

Coastal Protection and Flood Resilience Institute (CFI) Singapore

NUS National University of Singapore

Coastal Protection and Flood Resilience Institute Singapore

Climate change drives extreme weather events, sea level rise, and increasingly intense rainfall.

As an island, Singapore is particularly vulnerable to sea level rise, due to its geographical location and low-lying land area — about 30% of land surface is less than five metres above mean sea level. Without a robust coastal protection system in place, severe flooding events could bring about devastating consequences, affecting essential services and critical infrastructure.

The Coastal Protection and Flood Resilience Institute (CFI) Singapore was established in 2023 as the Centre of Excellence (CoE) for PUB's Coastal Protection and Flood Management Research Programme (CFRP), under Singapore's Research, Innovation and Enterprise 2025 (RIE2025) Plan.

CFI Singapore is dedicated to strengthening local capabilities and expertise in coastal protection and flood management research and solution development. As a multi-institutional, interdisciplinary research institute, CFI Singapore brings together the strengths of local universities, research institutes and industry partners.

CFI Singapore will continue to advance research and develop solutions to strengthen Singapore's long-term coastal and flood resilience efforts as the CoE for research in Coastal Protection and Flood Resilience (CFR) under Singapore's Research, Innovation and Enterprise (RIE2030) Plan.

