land users have access to relevant science, data, and

other evidence that empowers them to learn and innovate for sustainable agricultural water resources management and food security.

Annex 1. Workshop Agenda

APEC Policy Partnership on Food Security (PPFS)

A Three-Tiered Approach to Increasing Sustainable Water and Food Security in the APEC Region

February 16, 2023: 9:00am-4:00pm PST

Location: [Renaissance Palm Springs Hotel – Mojave Room, Palm Springs, CA](#)

8:30 - 9:00 a.m.	<p>Arrival and Check-ins</p> <ul style="list-style-type: none">• Arrival and check-in of Delegates, APEC Observers, and Guests.• Virtual waiting room opens for online participants. <p>NOTE: Virtual participants should use their Zoom meeting link sent to them after pre-registration to access the meeting. Virtual participants may check-in as early as 8:30 to verify audio and visual connections.</p>
9:00 – 9:10 a.m.	<p>Welcome and Opening Remarks (10 min)</p> <p>Allison Thomas, Managing Director, Trade Policy and Geographic Affairs, Foreign Agricultural Service, United States Department of Agriculture (USDA)</p> <ul style="list-style-type: none">• Introduction of Moderator: Akiko Hamada-Ano, United States Department of Agriculture, Foreign Agriculture Service
9:10 – 9:30 a.m.	<p>Keynote Address: APEC’s Comparative Advantage for Positive Impact on Agricultural Water Management Across the Region and the Globe</p> <p>Victor Ibeanusi, Dean, School of the Environment, Florida Agriculture and Mechanical University</p>

9:30 – 10:50 a.m.	<p>The First Tier: How to Consider the Local Context in Water Security Policymaking (80 min; 20 min per speaker including Q&A)</p> <p><i>Best Practices for Macro-level Policies in Agricultural Water Management</i></p> <ul style="list-style-type: none"> • James P. Dobrowolski, National Program Leader, Division of Environmental Systems, USDA • Adisorn Champathong, Senior Expert on Hydrology, Thailand Royal Irrigation Department • Matthew Tan, Co-Chair, PPFS WG1 • Dr. Ku McMahan, Team Lead, Water and Energy for Food, Exploratory Program and Innovation Competitions (EPIC), WE4F, USAID <p><i>20-minute presentation per speaker including Q&A</i></p>
10:50 – 11:05 a.m.	Break
11:05 – 12:25 p.m.	<p>The Second Tier: Effective Policies for Enhancing the Efficiency of Main Water Systems and Use of Water Resources in Agriculture (80 min; 20 min per speaker including Q&A)</p> <p><i>Best Practices for On-Farm Investments in Agricultural Water Efficiency</i></p> <ul style="list-style-type: none"> • Robert Kaiwai, General Manager, Te Tai Tokerau Water Trust • Radasiri Wachirapunyanont, Regional Innovation Hub Manager, WE4F, Tetra Tech • Dr. Nick Brozović, Director of Policy, Daugherty Water for Food Global Institute (University of Nebraska) • Dr. Amal Talbi, Senior Water Supply & Sanitation Specialist, World Bank <p><i>20-minute presentation per speaker including Q&A</i></p>
12:25 – 2:00 p.m.	Lunch (95 min)

2:00 – 2.40 p.m.	<p>The Third Tier Part 1: Collecting Data to Better Understand Water Needs and Facilitate Precision Agriculture (60 min; 20 min per speaker including Q&A)</p> <p><i>Best Practices for Collection and Analysis of Data for Evidence-based Policymaking on Sustainable Agricultural Water</i></p> <ul style="list-style-type: none"> • Dr. Nicole Bernex, Senior Professor of Geography and Environment, Department of Humanities and Research Center in Applied Geography, CIGA Pontificia Universidad Católica del Perú • Chusak Chuenprayoth, Agriculture and Food Promotion Officer, Department of Agriculture and Food, The Thai Chamber of Commerce and Board of Trade of Thailand <p><i>20-minute presentation per speaker including Q&A</i></p>
2:40 – 3.10 p.m.	Break & Evaluation
3:10 – 3.50 p.m.	<p>The Third Tier Part 2: Collecting Data to Better Understand Water Needs and Facilitate Precision Agriculture (40 min; 20 min per speaker including Q&A)</p> <p><i>Best Practices for Collection and Analysis of Data for Evidence-based Policymaking on Sustainable Agricultural Water</i></p> <ul style="list-style-type: none"> • Dr. Chien-Hui Syu, Associate Researcher, Agricultural Chemistry Division, Taiwan Agricultural Research Institute, Council of Agriculture • Ronald Sofo, Research Manager, Economic Policy Research Program, Papua New Guinea APEC Study Centre <p><i>20-minute presentation per speaker including Q&A</i></p>
3:50 – 4:00 p.m.	<p>Workshop Summary Discussion and Closing Remarks</p> <p>Akiko Hamada-Ano, United States Department of Agriculture, Foreign Agriculture Service</p>

