MEDIA FACTSHEET

Coastal Protection and Flood Resilience Institute (CFI) Singapore's 2nd Annual Symposium – "Rising Stronger: Advancing Coastal and Flood Resilience through Science and Technology"

1. Key interim findings from research on enhancing coastal protection and flood management

Since the establishment of the Coastal Protection and Flood Resilience Institute (CFI) Singapore under national water agency PUB's Coastal Protection and Flood Management Research Programme (CFRP) in September 2023, the Institute has launched 17 innovative projects in coastal-related research. The interim findings from selected projects in the first and second tranches are:

i. Model development and quantifications of coupled near-shore processes impacted by climate change (Principal Investigator: Assistant Professor Yuzhu Pearl Li, Department of Civil and Environmental Engineering, College of Design and Engineering, NUS)

Researchers at CFI Singapore are developing a novel numerical model to simulate how sediments move within complex root systems, using field data from Rhizophora mangroves in Southeast Asia to ensure regional relevance. Though still in the development phase, the model has already shown versatility, with promising applications beyond mangroves to other vegetation such as seagrass. Early findings indicate that sediment can both erode and settle within mangrove roots, with certain sections more vulnerable during early growth.

These insights could guide future efforts to protect young mangroves, improve restoration success, and enable them to grow into strong natural shields against waves and storms. In the long run, healthy mangroves will not only help safeguard Singapore's coasts but also store carbon, support biodiversity, and strengthen resilience to rising seas and flooding.

ii. Shore Protection with Integrated Nature-based Solutions – Hydro (Principal Investigator: Assistant Professor Jiarui, Gary Lei, Department of Civil and Environmental Engineering, College of Design and Engineering, NUS)

Researchers are trialling a hybrid solution that combines concrete planters with young mangroves to reduce wave energy and build shoreline resilience. Early results show that concrete planters can cut wave heights by up to 15 percent, helping to lessen wave impact, run-up and overtopping.

The planters are designed to protect mangrove seedlings by reducing water flow inside, allowing them to establish and grow without being damaged by strong currents. Each planter consists of two halves that can be removed once the

mangrove becomes too large, and they are made from eco-friendly materials that minimise environmental and biodiversity impacts. As the mangroves mature, their role becomes increasingly valuable — providing stronger coastal protection through their expanding root systems, enhancing biodiversity by creating habitats for marine and coastal species, and contributing to long-term resilience as natural defences that grow stronger over time.

This combined nature–engineering strategy offers a cost-effective, sustainable approach to coastal defence and could play a key role in safeguarding Singapore's coastlines against rising seas and stronger waves.

iii. Eco-cement enhanced methods for beach erosion control and beach land restoration through soil accumulation (Principal Investigator: Professor Chu Jian, NTU)

Researchers at CFI Singapore have made significant progress in exploring eco-cement as a sustainable alternative for coastal protection. By reviewing global research on eco-cement techniques, the team identified key knowledge gaps and charted future research directions. Early laboratory experiments using eco-cement formulations with seawater-treated sand columns have already shown promising results, proving the material's potential for use in marine environments.

Building on this, the team has developed a structured research roadmap to guide systematic testing through small-scale physical models. This ensures rigorous validation and efficient resource planning as eco-cement applications move closer to real-world trials.

In collaboration with Surbana Jurong and HSL Constructor Pte Ltd, discussions and site visits are underway to establish a living lab project that will test eco-cement and jute tube barriers in muddy coastal conditions. These efforts mark an important step towards nature-based, industry-ready coastal protection solutions that not only safeguard Singapore's shores but also support sustainable development.

iv. Promoting hybrid solution resilience by optimising hydrodynamical and structural influences on coral larval attachment to reefs and sediment clustering amid seagrass (Principal Investigator: Dr Ronald Chan, A*STAR Institute of High Performance Computing (A*STAR IHPC))

This project seeks to advance hybrid coastal protection systems by optimising the interaction of natural and engineered wave-damping structures to promote robust coral larval attachment. The approach combines scenario-based modelling of different wave and current conditions with experimental validation to refine design effectiveness.

Together with the Technology Centre for Offshore and Marine, Singapore (TCOMS) and St John's Island National Marine Laboratory (SJINML), basin and seawater flume tests are being set up to characterise nearshore hydrodynamic conditions around low-crested breakwater structures. These include testing a 1:4 scale hybrid seahive–cubipod model and conducting seagrass deformation experiments to generate critical data on material strength and sediment transport.

In parallel, the team is developing multi-scale modelling tools: a numerical wave flume to evaluate breakwater efficiency, simulations of seagrass energy dissipation and sediment trapping, and reef-scale models that incorporate coral larval attachment dynamics through novel boundary conditions and agent-based

behavioural models. A key opportunity for industry collaboration lies in co-developing modular breakwater designs that promote coral growth which could form the basis for future Living Lab projects.

