

**Details of the Awarded Projects under the
Marine Science Research and Development Programme**

1.	Principal Investigator: Assistant Professor Huang Danwei Department of Biological Sciences Faculty of Science National University of Singapore
	Project title: Adaptation and resilience of coral reefs to environmental change in Singapore [Under the MSRDP research theme of Marine Ecosystems and Biodiversity] <u>Background:</u> Coral reefs around the world are declining dramatically due to many environmental stressors. However, Singapore's reefs have managed to survive, with over 200 species of reef-building corals and about 200 species of fish documented on reefs here. This project aims to study their biological and physical environments, as well as test the effects of key stressors on coral reefs, to understand how these species-rich habitats continue to endure. <u>Project details:</u> This project will integrate historical and modern-day approaches to uncover the mechanisms that reefs employ to cope with urbanisation. First, the project will reconstruct the genealogical and environmental history of Singapore's reefs over the last few centuries by profiling coral communities, both living and fossil, and their connections between populations. Second, it will study the responses of corals to various contemporary stresses, focusing on the changes in microbial composition and gene expression. These stresses include sediment damage due to land reclamation and seabed dredging, which have led to losses of more than 60% of the original reef area and up to 37% of coral species. <u>Expected outcomes:</u> This project will reveal how coral reefs in Singapore have survived in one of the most urbanised marine environments in the world, allowing researchers to exploit these habitats' utility as real-time biological monitors of environmental change.
2.	Principal Investigator: Associate Professor Federico Lauro Associate Chair, Asian School of the Environment, Nanyang Technological University Principal Investigator, Singapore Centre for Environmental Life Sciences Engineering
	Project title: Understanding the viral composition of phytoplankton blooms in Singapore coastal waters [Under the MSRDP research themes of Marine Ecosystems and Biodiversity, and Environment Impact and Monitoring] <u>Background:</u> Algal blooms are a growing problem in Singapore waters, often causing economic losses to industry (such as fish farming) and tourism. However, how algal blooms develop and how they disappear is not entirely understood.

	<u>Project details:</u> This project aims to understand how algal blooms rise and subsequently decline in tropical marine waters, by understanding the interplay between algal viruses and environmental parameters. Researchers will collect monthly water samples and ancillary environmental data over a full annual cycle, from five sites with contrasting oceanographic conditions. These samples will be analysed using DNA sequencing technology. Microscopic algal hosts will also be cultured, with a focus on dinoflagellates and cyanobacteria, which are responsible for most harmful algal blooms in Singapore waters. These cultures will serve as hosts for the isolation of new viruses. <u>Expected outcomes:</u> Through this project, the researchers hope to develop novel tools for risk assessment focused on environmental conditions that lead to algal blooms.
3.	Principal Investigator: Dr Tan Lik Tong Lecturer, Natural Sciences & Science Education, National Institute of Education Project title: Genomic and metabolomic approach to the discovery of functional metabolites from marine actinomycetes [Under the MSRDP enabling technology theme of Marine Technology and Platforms] <u>Background:</u> Studies have revealed that diverse marine microbes, particularly actinomycetes, have the capacity to produce an array of functional compounds for human medicine, animal health, crop protection and other biotechnological applications. However, the conventional method of growing and testing microorganisms in the laboratory is time consuming and driven largely by chance. <u>Project details:</u> This project uses an integrated genomic and metabolomic approach to predict the nature of metabolites from marine actinomycetes associated with diverse marine samples. This is carried out through genome mining of bacterial DNA for unique biosynthetic gene clusters as well as detecting the expression of these molecules using innovative chemical analytical technologies. Mass spectrometric profiling can also be used to identify interesting molecules for chemical purifications. <u>Expected outcomes:</u> The integration of bioinformatics and chemical technologies increases the efficiency of discovery and makes it possible to build a robust pipeline of new chemical entities from marine microorganisms. Significant discoveries could support local pharmaceuticals and biotechnology-based industries or businesses.
4.	Principal Investigator: Associate Professor Nathalie Goodkin Assistant Chair (Research and Graduate Studies), Asian School of the Environment, Nanyang Technological University Principal Investigator, Earth Observatory of Singapore Project title: Physical and biogeochemical effects of sediment transport on coral reefs [Under the MSRDP research themes of Marine Ecosystems and Biodiversity, and Environment Impact and Monitoring] <u>Background:</u> Coral reefs in Southeast Asia are threatened by declining water quality, especially from high suspended sediment loads and excessive nutrient concentrations. Singapore's coral reefs are already impacted by these threats, and future development in and around Singapore is likely to increase these impacts.