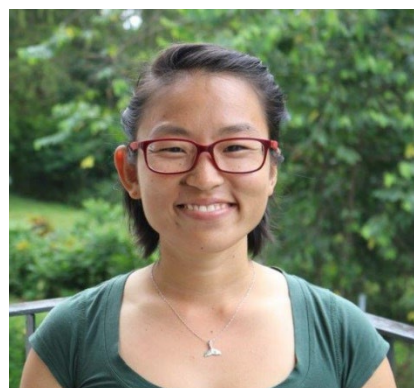
Annex 2. Speaker Biographies

Opening Remarks

Ms. Allison A. Thomas serves as the Managing Director for Trade Policy and Geographic Affairs in the United States Department of Agriculture (USDA) Foreign Agricultural Service (FAS). She is an international advocate and proponent for agricultural trade having spent the last 20 years working on agricultural trade policy and development issues. She began her career at USDA as a summer intern and has served in several capacities including Assistant Deputy Administrator in the Office of Country and Regional Affairs, (2018-2019), FAS Acting Associate Administrator and General Sales Manager (2017-2018), FAS Chief of Staff, (2014-2017) Mission Support Director for Afghanistan and Iraq (2010-2014), Special Assistant to the Deputy Administrator in Global Analysis (2009-2010). Ms. Thomas obtained a B.S. in agricultural economics from Southern University and A&M College and a M.S. in agricultural economics from the University of Arkansas. Ms. Thomas sits on the board of Women Empowering Nations, an international nonprofit organization that provides development opportunities to underserved young women throughout the world.



Moderator



Ms. Akiko Hamada-Ano is a program specialist with over 7 years of international development experience. For the past three years, she has been assessing, developing, and executing regional programs for the effectiveness and efficiency of U.S. international trade and food assistance. Her prior experience has been working at the Secretariat of the Pacific Environment Programme in the Independent State of Samoa as the Coastal and Marine Management specialist, developing a regional projects for the protection of coral reefs. She worked in the Philippines in the San Juan Department of Agriculture in Siquijor, where she worked with the folkfolk community to develop capacity building projects to ensure food security as the Coastal Resource Management specialist. She received her Bachelor's degree in Conservation and Resource Studies at the University of California, Berkeley.

Keynote Speaker

Dr. Victor Ibeanusi serves as Dean of the School of the Environment at Florida A&M University, where he is leading and advancing the EnergyWaterFoodNexus (EWFN) new science enterprise to address global challenges set by global climate change, depletion of natural resources, energy generation under sustainable conditions, and increased food and fresh water needs. He believes that there is only one path ahead, paved by transformative innovation built on open science and data with integration of novel applications and new technologies. He is a recipient of the Fulbright Specialist Program in Germany and a Senior Fulbright Fellow designed to support curricular and institutional planning at academic institutions. Dr. Ibeanusi is also one of the six pioneering recipients of the AT&T Foundation Industrial Ecology Fellow, a program that seeks to eliminate or reduce environmental impacts at every stage of a product's life cycle- from design, to manufacture, to use, to disposal or re-use. Dr. Ibeanusi holds a Ph.D. degree in Environmental Microbiology.



The First Tier: How to Consider the Local Context in Water Security Policymaking



Dr. James P. Dobrowolski is National Program Leader for Water and Natural Resources with the USDA-National Institute of Food and Agriculture Institute (NIFA), Institute of Bioenergy, Climate, and the Environment, Environmental Systems Division. Jim leads the agency in developing a systems approach to water availability from working, rural, and urbanizing lands. He leads or co-leads several USDA-NIFA programs, including Critical Agricultural Research and Extension (CARE); Water Quantity and Quality, Soil Health; Small Business Innovation Research (SBIR) Air, Water, and Soil; and the USDA-NIFA/National Science Foundation's Innovations at the Nexus of Food, Energy, and Water (INFEWS) and Signals in the Soil (SiTS) collaborations. Prior to USDA, Dobrowolski was a tenured teaching/research professor for 16 years in watershed science at Utah State University, Logan, and the State of Washington Watershed Extension Specialist and tenured extension/research professor for seven years at Washington State University, Pullman. Dobrowolski received his PhD in Hydrology and Watershed Management from Texas A&M University, Master of Science in Arid Land Ecology from Washington State University, and Bachelor of Science from the University of California at Davis.

