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One paragraph Bio

Assoc Prof Shirley Lim is a marine ecologist with more than 30 years of experience in marine invertebrate research. She started out her research career working on crustacean larvae, followed by her doctoral work in the Canadian sub-Arctic working on the Baltic clam. Her post-doctoral work took her to the east coast of Canada to evaluate the effect of salmon-cage farming on the coastal benthic community. On her return to Singapore, her primary research thrusts are in the study of the ecology of crabs and molluscs in wetlands and coastal regions, with particular emphases on functional morphology and habitat adaptations. Extensive field studies on ocypodid crabs and littorinid snails have been carried out by her research team at two off-shore islands (Tanjung Chek Jawa on Pulau Ubin and Pulau Hantu), as well as at other coastal sites on mainland Singapore (e.g., Pasir Ris mangroves, Changi beach and the East Coast sandy shores).

Write up on the possible project

* The proposed research should fall within current MSRDP themes which consist of the study of marine ecosystems and biodiversity (MEB), environment impact and monitoring (EIM), coastal ecological engineering (CEE) and marine technology and platforms (MTP).

Characterization of Singapore mangrove stands and associated crab communities with a view of coastal restoration

Despite a trend of continual decline in cover, mangroves contribute disproportionately to ecosystem services such as aquaculture, shoreline protection, and important sources and sinks for nearshore terrestrial and marine habitats (Kathiresan & Bingham 2001; Duke et al. 2007; Alongi 2008; Huxham et al. 2010; Duarte et al. 2013). An estimate of the global valuation of these mangrove services is approximately US$1.5 billion per annum (Constanza et al. 1997). Occupying less than 0.5% of the global seabed, mangroves are capable of storing above 70% of the blue carbon (i.e., carbon from coastal and marine ecosystems) with an annual sequestration rate of 1.15–1.39 t ha^{-1}(Boullian et al. 2008; Nellemann et al. 2009; Siikamaki et al. 2012). This is three to five times more effective than the green carbon sink services provided by terrestrial forests (Donato et al. 2011). In the face of climate change, conservation of existing mangroves is paramount. The restoration of degraded mangrove forests plays a crucial role in the mitigation of deleterious effects of overexploitation, habitat destruction and conversion for development.

Located at the southern tip of the Malay Peninsula, Singapore is situated in the region with the largest mangrove extent (over 40% of the total mangrove cover in the world) and greatest mangrove diversity (Sasekumar et al. 1994; Polidoro et al. 2010). However, due to the perceived low utilitarian value of mangroves, much of the original cover was cleared for urban development and reclamation, as the overall land area in Singapore increased from 581 km^2 in 1957 to 775.5 km^2 in 2008 (De Koninck et al. 2008). Currently, mangrove coverage stands at a mere 6.6 km^2 (Yee et al. 2011) and is further projected to fall to 4% of the original cover by 2030 (Hilton & Manning 1995). As the rest of Southeast Asia develops, mangrove conservation takes the backseat, foretelling the same predicament for the estuarine areas in this region (Jepson et al. 2001).

With the realization of the value of mangroves, increasing attention has been given to their ecological restoration in the recent decades (Lewis 1999). However, most attempts fail as they often proceed with the replanting phase without examining the reasons that prevented natural recovery in the first place (Lewis 2005). Few replanting attempts involve collaborative work between both ecologists and management (Kentula 2000); hence there is usually a divide between restoration expectations and actual results (Kamali & Hashim 2011). For example, poor species and site selection of a mangrove restoration exercise cost the Philippines millions of dollars over the course of 20 years (Primavera & Esteban 2008; Samson & Rollon 2008). To successfully restore a mangrove, it is necessary to understand the local ecology and the potential of the site to support the targeted mangrove species, assess the site for stress factors that may prevent succession, and then design the restoration program accordingly (Lewis & Marshall 1997).

As keystone species, mangrove stands create a suitable habitat and valuable nursery for various terrestrial, estuarine and marine fauna. There are anecdotal reports from local naturalists (P.K.L. Ng, pers. comm) that the benthic fauna, especially that of brachyurans (i.e., crabs) in our mangroves have diminished both in abundance and biodiversity. Hence, it is timely at this juncture to initiate a study to assess the current state of health of the few remaining mangrove stands as well as to gather data on the benthic fauna in the respective stands. As it is not feasible to conduct a comprehensive mangrove benthic community structure research without a prolonged longitudinal study, we will concentrate on the most dominant taxa present—the brachyurans.

Therefore, the objectives of this project are to:

1) Characterize the floral diversity, abundance and distribution in the few remaining stands of mangrove on mainland Singapore;
2) Determine the benthic macrofaunal species composition, with emphasis on crab biodiversity, abundance and distribution in the identified mangrove stands of interest.

In order to gather reliable data, we propose to conduct a two-year field study to document the succession (if any) of the mangrove species as well as to track any changes in the associated brachyuran community. Laboratory analyses of the collected benthos as well as data analyses will be carried out simultaneously as the field data collection. After the two years, it is anticipated that complete data analyses, coupled with the writing of reports, manuscripts, etc., for publication, would require a further year. Hence, the proposed period of research would be for a total of three years.

