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Managing River Deltas: Global and Local Perspectives

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Presentation Abstracts

(in order of surname of speakers)

Keynote: Mekong Delta's History, Geography and Socio-Economics

Andersen, Matthew E., International Science Advisor, Biology, Office of International Programs, U.S. Geological Survey, USA; **Van Pham Dang Tri,** Professor and Director, DRAGON-Mekong Institute for Climate Change, Can Tho University, Viet Nam

Approximately 60 million years ago, a continental fragment that would become India broke off Eastern Africa, embarking on a 10-million-year journey to a collision with the Eurasian continent that continues to this day. This ongoing collision creates the Himalayas. At the eastern margin of this collision, the Eurasian continent uplifted and lagged the active subsidence front, resulting in the multiple, long, narrow river valleys we observe today, including the Mekong River, bounded to the east by the Annamite Range (Dãy Trường Sơn).

Five million years of sediment washing down the Mekong River from the Himalayas has produced a unique geology and hydrology that has been very productive for natural ecosystems and humans for millennia. The Khmer kings and their people were highly impactful in the lower Mekong River Basin, taking advantage of a unique period of consistent monsoonal weather patterns to harness water, agriculture, and fisheries, enabling the 400-year-long Angkor era of prosperity and the construction of hundreds of impressive temples still visible today. They successfully repelled or expelled multiple invading armies. The ideal weather patterns that supported the Angkor civilization changed at the end of this period. As they struggled to adapt to the effects of changing weather patterns on their highly organized hydrologic engineering, they finally succumbed to military intrusion, and likely communicable disease as well, and all large, organized civilizations in the region dispersed for hundreds of years after 1400 CE. Some human population growth continued. More sustained governmental influence in the region came first from the Vietnamese in the early 19th Century, then the French in the middle 19th Century. The French were the first to introduce mechanized equipment for canal building to replace hand-held tools.

The relatively constant influence of the French in the lower Mekong River in what would become modern Lao PDR, Cambodia, and Viet Nam was interrupted beginning in 1940 with a series of wars in Indochina that would last until 1991. In 1995, the four Lower Mekong River Basin nations, now also including Thailand, signed the Mekong River Agreement that ushered in the current era of normalized diplomatic relations and cooperation in some aspects of Lower Mekong River management. China and Burma are the other two nations that share the modern Mekong, but they are not signatories to the Mekong River Agreement, rather participating in the Chinese-led Lancang-Mekong Cooperation (2016) agreement between the six nations.

The modern Lower Mekong River is subjected to multiple stressors, both man-made and natural. Among the most important man-made stressors are agriculture, hydropower dams, groundwater withdrawal, navigation, sand mining, and rare earth minerals mining. Natural stressors include warming air temperatures and rising sea levels. The human population continues to grow, as more than 60 million people now depend on the natural system, some at the subsistence level. More than 25 conservation and development plans have been written during the last 20 years for this region, but a single consensus approach has not been reached, especially for the most difficult and long-term challenges.

The Amazon Delta at a Crossroads: Preserving Resilience in a Transforming Basin and Changing Climate

Brondizio, Eduardo S., Distinguished Professor, Dept. of Anthropology; Director, Center for the Analysis of Social Ecological Landscapes; and Senior Research Fellow, Ostrom Workshop, Indiana University Bloomington, USA

Although the Amazon delta is often regarded as relatively preserved compared to other deltaic regions, it is undergoing significant transformations driven by local, regional, and global forces. These accelerated changes signal a basin in transition and mirror broader patterns of environmental, social, and economic shifts observed across delta regions in the Global South. As the location the upcoming UNFCCC COP30 in November 2025, host city Belém, Pará State, the

Amazon delta serves as a window through which to examine the complex governance challenges faced by delta regions worldwide, from local adaptation to global climate policy. The Amazon delta is increasingly affected by upstream land use and land cover changes, extreme droughts, urban expansion, pollution, infrastructure and hydroelectric dam development, and extractive industries such as mining. Simultaneously, it is beginning to experience the impacts of sea-level rise, which intensifies tidal fluctuations and alters water salinity during certain times of the year. Prospects for large-scale oil drilling further exacerbates environmental risks to the delta region.