Mr. Adisorn Champathong is an Expert in Hydrology at the Royal Irrigation Department of Thailand. He graduated with a bachelor's degree in Irrigation Engineering from Kasetsart University in 1996 and a master's degree in Water Engineering and Management School at the Asian Institute of Technology (AIT) in 2009. He has been working at Royal Irrigation Department for 25 years. His experiences contribute to designing and improving irrigation systems and hydrological applications. Currently, he works on hydrological information and forecasting, including sediment and water quality, to support development, management, and disaster reduction related to water issues across various basins of Thailand. He is also researching climate change adaptation to explore adaptation measures to cope with floods and droughts in the future.



Professor Matthew Tan is a Food Security specialist and an Agri tech veteran with more than 20 years of experience. He is currently Singapore Representative (Private Sector) to APEC Policy Partnership on Food Security and is also the current APEC Chair for Sustainable Development in Agricultural and Fishery sectors (PPFS) where he coordinates discussions between senior officials, APEC governments and the private sector on the use of technology and combined resources for Sustainable Development in the Agriculture and Fishery industry. For the past number of years, he has also been actively involved

in assisting governments with their economic transformation in light of food security; working in tandem with ministries and multiple stakeholders with an overarching view to achieving their future food securities goals. In tandem with his current APEC appointment, A/Prof Tan is also serving as the Chief Executive Officer (Asia) of Assentoft Aqua Asia Pte Ltd., as well as an Adjunct Senior Research Fellow and Associate Professor (Aquaculture) with the Centre for Sustainable Tropical Fisheries and Aquaculture (CSTFA) at James Cook University's College of Science and Engineering.

Dr. Ku McMahan serves as Team Lead for Water and Energy for Food: A Grand Challenge for Development in the Bureau for Development, Democracy, and Innovation's Innovation, Technology, and Research Hub at USAID. He received his Ph.D. in environmental sciences and an M.P.H. in environmental health from the University of North Carolina at Chapel Hill under NSF and EPA STAR Fellowships. He received a B.A. in environmental sciences and policy. In addition, he developed a simple, low-cost water quality test for developing countries and emergency situations. Ku was recently a program executive officer for the USAID WA-WASH program in GLOWS and assistant professor of research at Florida International University.



The Second Tier: Effective Policies for Enhancing the Efficiency of Main Water Systems and Use of Water Resources in Agriculture

Mr. Robert Kaiwai is currently serving as General Manager of a large water infrastructure program in New Zealand. Prior to this, he worked in China for 5 years as a property developer after serving as a career diplomat with the NZ foreign service. He has served as ambassador, high commissioner, and consul general in several countries. As part of this work, he was involved in a number of large-scale development projects in the Pacific. These included a \$30m development-assistance program in Kiribati which included waste management, climate change mitigation, adaptation, and sustainable housing development. He lived and worked in Japan for around 9 years in his early years, completing his post-graduate study there. His hobbies are all water related: surfing, kayaking, and outrigger canoeing. He earned a B.A. from Victoria University and a M.Sc. from Shizuoka National University Japan.



Mr. Rattasiri Wachirapunyanont is a Regional Innovation Hub Manager for South and Southeast Asia at Water and Energy for Food (WE4F) program. He has over ten years of experience in climate resilience development, clean energy and sustainable agriculture in South and Southeast Asia. Prior to WE4F, Rattasiri worked at New Energy Nexus (previously known as CalCEF Innovations), USAID's Green Invest Asia, the Asian Development Bank (ADB) and USAID's Low Emissions Asian Development (LEAD) program. Rattasiri is also a co-author of the ADB's Inclusive Green Growth Index (IGGI) to measure prosperity of the economics from economic, social and environmental aspects. Rattasiri holds a Master of Public Policy (Urban, Environmental and Sustainable Policy) from Lee Kuan Yew School of Public Policy, National University of Singapore, and a Bachelor of Arts in Economics from Chulalongkorn University. Rattasiri is based in Bangkok, Thailand.