Host Institute

NUS National University of Singapore

Partner Institutes

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

SIT SINGAPORE INSTITUTE OF TECHNOLOGY

SUTD SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

A*STAR Agency for Science, Technology and Research SINGAPORE

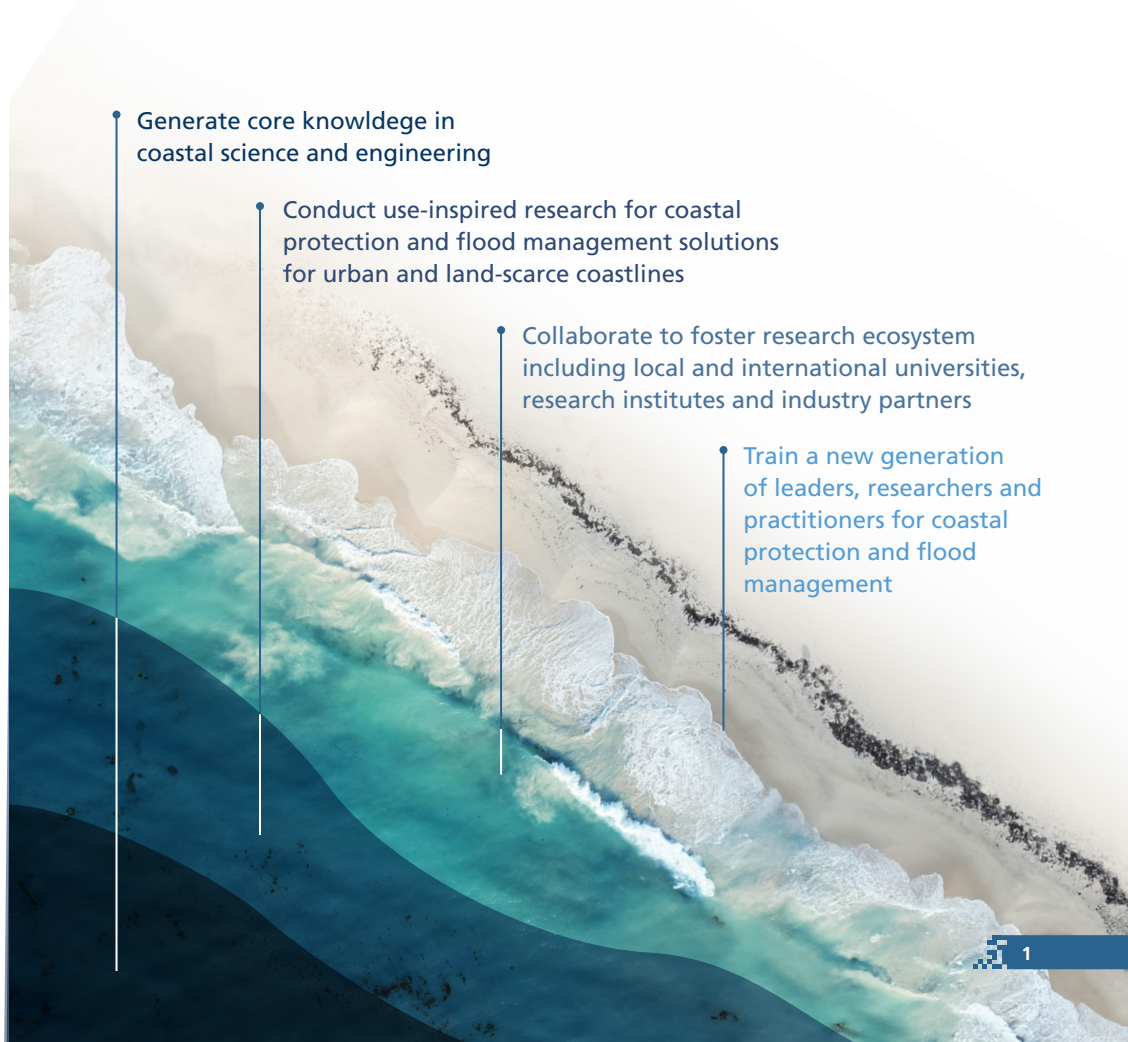
TCOMS

To be a Leading Global Research Institute in Coastal Protection and Flood Resilience

As the host of CFI Singapore, the National University of Singapore (NUS) works closely with Nanyang Technological University (NTU), Singapore University of Technology and Design (SUTD), Singapore Institute of Technology (SIT), the Agency for Science, Technology and Research (A*STAR), and the Technology Centre for Offshore and Marine, Singapore (TCOMS) to achieve the institute's key missions:

Scan here to learn more about CFI Singapore

- Generate core knowldege in coastal science and engineering
- Conduct use-inspired research for coastal protection and flood management solutions for urban and land-scarce coastlines
- Collaborate to foster research ecosystem including local and international universities, research institutes and industry partners
- Train a new generation of leaders, researchers and practitioners for coastal protection and flood management



CFI Singapore

Singapore's research in Coastal Protection and Flood Resilience (CFR)

Under RIE2030, CFR consists of three research verticals to develop innovative, sustainable and smart solutions tailored for Singapore's urban and land-squeezed environment — a challenge that many other coastal cities also face. The verticals are supported by three cross-cutting research horizontals. CFI Singapore is the main vehicle to administer Core Research and supports PUB in shaping the research focus and topics for grant calls in the Applied Research areas, comprising Applied Research and Living Lab.

C Core research A Applied research

H1 H2 H3

V1 V2 V3

C

Horizontal 1 **Coastal Science**

- Numerical model development and improvements
- Coastal hydrodynamics
- Sediment transport and morphology

C A

Horizontal 2 **Data-Driven Approaches**

- New monitoring technologies for data collection
- Integrated data-driven digital systems
- Enhanced runoff prediction

A

Horizontal 3 **Planning and Resilience Tools**

- New decision-making methodology that addresses uncertainty
- Resilience planning

C A

Vertical 1 **Engineering Solutions**

- Innovative engineering solutions
- Tidal Gates and Pumping Stations Systems (TG-PS)
- Resilient engineering design

C

Vertical 2 **Hybrid Green-Grey Solutions**

- Hybrid typologies for solutioning
- Integrated systems of hybrid typologies
- Measures to enhance resilience

A

Vertical 3 **Sustainable Infrastructure**

- Sustainable materials for coastal and drainage infrastructure
- Innovative construction methodology

CFI Singapore

CFI Singapore's Core Research Domains

CFI Singapore's research is structured into two horizontal domains — H1 and H2 — which provide cross-cutting support across the programme, and two vertical domains — V1 and V2.