Direct benefits to Singapore's marine environment would be in the form of scientific evidence (instead of anecdotal tales) on the current state of health of the few remaining stands of mangroves together with their respective associated benthic fauna. The data gathered from this study would serve as baseline information for the conservation of the rapidly diminishing coastal biodiversity. In terms of sustainability of the environment, viable and healthy mangrove stands provide an important buffer between land and sea, as well as provide the much needed nursery ground for marine life. Current worldwide efforts in mangrove restoration have not met with much success as most projects lack the evaluation of the ecosystem functionality. Incorporating the results from this

study into mangrove conservation protocols could potentially place Singapore as the world leader in mangrove restoration.

Equipment: Most of the equipment necessary for benthic ecology research work is already available in the PI's Ecology Lab. Foreseeable costs would be the replacement of the fine-grade sieves that are necessary for sediment analyses and benthos collection.

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MSRDP theme: MEB, EIM

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One paragraph Bio: Dr. Tan Lik Tong obtained his BSc (Hon) from the Department of Zoology at the National University of Singapore. In 1993, he was awarded the Japanese Government (Monbusho) Scholarship to pursue MSc (Marine Sciences) research, under the supervision of Professor Tatsuo Higa, at the University of the Ryukyus, Okinawa, Japan. His MSc research topic was on the isolation and characterization of bioactive secondary metabolites from marine sponges. His continued interests in marine natural products brought him to Oregon State University at the College of Pharmacy, where he obtained his PhD in Medicinal and Natural Products Chemistry. His PhD dissertation was on the biomedical potential of marine cyanobacteria, conducted at the laboratory of Professor William Gerwick. Subsequently, he undertook Post-Doctoral research at the Scripps Institution of Oceanography (SIO), University of California, San Diego. His research at SIO involved drug discovery from novel marine microbes as well as chemical ecology of marine algae. This was at the laboratory of Professor William Fenical. Before joining NIE, he was Senior Research Chemist at Merlion Pharmaceuticals in Singapore. Dr. Tan is also a reviewer for many top tier journals, including the *Journal of Natural Products*, co-published by the American Chemical Society and the American Society of Pharmacognosy.

Write up on the possible project :
Title: Isolation and Structural Determination of Bioactive Natural Products from Marine Microbes
Marine microbes, such as cyanobacteria and actinomycetes, are prolific sources of novel natural products with pharmaceutical potentials. The main aim of this project is on the isolation and structural elucidation of bioactive natural products from marine microbes. The project involves:
1. Collection and culturing of marine cyanobacteria and actinomycetes
2. Extraction of marine samples
3. Isolation and purification of novel bioactive secondary metabolites
4. Structural elucidation of bioactive secondary metabolites using spectroscopic techniques, such as NMR and mass spectrometry.
5. Chemical manipulation of secondary metabolites to determine absolute stereochemistry of secondary metabolites.
6. Perform semi-synthesis of bioactive secondary metabolites to obtain SAR information.

MSRDP theme: MTP

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One paragraph Bio:
Dr. Ali Miserez is an Associate Professor in the School of Materials Science and Engineering and the School of Biological Sciences at Nanyang Technological University (NTU). He graduated from the Ecole Polytechnique Fédérale de Lausanne (EPFL, Switzerland) with a PhD (2003) in Materials Science and Engineering in the field of composite materials and mechanics of materials. In 2004, he received a Swiss National Science Foundation post-doctoral fellowship and moved to the University of California, Santa Barbara (UCSB), where he was affiliated with the Materials Department and the Marine Science Institute. At UCSB, he expanded his research interest towards biomimetic materials and biochemistry of extra-cellular tissues. He moved to NTU as an Assistant Professor in 2009, and in 2011 he was awarded the Singapore National Research Foundation (NRF) Fellowship, a highly-competitive $3 Million individual research grant for early career scientists. Dr. Miserez's research is centered on revealing the molecular, physico-chemical, and structural principles from unique biological materials (mostly from marine organisms) and on translating these designs into novel biomimetic synthesis strategies. His research group is strongly cross-disciplinary, with molecular biologists, chemists, bio-physicists, and materials scientists combining their expertise towards bioinspired engineering from various angles, including protein biochemistry, extra-cellular tissue transcriptomic, polymer chemistry, biomimetic peptide design, biophysics, and nanomechanics. In recent years, his work has appeared in both general (*Science, Nature Materials, Nature Biotechnology, Nature Chemical Biology, Advanced Materials*) and specialized journals (*Biomacromolecules, ACS Nano, JBC, etc,*). He has delivered numerous invited talks, including at various Gordon Research Conferences in the field of bioinspired materials, biomineralization, and biofouling.

Write up on the possible project (3 possible projects)

Prof. Miserez's lab has a strong interest in marine science from a biomimetic/bioinspired perspective. His group is leading multi-scale structure/property relationship studies of unique extra-cellular biological materials from marine organisms, such as hard tissues from cephalopods (squids and cuttlefish), bioadhesives from marine mussels, or ultra-damage resistant mineralized appendages from crustaceans. His lab is also highly active in the field of marine biofouling, with a focus on understanding basic interactions between adhesive produced by marine foulers and immersed substrates. There are currently 3 possible research projects related to marine science.

