

The Marine Climate Change Science (MCCS) Programme

1st Grant Call Briefing (6 Jan)

MCCS – Launch of 1st Grant Call

- The first grant call of the Marine Climate Change Science (MCCS) Programme has been launched as of **17 Dec 2021**.
- We invite interested researchers to submit suitable full proposals for potential funding support under **6 Call Topics**:
 - 1) Assessing the carbon storage and sequestration potential of blue carbon resources in Singapore
 - 2) Coastal nature-based solutions for climate change mitigation and adaptation
 - 3) Integrating green and grey infrastructure as multi-functional coastal protection systems for climate change adaptation
 - 4) Thresholds and tipping points: Understanding responses of Singapore's coastal and marine ecosystems to anthropogenic and climate change impacts
 - 5) Enhancing the ecological resilience of coral reefs in response to climate change stressors
 - 6) Developing modular mangrove and seagrass planters for habitat restoration, carbon sequestration, and bioremediation
- Interested parties are strongly encouraged to form research teams that collaborate across public research institutes and the private sector (including industry), and support translation of research outcomes to real-world applications.

Schedule

- 9.00am Overview of MCCS 1st Grant Call – by **MCCS Programme Office**
- Overview of Marine Climate Change Science (MCCS) programme
 - Grant call eligibility & funding criteria
 - Review process
 - Instruction for submission of proposals
 - Q&A on Grant Call Processes

- 9.30am Call Topic 1 – by **JTC**
“Assessing the carbon storage and sequestration potential of blue carbon resources in Singapore”

- 9.50am Call Topic 2 – by **PUB** and **NParks**
“Coastal nature-based solutions for climate change mitigation and adaptation”

- 10.10am Call Topic 3 – by **PUB** and **NParks**
“Integrating green and grey infrastructure as multi-functional coastal protection systems for climate change adaptation”

Schedule

10.30am Call Topic 4 – by **NParks** and **CCRS/NEA**

“Thresholds and tipping points: Understanding responses of Singapore’s coastal and marine ecosystems to anthropogenic and climate change impacts”

10.50am Call Topic 5 – by **NParks** and **CCRS/NEA**

“Enhancing the ecological resilience of coral reefs in response to climate change stressors”

11.10am Call Topic 6 – by **NParks** and **SDC**

“Developing modular mangrove and seagrass planters for habitat restoration, carbon sequestration, and bioremediation”

11.30am Final Q&A

Note: A short Q&A timeslot will be allocated during the presentation of each Call Topic (strictly capped at 20mins each). This final Q&A session will be dedicated for any additional questions that have not yet been addressed earlier.

12.00pm End

Overview of the Marine Climate Change Science (MCCS) programme

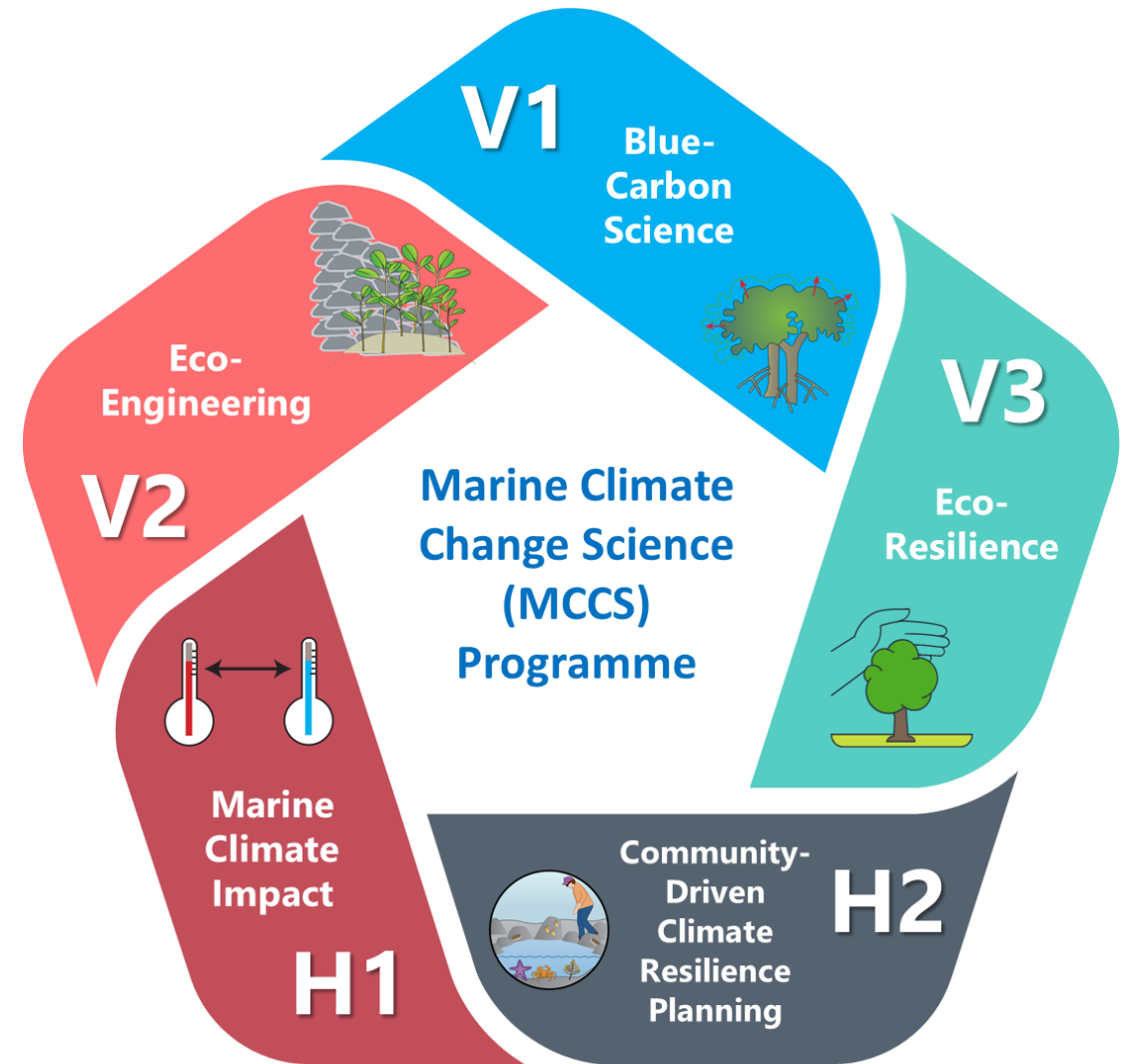
The Marine Climate Change Science (MCCS) Programme

- New NRF-funded Funding Initiative (FI) totaling \$25.0M to support a 5-year programme under the Urban Solutions and Sustainability (USS) domain under RIE2025.
 - Led by NParks as Implementing Agency (IA)
- Multi-stakeholder research programme which seeks to advance the core sciences of marine climate change, and develop solutions to help address the challenges faced by our coastal and marine environment arising from climate change
 - Builds on the foundational science developed under past/ongoing programmes, including the Marine Science R&D Programme (MSRDP) (2016-2021)
 - Developed in response to the current challenge of future-proofing Singapore's marine environment, in the face of climate change
 - Part of overall efforts to transform Singapore into a City in Nature, as well as contribute towards a nationwide effort to build climate resilience under the Singapore Green Plan 2030.
- Entails important baseline and applied marine climate change research, to:
 - Address gaps in the climate science research landscape for the marine domain
 - Understand responses of marine ecosystems to increasing environmental and climate change pressures
 - Enable translatable actions that public/private practitioners – in Singapore and elsewhere – can adopt, apply and implement

MCCS – Objectives

The MCCS programme aims to serve as a **national focal point for multi-disciplinary marine climate change research**, that will:

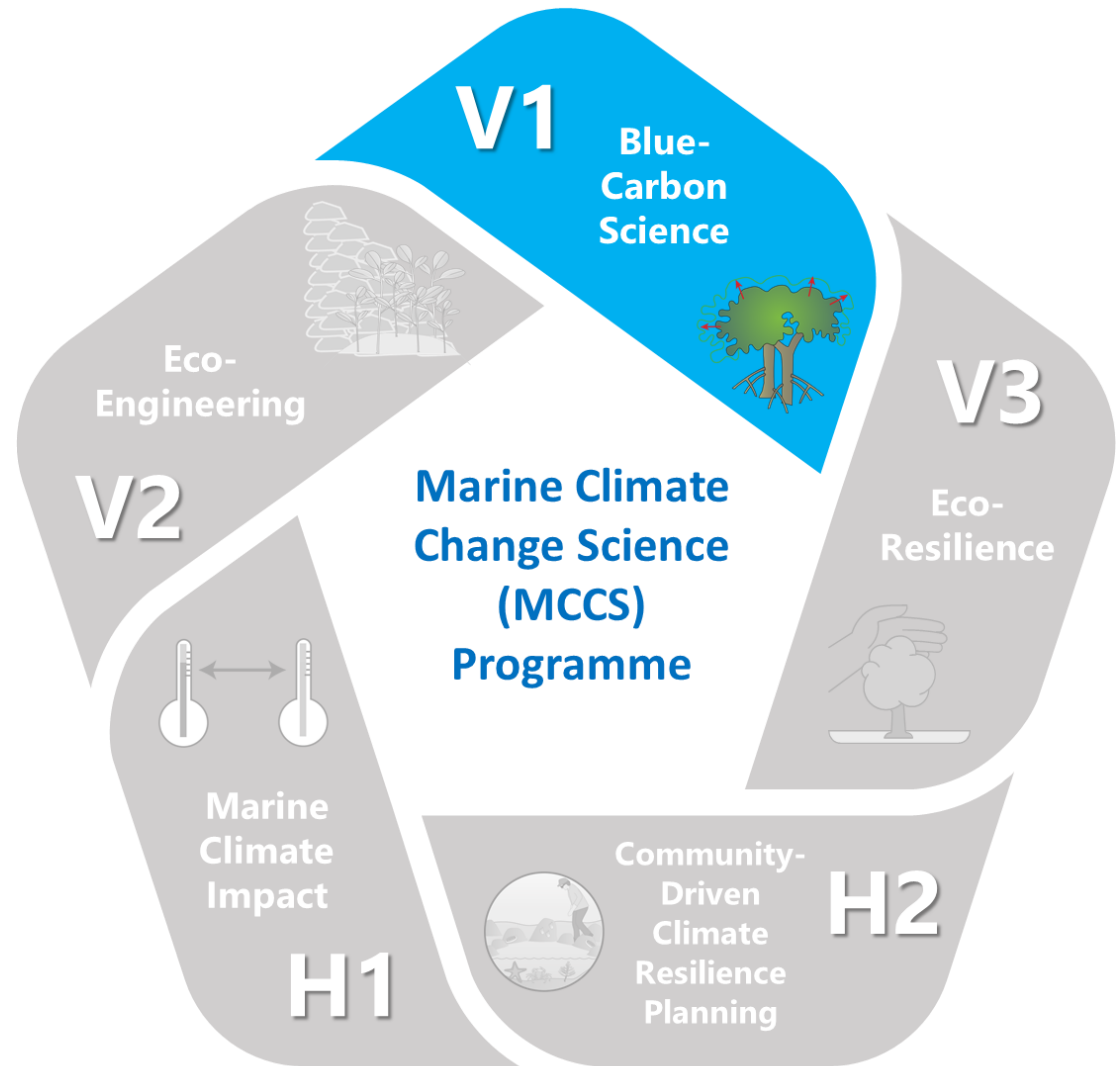
1. **Address current national needs and knowledge gaps** identified by agencies through core research verticals and enabling horizontals
2. **Leverage on synergies** across local IHLs, agencies and industry to strengthen and support national efforts to mitigate and manage climate change challenges
3. Create scientific insights and evidence to support the creation of **evidence-based interventions and solutions**