This presentation explores the interconnected dynamics between the transformation of the wider Amazon Basin and its cascading effects and interactions with changes occurring within the Amazon delta. It begins with an overview of current and projected basin-wide changes influencing the delta region. At the delta level, it examines environmental, sociodemographic, and economic trends, highlighting the delta's role as the most economically significant zone within the Amazon Basin. Focusing on rural areas, the presentation illustrates how the delta has become a center for smallholder agroforestry expansion and intensification, a trajectory that has enabled the region to maintain and expand its forest and agroforestry land cover during a period of record deforestation elsewhere in the basin. In urban areas, the presentation highlights the growing vulnerability of populations to flooding and other environmental stressors. Finally, the presentation discusses the broader implications of these changes for other relevant regions, specifically the Guianas and the Caribbean. The presentation concludes with a reflection on existing and potential governance mechanisms aimed at enhancing the resilience of the Amazon delta in the face of mounting environmental and climatic pressures and pressing social needs.

Salt Intrusion in the Mekong and a Systems Perspective for Deltas Worldwide

Eslami, Sepehr, Senior Adviser, Fluvial & Coastal Systems, Deltares, Delft, University of Techology, The Netherlands

Deltas worldwide suffer from very similar hazards such as elevation loss, fluvial sediment decline, river bed, bank and coastal erosion, flooding or drought, salt intrusion, biodiversity decline, hydrological regime shifts, leading in return to various socio-economic impacts. Yet, they are extremely complex and fundamental to the livelihood of more than half a billion people. They also often host mega-cities, thanks to their access to open seas and fertile soil for food production. Mekong Delta is not an exception. Specifically, in the past two decades it has been largely impacted by increased trends of salt intrusion. When studying salt intrusion in the Mekong Delta, we could identify a very wide range of drivers from all the way upstream in the basin to the coastal seas (see Figure 1). Some of them are driven by climate change, and some by human intervention. Looking at the past trends and future projection when combining all the drivers of change, we see that anthropogenic drivers dominate those dynamics in the first half of the century while in the second half of the century perhaps climate change becomes the dominant driver of change.

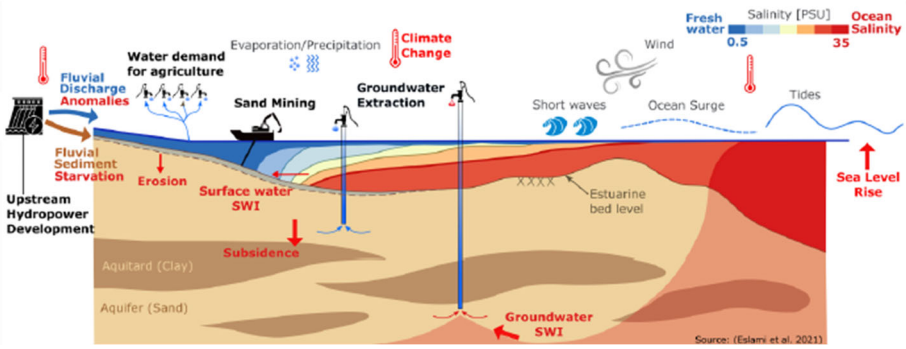

Figure 1, A cross-profile of a delta through its estuarine system (from Eslami, 2022), and the primary anthropogenic (black) and climatic (gray) drivers of change (red).

The Mekong Delta is exemplar of the challenges many deltas face today worldwide. But, when studying them collectively, we can identify common drivers of biophysical change across a range of spatial and temporal scales. When mapping these drivers at various scales and linking them to their direct and indirect biophysical and societal impacts we can develop a more clear systems understanding as a very important step in the adaptation planning. Furthermore, this framework can help facilitating dialogue among various stakeholders, and simplify a more critical thinking for policy makers, public and technical sectors. This system understanding of a delta from its source to its

sink, is a critical first step in effective and sustainable adaptation planning, while it often gets less resources associated than it deserves.

Testing and Scaling Nature-Based Solutions to the Threats Facing River Deltas with a Focus on the Mekong Delta

Goichot, Marc, Asian Pacific Freshwater Lead, World Wildlife Fund (WWF), Vietnam

Deltas across Asia face multiple existential threats, some of which originate outside the country in which the delta is situated. This presentation will summarize these threats and their potential consequences for people and nature. It will focus on WWF's experience in the Mekong Delta working with national and local government, farming communities, and the private sector to tangibly move forward action to address some of these threats. This includes deploying philanthropic, public and private sector funding to build the case for restoration of the natural processes that sustain deltas, providing demonstrations and proofs of concept, investigating financial and technical feasibility, and developing pathways to a resilient and nature positive future. A basin-wide approach is essential to address threats arising outside deltas and reference will be made to the challenges and opportunities of taking such an approach. Consideration will be given in closing to what would drive transformation at scale both in deltas and basins, and some of the actions NGOs, the private sector, civil society and government can take to help make this happen.

