

MEDIA FACTSHEET

Eight new research projects to advance Singapore's coastal and flood resilience

Projects will explore deployable coastal barriers, AI-enabled monitoring, advanced sensing, and nature-based and hybrid protection solutions.

The Coastal Protection and Flood Resilience Institute (CFI) Singapore is embarking on eight new research projects under the third tranche of the Coastal Protection and Flood Management Research Programme (CFRP). The projects round off the new research projects supported under the Research, Innovation and Enterprise 2025 (RIE2025) plan and expand research into areas ranging from rapidly deployable and scalable coastal barriers to artificial intelligence (AI), advanced sensing and monitoring technologies, and nature-based and hybrid coastal protection solutions.

Together, the projects seek to address practical challenges in how Singapore understands, designs, monitors and maintains coastal protection systems, while strengthening the scientific and engineering capabilities needed for long-term coastal resilience. The eight projects are:

i. Impact of extreme coastal processes and flooding on the stability of coasts and green-grey protection structures (Principal Investigator: Assistant Professor Yuzhu Pearl Li, National University of Singapore [NUS])

During severe storms, damage to coastal defences may not only happen above water. Strong waves and storm surges can also affect the seabed beneath and around coastal structures, causing erosion, weakening slopes and, in severe cases, making the soil unstable. This project will study what happens beneath the seabed during extreme weather, and how waves, currents, sediments, groundwater and coastal structures interact. Researchers will use computer modelling and laboratory experiments to identify when seabed conditions may become unstable.

The findings could help engineers design safer and more resilient coastal protection, including hybrid solutions that combine engineered structures with natural features, and better account for Singapore's coastal and seabed conditions.

The project will develop an integrated framework that brings together waves, currents, coastal structures, sediments and groundwater. Through numerical modelling, laboratory experiments and analytical methods, the team aims to establish quantitative thresholds for seabed instability and provide design-ready guidance for climate-resilient coastal protection suited to Singapore's conditions.

ii. AI-enhanced synthetic aperture radar imaging with denoising and super-resolution for coastal protection (Principal Investigator: Dr Cheng Jun, Agency for Science, Technology and Research (A*STAR), Institute of Advanced Intelligence and Computing (IAIC))

Natural habitats such as mangroves and seagrass can help protect coastlines by reducing wave energy and stabilising sediments. However, understanding how well these natural defences are performing requires researchers to monitor changes in vegetation and the surrounding coastal environment over large areas and over time.

This project will explore how AI can improve satellite radar images of Singapore's coastline, allowing researchers to see coastal features in greater detail and monitor them even under cloudy or rainy conditions. By combining enhanced satellite images with information from other sensors, researchers aim to track changes in vegetation, the ground beneath it and surrounding coastal conditions. This could help agencies better understand how nature-based coastal protection is performing and how it changes over time, supporting more informed coastal planning and management.

iii. Real-time monitoring of spatial distribution of nearshore hydrodynamics through multi-modal sensor fusion (Principal Investigator: Assistant Professor Yin Xunyuan, Nanyang Environment & Water Research Institute [NEWRI], Nanyang Technological University, Singapore [NTU Singapore])

Existing coastal monitoring tools such as buoys and single-point underwater sensors provide accurate measurements but cover limited areas and can be costly to maintain. This project aims to develop a scalable and cost-effective system that provides real-time information on waves and water levels across larger nearshore areas.

This project will develop a new monitoring system that combines underwater acoustic sensors with shore-based Light Detection and Ranging (LiDAR), which uses laser light to measure conditions at the water surface. By bringing information from different sensors together, the system aims to provide a more complete, real-time picture of wave heights and water levels across a wider stretch of coast.

The technology will be tested in laboratories, large-scale wave facilities and eventually in Singapore's coastal waters. In future, such real-time information could help agencies detect potentially hazardous coastal conditions earlier, assess how coastal defences are performing and make better-informed operational and maintenance decisions.

Note to media: The team will present their project with a video rendition showing the sensing system.

iv. Rapid deployment of Movable Coastal Barrier based on Screw pile and Caisson foundation (MCB-SC) (Principal Investigator: Assistant Professor Rui Shengjie, NUS)

Most coastal barriers are designed to remain permanently in place and can take considerable time to build. But there may also be situations where coastal protection is needed more quickly. For example, ahead of an extreme weather event or while an existing seawall is undergoing repairs.

This project will develop a modular coastal barrier that can be transported and assembled quickly when and where additional protection is needed. The barrier will combine concrete caisson foundations with screw piles, which are twisted into the seabed rather than hammered in, reducing noise, vibration and disturbance during installation. Researchers will test how quickly the barrier can be installed and removed, how it performs against waves and currents, and how it behaves under different seabed conditions. The concept could eventually provide Singapore with a more flexible coastal protection option that can be used temporarily during emergencies or incorporated into permanent coastal defences.

v. Scalable and sustainable coastal barriers for wide and deep channels (Principal Investigator: Professor Qian Xudong, NUS)

Protecting wide and deep waterways from coastal flooding presents a particular challenge. Conventional storm surge barriers can require permanent structures in the water, which may interfere with shipping and navigation, affect sea views and limit how waterfront areas can be used in future.