1) Eco-friendly Slippery Coatings for Marine biofouling

In this project, we are interested in understanding the molecular strategies by which fouling organisms such as mussels and barnacles efficiently stick to immersed solid substrates. In recent years, we have sequenced the adhesive proteins of the Asian green mussel (Guerette *et al*., ***Nature Biotechnology*** 2013) and elucidated its molecular mechanisms of adhesion (Petrone *et al*., ***Nature Communications*** 2015). We have also instigated studies on the mechanisms of barnacle cement protein adhesion using a combination of structural biology (protein NMR)

and computational methods. From an applied perspective, such knowledge provides a key understanding to develop the next-generation of anti-fouling coatings. In a recent study, we have for instance demonstrated that lubricant-infused coatings are remarkably efficient at deterring mussel attachment (one of the most problematic macro-fouling organism) and at minimizing the adhesive strength of their filamentous adhesive (Amini et al, ***Science***, 2017). Our interest in this area is to further optimize such anti-fouling coatings in order to make them fully eco-friendly and harmless for the marine environment.

2) Biomineralization of ultra-damage resistant biotools

Stomatopods (mantis shrimps) are equipped with an ultra-fast hunting appendage called the dactyl club that is used as a "biological hammer" to shatter the hard shells of its prey. The club is a fascinating model system for biomimetic studies, being one of the fastest movement of the animal kingdom with speed of 25 m/s. It is a complex biocomposite made of fluorapatite, amorphous calcium carbonate, chitin, and proteins with specific microstructural spatial distribution along the club. In recent years, we have shed light on the multi-scale structural arrangement of the clubs (Weaver *et al*., ***Science*** 2012; Amini *et al*, **Nature Communications** 2014). We have also unveiled the nano- and micro-structural design principles behind their remarkable contact damage tolerance, which allows to strike on hard preys while minimizing internal damage (Amini *et al,* ***Nature Materials*** 2015). Recently, using a combination of next-generation and proteomic methods, we have identified putative acidic proteins that are likely involved in the mineralization of the club. This project will aim at elucidating the molecular mechanisms of biomineralization of the dactyl club using these recently identified proteins. The study will be conducted using proteins obtained by recombinant expression.

3) Eco-friendly biopolymers inspired by cephalopod's hard tissues

In order to make hard (load-bearing) structures, living organisms use biomineralization, mostly calcium-based including calcium carbonate or calcium phosphate (apatites). However it has been recognized in the past decade that the use of minerals is not the only strategy that Nature employs to make tissues with grinding or biting functionalities. In our laboratory, for example, we have demonstrated that cephalopods' beak and sucker ring teeth (SRT) located on their tentacles are fully devoid of minerals and only made of proteins or protein/polysaccharide complexes (Miserez *et al*, ***Science*** 2008; Miserez *et al*. ***Advanced Materials*** 2009). These findings offer novel paradigms for green synthesis and processing of robust and biocompatible structural polymers that are not produced from fossil fuels. In recent years, we have pioneered the use of next-generation RNA-sequencing in the field of biopolymers (Guerette et al*.*, ***Nature Biotechnology*** 2013) to show that SRT are entirely made of modular silk-like "suckerin" proteins, which assemble into a supramolecular network reinforced by nano-confined β-sheets (Guerette et al, ***ACS Nano***, 2014). We have also sequenced the proteins forming the hard squid beak and shed light on the bioprocessing pathway by which the beak is produced (Tan *et al*., ***Nature Chemical Biology***, 2015). In SRT, we have shown that inter-chain chemical cross-linking is absent and that and the teeth are fully stabilized by a network of hydrogen bonds. Because of their supra-molecular assembly, SRTs exhibit thermoplastic properties –an unusual feature for a protein-based material– which can be exploited to re-process and mold the proteins into complex shapes by simple lithographic techniques and make SRT a promising material as "bio-ink" for 3D bioprinting (Latza *et al.*, ***Nature Communications*** 2015) We have also established recombinant expression systems that allow us to readily express full-length suckerins in large quantities, which we are now using in nanomedicine applications (Ping *et al*, ***ACS Nano*** 2017). In this project, we are specifically interested in exploiting the biotechnology aspect of SRT and squid beak proteins. The goal is to translate these structural proteins that we are producing by protein engineering for smart and stimuli-responsive drug delivery or as a novel type of bioinks for 3D bioprinting.

MSRDP theme: MEB, MTP

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One paragraph Bio:
Professor Benjamin Horton joined NTU as a tenured Professor in the Asian School of the Environment in 2017. He was previously an Assistant, Associate and Full Professor with tenure at the University of Pennsylvania and Rutgers University (USA). Professor Horton obtained his BA and PhD from the University of Liverpool and University of Durham, UK, respectively. Professor Horton has received awards from European Geosciences Union (Plinius Medal), American Geophysical Union (Voyager Award), the Geological Society of America (W. Storrs Cole Award) and Commanding General of the United States Army Corps of Engineers (Medal for Research Excellence). He was made a Fellow of the Geological Society of America in 2013. Professor Horton has published over 180 articles in peer-reviewed journals, including over 20 in Science, Nature and Proceedings of the National Academy of Sciences. Professor Horton is supervising or has supervised 21 students to the degree of PhD and 14 postdoctoral scientists, of which 13 now occupy academic positions.