Core domains and enablers of the MCCS programme

V1 Blue Carbon Science

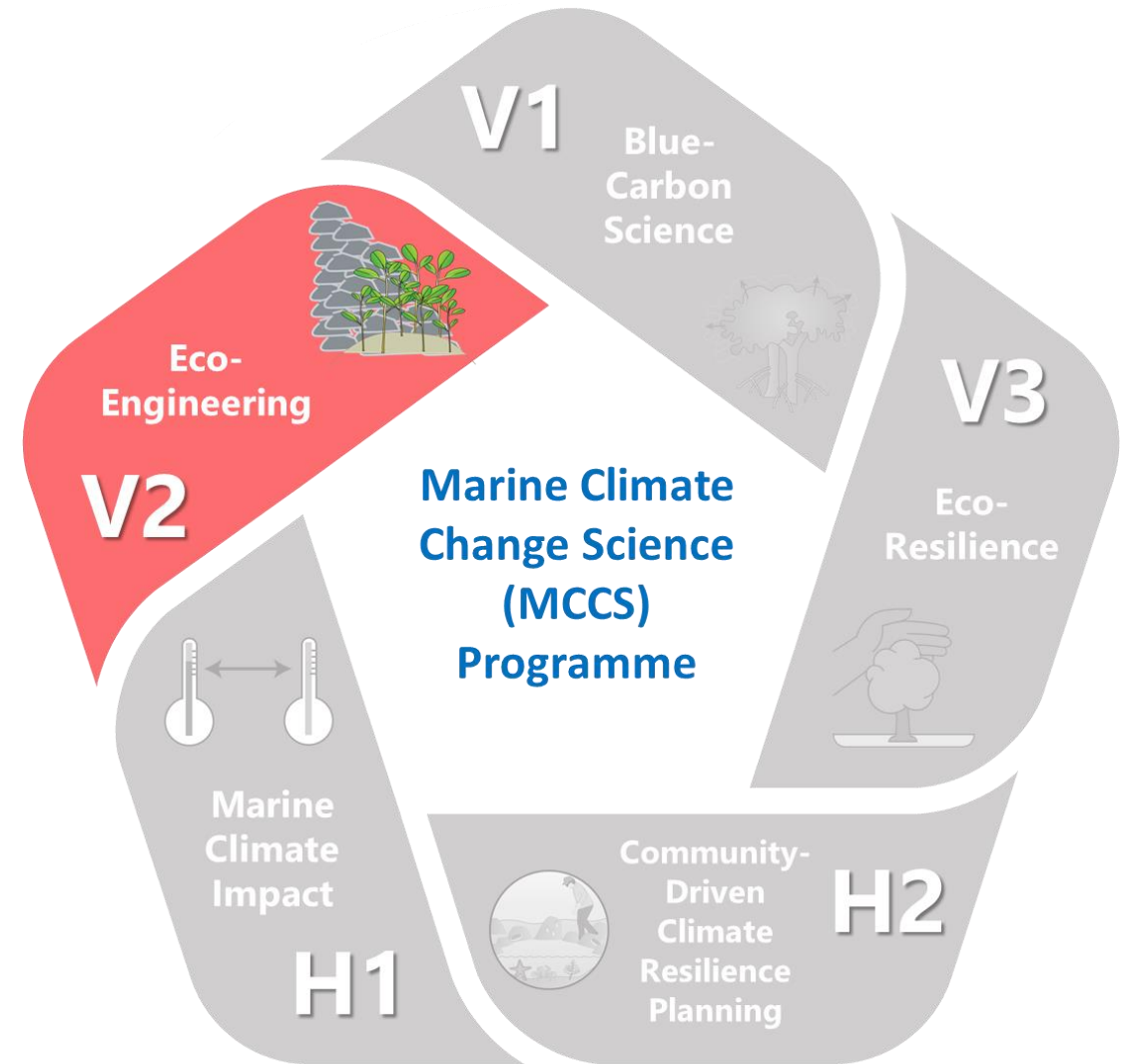
- Build foundational blue-carbon science in Singapore
- Assess blue carbon opportunities in Singapore
- Reduce Singapore's carbon footprint while mitigating climate change effects on coastal water quality, habitats and infrastructure



Core domains and enablers of the MCCS programme

V2 Eco-Engineering

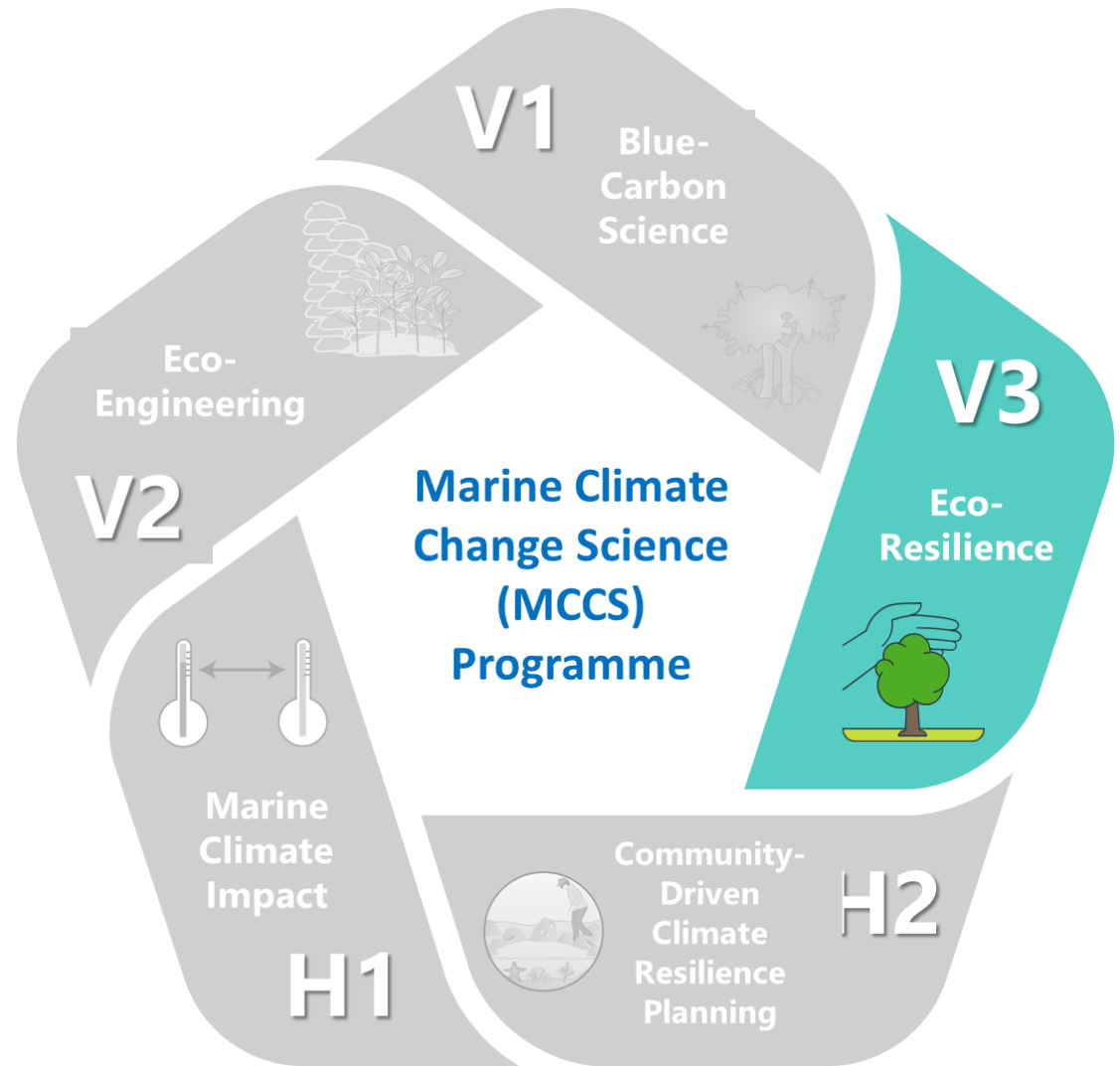
- Align engineering with nature-based solutions
- Mitigate sea-level rise, extreme storm events and flood protection, while enhancing and restoring marine environments and creating new habitats
- Provide sound basis for the sustainable development of Singapore's islands and coasts