Integrating New Knowledge into Community and Economic Development

Hales, Brent, Associate Vice President for Research and Extension, Agriculture and Natural Resources, University of California, USA

Communities have context. They are created and reflect the historical, economic, ecological, political, and environmental realities where they exist. As a result, communities and their institutions have the potential to become insular and to maintain cultural, social, and ideological homeostasis. The introduction of new knowledge into well-established systems of thinking, knowing, and doing requires the establishment of trust in those communities. This is particularly true in the field of community and economic development due to the embedded nature of the community and cultural norms that underlie these systems. The Cooperative Extension system in the United States was established in 1914 with the expressed purpose of extending research into communities throughout the United States. It has done so by embedding researchers and practitioners in the communities that they serve. While initially focusing on agricultural and mechanical fields, the system has evolved to include youth development, nutrition, natural resource development, community and economic development, and much more. This presentation focuses on the integration of new knowledge into the realm of community and economic development and the positive role that the Cooperative Extension system plays in these efforts. Specific examples will include the use of effective water policies and practices and their impact on community viability.

Case Study: Multi-Benefit and Science-Informed Management of California's Sacramento-San Joaquin Delta in a Changing Climate

Larsen, Laurel, Former Delta Lead Scientist, Delta Stewardship Council, California USA, and Senior Lecturer/Associate Professor, Hydrology, Uppsala University, Sweden

California's Sacramento-San Joaquin Delta, one of the most highly managed deltas in the world, lies at the heart of California's water management system. Two-thirds of California residents use water sourced from the Delta, which also supports one of the nation's richest agricultural economies. The Delta also sustains a biodiverse ecosystem, which provides critical habitat for commercial salmon, and it is integral to the culture of many of California's Tribal communities.

Even without the pressures of climate change, management of the Delta is complex and highly political; its governance comprises over 100 state, federal, and local institutions, and tradeoffs are inherent among the multiple beneficial uses for which water is managed. Climate change compounds the challenges. Management entities must grapple with sea-level rise, which threatens to both inundate islands subsided below sea level that are tenuously protected by levees and contaminate municipal and agricultural water supplies with salinity. Warming temperatures and increasing frequency and intensity of hydroclimatic extremes deplete long-term water supplies but also the capacity to avert flooding. Water quality challenges, including increasing incidence of harmful algal blooms and higher concentrations of emerging toxins, are also linked to climatic change. Often, however, solutions that agencies

propose to address these challenges, such as new water conveyance infrastructure or storage, are contested because of high costs, clashes of values among stakeholders, and conflicting interpretations of scientific information or underlying assumptions.

Institutions that govern the Delta have needed to adapt their practices to anticipate and address water resource challenges and navigate the development of solutions in ways that build support among diverse stakeholders. The approaches developed in California under the urgency of climate-related emergencies and the high stakes of the decisions serve as a model of post normal science put into practice, and their successes and failures may provide insightful guidance for other deltas navigating similar challenges. Among the success stories in California are the operational adoption of decision-making under deep uncertainty techniques to assess climate risks for water resource systems, the integration of structured decision-making approaches to incorporating values into collaborative science and adaptive management, and the increasing use of co-production in the design of studies to reduce scientific uncertainty. Agencies have learned from past failures of exclusion of core constituents (e.g., tribal communities) in the development of infrastructure projects and regulations and have been making strides to enhance recognitional and procedural equity. Meanwhile, establishment of an institutional "neutral" arbiter for science that spans state and federal government and the academic community has aided in the engagement of an extended peer community in evaluating the quality of the science that informs policy, provided a consistent source of science funding, and established a vision for—as well as accelerated the adoption of—best practices at the interface of science and policy. However, with respect to governance, inclusivity, and the ways in which science informs decision making, iterative refinement remains necessary.

Integrated Water and Land Management Approaches for Enhanced Socio-Ecological Resilience in River Deltas

Loucks, Daniel P., Professor Emeritus, School of Civil and Environmental Engineering and the School of Public Policy, Cornell University

The presentation provides an overview of the threats to the world's largest deltas. River deltas are valuable assets of any country that has them. They are homes to mega cities and agricultural production zones and play a large role in enhancing the livelihoods of people living both inside and outside of the delta. But deltas are also very vulnerable to disruptions of what sustains their land mass and water. i.e., the impacts of a changing climate, the development activities upstream such as sand mining and the building of hydropower dams. Today, coastal river deltas are among the Earth's most densely populated areas. For example, the Ganges-Brahmaputra-Meghna Delta is home to more than 100 million people. Others are home to the largest cities in the world, such as Cairo, Dhaka, Kolkata, and Shanghai. Other deltas, like the Mekong, are critically important for food and fish production. Some studies estimate the annual value of ecosystem services derived from major deltas worldwide to be in the trillions of US dollars.