Write up on the possible project:
Rising sea levels will have serious impacts on marine ecosystems and biodiversity. The amount of light reaching submerged aquatic vegetation and algae dependent on photosynthesis could be reduced, while coastal habitats are already being flooded and eroded. Rapid sea-level rise will likely be the greatest climate change challenge to wetland ecosystems. If sea-level rise exceeds the rate of vertical accretion, wetland ecosystems degrade or collapse.

The Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report (AR5) projected global sea-level rise of 52–98 cm in the case of unmitigated growth of emissions (Representative Concentration Pathway (RCP) 8.5 scenario) by 2100 CE. Additionally, by 2300 CE, IPCC AR5 projects global sea-level rise of 1 m to > 3 m with medium confidence. But the IPCC AR5 predictions of sea-level rise are limited by uncertainties surrounding the dynamic response of the Greenland and Antarctic ice sheets. Recent coupled ice sheet and climate dynamics models suggest Antarctica alone could contribute more than 1 m by 2100, and more than 10 m by 2300.

Accurate estimates of sea-level rise in the pre-instrumental era are needed in order to provide a context for these future projections and a basis on which to calibrate the climate-sea-level relationships and decipher regional variability. The principal mechanism for regional variability in tectonically stable regions of Southeast Asia (e.g., Sunda Shelf) is Glacial Isostatic Adjustment (GIA). Holocene (11,700 to 0 years before present) relative sea level (RSL) data provide a vital constraint for parameters of earth and ice components of GIA models, which cannot be estimated from direct measurements. Geographically, RSL data from far-field locations (distal to ice sheets), such as Southeast Asia, constrain global mean sea level and aid in separation of lower and upper mantle viscosities. But our understanding of Holocene RSL in Southeast Asia is held back by imprecise reconstructions with often-large uncertainties, and by a distribution of reconstructions that cannot define the spatially variable patterns of past sea-level change to constrain a GIA model.

This project will use geological proxies to reconstruct sea level at ±<0.2m vertical and decadal-to-centennial temporal resolution in Southeast Asia. We will place the new reconstructions in a Bayesian statistical framework and compare with models of Glacial Isostatic Adjustment. The proposed project will address three questions:

1. Can a comprehensive Holocene database of RSL changes constrain future projections of global and regional sea level?
2. Can spatial and temporal variability of Holocene RSL be attributed to atmosphere/ocean dynamics and/or ice mass balance?
3. Is the rate of RSL rise since ~1850 CE greater than other Holocene centennial trends?

We propose to develop a Southeast Asia dataset of high-precision RSL data over a three-year research program. Moreover, using a novel statistical approach and state-of-the-art GIA models, we can for the first time determine the rates, mechanisms and geographic variability of Holocene sea-level change for Southeast Asia. The Holocene data will constrain future global and regional projections for Southeast Asia and assess their environmental impact on the coastal zone. Our team have made significant advances in: sea-level reconstructions to resolve spatial variations in RSL change over the Holocene; statistical analysis of modern and paleo-sea level data; development of GIA models; and predictive models of future sea levels and the vulnerability of coastal ecosystems. We will bring internationally recognized skills needed to make a step change in our understanding of the patterns and causes of past and future sea-level change and their impacts on marine ecosystems and biodiversity.

MSRDP theme: Marine ecosystems and biodiversity (MEB) and Environment impact and monitoring (EIM).

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One paragraph Bio

Dr Enrico Marsili received his PhD in 2005 from University of Rome, Italy. He then joined the group of Daniel Bond at University of Minnesota, USA, where he developed methods for characterization of electroactive biofilms. Following four years as Lecturer at Dublin City University, Ireland, he joined the Singapore Centre for Environmental Life Sciences Engineering, Singapore, as Principal Scientist. He contributes to research in microbial corrosion, biosensor development and microbial ecology of electroactive biofilms.

Write up on the possible project

* The proposed research should fall within current MSRDP themes which consist of the study of marine ecosystems and biodiversity (MEB), environment impact and monitoring (EIM), coastal ecological engineering (CEE) and marine technology and platforms (MTP).

Effect of biofilms microstructure on microbially influenced corrosion (MIC) of micro-patterned Nickel surfaces

Corrosion leads to metal deterioration in any environment, with substantial environmental, economic damages and even health damages (e.g., marine infrastructure and oil&gas installations). Microorganisms play a key role in metal corrosion, particularly in nutrient-rich environments. Despite >100 years of fundamental and applied research on MIC, many aspects of this process are still obscure. In this project, the research fellow will assess the role of mixed microbial consortia in the onsets of MIC, combining advanced microscopy and high-throughput electrochemistry. The research fellow will work on micro-patterned Nickel surface, prepared in collaboration with Institute for Material Research and Engineering (A*Star), as model material. Following characterization, the researcher will devise novel micro-patterned structures to minimize MIC by changing biofilm attachment and its microstructure. Suitable candidates would have a PhD in Microbiology or Physical Chemistry and interest in multidisciplinary research.

MSRDP theme: MTP

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One paragraph Bio:
I am an Assistant Professor at the Asian School of the Environment at Nanyang Technological University in Singapore. I am also the Principle Investigator for the Coupled Human and Natural Systems Lab. Much of our work focuses on developing research questions that address the challenges of managing socioecological systems in the tropics, especially within Southeast Asia. I have worked on commercial and small-scale oil palm expansion in Sumatra, and am currently working on two other land use change issues in the region – the social drivers of fire activity in Sumatra, as well as the drivers of agricultural land abandonment in the tropics. I am keen to expand my group's research interest into the topic of food security in the face of environmental changes and the possible impacts this has on public health and nutrition.