Core domains and enablers of the MCCS programme

V3 Ecological Resilience

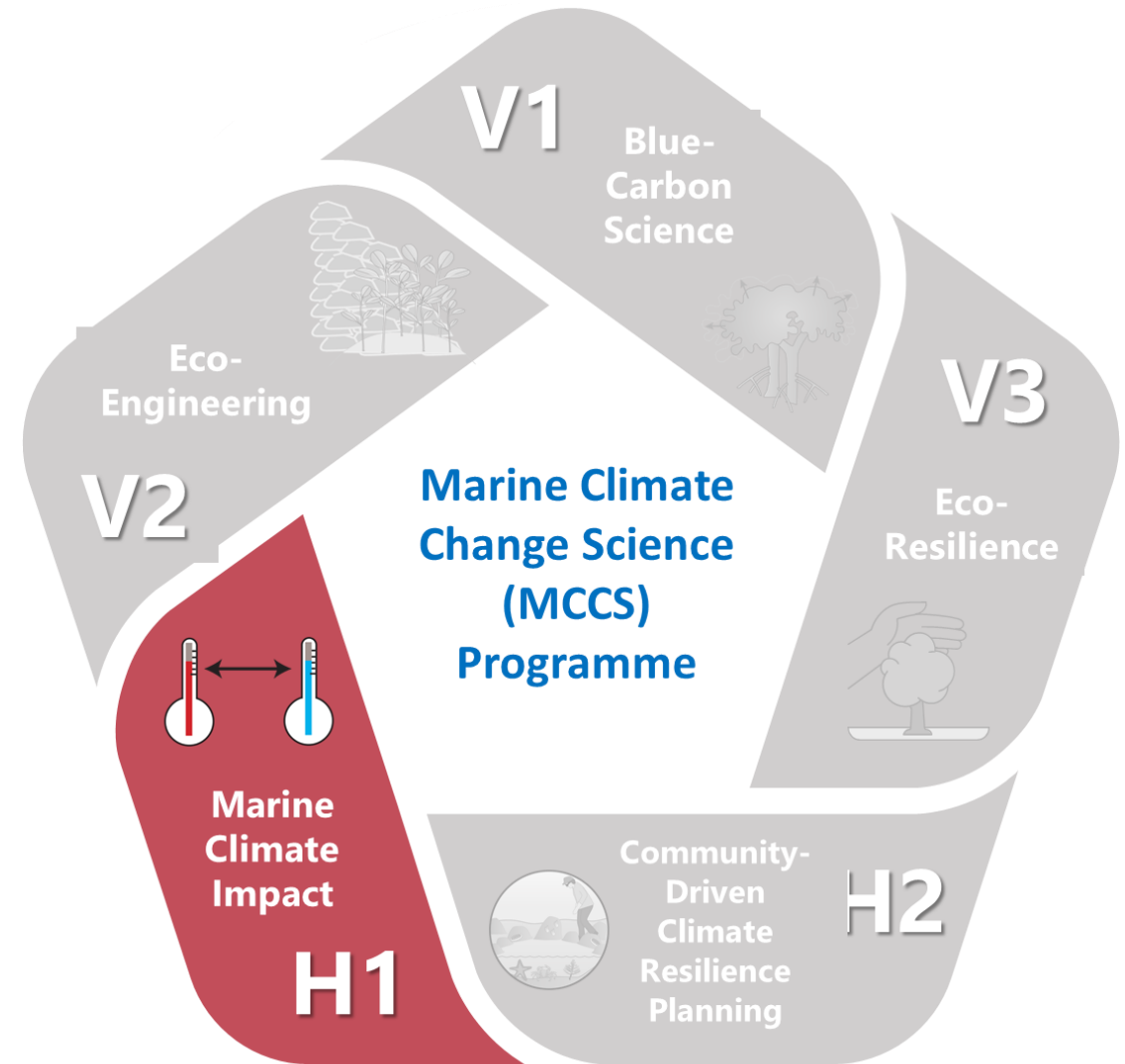
- Research to future-proof our coastal and marine ecosystems against increasing pressures from anthropogenic and climate change drivers
- Safeguard our natural marine capital through science-based management



Core domains and enablers of the MCCS programme

H1 Marine Climate Impact

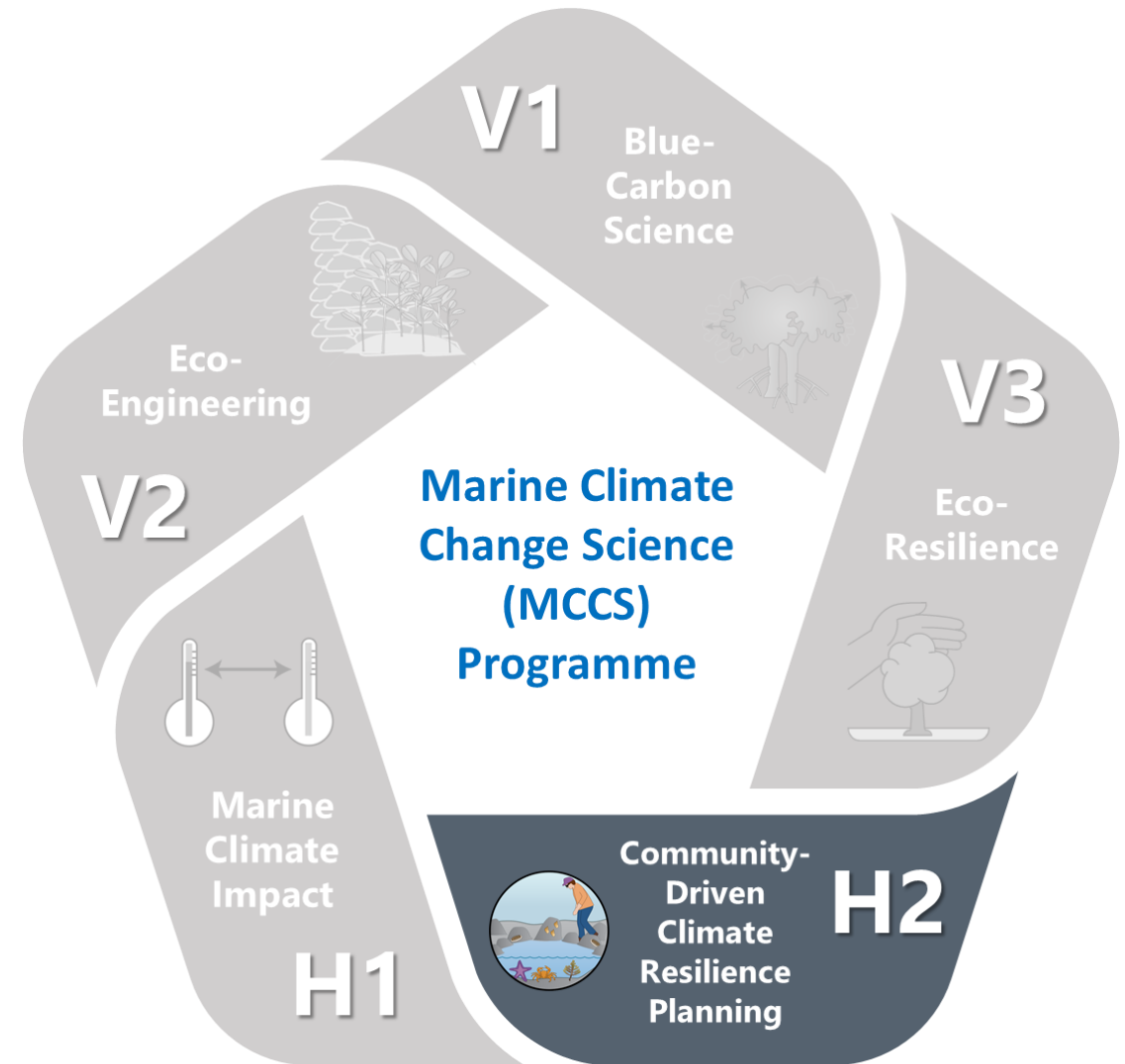
- Develop down-scaled global models for local climate change indicators relevant to the marine environment
- Benchmark MCCS research against relevant climate scenario projections and timescale horizons



Core domains and enablers of the MCCS programme

H2 Community-Driven Climate Resilience Planning

- Harness social sciences to add important methods, perspectives, and data to climate change mitigation and adaptation efforts



Core domains and enablers of the MCCS programme

Grant Call Eligibility & Funding Criteria

Grant Call Eligibility & Funding Criteria

- All Singapore-based public research institutes (RIs) (e.g., Institutions of Higher Learning (IHLs) and A*STAR RIs) and Singapore-based private sector entities (including not-for-profit organisations) are eligible to participate in the call.
- The Lead PI who leads the Research must be based in Singapore. Teams are strongly encouraged to collaborate with researchers and other experts from Singapore-based or overseas organisations, in the capacity as Co-Investigators (Co-Is) or Collaborators.
- R&D proposals already funded by other government agencies will not be considered. R&D proposals with similar scope, which are currently under evaluation by other funding initiatives, will not be considered until the results from the other funding initiatives are finalised. Lead PIs and Co-Is will need to declare other funding sources and participation in other funding initiatives during application.
- All funding awarded must be used to carry out the research work in Singapore, unless expressly approved by the grantor. All assets acquired using the funding must be located in Singapore and maintained within the control of the grantees.

Grant Call Eligibility & Funding Criteria

For private sector

- Collaboration with a public research performer is required for funding of private sector Lead PIs for:
 - Research projects with a total project budget more than S\$500,000;
 - Test-bedding/demonstration/scale-up projects with a total project budget more than S\$2.0mil.
- A Singapore Technology Licensing Office (STLO) must be appointed in projects that fund non-Singapore entities (i.e., companies registered in Singapore with less than 30% local shareholding, determined by the ultimate individual ownership).

Grant Call Eligibility & Funding Criteria

Direct Costs*

- Supportable direct costs are incremental cost required to execute the programme; can be classified into the following cost categories:-
 - Expenditure on manpower (EOM);
 - Equipment;
 - Other Operating Expenses (OOE);
 - Overseas Travel; and
 - Research Scholarship

Indirect Costs (i.e. “overheads”)

- Costs that are incurred for common or joint objectives and therefore cannot be identified readily and specifically with a particular sponsored research project, but;
- Contribute to the ability of the Institutions to support such research projects (e.g. providing research space, research administration and utilities, and not through the actual performance of activities under the sponsored projects).

** Please refer to the Annex C of the Grant Call info sheets for the list of non-fundable direct costs of research.*

Grant Call Eligibility & Funding Criteria

Singapore-based public research institutes
(e.g., IHLs and A*STAR RIs)

- Lead PI or Co-I will qualify for:
 - **[Direct costs] 100%** of the approved qualifying direct costs of a project;
 - **[Indirect costs] 30%** of the total qualifying approved direct costs of a project.