This project will explore a different approach: a large coastal barrier that is deployed only when it is needed. The proposed system uses offshore jack-up platforms to temporarily support a retractable barrier across a waterway during extreme events. Under normal conditions, the barrier would be retracted, keeping the channel open. Researchers will study how the system responds to waves and currents, how it interacts with the seabed and how multiple platforms can be coordinated during deployment. The aim is to develop a flexible and scalable option for protecting wide waterways without permanently blocking or occupying them.

vi. Surveying Eco-functioning And Creating Resilient Eco-Shorelines for Tomorrow (SEACREST) (Principal Investigator: Associate Professor Peter Alan Todd, NUS)

Hybrid shorelines combine conventional coastal structures with natural habitats such as mangroves and corals. These living components can help reduce wave energy and provide ecological benefits, but unlike concrete structures, they can grow, change or be damaged by environmental conditions over time.

SEACREST will investigate how these hybrid shorelines can be monitored to ensure that they continue to provide effective coastal protection. Researchers will also study what happens to their natural components during stresses such as high temperatures, heavy rainfall and oil spills, and how their protective function can be restored if they are damaged.

The findings will help develop practical guidelines for monitoring the health and performance of hybrid shorelines and determining when remedial action may be needed, supporting their longer-term use as part of Singapore's coastal defences.

vii. Spectral and Environmental Network for Tropical Integrated Examination and Live monitoring (SENTINEL) (Principal Investigator: Professor Karina Gin Yew-Hoong, NUS)

Hybrid coastal defences bring together engineered structures such as seawalls with natural habitats such as mangroves and seagrass. Monitoring these systems can be complex because engineers need to understand not only the condition of the structures, but also the health of the surrounding natural environment.

SENTINEL aims to create a real-time monitoring system that brings this information together in one place. It will combine satellite and drone imagery, fixed cameras, water-quality sensors and field observations to monitor changes along the coast.

The information will be used to produce practical tools such as maps showing vegetation health, warnings of changes in water quality, indicators of potential structural problems and short-term forecasts. This could help planners and engineers identify emerging issues earlier and decide where closer inspection or action may be needed.

viii. Visual And Smart Ecohydrodynamics with Robotics (VASE-R): AI-assisted monitoring of flow, vegetation, bed morphology, and attenuation capability and

uniformity (Principal Investigator: Assistant Professor Jiarui Gary Lei, NUS, and Assistant Professor Fu Yuguang, NTU)

Mangroves, seagrass and other nature-based coastal protection measures change over time. Vegetation can grow or thin out, the seabed can shift, and storms can create erosion or other weak spots. Monitoring these changes using conventional methods can require significant time and manpower.

VASE-R will explore how AI, cameras, laser scanning and small robotic platforms such as drones can make these inspections faster and less intrusive. For example, cameras can track how vegetation moves with water flows, while 3D mapping can detect small changes in the seabed around roots and coastal structures. By identifying areas where vegetation has thinned, erosion has occurred or structures have become exposed, the system could help researchers and coastal managers spot potential problems earlier and focus detailed inspections where they are most needed.

Note to media: The team will present their project with a demonstration video as well as a prototype of nano-drone showing how it works with mangroves.

Strengthening Singapore's coastal and flood resilience research capabilities under RIE2030

The eight projects complete CFI Singapore's new research portfolio under RIE2025. Building on this foundation, the institute will enter its next phase under RIE2030.

Under the Coastal Protection and Flood Resilience Research (CFR) Funding Initiative, CFI Singapore will continue to serve as its Centre of Excellence, building on research undertaken under RIE2025. For its proposed next phase under RIE2030, CFI Singapore aims to strengthen cross-institutional collaboration, research infrastructure and talent development, while accelerating the translation of promising research into practical coastal and flood resilience solutions.

Strengthening strategic and cross-institutional governance

CFI Singapore will be overseen by an inaugural Management Board which will guide the strategic development of CFI Singapore into a globally recognised Centre of Excellence and grow its role as a national knowledge aggregator and translation engine, it will also strengthen inter-institutional collaboration and align research priorities with national coastal protection and flood resilience goals. The Management Board will be chaired by PUB Chief Executive Mr Ong Tze Chin, with senior representatives from NUS, NTU, Singapore University of Technology and Design (SUTD), Singapore Institute of Technology (SIT), A*STAR, Technology Centre for Offshore and Marine, Singapore (TCOMS) and Enterprise Singapore.

Developing and retaining strategic research talent

A new Strategic Research Fellows (StRF) scheme will be kickstarted under RIE2030 in CFI Singapore to complement the existing project-based manpower training and develop and retain strategic manpower across the various coastal protection and flood resilience domains. It aims to provide continuity in domain training and build a pipeline of researchers for Singapore who can progress into project leads, technical experts, consultants or industry-facing management in the future. The scheme will comprise Central-hosted StRFs who will support core CFI activities and projects, as well as Domain-Lead StRFs who will support the respective Domain Leads and domain-related niche projects.

For media enquiries, please contact:

Lyn LAI
Manager, Communications
Office of University Communications
National University of Singapore
DID: +65 6516 1526
Email: lyn.lai@nus.edu.sg

Edmund QUEK
Senior Communications Manager, 3P Network Department
PUB, Singapore's National Water Agency
HP: 9149 7624
Email: Edmund_QUEK@pub.gov.sg