Write up on the possible project:
* The proposed research should fall within current MSRDP themes which consist of the study of marine ecosystems and biodiversity (MEB), environment impact and monitoring (EIM), coastal ecological engineering (CEE) and marine technology and platforms (MTP).

Ciguatera food poisoning (CFP) is a seafood-borne illness caused by the consumption of reef fish contaminated with ciguatoxins or maitotoxins. These potent toxins originate from *Gambierdiscus toxicus*, a small marine organism (dinoflagellate) which grows on and around coral reefs. *G. toxicus* are ingested by herbivorous fish, and the toxins are modified and concentrated as they pass up the food chain to carnivorous fish which are consumed by humans. The study of CFP has been focused on localities where CFP is endemic (e.g., Polynesia) although this focus is changing as a result of the increasing global demand for seafood. At present, nearly 40% of global seafood production enters international markets, and there has been a 65% increase in the number of seafood trading routes over the last two decades. At the same time, the health of coral reefs has declined as a result of overfishing, coastal development, marine pollution, and rising ocean temperatures. Approximately 75% of the world's coral reefs are under threat from anthropogenic activities and warmer oceans. This decline in coral reef health has been associated with an increase in the *Gambierdiscus* species, potentially increasing the risk of CFP in society. The aim of this research project is to investigate the link between coral reef health and the risk of CFP through the international seafood trade. The two main objectives for this research project are: (1) To quantify the extent of global trade in reef fishes known to carry ciguatoxins and trace the geographic localities of the harvesting and consumption of these reef fishes, (2) To explore the trends between coral bleaching events and CFP outbreaks at the level of local consumption and international consumption via the seafood trade.

MSRDP theme: EIM

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One paragraph Bio: Ng Bing Feng received his PhD degree from Imperial College London under the sponsorship of the Singapore National Research Foundation Energy Innovation Programme Office (NRF EIPO). Over the years, he has developed his own numerical model for aeroelasticity and load analysis on flexible turbine blades, for which the results were presented at leading conferences and published in top-notch journals in the field of wind/marine energy. He is now an Assistant Professor in Nanyang Technological University and his recent work on aeroelasticity of marine-inspired leading-edge serrations from humpback whales has seen him been invited to co-edit a book on the application of leading-edge tubercles. His current research interests include tidal turbines, flow control, environment sustainability and wind energy.	**One paragraph Bio:** Dr. Henrik Hesse is Assistant Professor in Aerospace Systems with the University of Glasgow in partnership with Singapore Institute of Technology. Henrik has a PhD from Imperial College London (2013) where he investigated reduced-order modelling approaches for load control in flexible aircraft. During his postdoctoral appointment at ETH Zurich (2014-2016), Henrik developed novel estimation and control methods for the autonomous operation of tethered drones for a wind power prototype system. He also ventured into robotics focusing on sensor fusion and localisation of unmanned aerial vehicles in GPS-denied environments which led to several titles in robotics competitions. His current research focuses on modelling, design and control of autonomous systems in the context of their practical application. In this context, he also explores the development of novel renewable energy solutions in offshore environments.

Project Description: Investigation of Novel Marine Harvesting Technologies

Marine and tidal flows provide a reliable and endless driving force for sustainable power generation and could be a viable solution to powering islands that are off the grid from mainland. This is particularly critical in the South-East Asia region, which is dotted with many islands. This project seeks to investigate and develop a novel marine energy harvesting technology using oscillating platforms undergoing limit-cycle-oscillations. Through the design of innovative lifting mechanisms, energy can be extracted efficiently by the oscillatory motion. The proposed oscillatory concept can provide a more cost effective

and reliable alternative to conventional tidal turbines. Unlike the disturbances generated behind tidal turbines, the comparatively small planform of oscillating platforms reduces their impact on the surrounding ecosystem.

The project will numerically explore the underlying flutter mechanism, which is commonly feared in aircraft but desired here to drive the proposed energy harvesting concept. The postdoctoral fellow will develop novel numerical tools to understand the underlying principle of the limit-cycle-oscillations. The resulting multidisciplinary simulation environment will provide a design tool for novel tidal power devices and allow detailed studies of their impact on the marine footprint.

This project further supports the collaboration between Nanyang Technological University (NTU), and the University of Glasgow (in partnership with the Singapore Institute of Technology) in the development of novel marine robotic platforms. As part of this collaboration, the postdoctoral fellow would have the opportunity to be exposed to experimental applications of robotic platforms to support the numerical investigation, which will be the main focus of the proposed project.

MSRDP theme: MTP, EIM

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One paragraph Bio

Patrick Martin obtained his B.Sc. in Biology from the University of York, UK (2007), and completed his Ph.D. in Ocean Biogeochemistry at the National Oceanography Centre, Southampton, UK (2011). His doctoral research focused on the ocean's biological carbon pump. He subsequently moved to Woods Hole Oceanographic Institution as a Postdoctoral Scholar, studying how physiological changes in phytoplankton under phosphorus starvation impact the biogeochemical cycling of phosphorus. Upon moving to Singapore, he first worked as a Postdoctoral Research Fellow, and then joined the faculty as Assistant Professor in 2016. His current research focuses on the transport and cycling of dissolved organic matter from land to coastal seas.