Singapore-based private sector entities (incl. not-for-profit organisations)

- Lead PI or Co-I will qualify for:
 - **[Direct costs] Up to 70%** of the approved qualifying direct costs of a project
 - 30% for all non-Singapore entities (incl. non-Singapore not-for-profits);
 - 50% for Singapore Large Local Enterprises (LLEs);
 - 70% for Singapore Small Medium Enterprises (SMEs), start-ups and not-for-profits.

Overseas organisations

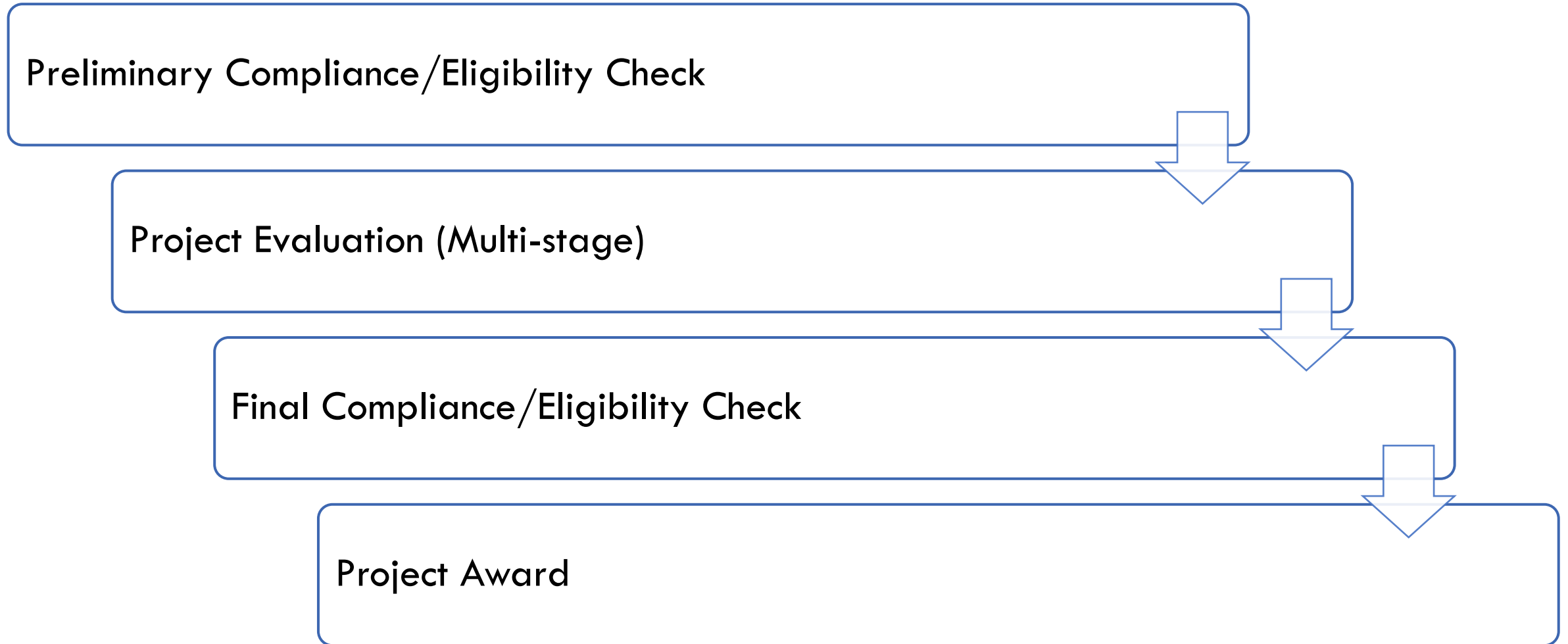
- **Not** permitted to receive, directly or indirectly, any part of the funding, whether in cash or in the form of assets acquired or otherwise, using the funding.
 - Exception: **Travel expenses** for overseas-based Co-Is and Collaborators **to come over to Singapore**, which should be identified and budgeted for upfront in the Other Operating Expenses vote to be incurred by the Host Institution.

Collaborators (in Singapore-based public RI, private sector entity or Overseas organisations)

- **Not** permitted to receive, directly or indirectly, any part of the funding, whether in cash or in the form of assets acquired or otherwise, using the funding.

Review Process

Review Process – at a glance



Evaluation of Proposals

Evaluation of proposals will include:

1. Technical Peer Review

Proposals will be subject to a round of technical peer review by domain experts* with relevant expertise, to ensure excellent science in proposals.

2. Project Evaluation Panel

Shortlisted applicants will be invited to present their proposals to a Project Evaluation Panel, consisting of relevant agency representatives, the Programme and Technical Directors, and other external experts (where relevant).

Successful applicants will be informed by the M CCS Programme Office on the award of the grant. The M CCS Programme Office's decision on project and funding support will be final.

** Research teams applying for the grant call are required to recommend potential suitable peer reviewers for the M CCS Programme Office's consideration, as part of the proposal submission process. The final decision on the peer reviewers will be decided by the Programme Office.*

Evaluation Criteria

Criteria	Weightage
Research Excellence <ul style="list-style-type: none">• Significance of proposed research, including novelty, extent to which project deliverables address/answer key research gaps/questions in the research area, and the potential for breakthrough/innovation.• Clarity of plans for proposed research project, including proposed deliverables, milestones, timelines, and budget.	30%
Innovation and Enterprise Potential <ul style="list-style-type: none">• Potential for application of research project outcomes/solutions to address important challenges/needs in Singapore, as well as globally.• Extent that anticipated project output can be expected to meet significant policy, operational, or commercial needs in Singapore, as well as globally.	20%
Strength of Research Team <ul style="list-style-type: none">• Relevance and quality of expertise and experience of the Lead PI, Co-Is and key project team members.• Time commitment of Lead PI, Co-Is and Collaborators in proposed project.	30%
Contribution to MCCS Objectives <ul style="list-style-type: none">• Relevance and degree of contribution of proposed research to the stated objectives, outcomes and targets for the Call Topic.• Value for money in relation to deliverables expected and budget required.	20%

Instructions for Submissions of Proposals

Overview of Timeline

FOR APPLICANTS & INTERESTED PARTIES (SGT, UTC +08:00)

Grant Call Opens (for 8 weeks)	17 December 2021, 11.00am
Virtual Briefing for MCCS 1 st Grant Call	6 January 2022, 9.00am
Grant Call Closes (Proposal Submission Deadline)	16 February 2022, 2.00pm

FOR SHORTLISTED APPLICANTS ONLY

Notification of shortlisted applicants	April 2022*
Presentation to Project Evaluation Panel (2 or 3 days)	May 2022*

FOR SUCCESSFUL AWARDEES ONLY

Approval and Letter of Award	Between July to August 2022*
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** Timings are indicative; shortlisted/successful applicants will be notified accordingly.*

Grant Call Details

Grant call information and relevant documents at:

- [MCCS 1st Grant Call website](#)
- [IGMS](#)

Application only through IGMS:

- See section on “Application Guidelines”. All funded proposals should follow the prevailing Terms and Conditions of Grant and NR Fund Guide.
- The application will only be considered valid if the submission of the full proposal is completed in IGMS, including endorsement by the Director of Research (also in IGMS) by the proposal submission deadline (**16 February 2022, 2.00pm**).
 - A copy of the application should also be sent via email to the MCCS Programme Office (MCCS@nparks.gov.sg), after this.
- E-mail or walk-in applications will not be accepted.
- Late submissions will not be considered. Incomplete submissions may also not be considered. Applicants are advised not to submit their application at the last minute in case of technical errors with the IGMS website.
- The following slides outline steps for “Using IGMS” and “Full Proposal Submission”.

Application Guidelines

1

For Business Users

For all users who are transacting on behalf of your company, with the following roles:

- PI / ORE / DOR
- HI Admin / HI HR / HI Finance

Log in with singpass

2

For Individual Users

For users who want to:

- Apply for grant calls in an individual capacity (e.g NRF Fellowship grants)
- Review Proposals

Log in with singpass

3

For overseas users without Singpass

Enter

[Reset password](#) [Register](#) [Forgot your password?](#)

Using IGMS:

Key details for first time users

- Under the landing page, login or register using
 - 1) SingPass for Business Users (e.g., associated with Host Institution);
 - 2) SingPass for Individual Users; or
 - 3) Login for overseas users without Singpass
- **Authorise ORCID ID** before any grant application
- Fill up mandatory fields
- Update user profile

Application Guidelines

Full Proposal Submission:

- Login to the system using SingPass for Business Users, SingPass for Individual Users, or Login for overseas users without Singpass.
- Click on grant call topic of interest under “Open Opportunities” and click “Apply”.

For detailed steps, please refer to:

- [Quick guide for Potential Applicants](#); and
- [Help guide for Potential Applicants](#)

(also available on the IGMS “Training Guides” page:

<https://researchgrant.gov.sg/Pages/TrainingGuides.aspx>)

Contact Information

- For **general information**, please refer to the Grant Call FAQs document in either:
 - [MCCS 1st Grant Call website](#)
 - Under “Related Documents” under the grant call topic of interest on [IGMS](#)
- For transparency, no verbal enquiries will be entertained. However, if you require clarification, please email the MCCS Programme Office at MCCS@nparks.gov.sg. Answers to all received queries will also be reflected in the Grant Call FAQs document (see above), which will be updated periodically to ensure that all applicants have equal access to additional information.
- For any queries on the **use of IGMS**, please contact the IGMS helpdesk.
Tel No: (65) 6556 8807 or (65) 6556 6971
E-mail: helpdesk@researchgrant.gov.sg

Q&A on Grant Call Processes

Call Topic 1: Assessing the carbon storage and sequestration potential of blue carbon resources in Singapore

V1 Blue Carbon Science

1st Grant Call: Topic 1
MCCS_V1_2021-1_T1
Vertical 1 (Blue Carbon Science)

Call Topic: Assessing the carbon storage and sequestration potential of blue carbon resources in Singapore

Budget: S\$ 2 Mil

Duration of Project: up to 4 years

Lead Agency: JTC

Project Details:

Assessing the carbon storage and sequestration potential of blue carbon resources in Singapore

Background

Carbon sequestered and stored within coastal mangrove ecosystems is estimated to be up to three times that of terrestrial forest ecosystems, and this has triggered questions on the potential ability of other coastal and marine resources including seagrass beds, coral reefs, macroalgae communities and seafloor habitats in sequestering and storing carbon.