Many of the world's deltas are threatened by the same stressors as the Mekong Delta. These include those caused by sediment and nutrient depletion and flow distortion due to upstream dam development, sea level rise due to a warming climate, and coastal erosion and subsidence due to groundwater extraction. Recent research suggests that 85% of the river deltas around the world have shrunk during the first decade of this century due to upstream sediment capture. With much of their lands just above or below sea level, many developed river deltas along coasts are vulnerable to floods and saltwater intrusion. With rising sea levels, and increased groundwater pumping that leads to land subsidence, their vulnerability to flooding will likely increase both in terms of extent and duration.

A central premise of this presentation is that the management innovations that emerged from a study of alternatives for producing renewable energy in the Mekong Basin, and their impact on the Mekong Delta, can illuminate environmentally compatible ways of reducing the vulnerability and enhancing the resilience of other river deltas. Among the many management options available in the Mekong Basin are the appropriate siting, design and operation of any new hydropower dams in ways that will preserve the natural flows of water, sediment and nutrients that sustain a delta's geomorphology and productivity, the installation and coordinated operation of solar panels on existing hydropower reservoirs that reduce the need to create new reservoirs, and the reduction of upstream sand mining and water abstractions. Each of these options along with others are aimed at letting nature play a larger role in sustaining a basin's, including its delta's, aquatic life and its habitats, geomorphology, biodiversity, and agricultural and industrial

productivity. All of that together contributes to the livelihoods of the people living in and outside of the delta. There are at least 30 vulnerable delta systems in the world for which the lessons learned from the study in the Mekong Basin have direct salience. The presentation will discuss what we learned from the Mekong and the relative effectiveness of these delta management alternatives using the Mekong as a case study.

Case Study: Wetland Landscapes, Eco-Hydroclimatic Dynamics, and Governance Challenges in the Paraná Delta, Argentina

Morandeira, Natalia, Researcher, Argentina's National Scientific and Technical Research Council; Professor, Environmental Research and Engineering Institute, Habitat and Sustainability School, University of San Martín, Argentina

The Paraná River Delta (19,520 km^2) flows into one of the world's largest estuaries, the De la Plata River in Argentina, featuring a large mosaic of freshwater wetland landscapes. Its heterogeneous geomorphological history, combined with high hydrological and climatic variability, diverse socio-ecological dynamics, and increasing land-use conflicts, poses complex challenges for management and governance. These challenges are further intensified by the involvement of multiple jurisdictions, including national, provincial, and municipal authorities.

For the last 12 years, the proposal of a National Wetlands Law to promote the conservation and sustainable use of wetlands has been in the spotlight, driven by a strong media presence and a socio-political and environmental agenda shaped by controversies among citizens, productive stakeholders, NGOs, legislators, and policymakers. In 2022, another failure to sanction the Law –followed by the change of the national government and a reduced budget for environmental and natural resource protection since 2023– effectively froze most of the debate. Nevertheless, throughout this period, several Wetland Inventory initiatives were developed and adopted by environmental agencies across multiple jurisdictions. Thanks to its long-standing history of research and environmental management practices, the Paraná Delta served as a pilot region for these inventories, benefiting from the broader visibility and public pressure. Looking ahead, future initiatives should strengthen participatory processes. One of the key lessons is the need to integrate geomorphological and hydrological variability into any wetland land-use planning and management.

The expansion of large-scale commodity agriculture in South America has major implications for the Paraná Delta. On the one hand, the promotion of agroextractivism has increased pressure on the Hidrovía Paraguay-Paraná, a navigation project intended to transport crops and other commodities to the De La Plata estuary and the ocean. Deepening the natural Paraná River channel and increasing barge navigation would increase riverbank erosion, threaten local communities living by the river and their access to water, decrease sediment input to the floodplain, and potentially endanger natural areas of high ecological value (three national parks, a Ramsar Site, and a UNESCO Biosphere Reserve). On the other hand, upland agricultural expansion displaces livestock into the Paraná Delta, affecting both socio-ecological systems and wetland health. In addition, agrochemicals from upland crops runoff or leach into water systems and have been detected in the Paraná River. This highlights how decisions in one territory can create ripple effects in others. Another example is sand extraction in the Delta, an emerging pressure driven by fracking-related hydrocarbon exploration in Patagonia, southern Argentina.