Write up on the possible project

Globally, rivers deliver a substantial flux of carbon to coastal seas every year, much of it in form of dissolved organic carbon (DOC). It has been recognised for some time that, although the riverine flux of terrigenous DOC (tDOC) can in theory supply most of the DOC found in the open ocean, the open ocean DOC pool in fact shows little contribution of tDOC (Bianchi 2011; Cai 2011). This apparent paradox

demonstrates how poorly we understand the biogeochemical processing of tDOC in the oceans. South-East Asia is estimated to account for 5–10% of the global land-to-sea DOC flux (Alkhatib *et al.* 2007; Moore *et al.* 2011), owing to the region's extensive coastal peatlands. South-East Asia's coastal seas therefore provide excellent study sites to determine the biogeochemical processes by which tDOC is altered and/or remineralised in coastal waters, and quantify the rates of these processes.

Our laboratory is currently working on research projects within and beyond Singapore to study the magnitude and chemical composition of the tDOC flux from South-East Asian peatlands, and its biogeochemical processing by photo-oxidation and bacterial remineralisation in the shelf sea. To do so, we are using a broad range of techniques that include measuring total DOC concentration, the coloured and fluorescent components of the organic matter (CDOM and FDOM spectra), stable carbon isotope ratios, and monitoring the full seawater carbonate chemistry to determine whether remineralisation of land-derived DOC exerts an acidification effect on the seawater. This observational work will be completed by experimental incubations to measure DOC degradation and alteration by bacteria and by sunlight. Finally, we are also developing tools to estimate DOC concentrations in South-East Asia using satellite remote sensing, to which end we are developing a semi-analytical optical model for these coastal waters.

A Postdoctoral Fellow could join our laboratory to work on one of several possible areas relating to this broad research topic, specifically the following:

- Using stable carbon isotopes of DOC and dissolved inorganic carbon (DIC) to trace the movement and processing of tDOC in South-East Asia, and analyse the impact of tDOC degradation on the seawater carbonate system;
- Determining the biogeochemical alteration of tDOC using fluorescence and absorbance spectroscopy, and using these tools as tracers of tDOC in South-East Asia;
- Determining what factors control the rates of biogeochemical processing of tDOC within estuaries, especially how salinity and pH influence extracellular enzyme activities, and whether there is a "priming" effect from freshly produced organic matter

Other research questions may also be considered. Please contact Dr. Patrick Martin to discuss these research questions in more detail.

MSRDP theme: EIM

References

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Moore S., Gauci V., Evans C.D., Page S.E. (2011). *Biogeosciences* **8:**901-909, doi:10.5194/bg-8-901-2011

Name: Qichun Zhang

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One paragraph Bio

Dr. Qichun Zhang obtained his B.S. at Nanjing University in China in 1992, MS in physical organic chemistry (organic solid lab) at Institute of Chemistry, Chinese Academy of Sciences in 1998, MS in organic chemistry at University of California, Los Angeles (USA), and completed his Ph.D. in inorganic chemistry at University of California Riverside (in 2007. Then, he joined Prof. Kanatzidis' group at Northwestern University as a Postdoctoral Fellow (Oct. 2007 –Dec. 2008). Since Jan. 2009, he joined School of Materials Science and Engineering at Nanyang Technological University (NTU, Singapore) as an Assistant Professor. On Mar 1st, 2014, he has promoted to Associate Professor with tenure and on Dec 1st, 2014, he became an adjunct Associate Professor at Division of Chemistry and Biological Chemistry, School of Physical and Mathematical Sciences, Nanyang Technological University. Besides these, he also has three-year working experience in research institute of Nanjing Chemical Industry Co. (Aug. 1992 – Aug. 1995) and two-year's research experience in ICCAS (Aug. 1998 – Jun 2000). He received TCT fellowship in 2013 and lectureship from National Taiwan University in 2014. Currently, he is an associate editor of J. Solid State Chemistry, the Advisory board member of Materials Chemistry Frontiers, and the Advisory board member of Inorganic Chemistry Frontiers. Currently, he is a fellow of the Royal Society of Chemistry. He has published > 253 papers and 4 patents (H-index: 52).

Write up on the possible project

1. Organic dye-sensitized bacteria for highly-efficient photocatalysis and water remediation
2. Novel Metal-organic Framework for purifying and recycling heavy oils from engine

MSRDP theme: CEE

Name

Scott Rice

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One paragraph Bio

A/Prof Rice has developed his career investigating the genetic mechanisms that drive biofilm formation and the consequences of biofilm development for the survival and function of bacteria in the environment. This body of work has resulted in several important, novel discoveries including the role of biofilm formation in defence from predation by protozoa, the application of quorum sensing antagonists to control biofilm development, the involvement of nitric oxide in mediating dispersal of biofilms, and most recently the role of carbon starvation and cAMP in biofilm dispersal. Most recently, he has been engaging in studies of mixed species biofilm communities, which are more reflective of natural biofilm systems. In particular, the goal is to develop experimentally reproducible mixed community systems that can be used to study how community level interactions enable bacteria to colonise a broad range of surfaces, from mammalian cells to industrial surfaces, e.g. metals in the marine environment. This body of work involves understanding the genetic and biochemical pathways that enable mixed species biofilm communities to function and that drive biofilm development.