The research under this topic aims to improve fundamental blue carbon science, establish baselines (e.g., information on stocks potential and sequestration potential) and develop cost-effective carbon accounting and monitoring methodologies to inform the potential use of blue carbon resources for climate change mitigation. This has the potential to support businesses locally and beyond in becoming carbon-light/carbon neutral in their operations or investment options, and to reduce Singapore's carbon footprint while mitigating climate change effects on coastal habitats and infrastructure.

Project Details:

Assessing the carbon storage and sequestration potential of blue carbon resources in Singapore

Key Research Questions

Proposed projects should seek to address, but are not limited to the following key research questions:

- (a) What are the carbon storage and sequestration potentials of mangroves, mudflats, and seagrass meadows, as well as coral reefs, macroalgal beds, seafloor and the water column, as potential blue carbon resources?
- (b) How can we improve the cost-effectiveness of carbon accounting and monitoring methodologies for blue carbon resources?

Project Details:

Assessing the carbon storage and sequestration potential of blue carbon resources in Singapore

Objectives

Proposed projects should include, but are not limited to the following research objectives:

- (a) To effectively quantify above- and below-ground (e.g., soil and root systems) carbon stocks and sequestration rates within mangroves, mudflats, seagrass meadows, coral reefs, macroalgal beds, seafloor, and water column in Singapore.
- (b) To develop cost-effective carbon accounting and monitoring methodologies for blue carbon resources.
- (c) To model the spatial and temporal blue carbon fluxes in Singapore.

Projects are encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.

Project Details:

Assessing the carbon storage and sequestration potential of blue carbon resources in Singapore

Project Deliverables

Proposed projects should address, but are not limited to the following project deliverables:

- (a) Assessment (e.g., spatial representation) of the standing stock of blue carbon above- and below-ground (baseline) and sequestration (including historical, current and future) rates within mangroves, mudflats, seagrass meadows, as well as coral reefs, macroalgal beds, seafloor and the water column as potential blue carbon resources in Singapore.
- (b) Development of peer-reviewed blue carbon accounting and monitoring methodologies. Possible to also combine with the current carbon accounting framework for terrestrial systems.
- (c) Spatial and temporal (past, present and future) blue carbon stock and flux maps for Singapore.

Projects are encouraged to further build upon the above-mentioned deliverables, and/or propose additional deliverables.

Project Details:

Assessing the carbon storage and sequestration potential of blue carbon resources in Singapore

Impact Outcomes and Pathway to Impact

In relation to the key programme-level deliverables of this vertical, this project should look towards contributing to the following impact outcomes:

- (a) Quantify the carbon storage and sequestration potential of blue carbon resources in Singapore so as to subsequently look to increasing the total carbon stock of Singapore.
- (b) Contribute to carbon offset programmes through the development of blue carbon accounting and monitoring methodologies and subsequently, enhancement of carbon offset methodologies. This can support the generation of quality, credible blue carbon credits for carbon market activities in the region, downstream of this project. Outputs from this can eventually contribute to various guidelines and be adopted at international platforms e.g., climate change COP.
- (c) Development of a database, that incorporates above- and below-ground carbon stocks, monitored and updated regularly by relevant agencies or carbon accounting entities to be used to record historical and current greenhouse gas (GHG) stocks and fluxes from the blue carbon ecosystems etc.
- (d) Identifying key carbon stock areas of the Singapore “carbon capital” for conservation or restoration in the future.
- (e) Promoting Singapore as one of the knowledge centres in blue carbon stock and blue carbon stock management.

Project Details:

Assessing the carbon storage and sequestration potential of blue carbon resources in Singapore

Impact Outcomes and Pathway to Impact (continued)

In relation to the key programme-level deliverables of this vertical, this project should look towards contributing to the following impact outcomes:

- (f) Developing mechanisms and protocols to enhance or promote Singapore efforts in net zero emissions future.
- (g) Data on spatial and temporal blue carbon stock and fluxes can support the Singapore Green Plan 2030 by helping to guide policy to support Singapore's longterm net zero emissions aspiration as soon as viable.
- (h) Data on blue carbon can support Singapore's reporting commitments under various Multilateral Environmental Agreements (MEAs) like the UN's 2030 Sustainable Development Agenda and the Paris Agreement.
- (i) Scientific quantification of blue carbon sinks will allow Singapore to implement more robust evaluation of future coastal developments, taking into account the impacts (both positive and negative) on the blue carbon habitats and its associated carbon capital. For example, associate blue carbon stock with relevant monetary value that can then be applied in the cost-benefit analysis of the proposed coastal development.

Project Details:

Assessing the carbon storage and sequestration potential of blue carbon resources in Singapore

**Proposed
Study/ Pilot
Testbed
Site(s):**

Proposed projects may consider the following coastal and marine areas (industrial and non-industrial) in Singapore for study and pilot test-bedding, including, but not limited to:

Sungei Buloh Wetland Reserve and Mandai Mangrove and Mudflats, Pulau Ubin, Changi creek, Coney Island, Berlayer Creek, Labrador Nature Reserve, Sentosa, and the southern islands of Kusu, St John's, Lazarus, Sister's, Hantu and Semakau.

Agencies Involved:

Assessing the carbon storage and sequestration potential of blue carbon resources in Singapore

Role	Agency
Lead	JTC Corporation
Member	National Parks Board

Q&A on Call Topic 1

Call Topic 2: Coastal nature-based solutions for climate change mitigation and adaptation

V2 Eco-Engineering

1st Grant Call: Topic 2

MCCS_V2_2021-1_T2

Vertical 2 (Eco-Engineering),

Vertical 1 (Blue Carbon Science), Vertical 3 (Ecological Resilience)

Project Topic: Coastal nature-based solutions for climate change mitigation and adaptation

Budget: S\$ 3 Mil

Duration of Project: up to 4 years

Lead Agencies: PUB, NParks

Project Details:

Coastal nature-based solutions for climate change mitigation and adaptation

Background

Singapore's coastal and marine ecosystems exist as slivers distributed around Singapore's coastlines and offshore islands. Although literature highlights the important role ecosystems like coastal forests, mangroves, seagrass meadows and coral reefs can play in mitigating various climate change impacts like storm surges, wave over-topping and coastal erosion, we do not know if Singapore's contemporary coastal and marine ecosystems can serve similar functions now, and under different climate scenarios. Many of the earlier studies were conducted in lab and flume experiments, which have yet to be validated in real world conditions.

This project will address these knowledge gaps and will increase our understanding of the coastal protection potential of our contemporary coastal and marine ecosystems as nature-based solutions, as well as identify the unique characteristics and attributes of these ecosystems in conferring coastal protection within an urban setting.

This project will develop important ecological and functional baselines and identify ecosystem attributes that confer coastal protection functions. To harness and maximise the potential coastal protection benefits, contemporary baselines that will be used in parameterising predictive ecological and functional models need to be established. This project will generate the necessary baselines for the development of predictive models. We can then understand the environmental conditions and land-use contexts necessary for these ecosystems to play an effective role in providing multi-functional coastal protection. The outputs from this project will support and contribute towards other MCCS research projects within this and other verticals and horizontals, serve as an ecological palette for developing the science and technologies that will underpin the future of eco-engineering infrastructure, and provide a sound basis for the framework for ongoing and future development in Singapore.

Project Details:

Coastal nature-based solutions for climate change mitigation and adaptation

Key Research Questions

Proposed projects should seek to address, but are not limited to the following key research questions:

- (a) What are the key functional attributes/indicators of our coastal and marine ecosystems like coral reefs, seagrass meadows, mangrove and coastal forests that contribute to their effectiveness in adapting to climate change related (i) increases in sea level rise, (ii) intensity/frequency of storms and mitigating erosion?
- (b) How can we enhance the effectiveness of contemporary coastal and marine ecosystems in reducing wave energy, run-up, storm surges and erosion and in increasing contribution to sediment accumulation?
- (c) What interventions, including nature-based solutions, are required to (i) enhance their functional attributes, and (ii) ensure their persistence over time and under different climate change scenarios (Shared Socioeconomic Pathways* (SSP))?

* IPCC AR6

Project Details:

Coastal nature-based solutions for climate change mitigation and adaptation

Objectives

Proposed projects should include, but are not limited to the following research objectives:

- (a) Assess and quantify the functionality and effectiveness of Singapore's contemporary coastal and marine ecosystems under various climate change scenarios in:
 - a. Attenuating wave energy,
 - b. Reducing wave run-up and wave overtopping,
 - c. Reducing propagation of storm surges to coastline,
 - d. Reducing erosion, and
 - e. Accumulating sediments to buffer coastlines against sea level rise.
- (b) Determine environmental conditions and ecosystem attributes (e.g., density, stiffness, porosity, configuration, consolidation, habitat complexity, habitat area, slope, etc.) required to ensure the persistence of Singapore's contemporary coastal and marine ecosystems over time and under different climate change scenarios.
- (c) Develop design guidelines, including nature-based solutions for coastal protection taking into account research outputs from (b).
- (d) Identify coastal and marine areas around Singapore (including regional, where relevant) that may benefit from the introduction or persistence of nature-based solutions that incorporate enhanced ecosystem functionality.

Projects are encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.

Project Details:

Coastal nature-based solutions for climate change mitigation and adaptation

Project Deliverables

Proposed projects should address, but are not limited to the following project deliverables:

- (a) Assessment on Singapore's contemporary coastal and marine ecosystem attributes and the synergies between these ecosystems that contribute to their functionality and effectiveness in conferring coastal protection.
- (b) Models (calibrated by e.g., numerical modelling, field experiments) and projections on the functionality and effectiveness of Singapore's contemporary coastal and marine ecosystems, especially involving the following processes under various climate change scenarios:
 - a. Wave attenuation
 - b. Reducing wave-overtopping/ wave run-up
 - c. Erosion reduction
 - d. Surge propagation
 - e. Sediment accumulation

Projects are encouraged to further build upon the above-mentioned deliverables, and/or propose additional deliverables.