2. Driving Innovation through a Growing Academia–Industry Ecosystem

To drive collaborative research and development in technology translation - focusing on coastal protection and flood management solutions tailored for urban and land-scarce coastlines - CFI Singapore has extended its partnership network to include Giken Seisakusho Asia Pte. Ltd, Jacobs International Consultants Pte Ltd, Pan-United Concrete Pte Ltd, Samsung C&T, ST Engineering Unmanned and Integrated Systems Pte Ltd and Surbana Jurong Consultants Pte Ltd. The areas of cooperation include:

(a) Coastal science research;

(b) Monitoring, prediction and digitalisation of the coastal environment;

(c) Integrated and adaptive planning;

(d) Innovative engineering solutions for coastal protection and flood management;

(e) Integrated nature-based solutions for coastal protection;

(f) Sustainable infrastructure solutions for coastal protection and flood management; and

(g) Smart management solutions for operation and maintenance for coastal protection and flood management.

Professor Adrian Law, Executive Director, Coastal Protection and Flood Resilience Institute Singapore: "Across Asia, coastal cities face common challenges with climate change and sea level rise. At CFI Singapore, our focus is on use-inspired research — from improved predictive assessment based on comprehensive coastal science knowledge and field monitoring, to innovations in multi-functional and integrated nature-based solutions — that can enhance our coastal adaptation for the future. This symposium is about bringing together regional expertise and partnerships, so that the knowledge we build in Singapore contributes to stronger, more resilient coastlines across the region."

Mr Ryo Kamioka, Manager, Giken Seisakusho Asia Pte. Ltd: "Giken is currently engaged in numerous coastal storm surge countermeasure projects in Japan, and we hope to see this innovative technology adopted in Singapore and other countries as well."

Mr Vinod Singh, Senior Director, Jacobs International Consultants Pte Ltd: "With a global footprint and deep technical expertise, Jacobs is committed to delivering integrated, forward-thinking solutions that address coastal and flood risks, water scarcity, and sustainable resource recovery. Through strategic collaboration and data-driven innovation, we bring market insights and global best practices to co-create resilient outcomes—empowering communities in Singapore and across the region to adapt, thrive, and shape a more sustainable future."

Mr Ken Loh, Chief Executive Officer (CEO), Pan-United Corporation Limited: "Pan-United is proud to be collaborating with CFI Singapore on innovative, sustainable engineering solutions to strengthen Singapore's coastal resilience. By combining our expertise in specialised low-carbon concrete and our proprietary AI technology with CFI

Singapore's capabilities in coastal science innovation, we can co-develop systems that will enhance coastal protection and ensure a safer Singapore for future generations."

Mr Robin Liao Binkui, Director (Coastal Engineering), Surbana Jurong Consultants Pte Ltd.: "We are committed to advancing coastal resilience by integrating innovative engineering, sustainable practices, and nature-based solutions to safeguard communities and ecosystems for the future."

Mr. Kim Woosung (Group Leader from our Global Infra Business Development Team (Global Infra Specialty Product Development Group), Samsung C&T: "Samsung C&T looks forward to partnering with CFI members to further promote environmentally-friendly approaches in future coastal protection projects and support the adoption of these practices in similar initiatives."

Mr. Mr Goh Ming Joo Senior Vice President / General Manager, ST Engineering Unmanned & Integrated Systems Pte Ltd: "This MoU with the NUS Coastal and Flood Resilience Institute (CFI) reflects our shared commitment to advancing coastal resilience through innovative, sustainable, and collaborative solutions. By bringing together cutting-edge research and practical engineering expertise, we look forward to co-creating innovative solutions and achieve positive impact through this collaboration."

The CFI industry network now includes more than 11 members, ranging from construction and engineering firms to environmental consultancies and an information technology company. This growing diversity has expanded the potential for cross fertilisation of ideas and strengthened opportunities for innovation through collaboration.

Several CFI Singapore's MoU partners are now actively engaged in Applied Research projects (under the PUB Applied Research scheme), underscoring the growth of a dynamic government-academic–industry ecosystem.

Industry collaborators such as Delta Marine Consultants Pte Ltd, Fugro Singapore Marine Pte Ltd, Kajima Technical Research Institute (Kajima Corporation), Pan-United Concrete Pte Ltd and Surbana Jurong Consultants Pte Ltd are working alongside CFI researchers to co-develop hybrid coastal protection solutions, test sustainable materials and innovative technologies for shoreline resilience.

These partnerships are translating research into practical innovations that strengthen Singapore's coastal and flood resilience, while fostering deeper collaboration between academia, industry, and public agencies.

3. Developing a strong talent pipeline for coastal protection and flood management

A core mission of CFI Singapore is to nurture the next generation of leaders, researchers, and practitioners who will shape Singapore's resilience to coastal and flood risks. Since its launch in 2023, the Institute has grown a vibrant community of close to 90 principal investigators, researchers, PhD and Master students across 17 projects funded by the CFRP. Together, they are strengthening local expertise and advancing innovative solutions to address climate challenges.

Ms Heidi Seah Tse Shing, Research Engineer, CFI Singapore: "As an engineer, I love seeing my designs come to life in the real world. Given the threat of sea-level rise and the increasing risk of coastal flooding in Singapore, I find immense value in contributing to efforts that enhance the resilience of Singapore's coastline."

Mr Tan Hans Siang, Research Engineer, CFI Singapore: "When I see the growing impacts of climate change—rising sea levels, increasing temperatures, I feel a deep responsibility to be part of the solution. We can't afford to wait. I want to contribute to efforts that not only address these challenges but also prevent them from escalating for future generations."