Hydrological dynamics, driven by the flood pulses of the Paraná River and upstream rivers as well as by tides from the Del Plata estuary, and influenced by El Niño-Southern Oscillation events, sustain biodiversity, nutrient cycling, and ecological integrity. As such, they have been recognized as a key conservation value. However, climate change has been linked to extreme events, posing additional challenges for management. Extended floods strongly impact local communities (*isleños*, or islanders), who are highly vulnerable and often lack basic infrastructure (energy, safe drinking water) as well as access to health care and education. Depending on the effectiveness of flood alert systems and the limited infrastructure to move cattle from the Delta to upland areas, livestock or domestic animal deaths may occur. In contrast, recent years have been historically dry, bringing difficulties for navigation, isolation of *isleños*, reduced artisanal and industrial fisheries, and fueling massive wildfires across the Delta. Fire management has challenged government agencies, leading to the creation of the Comprehensive Strategic Plan for the Conservation and Sustainable

Use of the Paraná Delta (PIECAS-DP). This regional, inter-jurisdictional forum was initially established in response to the widespread fire events of 2008 and was reactivated in 2020, serving as an example of adaptive governance.

The PIECAS-DP performance was crucial to convening actors to coordinate actions during emergency periods and to promote fire management legislation. Yet, its capacity to transcend crisis-driving activation and remain consistently engaged in addressing broader, long-term environmental issues has been limited. Other examples of issues requiring regional coordination include major infrastructure projects with downstream impact, harmonized inter-provincial fisheries legislation, territorial planning of productive activities, effective enforcement of protected areas, and the regulation of hydraulic alterations (poldering, dike construction, channel rectification, and drainage works). While diking was traditionally associated with forestry activities, its use has expanded dramatically, especially by external stakeholders during dry periods, linked to urban development, intensive cattle grazing, and illegal agricultural projects involving agrochemicals and forced displacement of *isleños*.

Local community engagement in territorial planning and governance is mostly absent or limited to isolated workshop events. One notable exception is the role of the National Institute of Agropecuary Technology (INTA) in the Frontal Delta, where networks and programs have been coordinated to promote productive sectors such as forestry, sustainable livestock, beekeeping, wickerwork, fruit growing, and family farming. Socio-environmental conflicts have emerged because of the arrival of external stakeholders who hold different views about the wetland features and how productive activities should be carried out within them. Values in dispute and power asymmetries are a fact in these complex socio-ecosystems. Sustained community participation is essential for delineating management policies, emphasizing local expertise and *isleños*' perspectives on the Paraná Delta's common goods to guarantee their well-being.

Overview Presentation on Different Considerations and the People Who Rely on Deltas

Santipitaks, Busadee, Chief Executive Officer, Mekong River Commission Secretariat, Laos

The Mekong Delta, the vital downstream region of the Mekong River Basin, has faced pressing challenges, including declining sediment flows, rising sea levels, worsening saltwater intrusion, and the dual threats of floods and droughts on communities and livelihoods. As the regional body mandated to enhance the sustainable development and management of the Mekong River, the Mekong River Commission (MRC) plays a central role in strengthening the resilience of the Mekong, its delta and the communities that depend on it. The MRC has strengthened its efforts to enhance data collection, vulnerability assessments, and regional cooperation, particularly through joint studies with China, as well as enhanced forecasting and early warning systems. Community engagement has also become a central focus, with initiatives such as Mekong Products development and the One Mekong App showcasing how local knowledge and digital tools can drive adaptation and resilience. As the MRC is wrapping up the current Strategic Plan (SP 2021-2025), the priorities for the next SP 2026-2030 will emphasize stronger transboundary projects, modernized monitoring, and inclusive approaches to secure the Mekong Delta's future. Enhanced data collection and analysis, monitoring, and forecasting will provide the MRC Riparian Countries (Cambodia, Lao PDR, Thailand, and Viet Nam) with evidence needed to make better-informed decisions on water flow, sediment management, and disaster risk reduction. This will enable more adaptive, equitable, and proactive planning for the Mekong and its delta, improving resilience to floods, drought, and other climate related challenges. The next phase will also introduce future transboundary projects, including coordinated hydropower and flow operations, integrated sediment management, and water–energy–food nexus pilots, all designed to deliver tangible community benefits and strengthen cooperation across the Lower Mekong Basin.