Project Details:

Coastal nature-based solutions for climate change mitigation and adaptation

Project Deliverables (continued)

Proposed projects should address, but are not limited to the following project deliverables:

- (c) Assessment on the environmental conditions and ecosystem attributes required to ensure coastal and marine ecosystems persistence over time and under different climate change scenarios.
- (d) Design guidelines for incorporating coastal and marine ecosystem attributes into nature-based solutions for coastal protection, taking into account functionality, persistence, cost-effectiveness, local environmental conditions and land-use contexts.
- (e) A map highlighting potential areas where nature-based solutions may mitigate/ adapt to climate change impacts (a “Nature-Based Solutions potential map” for Singapore’s coastal and marine environment) including recommended implementation timeline.

Projects are encouraged to further build upon the above-mentioned deliverables, and/or propose additional deliverables.

Project Details:

Coastal nature-based solutions for climate change mitigation and adaptation

Impact Outcomes and Pathway to Impact

In relation to the key programme-level deliverables of this vertical, this project should look towards contributing to the following impact outcomes:

- (a) Identify the conditions and contexts in which coastal ecosystem restoration is appropriate for achieving multi-functional coastal protection and contribute to the City in Nature, Sustainable Living and Resilient Future pillars of the Singapore Green Plan 2030.
- (b) Provide effective multi-functional coastal protection, by identifying the conditions/situations in which coastal ecosystem restoration should be considered and hence, inform architectural design and develop technological solutions based on ecosystem attributes to mitigate the impacts of urbanisation on coastal and marine ecosystems, and to provide the ecosystem services implicit in resilient ecosystems.
- (c) Contribute towards the development of design guidelines for incorporating coastal protection attributes into nature-based solutions for coastal protection. This includes informing the design of full scale, science-based and future-ready coastal protection strategies and/or infrastructure that can host a diverse array of native species, contribute to carbon capture, and provide cultural and recreational value through increasing knowledge on ecological and functional baselines and coastal protection attributes of Singapore's contemporary coastal and marine ecosystems.

Project Details:

Coastal nature-based solutions for climate change mitigation and adaptation

Impact Outcomes and Pathway to Impact (continued)

In relation to the key programme-level deliverables of this vertical, this project should look towards contributing to the following impact outcomes:

- (d) Inform urban and coastal planners on strategies to promote coastal marine ecosystem health and human well-being, and contribute towards crafting climate policy and investment decisions by government and corporate sector stakeholders.
- (e) Create opportunities for achieving blue carbon and ecological resilience outcomes, by promoting diverse marine and coastal ecosystems with enhanced potential to sequester carbon from seawater and air.

Project Details:

Coastal nature-based solutions for climate change mitigation and adaptation

**Proposed study/
pilot testbed
site(s):**

Proposed projects may consider the following ecosystems from both the Johor Straits and Singapore Straits for study and pilot test-bedding, including, but not limited to:

- (a) Mangroves at Pulau Tekong, Pulau Ubin, Sungei Buloh Wetland Reserve, Kranji, Mandai and Pulau Semakau
- (b) Seagrass meadows at Chek Jawa, Changi, Labrador, and Pulau Semakau
- (c) Fringing coral reefs at the Sisters' Islands Marine Park, Sentosa, St John's Island, Lazarus Island, Pulau Jong, Pulau Tekukor, Kusu Island, Pulau Semakau, Pulau Hantu and Pulau Satumu
- (d) Coastal forests at Pulau Ubin, Coney Island, Pulau Seletar, Southern Islands

Agencies Involved:

Coastal nature-based solutions for climate change mitigation and adaptation

Role	Agency
Lead	PUB, Singapore's national water agency
Lead	National Parks Board
Member	Sentosa Development Corporation

Q&A on Call Topic 2

Call Topic 3: Integrating green and grey infrastructure as multi-functional coastal protection systems for climate change adaptation

V2 Eco-Engineering

**1st Grant Call: Topic 3
MCCS_V2_2021-1_T3**

Vertical 2 (Eco-Engineering),

Vertical 1 (Blue Carbon Science), Vertical 3 (Ecological Resilience), H2 (Community-Driven Climate resilience)

Project Topic: Integrating green and grey infrastructure as multi-functional coastal protection systems for climate change adaptation

Budget: S\$ 3 Mil

Duration of Project: up to 4 years

Lead Agencies: PUB, NParks

Project Details:

Integrating green and grey infrastructure as multi-functional coastal protection systems for climate change adaptation

Background

This project will develop cost-effective and eco-friendly solutions for enhancing natural capital and ecosystem services in the built marine environment through the development of multi-dimensional and multi-functional design elements. In doing so, the project will integrate nature-based solutions through surface-treatment to mitigate against wave run-up and overtopping exacerbated by sea-level rise and extreme storm events, while enhancing and restoring marine environments and creating new habitats. The range of solutions will be applicable to existing as well as future built coastal protection infrastructure.

There are several past and ongoing research projects on developing eco-engineering solutions, but they were and are primarily focussed on biodiversity enhancement and have not included considerations for the climate change drivers mentioned above, which is the focus of this project. In addition, this project will also study the importance of biofilms and other factors essential for priming surfaces and making them suitable for biodiversity to settle and colonise.

Land, and in particular land with shore access, is scarce in Singapore, making it essential to maximise its utility. At the same time, maintaining Singapore's physical, social, and ecological resilience amidst climate change and continued urbanisation requires coastal land uses to meet multiple needs such as coastal protection, recreational spaces, and habitat for biodiversity. This project will help achieve these objectives by developing design parameters for cost-effective multi-functional hybrid solutions with nature-based elements.

Project Details:

Integrating green and grey infrastructure as multi-functional coastal protection systems for climate change adaptation

Key Research Questions

Proposed projects should seek to address, but are not limited to the following key research questions:

- (a) How can we develop coastal protection systems that integrate green (multi-functional nature-based elements) and grey infrastructure that (i) promotes biodiversity, (ii) increases ecological resilience in terms of long-term efficacy, maintainability, disamenity, adaptability, (iii) provides recreation, and (iv) promotes education, (v) reduces cost?
- (b) How can existing and emerging systems be enhanced to meet the requirements described in (a)?

Project Details:

Integrating green and grey infrastructure as multi-functional coastal protection systems for climate change adaptation

Objectives

Proposed projects should include, but are not limited to the following research objectives:

- (a) To develop a comprehensive assessment of the ecological, physical and engineering requirements for multi-functional coastal protection systems with nature-based elements under a combination of climate change and land use considerations.
- (b) To assess and quantify factors (e.g., biofilms) that influence the settlement, colonisation and succession of biodiversity on these multi-functional nature-based elements.
- (c) To develop novel innovative integrated coastal infrastructure with multi-functional nature-based elements (e.g., eco-armour and biodiversity enhancement tiles) that meet the desired requirements at one or more sites* in Singapore, and quantify their effectiveness in coastal protection, ecological and societal functions, and enhancing natural capital in both the existing and future built marine environment.

* Proposed project budget should be reasonably estimated and reflective of the number of proposed pilot sites.

Projects are encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.

Project Details:

Integrating green and grey infrastructure as multi-functional coastal protection systems for climate change adaptation

Objectives (continued)

Proposed projects should include, but are not limited to the following research objectives:

- (d) To determine the long-term efficacy, maintainability, disamenity (e.g., compromise structural integrity), adaptability (including re-deployability) and the cost-effectiveness of the integrated coastal infrastructure with nature-based elements in creating coastal protection, social, and ecological value.
- (e) To inform the development of guidelines for the application of the spectrum of eco-engineered solutions for enhancing natural capital in the built marine environment.

Projects are encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.

Project Details:

Integrating green and grey infrastructure as multi-functional coastal protection systems for climate change adaptation

Project Deliverables

Proposed projects should address, but are not limited to the following project deliverables:

- (a) Documentation of innovative coastal protection infrastructure with multi-functional nature-based elements developed and tested at one or more sites*, including measures suitable for retrofitting existing built coastal infrastructure.
- (b) Description and quantification of the factors that influence the settlement, colonisation and succession of biodiversity on the various nature-based elements.
- (c) Description and quantification (e.g., through numerical modelling, laboratory tests and field surveys) of the effectiveness of the proposed multi-functional nature-based elements in enhancing natural capital of the built marine environment at the study sites without compromising the integrity of coastal protection measures.

* Proposed project budget should be reasonably estimated and reflective of the number of proposed pilot sites.

Project Details:

Integrating green and grey infrastructure as multi-functional coastal protection systems for climate change adaptation

Project Deliverables (continued)

Proposed projects should address, but are not limited to the following project deliverables:

- (d) Description and quantification on the long-term resilience, efficacy, disamenity, maintainability, and the cost-effectiveness of the proposed multi-functional nature-based elements across different aspects of coastal protection (including but not limited to wave run-up and overtopping), social, and ecological value.
- (e) Preparation of technical guidelines (including design parameters) for hybrid solutions that integrate multi-functional nature-based and human engineered infrastructure. The guidelines may also be incorporated into a decision-making tool for implementing nature-based solutions to enhance natural capital and coastal protection in the built marine environment in Singapore and other tropical coastal cities.

Projects are encouraged to further build upon the above-mentioned deliverables, and/or propose additional deliverables.

Project Details:

Integrating green and grey infrastructure as multi-functional coastal protection systems for climate change adaptation

Impact Outcomes and Pathway to Impact

In relation to the key-programme level deliverables of this vertical, this project should look towards contributing to the following impact outcomes:

- (a) Inform the design of full scale, science-based and future-ready living coastal protection infrastructure that can host a diverse array of native species, contribute to carbon capture, and provide cultural and recreational value, and hence contribute to the City in Nature, Sustainable Living and Resilient Future pillars of the Singapore Green Plan 2030.
- (b) Inform architectural design and develop technological solutions based on ecosystem attributes to mitigate the impacts of urbanisation on coastal and marine ecosystems, provide the ecosystem services implicit in resilient ecosystems, and ultimately contribute towards coastal risk reduction and increase ecosystem and community resilience when these solutions are adopted by government and corporate sector stakeholders.
- (c) Test-bedding of new eco-design typologies will be generated to inform urban and coastal planners on methodologies to promote coastal marine ecosystem health and human well-being.
- (d) Create opportunities for achieving blue carbon and ecological resilience outcomes, by promoting diverse marine and coastal communities with enhanced potential to sequester carbon from seawater and air.