H1 Coastal Science

Coastal Science examines how waves, currents and sediment shape Singapore's varied coastlines, providing evidence to plan protection against rising seas, extreme surges and combined coastal and inland flooding.

Research focus

Coastal processes and models	Investigate flows and sediment movement around deep-water reclamation, and improve models of extreme sea levels and the combined effects of coastal flooding, rainfall and drainage
Seabed and shoreline change	Assess how waves affect seabed stability and coastal structures. Model sediment transport and shoreline change across Singapore over decades to identify long-term risks.
Faster flood modelling	Harness AI to accelerate detailed simulations of coastal, rainfall and drainage interactions, and assess infrastructure performance under extreme events and uncertain future conditions.

The findings can support coastal protection tailored to local conditions and strengthen long-term adaptation to changing flood risks and shorelines.

Scan to learn more about H1 projects



H2 Data-Driven Approaches

Data-Driven Approaches connect observations, forecasts and operational decisions to improve coastal protection and flood management, including the upkeep and renewal of ageing infrastructure.

Research focus

Integrated observations	Combine observations from sensors, cameras and remote monitoring, with checks on data quality and uncertainty, to keep coastal and rainfall-runoff models aligned with observed conditions.
Forecasting and decision support	Develop models that combine physics with AI to improve flood prediction, with validation checks and clear confidence levels to support operational decisions.
Operations and asset management	Develop automated monitoring and control of tidal gates and pumps, alongside predictive maintenance and tools to assess deterioration, diagnose damage and guide infrastructure strengthening or renewal.

More reliable forecasts and earlier detection of infrastructure problems can improve flood response and support timely maintenance and renewal.

Scan to learn more about H2 projects



V1 Engineering Solutions

This domain develops adaptable coastal defences and drainage systems for Singapore's constrained urban waterfronts, with attention to reliability and performance throughout their service life.

Research focus

Reliable infrastructure	Develop compact systems combining tidal gates and pumps, alongside drainage storage and retrofits. Balance flow capacity, space and structural durability, with provision for maintenance and future adaptation.
Multi-functional designs	Design coastal defences that share space with recreation, ecological features or transport. Develop and validate layouts suited to constrained waterfronts and changing protection needs.
Design and resilience tools	Develop methods to test infrastructure against combined rainfall, surge and wave hazards, assess failure risks and guide rapid repair and recovery after extreme events.

Scan to learn more about V1 projects

The research can improve the reliability and adaptability of coastal infrastructure, supporting effective protection throughout its service life.

V2 Hybrid Green-Grey Solutions

Hybrid green-grey solutions combine engineered structures with habitats such as mangroves, seagrasses and coral reefs to provide coastal protection while ecological components establish and mature.

Research focus

Protection performance	Measure how natural and hybrid systems reduce waves, overtopping and erosion under different coastal conditions. Establish design limits for options such as engineered beaches and tidal flats.
Integrated systems and retrofits	Assess how combinations of habitats and structures perform together, and develop compatible layouts. Explore vegetation and reef units for existing defences, including their effects on structural stability.
Maintenance and recovery	Identify warning signs of damage and ecological decline, and develop monitoring, maintenance and repair guidance. Address sediment build-up and support natural recovery to reduce maintenance demands.

Scan to learn more about V2 projects

The research can strengthen coastal protection while supporting biodiversity, with designs and maintenance approaches that sustain these benefits as environmental conditions change.



Partnerships & Collaborations

Building Resilience Together: Collaborations & Strategic Partnerships

CFI Singapore partners with local and international experts across academia, government, and industry to address the complex challenges of coastal protection and flood resilience. By integrating science and technology across disciplines, we co-develop innovative solutions tailored to urban coastal environments. These collaborations strengthen our collective capability to build climate-resilient coastlines and future-ready communities.