Write up on the possible project

The successful candidate will undertake experiments using mixed species consortia derived from marine waters and sediments collected from around Singapore. The goal will be to define the physic-chemical and ecological drivers that enable communities to form biofilms on natural and engineered surfaces. In

addition, we will undertake long term, 60-90 days, experiments to define the successional processes during mixed species biofilm development. Changes in community composition will be assessed in conjunction with changes in the spatial organization of the biofilm as well as changes in the material surface. Further work will be undertaken to investigate whether initial biofilm formation is deterministic of long term biofilm community composition and spatial organization by forming biofilms with defined enrichments and subsequently challenging established biofilm with invading species as well as the impacts of changing environmental conditions on established communities, such as pH (reflecting ocean acidification), UV, oxygen tension and nutrient levels. Finally, experiments will be performed testing the impact of non-biocidal dispersal agents, e.g. nitric oxide or quorum sensing inhibitors, as potential biofilm control strategies for marine biofilm communities.

MSRDP theme: CEE

Name
Stefan Wuertz (NTU)
Maria Yung (NUS)

Title
Transport phenomena in marine coastal waters: effects of physical forces on biofilm-sediment-water exchange

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One paragraph Bio
Professor Wuertz's research focuses on the structure and function of microbial communities in natural systems and the built environment. He specialises in biofilm systems, the use of molecular tools to describe microbial communities and biological processes, and developing methodology to

detect low-level pathogens in the environment, combined with microbial source tracking and quantitative microbial risk assessment. He is establishing engineering bioprocess systems and investigating environmental solutions to create novel and multi-scale interactive engineering platforms for multiple purposes, such as the removal of nutrients by biofilm processes and the role of biofilms as repository of pathogens.

Dr Yung obtained her PhD in the University of New South Wales, Sydney, under the Centre of Marine Bio-Innovation (CMB). Her PhD project investigate the phylogenetic and functional diversity of the microbial communities associated with marine sponges found in coastal areas of Australia using the metagenomics approach (Thomas et al 2010). Her research interest includes high throughput screening for antimicrobials, biocatalysts and metagenomics library clones (Yung PY et al 2009, 2011), as well as NGS data analysis on natural and engineered microbial communities for biosensor development (Yung et al 2016), palm oil mill effluent operation (Neoh et al 2017), and electroactive biofilms enriched from tropical sediments (Doyle et al 2017).

Write up on the possible project

* The proposed research should fall within current MSRDP themes which consist of the study of marine ecosystems and biodiversity (MEB), environment impact and monitoring (EIM), coastal ecological engineering (CEE) and marine technology and platforms (MTP).

Themes: MEB and EIM

Microorganisms in aquatic environments often exist in communities embedded in exopolysaccharides where they behave very differently from their planktonic (free-living) counterparts. This two-year project investigates the fluid and particle dynamics in a nearshore coastal water setting to understand on a mechanistic level the exchange between the solids in sediments and the water column, with an emphasis on microbial flocs or similar biological structures. The study involves field sampling and potential mesocosm studies in the field. This research is expected to shed light on the importance of sediment-associated biofilms in the persistence of pathogens and other microorganisms.

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One paragraph Bio

Dr Xu Yan is now holding the Nanyang Assistant Professorship at Nanyang Technological University (NTU). Prior to joining NTU, he held the University of Sydney Postdoctoral Fellowship at University of Sydney, Australia. His research areas include power system (microgrid and ship power systems), renewable energy integration, and data-analytics for smart grid applications.
He has published 65+ international SCI journal papers including 40 in IEEE Transactions, 15 in IET Proceedings, and 10+ in Applied Energy, Electric Power System Research, Renewable & Sustainable Energy Reviews, etc. He has also published 2 book chapters and over 30 international conference papers. He has received 5 awards from IEEE and IET paper contest, conference best paper, etc. His research deliverables have been practically applied by power utilities in Australia, USA, Hong Kong, Macau, and China Mainland.

Project Title: Intelligent fault diagnosis for ship power systems.
Scope of work:
Dr Xu Yan is now working on ship power system fault diagnosis techniques in collaboration with Rolls-Royce. This research topic falls in the themes marine technology and platforms (MTP).
The scope of this research includes the development of intelligent monitoring systems to diagnose faults within unmanned machinery spaces in ships. The role involves working as part of a team to understand common faults within ship machinery and auxiliary systems, how these faults may be observed, and how current and future sensing and processing technologies could be used to identify the fault location and fault type. The role requires a broad understanding of electrical and control engineering, and of instrumentation. Knowledge of electrical power generation and distribution and/or of diesel engines and mechanical propulsion and steering systems for ships is desirable.