Project Details:

Integrating green and grey infrastructure as multi-functional coastal protection systems for climate change adaptation

Proposed Study/ Pilot Testbed Site(s):

Proposed projects may consider the following sites for study and pilot test-bedding, including, but not limited to:

- (a) Vertical concrete seawalls along East Coast Park, Berlayer Creek, Sentosa, Singapore Cruise Centre, etc.
- (b) Granite rip rap revetments at East Coast Park, Sentosa, St John's Island, the Sisters' Islands, Kusu Island, Pulau Hantu and Pulau Satumu, etc.
- (c) Jetties and floating pontoons at Sentosa, St John's Island, the Sisters' Islands, Labrador, boating marinas, etc.
- (d) Intertidal and subtidal lagoons at East Coast Park, Sentosa, St John's Island and Small Sister's Island, etc.
- (e) Mudflats from Sungei Buloh to Kranji coastal walk.
- (f) Changi beach.
- (g) Sentosa island.
- (h) South-eastern/ South-western coasts under MPA's jurisdiction.
- (i) Coastal reservoir dams.

Note: Researchers are encouraged to explore different typologies in Singapore

Agencies Involved:

Integrating green and grey infrastructure as multi-functional coastal protection systems for climate change adaptation

Role	Agency
Lead	PUB, Singapore's national water agency
Lead	National Parks Board
Member	Sentosa Development Corporation
Member	Maritime and Port Authority of Singapore

Q&A on Call Topic 3

**Call Topic 4: Thresholds and tipping points:
Understanding responses of Singapore's coastal
and marine ecosystems to anthropogenic and
climate change impacts**

V3 Ecological Resilience & H1 Marine Climate Impact

1st Grant Call: Topic 4
MCCS_V3H1_2021-1_T4

Vertical 3 (Ecological Resilience), Horizontal 1 (Marine Climate Impact)
Vertical 2 (Eco-Engineering)

Call Topic: Thresholds and tipping points: Understanding responses of Singapore's coastal and marine ecosystems to anthropogenic and climate change impacts

Budget: up to S\$ 3.5 Mil

Duration of Project: up to 4 years

Lead Agencies: NParks, NEA

Project Details:

Thresholds and tipping points: Understanding responses of Singapore's coastal and marine ecosystems to anthropogenic and climate change impacts

Background

Climate change will impact coastal areas that are already stressed by human activities. Warmer and more acidic oceans can disrupt physiological processes and biogeochemical cycles while rising sea levels can erode and inundate coastal ecosystems and eliminate low-lying habitats that are unable to keep pace with it.

While earlier works studying the influence of environmental pressures on our coastal and marine ecosystems have generated significant knowledge gains, there has been limited focus on assessing and understanding responses to climate change impacts like sea level rise, elevated sea surface temperatures and ocean acidification, and the interactions between them and anthropogenic impacts.

Projects under this topic will provide the opportunity for multi-disciplinary research that incorporates basic marine biogeochemical modelling as well as both anthropogenic and climate drivers to establish the conditions that affect the physical and biological processes within individual habitats and across entire ecosystems, and to integrate our overall understanding of how ecosystem health and resilience can be promoted in face of long-term climate change. Knowledge generated from the research would support our efforts in conservation of key habitats, a thrust under National Parks Board's Nature Conservation Masterplan, by guiding management strategies to ensure that the functionality and persistence of our coastal and marine ecosystems are not negatively altered.

Project Details:

Thresholds and tipping points: Understanding responses of Singapore's coastal and marine ecosystems to anthropogenic and climate change impacts

Key Research Questions

Proposed projects should seek to address, but are not limited to the following key research questions:

- (a) How are the key marine biogeochemical parameters* changing under different climate change Shared Socioeconomic Pathways** (SSP) scenarios in Singapore's coastal regions?
- (b) How will anthropogenic activities and climate change* affect ecological patterns, processes, and the functioning of Singapore's coastal and marine ecosystems under different climate change scenarios (SSP)**?
- (c) What are the thresholds of climate change* that when exceeded could lead to extreme and potentially irreversible ecological impacts?

* E.g., sea surface temperature, acidification, sea level rise etc.

** IPCC AR6

Project Details:

Thresholds and tipping points: Understanding responses of Singapore's coastal and marine ecosystems to anthropogenic and climate change impacts

Objectives

Proposed projects should include, but are not limited to the following research objectives:

- (a) To simulate/model a broad set of marine biogeochemical parameters* for the different Shared Socioeconomic Pathways** (SSP) scenarios supporting marine climate change impacts research for Singapore.
- (b) To evaluate the impacts of anthropogenic activities and climate change* on ecological patterns, processes and the functioning of Singapore's coastal and marine ecosystems under different climate change scenarios (SSP**).
- (c) To identify the thresholds of climate change* that when exceeded could lead to exceptionally large and potentially irreversible ecological impacts and to model the trajectory of these ecological impacts.

* E.g., sea surface temperature, acidification, sea level rise etc.

** IPCC AR6

Projects are encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.

Project Details:

Thresholds and tipping points: Understanding responses of Singapore's coastal and marine ecosystems to anthropogenic and climate change impacts

Project Deliverables

Proposed projects should address, but are not limited to the following project deliverables:

- (a) A broad set of marine biogeochemical parameters* for the different Shared Socioeconomic Pathways** (SSP) scenarios supporting marine climate change impacts research for Singapore.
- (b) Evaluate the effects of anthropogenic activities and climate change* on ecological patterns, processes and functioning of Singapore's coastal and marine ecosystems under different climate change scenarios (SSP**). Examples of impacts include microbial composition, genetic predisposition (e.g., to elevated temperature resilience), larval connectivity, bioerosion, herbivory, and coastal water quality.
- (c) Create models and datasets that predict the trajectory of exceptionally large and potentially irreversible ecological impacts that result from climate change*, hence determining the ecological thresholds and tipping points of Singapore's coastal and marine ecosystems.

* E.g., sea surface temperature, acidification, sea level rise etc.

** IPCC AR6

Projects are encouraged to further build upon the above-mentioned deliverables, and/or propose additional deliverables.

Project Details:

Thresholds and tipping points: Understanding responses of Singapore's coastal and marine ecosystems to anthropogenic and climate change impacts

Impact Outcomes and Pathway to Impact

In relation to the key programme-level deliverables of this vertical and horizontal, this project should look towards contributing to the following impact outcomes:

- (a) Contribute to the City in Nature, Sustainable Living and Resilient Future pillars of the Singapore Green Plan 2030 through identifying thresholds of our coastal and marine ecosystems through human-induced climate change impacts.
 - a. Understand the anthropogenic and climate change impacts on local marine ecosystems across a range of key parameters, such as temperature, salinity, acidity, coastal weather disturbances and turbidity.
 - b. Identify threats to marine community resilience across Singapore's natural and built coastal environments and incorporate this knowledge into adaptive environmental management and urban planning processes.
- (b) Contribute towards crafting climate policy and investment decisions by government and corporate sector stakeholders especially in the face of long-term climate change.
- (c) Knowledge derived from this vertical will also provide the basis and context for the development of project solutions under the Blue Carbon and Eco-Engineering verticals.

Project Details:

Thresholds and tipping points: Understanding responses of Singapore's coastal and marine ecosystems to anthropogenic and climate change impacts

**Proposed Study/
Pilot Testbed
Site(s):**

Proposed projects may consider the following sites for study and pilot test-bedding, including, but not limited to:

- (a) Mangroves: Sungei Buloh Wetland Reserve, Pulau Ubin, Changi Creek, Berlayer Creek, Pulau Semakau
- (b) Intertidal areas (including mudflats and seagrass beds): Mandai Mudflats, Changi Beach, Sisters' Islands, St John's Island, Lazarus Island, Pulau Semakau, Pulau Hantu, Pulau Jong, Pulau Satumu, Cyrene Reefs, Terumbu Reefs, Raya Reefs
- (c) Coral reefs: Sisters' Islands, Kusu Island, St John's Island, Lazarus Island, Pulau Semakau, Pulau Hantu, Pulau Jong, Pulau Satumu

Agencies Involved:

Thresholds and tipping points: Understanding responses of Singapore's coastal and marine ecosystems to anthropogenic and climate change impacts

Role	Agency
Lead	National Parks Board
Lead	National Environment Agency*

* Will help to align projects under this topic with broader underpinning/climate impact research under the National Climate Science Research Masterplan.

Q&A on Call Topic 4

Call Topic 5: Enhancing the ecological resilience of coral reefs in response to climate change stressors

V3 Ecological Resilience & H1 Marine Climate Impact

1st Grant Call: Topic 5
MCCS_V3H1_2021-1_T5

Vertical 3 (Ecological Resilience), Horizontal 1 (Marine Climate Impact)

Call Topic: Enhancing the ecological resilience of coral reefs in response to climate change stressors

Budget: up to S\$ 2.5 Mil

Duration of Project: up to 4 years

Lead Agencies: NParks, NEA

Project Details:

Enhancing the ecological resilience of coral reefs in response to climate change stressors

Background

Climate change will impact coastal areas that are already stressed by human activities. Warmer and more acidic oceans can disrupt physiological processes and biogeochemical cycles while rising sea levels can erode and inundate coral reef ecosystems and eliminate low-lying habitats that are unable to keep pace with it.

Mangroves, seagrasses, and other marine ecosystems can thrive on a wider range of temperature changes while coral reefs can only withstand a smaller threshold. The study of how different climate change stressors, including heat stress, is therefore more urgent for coral reefs as a vulnerable marine ecosystem. Modelling of marine biogeochemical parameters (such as acidification and intensified heat) and their changes under climate change is key to understand future impact to Singapore's coastal coral reef systems.

Research into the consequences of heat stresses on our coral reef ecosystems is not new to science. However, most research in the past was largely focused on the effects of heat stresses on single coral reef species. Hence, there is a need to deepen our knowledge on how various climate change stressors (e.g., the effect of acidification and intensified heat) can synergistically affect reef organisms from populations to communities. This will enable the development of strategies to deliver ecological resilience of our coral reefs, in response to climate change, at multiple trophic levels.