Scan here for partnership enquiries

Collaboration Mechanisms

Joint Research Projects

Co-funded or co-developed research initiatives focused on shared priorities such as flood modelling, coastal engineering, or climate adaptation.

Strategic Industry Advisory and Technical Working Groups

Draw on interdisciplinary expertise to shape national approaches, including design standards and frameworks.

Capacity Building and Training

Workshops, training sessions, and staff exchanges to strengthen technical skills and institutional capabilities.

Visiting Scientist or Fellowship Programs

Opportunities for researchers and practitioners to collaborate on-site and contribute expertise.

Knowledge Exchange Platforms

Co-hosted events that foster dialogues and discussions across public and private sectors. These include conferences, business forums, roundtables, or digital platforms for sharing data, tools, and best practices across stakeholders.





Education & Training

Training the Next Wave of Coastal Protection and Flood Management Leaders

CFI Singapore is committed to developing the next generation of coastal protection and flood resilience professionals through targeted education and training programmes. We offer workshops, technical courses, and knowledge-sharing sessions that equip practitioners, researchers, and policymakers with the skills needed to address complex flood and coastal protection challenges. By fostering a strong foundation in science, innovation, and systems thinking, we aim to build a resilient talent pipeline for Singapore and the region.

Scan here to learn more

CFI Singapore Institute Research Scholar (RS) Programme

In support of its missions, CFI Singapore has established the CFI Institute Research Scholars (RS) Programme to sustain and expand research talent development within its network. These Scholars are supervised by expert faculty members in various disciplines across CFI Singapore host and partnering institutions. Their research will advance state-of-the-art knowledge and deepen our fundamental understandings of coastal protection and flood resilience, while enabling the development of groundbreaking solutions for Singapore and the global community.



The programme aims to:

- Grow the local research talent pool by providing research scholarships to PhD students working on interdisciplinary topics relevant to coastal protection and flood resilience.
- Strengthen CFI Singapore's research capacity across its key domains with the involvement of these Research Scholars embedded in CFI Singapore's host and partnering institutions.
- In the long run, maximise the human capital development in support of Singapore's long-term coastal protection and flood resilience goals.



TCOMS Ocean Basin

Facilities

Leveraging on modern and collaborative facilities for coastal protection and flood resilience solutions

CFI Singapore benefits from a range of established facilities provided by our various partners, supporting coastal protection and flood resilience research. These include laboratories, simulation rooms, and field-testing environments that foster experimentation and collaboration. These well-established resources enable a variety of interdisciplinary projects, from hydrological modelling to coastal engineering. By leveraging these facilities, we are focused on developing practical and scalable solutions to strengthen the resilience of coastal communities.

Scan here to learn more

Key facilities supporting CFI Singapore

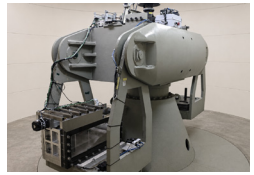
NUS



Hydraulics and Coastal Resilience (HCR) Lab



Structural Engineering Laboratory



Geotechnical Engineering

NTU



Protective Engineering Laboratory

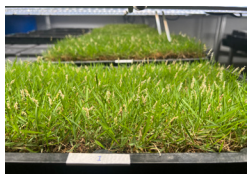


Geotechnics, Transport and Geospatial (GTG) Laboratory



Hydraulics Laboratory

SIT



Construction Technology Innovation Laboratory (CTIL)

National Level



St. John's Island National Marine Laboratory (SJINML)

CFI Singapore

National University of Singapore
Block SDE1, #03-05,
4 Architecture Drive,
Singapore 117566

Email: cfisg@nus.edu.sg

Stay in touch with CFI Singapore on the latest updates and events

NUS National University of Singapore | Coastal Protection and Flood Resilience Institute Singapore