	<u>Project details:</u> This project will quantify current patterns of sediment transport, nutrient levels, and nutrient cycling on coral reefs in Singapore, and establish how sediment delivery and nutrient inputs are linked. This will be carried out through long-term observation sites on coral reefs in Singapore, collection of water and sediment samples, experiments on coral fragments, and the use of autonomous sensors that take measurements continuously. <u>Expected outcomes:</u> This project will provide insights into how Singapore's corals survive in the face of high sediment and nutrient loads. Studies on the spatial patterns of sediment transport to the reefs will also help researchers to assess how the reefs might be impacted by planned development projects.
5.	Principal Investigator: Assistant Professor Peter Todd Department of Biological Sciences Faculty of Science National University of Singapore Project title: Ecologically engineering Singapore's seawalls to enhance biodiversity [Under the MSRDP research theme of Coastal Ecological Engineering] <u>Background:</u> The combination of coastal urban development and threats associated with climate change has resulted in a rapid and worldwide increase in the construction of hard defences such as seawalls. However, seawalls do not host the level of biodiversity generally associated with the natural habitats they replace. <u>Project details:</u> Researchers will run their own software "CASU" to design concrete tiles of different complexities, and use these, to test the effects of complexity and structural component type on intertidal diversity and community composition. Researchers will also test the effects of novel construction materials on biofilm formation and subsequent colonisation by larger marine organisms. At the lower parts of the seawalls, they will attempt to encourage coral communities by affixing coral fragments directly onto the seawall. They will also be testing the hydrodynamics of seawalls to identify ways in which they can be designed to be more attractive to wildlife. <u>Expected outcomes:</u> Findings from this project can be integrated into engineering practices at the seawall design stage, or during retrofitting of existing seawalls. These efforts will aid the enhancement and conservation of biodiversity on engineered shores, and enhance the value of seawalls as a habitat while retaining its utilitarian function.
6.	Principal Investigator: Dr Serena Teo Senior Research Fellow, Tropical Marine Science Institute, National University of Singapore, and St. John's Island National Marine Laboratory Project title: Tropical model marine organisms for experimental marine science [Under the MSRDP research theme of Marine Ecosystems and Biodiversity, and the enabling technology theme of Marine Technology and Platforms]

	Background: A steady supply of laboratory-reared organisms is a crucial resource in marine experimental research. This project aims to establish cultured stocks of local marine invertebrates so that they are readily available to researchers and for educational purpose. The study will focus on local species of: sea urchins, calcareous tubeworms and ascidians. Microplastics (particles with a diameter less than 1mm) are a serious emerging global environment issue. Hence, the study will also conduct preliminary studies of ecotoxicity of microplastics on native species' life cycle, as a demonstration of potential applications using cultured stocks of local marine invertebrates. Project details: In the initial phase of this project, researchers will design suitable aquaria facilities to rear the organisms and field collection of wild broodstock, and subsequently develop in-house protocols to maintain a steady supply of organisms for research use. To demonstrate the application of marine model organisms in an environment, basic experimental assays (bioassays using known compounds) will also be conducted to provide comparative data with marine species used in other parts of the world. Expected outcomes: The availability of tropical model organisms will enable local marine scientists to explore more biotechnological and biomedical research questions. Research conducted with local species will also generate research that is immediately relevant to the Southeast Asia environment, and draw world-class scientists to Singapore for comparative studies against traditional temperate model species. The ability to conduct controlled laboratory experiments will also allow researchers to explore the detailed chemical mechanisms and effect of microplastics on local marine organisms. This could enable the future development of products that are safe for the environment.
7.	Principal Investigator: Dr Sin Tsai Min Senior Research Fellow, Tropical Marine Science Institute, National University of Singapore Project title: A cross-discipline user-focused data management platform for data collected under the Marine Science Research & Developmental Programme [Under the MSRDP research theme of enabling technology theme of Marine Technology and Platforms] Background: Complex phenomena in marine sciences need to be understood at larger spatial scales, and this is increasingly achieved through data-centric and macrosystem approaches. There is a need to develop a cross-disciplinary, user-focused data management platform to enable broader system approaches to marine science, which also promotes cross-theme sharing, and integrated management of data collected separately by each theme. Project details: The Marine Environment Information System (METIS) will include data from individual programmes under the Marine Science Research & Development Programme, but will also enable and anchor research data and outcomes to transition from multi-disciplinary to truly cross-disciplinary science. This involves designing and creating a flexible system architecture to support marine science R&D, developing

	and customising application modules to support researchers, and training and engagement of stakeholders in the use of METIS. Through the system, researchers will have access to project and programme data, quality control and assurance of data, and tools for basic visualisation, mapping and analysis of data. They can also search available open source data as well as access contact information for additional sources of data that are currently restricted.
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	<u>Expected outcomes:</u> This system will be the first centralised repository of publicly available environmental information in Singapore. It paves the way for a national-level data sharing initiative for research purposes, and will foster better and improved collaboration for future projects in the marine environment.
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