Projects under this topic will improve our overall understanding of coral reef health and resilience towards climate change stressors (e.g., elevated sea surface temperatures, ocean acidification, etc.) and identify interventions that can be integrated into adaptive conservation and management strategies to tackle climate change impacts in the near and long-term.

Project Details:

Enhancing the ecological resilience of coral reefs in response to climate change stressors

Key Research Questions

Proposed projects should seek to address, but are not limited to the following key research questions:

- (a) How are the changing marine biogeochemical parameters* impacting the ecological resilience of coral reef ecosystems?
- (b) How can we ensure ecological resilience of coral reef ecosystems, through natural or assisted adaptation strategies at multiple trophic levels, in response to climate change stressors under different climate change scenarios (Shared Socioeconomic Pathways** (SSP)), and thereby maintain coral reef health and resilience and prevent unwanted ecological shifts?

* E.g., sea surface temperature, acidification, sea level rise etc.

** IPCC AR6

Project Details:

Enhancing the ecological resilience of coral reefs in response to climate change stressors

Objectives

Proposed projects should include, but are not limited to the following research objectives:

- (a) To identify and evaluate the factors that influence (promote, inhibit, prevent) the resilience of coral ecosystems*.
- (b) To conduct model simulations to understand how these factors change under climate change Shared Socioeconomic Pathways** (SSP).
- (c) To develop tools and datasets for implementing adaptation strategies (natural or assisted) to increase resilience of coral reef ecosystems at multiple trophic levels in response to climate change stressors under different climate change scenarios (SSP).

* Knowledge is therefore also required on the composition and function of the microbiome community associated with the coral host.

** IPCC AR6

Projects are encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.

Project Details:

Enhancing the ecological resilience of coral reefs in response to climate change stressors

Project Deliverables

Proposed projects should address, but are not limited to the following project deliverables:

- (a) Description and quantification of the factors that influence resilience within coral reef ecosystems
- (b) Model simulations of how these factors change under climate change (SSP)*
- (c) Tools, datasets, technical guidelines, and recommendations that can be incorporated into management strategies to maintain, sustain, and enhance the health and resilience of coral reef ecosystems in response to climate change stressors and under different climate change scenarios

* IPCC AR6

Projects are encouraged to further build upon the above- mentioned deliverables, and/or propose additional deliverables.

Project Details:

Enhancing the ecological resilience of coral reefs in response to climate change stressors

Impact Outcomes and Pathway to Impact

In relation to the key programme-level deliverables of this vertical and horizontal, this project should look towards contributing to the following impact outcomes:

- (a) Contribute to the City in Nature, Sustainable Living and Resilient Future pillars of the Singapore Green Plan 2030 through strategies that can maintain, sustain, and enhance health and resilience of coral reef ecosystems in the face of long-term climate change. The outcomes from this research can generate comprehensive understanding of the underlying basis for maintaining, sustaining, and enhancing ecosystem resilience within Singapore's coral reef ecosystems. This can also inform the formulation and implementation of management tools and plans required to investigate and mitigate the effect of local and global environmental pressures.
- (b) Contribute to coastal risk reduction and increase ecosystem and community resilience locally and regionally. Benchmarks for ecologically resilient coastal cities in the tropics can be established by identifying key ecosystem services involved in sustaining resilience. Threats to coral reef resilience across Singapore's natural and built coastal environments can be identified and incorporated into adaptive environmental management and urban planning processes.

Project Details:

Enhancing the ecological resilience of coral reefs in response to climate change stressors

Impact Outcomes and Pathway to Impact (continued)	<p><i>In relation to the key programme-level deliverables of this vertical and horizontal, this project should look towards contributing to the following impact outcomes:</i></p> <p>(c) Contribute to crafting climate policy and investment decisions by government and corporate sector stakeholders. Management interventions, natural or assisted, to maintain, sustain, and enhance the health and resilience of Singapore’s coral reef ecosystems can be recommended, while coastal activities (e.g., marine aquaculture, shipping, coastal industries, recreation) within our urban coastal environment can be supported and sustained.</p> <p>(d) Knowledge derived from this vertical can also provide the basis and context for the development of project solutions under the Blue Carbon and Eco-Engineering verticals.</p>
Proposed Study/ Pilot Testbed Site(s):	<p><i>Proposed projects may consider the following sites for study and pilot test-bedding, including, but not limited to:</i></p> <p>(a) Coral reefs: Sisters’ Islands, Kusu Island, St John’s Island, Lazarus Island, Pulau Semakau, Pulau Hantu, Pulau Jong, Pulau Satumu</p>

Agencies Involved:

Enhancing the ecological resilience of coral reefs in response to climate change stressors

Role	Agency
Lead	National Parks Board
Lead	National Environment Agency*

* Will help to align projects under this topic with broader underpinning/climate impact research under the National Climate Science Research Masterplan.

Q&A on Call Topic 5

Call Topic 6: Developing modular mangrove and seagrass planters for habitat restoration, carbon sequestration, and bioremediation

V3 Ecological Resilience

1st Grant Call: Topic 6
MCCS_V3_2021-1_T6
Vertical 3 (Ecological Resilience),
Vertical 1 (Blue Carbon Science), Vertical 2 (Eco-Engineering)

Call Topic: Developing modular mangrove and seagrass planters for habitat restoration, carbon sequestration, and bioremediation

Budget: up to S\$ 800, 000

Duration of Project: up to 5 years

Lead Agencies: NParks, SDC

Project Details:

Developing modular mangrove and seagrass planters for habitat restoration, carbon sequestration, and bioremediation

Background

- As with many tropical coastal cities, Singapore's coastal ecosystems have been highly impacted by habitat loss and anthropogenic sedimentation. The remaining natural habitats are expected to be further impacted by climate change and continued urbanisation.
- Traditional marine habitat restoration efforts often do not extend to highly urbanised environments such as coastal promenades, marinas, storm drains, or residential estates. While there have been extensive studies done on enhancing biodiversity on seawalls, little has been done to assess the biodiversity enhancement potential of integrating other intertidal ecosystems such as mangroves and seagrass.
- Hence, there lies an opportunity to look into integrating such natural habitats with the urban environment and ongoing coastal protection efforts so as to ensure resilience of biodiversity and overall health of the marine environment. At the same time, social value such as urban heat mitigation, bioremediation and recreation can be provided to city residents. Further, there is an opportunity to explore the blue carbon sequestration potential of urbanised shorelines.

Project Details:

Developing modular mangrove and seagrass planters for habitat restoration, carbon sequestration, and bioremediation

Key Research Questions

Proposed projects should seek to address, but are not limited to the following key research questions:

- (a) How can coastal ecosystems such as mangroves and seagrasses be integrated into hard coastal defences along highly urbanised shorelines with space constraints?
- (b) What biodiversity can mangroves and seagrasses support if joined onto hard coastal defences?
- (c) How much ecosystem service value (biodiversity, carbon sequestration, bioremediation for water quality, social/recreational value) can such ecosystems provide in the context of hard urbanised shorelines?

Project Details:

Developing modular mangrove and seagrass planters for habitat restoration, carbon sequestration, and bioremediation

Objectives

Proposed projects should include, but are not limited to the following research objectives:

- (a) Develop novel modular and low maintenance mangrove and seagrass habitat planter units that can be deployed along highly urbanised, space-constrained shorelines and semi enclosed coastal water bodies across a range of bathymetries
- (b) Develop suitable planter unit designs that allow for the incorporation or modular add on of water quality monitoring sensors/ systems and possibly, wave gauges sensors to monitor waves on site
- (c) Create a novel technique to increase carbon sequestration and storage potential along highly urbanised shorelines
- (d) Investigate the biodiversity benefits of such planter units
- (e) Investigate the bioremediation benefits of such planter units on water quality, especially in hydrologically stagnant areas such as enclosed marinas, lagoons and basins.
- (f) Investigate the social and recreational value of such planter units

Projects are encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.

Project Details:

Developing modular mangrove and seagrass planters for habitat restoration, carbon sequestration, and bioremediation

Project Deliverables

Proposed projects should address, but are not limited to the following project deliverables:

- (a) Design specifications for mangrove planter units that can be deployed along seawall structures and/or floating platforms and support the growth of at least three species of mangrove
- (b) Design specifications for seagrass planter units that can be deployed along seawall structures and/or floating platforms and support at least two species of seagrass
- (c) Report on the quantifiable biodiversity and bioremediation benefits of such planter units
- (d) Report on the carbon sequestration rate and storage capacity per unit area of such planter units
- (e) Report on the social ecosystem services created by such planter units

Projects are encouraged to further build upon the above-mentioned deliverables, and/or propose additional deliverables.

Project Details:

Developing modular mangrove and seagrass planters for habitat restoration, carbon sequestration, and bioremediation

Impact Outcomes and Pathway to Impact

In relation to the key programme-level deliverables of this vertical, this project should look towards contributing to the following impact outcomes:

- (a) Develop first of its kind modular mangrove and seagrass planter units for Southeast Asian species.
- (b) Increase carbon sequestration and storage along highly urbanised shorelines
- (c) Create the foundation for bioremediation of hydrodynamically stagnant urban coastal water bodies.
- (d) Increase access to nature and biodiversity for recreation along highly urbanised shorelines.
- (e) The modular units developed by this project can then be scaled up by implementing them throughout coastal urban areas with high footfall and constrained spaces. This will support National Parks Board's (NParks) habitat restoration efforts under the Nature Conservation Masterplan as well as the City in Nature pillar under Singapore's Green Plan 2025.

Project Details:

Developing modular mangrove and seagrass planters for habitat restoration, carbon sequestration, and bioremediation

**Proposed study/
pilot testbed site(s):**

Proposed projects may consider the following sites for study and pilot test-bedding, including, but not limited to:

Sentosa Cove and other sites managed by Sentosa Development Corporation (SDC), Bendera Bay (managed by National Parks Board (NParks) on St John's Island) or private entities with suitable coastal shorelines or water bodies.

Agencies Involved:

Developing modular mangrove and seagrass planters for habitat restoration, carbon sequestration, and bioremediation

Role	Agency
Lead	National Parks Board
Lead	Sentosa Development Corporation
Member	Housing & Development Board
Member	PUB, Singapore's national water agency
Member	JTC Corporation

Q&A on Call Topic 6

Final Q&A

Thank You

For further enquiries, please contact: MCCS@nparks.gov.sg