Overview of Global Deltas: Adaptive Delta Plan Implementation—Lessons from a Practitioner

Sara, Jennifer, Water/Climate Director, The World Bank, USA (*former*)

River deltas worldwide face unprecedented challenges requiring innovative, inclusive and adaptive management approaches that balance environmental protection with economic development, short-term responses with long-term needs, local solutions with transboundary negotiations. While global deltas can be classified in order of importance by size or population, what is most critical is to understand the socio-economic situation and aspirations of the

communities who live there and the opportunities and threats provided by the unique and fragile ecosystem in which they live. As such, best practice delta planning and management approaches are most effective when they draw on scientists, policy-makers, practitioners and community stakeholders working collaboratively within an open multi-stakeholder engagement process with feedback loops. Major collaborative exercises in River Delta Planning, supported by international organizations, and based on experiences in delta management in high income countries, have led to the formulation of the first Mekong Delta plan in 2013, and to the launching, in 2018, of the Bangladesh Delta Plan 2100. Translating these comprehensive plans into on-the-ground implementation have revealed the opportunities and challenges of adapting the principles of adaptive management to existing government institutional mechanisms. Lessons from World Bank support to these two delta programs show the opportunities of working across sectoral perspectives, administrative boundaries and stakeholder groups. They also point to the inherent challenges of adopting an adaptive management approach at scale in terms of transforming existing institutional processes, finance mobilization and a results and learning focus.

This presentation will provide a brief overview of the importance and challenges of major river deltas to economic development and environment protection, the principles of adaptive management for river deltas, and drill down on lessons from World Bank support to government-led delta programs in the Mekong and Bangladesh. The presentation will conclude with policy recommendations related to implementing adaptive management principles for Delta Plan implementation with the need for: (1) local institutional ownership and adaptability, (2) mobilizing finance in the early stages of Plan adoption, (3) the criticality of delivering tangible results that improve community livelihoods within a changing environment, and (4) learning loops as an integral part of adaptive management of deltas.

Funding and Financing Basin Cooperation: Lessons Learned from Around the World

Schmeier, **Susanne,** Head, Water Governance Dept. and Professor, Water Law, Cooperation and Diplomacy, IHE Delft Institute for Water Education, The Netherlands

Establishing and maintaining institutional arrangements for governing shared basins and developing and implementing joint basin management require considerable financial resources. In many basins around the world, these financial resources are scarce – especially in times of economic downturn, broader economic and geopolitical crises and declining commitment to international cooperation over natural resources and the environment. This presentation provides an overview of the financial needs for transboundary water cooperation and the funding and financing mechanisms available, critically assessing the effects financial choices of basin countries and basin organizations have on effective cooperation more broadly.

Impact of Water Resources Development in the Delta and Upstream/Downstream Dams

Tian, Fuqiang, Professor, Tsinghua University, and Vice President of International Hydrological Science Association, Beijing, China

The Mekong River, a transboundary lifeline sustaining food security, hydropower, and ecosystems for six riparian nations, faces unprecedented pressures from intensive water resources development and climate change. As a global rice basket supplying 15% of international trade, the Mekong Delta's stability is critical, yet upstream dam construction, sediment starvation, and localized exploitation threaten its ecological and socioeconomic resilience. Recent analyses show that upstream dams have fundamentally altered the Mekong's natural flow regime by delaying both the peak and the minimum flows that are vital for floodplain agriculture and fisheries. Compared to the pre-dam period (1980–2000), the construction of dams between 2010 and 2024 has increased dry-season flows by 2–12% while reducing wet-season peaks by 15–30%. This disruption in flood pulses is critical because it underpins the ecological productivity of Cambodia's Tonle Sap Lake and Vietnam's Mekong Delta—areas that produce half of the basin's rice and 80% of its aquaculture. Concurrently, Sediment delivery to the delta declined by 36%, from a 1980–2000 mean of 100 Mt yr^{-1} to 64 Mt yr^{-1} in 2010–2024. This decline in sediment supply compromises land formation and nutrient cycling. Moreover, when combined with increased sand mining—which surged from 3.9 Mm3 in 2012 to 13.4 Mm3 in 2018—and intensified groundwater extraction, these changes have led to riverbed incision rates of over 10 cm per year. The combined effects are accelerating saltwater intrusion and delta subsidence.