Dr. Nick Brozović is an economist with more than twenty years of experience in water policy and management worldwide. He serves as the Director of Policy for the University of Nebraska's Daugherty Water for Food Global Institute and as a Professor of Agricultural Economics. Nick leads a variety of strategic programs at the intersection of policy, technology, and entrepreneurship. These include supporting irrigation entrepreneurs in the US, Sub-Saharan Africa, and elsewhere;



collaborating with multiple agtech incubator programs; corporate strategy and ESG consulting; and research on water risk and the value of water in agriculture. Nick holds doctoral and master's degrees in agricultural and resource economics from the University of California-Berkeley, a master's degree in geology from the University of Southern California and a bachelor's degree in geology from Oxford University.



Dr. Amal Talbi-Jordan holds a PhD and Master on Hydrology, Hydrogeology, and Geochemistry from the University Paris VI, France. In 2002, she joined the World Bank as part of the water unit and worked in the South Asia region, Africa region, and Middle East and North Africa region. She currently works in the Global Unit in the World Bank's Water Global Practice where she is the Global Lead of the Water in Agriculture Global Solution Group. Dr. Talbi-Jordan has worked in technical assistance activities, such as the Climate Change Development Report for Iraq, the Mashreq water initiative, the water scarce cities initiative, the climate risk assessment in the Niger Basin. Investment projects she contributed to include water resources management

and development, large-scale infrastructure, water in agriculture, water governance, and climate change resilience.

The Third Tier Part 1: Collecting Data to Better Understand Water Needs and Facilitate Precision Agriculture

Dr. Nicole Bernex holds a PhD in Geography and is a Senior Professor of the Pontifical Catholic University of Peru. Department of Humanities of the PUCP. President Emeritus of the Geographical Society of Lima. Member of the National Academy of Sciences of Peru; National Focal Point of the Water Program of the Inter-American Network of Academies of Sciences- IANAS. President Emeritus of Global Water Partnership Peru. Former Chair for Latin America and the Caribbean of the Scientific Committee of the United Nations Convention to Combat Desertification – UNCCD; consultant for several international organizations, as well as government entities, companies and civil society organizations in Peru, she has more than 170 publications including books and articles.



Mr. Chusak Chuenprayoth currently serves as Vice Chairman within the Thai Chairman of Commerce, as well as Chairman its Value Added on Agriculture Products Committee. He also lectures on the subject of Thai agriculture at the Department of Negotiations in the Thailand's Ministry of Commerce. He has served simultaneously as President of KC Fresh Co., Ltd., the leading exporter of fresh vegetables and fruits to the United Kingdom, European Union, and Asia, since 2000. He also is a member of the Board of Trade of Thailand. He was recognized in 2010 as one of ten agricultural personnel with outstanding achievement in the field of products and marketing development at the 10th Modern Agriculture Fair held by Bangkok Bank and has received

an honorary degree in the field of the Business Administration (Management) from the Rajamangala University of Technology Isan.

Dr. Chien-Hui Syu is an Associate Researcher at Taiwan Agricultural Research Institute with 15 years of soil science research experience. Dr. Syu specializes in soil chemistry and soil surveying and uses that expertise to implement research works related to agricultural water resources, Net Zero Emissions, and agricultural product safety.



Mr. Ronald Sofe is a Research Fellow and Manager of the PNG APEC Study Centre (PNGASC) at the National Research Institute (NRI) in Papua New Guinea (PNG). Mr. Sofe has a strong research background in state-owned enterprises (SOEs), pricing, service standard, competition and economic regulation relating to infrastructure and public utilities. Focusing on water and its use and provision in urban and rural communities, Mr. Sofe successfully completed a comprehensive review of urban water supply in PNG, which articulate some notable issues that affect the agricultural sector. He is currently researching on how use and access to water resource in rural communities of PNG can fuel conflict and how those dynamics can be managed through sustainable resource management. Mr. Sofe has successfully completed the prestigious United States Professionals Fellows Program, has been awarded the Australian Prime Ministers Pacific Awards and worked as research intern at the DevPolicy Centre at the ANU, Canberra. He earned an M.A. of International and Development Economics from the Australian National University (ANU) and a Bachelor of Economics from the University of Papua New Guinea.



Annex 3. Additional Resources

- PFFS Workplan 2022: [ppfs-work-plan-2022-28-july-2022-final.pdf](#) (apec.org)
- Food Security Roadmap 20230: The Food Security Roadmap Towards 2030 | Sixth APEC Ministerial Meeting on Food Security Joint Ministerial Statement | APEC
- Food Security Roadmap Implementation Plan: [endorsed-implementation-plan-of-food-security-roadmap-2030---2-sep-2022-\(clean\).pdf](#) (apec.org)
- Asia Pacific Information Platform on Food Security: APIP (apec.org)
- Ministerial Declarations on Food Security: Ministerial Declarations on Food Security (apec.org)