Linking Local Realities to Regional Agendas: Pathways to a Resilient Mekong

Van Pham Dang Tri, Director and Professor, DRAGON-Mekong Institute for Climate Change, Can Tho University, Vietnam

The Mekong Delta, at the southernmost end of the Mekong River Basin, is both a regional rice-basket and one of Southeast Asia's most climate- and water-vulnerable landscapes. The Delta and the wider Greater Mekong Subregion (GMS) face accelerating challenges: upstream hydrological changes, climate extremes, land subsidence, and seawater intrusion. These dynamics are undermining ecosystems, agricultural systems, and rural livelihoods, while exposing persistent gaps in water governance, resource management, and regional coordination.

Addressing these interconnected threats requires integrated solutions that combine scientific knowledge, innovative technologies, and inclusive governance. Digital water monitoring, climate-smart rice–shrimp systems, and ecosystem restoration strategies aligned with local capacities are examples of approaches that can secure livelihoods while strengthening resilience. At the regional level, effective cooperation is needed to harmonize national strategies, bridge governance gaps, and advance a just transition to low-carbon and climate-resilient growth.

Can Tho University and its Mekong Institute play a central role in this effort. As a hub, the Institute mobilizes resources internally and externally, linking universities, governments, communities, businesses, and international partners. Through applied research, stakeholder engagement, and policy dialogue, it works to translate science into practice and align local realities with basin-wide frameworks.

By fostering science–policy–community partnerships, Can Tho University and the Mekong Institute strengthen food security, climate resilience, and sustainable development pathways. Their role as a Knowledge Hub reaffirms the Mekong Delta's position as a cornerstone of regional sustainability and offers lessons applicable to other vulnerable river basins worldwide.

Addressing the Coastal Squeeze with Hybrid Nature-Based Solutions in the Mekong Delta

Wyatt, **Andrew,** Deputy Head, Lower Mekong Sub-Region, International Union for Conservation of Nature (IUCN)

Sea level rise in the Mekong Delta is occurring at a rate of 3.34 mm/yr and more intense storms and storm surges are projected (MONRE, 2016). Existing coastal defenses that rely on a thin line of defense consisting of a compacted earth sea dyke and a thin line of mangroves in front of the sea dyke create an extreme risk for communities living behind the sea dyke. Although regulations (Govt. Decree 156, 2018) stipulate a minimum 500 m of mangroves to be maintained in front of the sea dyke, this buffer does not exist along two-thirds of the delta's coastline. Here, the depth of the mangrove is less than 100-200 m on average and in many areas sea dykes are directly exposed to wave action, leading to rapid erosion and increasing maintenance costs.

The mangroves that remain in front of the sea dyke are disappearing as the "coastal squeeze" accelerates through a combination of: 1) greatly reduced sediment loads in the Mekong River from upstream hydropower dam development and sand mining (MRC, 2010; Anthony et al, 2015); 2) the possibility of >1m sea level rise by 2100 (NOAA, 2016; Hanson et al, 2016); 3) coastal subsidence of up to 2.5 cm/yr (Minderhoud et al, 2017; Erban et al, 2018); 4) and changing coastal dynamics. Under these conditions, the survival of mangroves in front of the sea dykes in many locations is impossible because of the coastal squeeze effect (Phan, K.L. et al, 2015). Today, it is no longer possible to plant new mangroves on the Mekong Delta's eroding shorelines because their habitats, the mudflats, have been eroded away. Furthermore, soft engineered solutions using sediment traps such as bamboo T-Fences are no longer able to rebuild the mudflats before the fences biodegrade because the greatly reduced Mekong sediment load is taking an increasingly longer time to trap.

As a result, a hybrid approach of combining longer lasting hard structures such as concrete breakwaters to rebuild the mudflats on which to re-plant mangroves is preferred by the government, whilst development partners such as IUCN advocate to increase the resilience of the coastal zone by combining the hard structures with setback zones behind the sea dykes using other forms of hybrid NbS such as mangrove-RAS that incentivize farmers to plant mangroves in their shrimp farms.

Case Study: Global Solution for A Silent Poison—Human Health Risks of Arsenic in the Mekong River Delta

Zheng, **Yan,** Chair Professor, Guangdong Provincial Key Laboratory of Soil and Groundwater Pollution Control, School of Environmental Science and Engineering, Southern University of Science and Technology, Shenzhen, China; Principal Investigator, State Key Laboratory of Soil Pollution Control and Safety, School of Environmental Science and Engineering, Southern University of Science and Technology, Shenzhen, China. Email: yan.zheng@sustech.edu.cn

This presentation is an assessment of human health risks of inorganic arsenic (As) from drinking well water and consumption of rice irrigated by high-As groundwater in the Mekong River Delta. Geogenic inorganic As (iAs) occurring at elevated levels in groundwater has been detected in more than 70 countries. Among mostly rural residents relying on groundwater for drinking, this exposure has resulted in negative health consequences including visible skin lesions, multiple internal organ cancers, numerous invisible non-cancer health effects such as cardiovascular diseases, and premature deaths.

The Mekong River Delta (MRD, defined as areas <10 m above sea level) has faced groundwater arsenic (As) contamination since its discovery in Cambodia (1999) and Vietnam (2005). Part I of this presentation systematically analyzes a dataset of 94,768 well water tests to delineate the spatial patterns and associated health risks across the delta. In Cambodia, 35.8% of 41,928 wells exceeded the WHO guideline (10 μg/L), and 21.5% exceeded the national standard (50 μg/L). In Vietnam, 10.0% of 52,858 wells exceeded the national standard (10 μg/L). High-As wells are strongly clustered within 5 km of the Mekong-Bassac rivers and in low-lying areas (<25 m in Cambodia, <10 m in Vietnam). They occur at shallow depths (<70 m) throughout the MRD, but also at deeper depths (300–500 m) in Vietnam. This leads to severe health impacts, with population attributable fractions exceeding 0.1 in 11 Cambodian and 3 Vietnamese districts all located near the Mekong, indicating that arsenic exposure is responsible for >1 in 10 adult deaths in these hotspots. Annually, this translates to 1,204 excess deaths in Cambodia (1 in 27 adults) and 1,486 in Vietnam (1 in 78 adults), underscoring this silent public health crisis.

Part II of this presentation report new Cambodian grain As speciation data (n=128), interpreted with literature data (n=39) according to spatially resolved low, medium and high groundwater As risk categories based on the aforementioned analysis, with %[As]water > 100 μg/L of 0.7%, 4.7% and 21%, and soil total As concentrations of 1.2±0.8 mg/kg (n=42), 7±3 mg/kg (n=14) and 13±3 mg/kg (n=10) accordingly, but a more muted grain total As concentrations response of 129±55 μg/kg (n=70), 93±28 μg/kg (n=10), and 303±138 μg/kg (n=87), respectively. In addition to a near absence (<1%) of monomethylarsonic acid (MMA) in rice grains (n=56) despite its dominance (~half) in soil extractable fractions, iAs instead of DMA, was found to account for 84±8% in rice grains (n=87) from high groundwater As areas, highlighting irrigation risks on rice safety.

Finally, examples of other regions are provided to illustrate strategies needed for solving this silent poison that is a major public health issue for the World Health Organization, with a call for action to test all domestic well water for arsenic worldwide. To achieve this ambitious target, the following evidence-based actions are needed: 1) prioritize testing for high As risk areas predicted by models or supported by sparse data at regional scale, 2) prioritize testing of wells close to a known high As well at local scale, and 3) develop and deploy sensitive, reliable, inexpensive, and user-friendly on-site testing methods.

Additional Resources:

1) Y Zheng*, B Xu, J Liu, Y Shen, K Phan, BC Bostick (2024) Arsenic in Hydro-geo-biospheres of the Mekong River Watershed: Implications for Human Health in D Chen, J Liu, Q Tang (ed.) Water Resources in the Lancang-Mekong River Basin: Impact of Climate Change and Human Interventions. pp. 121-202. Springer Nature, Singapore.
2) J Qiao, J Liu, A Palomo, BC Bostick, K Phan, Y Zheng*, F Li*. (2023) Prevalence of Methylated Arsenic and Microbial Arsenic Methylation Genes in Paddy Soils of the Mekong Delta. Environ. Sci. Technol. 57: 9675−9682.
3) Y Zheng*. (2020) Global solutions to a silent poison. Science 368:818-819
4) Y Zheng* and SV Flanagan (2017). The case for universal screening of private well water quality in the U.S. and testing requirement to achieve it: Evidence from arsenic. Environmental Health Perspective, 125(8) DOI:10.1289/EHP629. https://ehp.niehs.nih.gov/EHP629/
5) Zheng, Y.* (2017) Lessons Learned from Arsenic Mitigation among Private Well Households, Current Environmental Health Reports, 1-10.