MSRDP theme: MTP

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One paragraph Bio

Prof Christina Chai obtained her BSc (Hons) from the University of Canterbury, Christchurch, New Zealand and her PhD from the Australian National University, Canberra. Following her PhD, she was awarded a Samuel and Violette Glasstone Research fellowship at University of Oxford, UK where she studied bioorganic reaction mechanisms. This was followed by Faculty positions in Victoria University of Wellington, NZ (1991-1993) and Australian National University (1994-2004). She joined the Institute of Chemical and Engineering Sciences, Agency for Science Technology and Research (A*STAR) as a Principal Scientist and Programme Manager of the New Synthesis Techniques and Applications (NSTA) Programme from 2004 till 2011. From 2008-2011, she also held a co-appointment as Director of Graduate Affairs, Science and Engineering Research Council, A*STAR. Prof Chai joined the Department of Pharmacy, NUS as a joint appointee with A*STAR in 2011. She was Deputy Head of Department from Jan 2013-April 2014, and Assistant Dean in the Faculty of Science, NUS, from 2013-2016. She is currently the Head of the Department of Pharmacy since Jan 2016. Her research interests are broadly in the areas of natural products synthesis, biomimetic designs and medicinal chemistry. To date, she has >130 journal articles published, >15 patents filed, 5 patents granted, 3 books published, 1 book chapter.

Write up on the possible project

The tropical South China Sea contains the highest marine biodiversity on this planet, and most of the rich marine natural resources present remain untapped. In the 1990s, many attempts were made to harness marine natural products chemistry; however, as was the case internationally, traditional approaches to natural products chemistry were heavy handed and simplistic, lacking the multidiscipline approach needed to understand the intricate relationships between biology and chemistry. With the rapid development of environmental science in the past 10 years, our understanding of marine chemistry has increased substantially. Coupled with the urgent demand for new bioenergy resources, for fuel, food and medicine, it is timely to revisit the concept of marine bio-prospecting with a new perspective. In partnership with design strategies developed through combinatorial chemistry, marine natural products provide a rich source of inspiration for novel new drugs. Beyond chemicals, there are present in nature an amazing wealth and diversity of chemical scaffolds and biochemical pathways, which may provide exciting new environmentally sustainable ways to make materials. New tools in metabolomics also provide novel means to screen small molecules for biological activity.

The proposed project aims to discover and develop the following:

(i) Novel marine-inspired biomedicines – the aim is to expedite the development of described marine natural products with pharmaceutical value, into commercially viable products through novel design and synthesis

(ii) Novel anti-microbial agents for environmental applications – discover new degradable small molecules for use as anti-microbial agents in environmental applications such as water treatment and antifouling. The major challenge in environmental applications is to develop a suite of molecules that are radically different from the antibiotics used in human medicine. This will reduce the development of drug resistance from the widespread use of anti-microbials in environmental applications. Design features to increase degradability of these compounds also aid in reducing the likelihood of bioaccumulation and development of microbial resistance.

MSRDP theme: MTP

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8. One paragraph Bio
   Dan is an Assistant Professor in the Department of Geography, and the Principal Investigator of the Mangrove Lab. This group of researchers and students is interested in the ecosystem services provided by coastal mangrove forests, and how they are impacted by stressors such as sea level rise and land cover change. Dan's research is also interested in how to utilize ecosystem services in mangrove management and conservation. Dan's research is conducted throughout Southeast Asia, as well as Madagascar and New Caledonia.

9. Write up on the possible project
   Mangrove Ecosystem Services on Urban Islands
   Intertidal mangrove forests are important reservoirs of biodiversity, and recently we have begun to understand the crucial ecosystem services they provide that benefit local populations. Such ecosystem services include fisheries, coastal protection, storage of atmospheric carbon dioxide, and cultural values such as recreation. Ecosystem services are particularly important in urban settings due to the close proximity of human populations that benefit from mangroves. However, most research is conducted in rural settings, so we don't have a clear understanding of the level of ecosystem services that smaller, fragmented urban mangroves provide, or how urbanization affects ecosystem service provision. This significantly limits our understanding of urban mangroves, and how best to incorporate them into urban planning. To improve our understanding, this project will answer three research questions: 1) what are the ecosystem services provided by urban mangroves? 2) what natural and human factors affect ecosystem service provision? and 3) how can mangrove ecosystem services be incorporated into urban planning and design?

   This project will be focused on Singapore and other urban islands across a latitudinal gradient, potentially in Australia, Sri Lanka, Malaysia and China. For Question 1 this allows us to estimate the ecosystem services of an 'average' urban mangrove, based on several different sites. For Question 2, this allows us to test several natural (e.g., climate, species) and human (development, pollution) impacts on mangrove ecosystem services. For Question 3, this allows us to consider how to integrate mangroves into land use planning across different political settings. This project is novel because it requires an interdisciplinary approach, including field-based measurements and modelling of ecosystem services (Questions 1 and 2), and qualitative social science skills to interact with key urban planning stakeholders and to analyse policy documents. This project would be suitable for a postdoctoral Research Fellow with advanced

skills in remote sensing and modelling (particularly R), and who is interested in developing skillls in field-based methods and stakeholder analysis.

10. State the MSRDP theme falls under
    - Marine ecosystems and biodiversity (MEB)

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8. One paragraph Bio: Research in the Reef Ecology Lab focuses on the diversity, ecology and restoration of coral reef ecosystems in Singapore and the Southeast Asian region. We are interested in understanding the diversity of corals and reef-associated organisms using integrative molecular, morphological and phylogenetic methods. Ecological studies of reef organisms employ a variety of survey techniques as well as field and *ex situ* experiments. Our objective is to apply this research to support coral reef restoration and integrated coastal management.

9. Write up on the possible project:

   Impacts of changing sea levels on coral reefs in the South China Sea
   The effects of ocean warming and acidification on coral reefs are now extensively studied, but the outlook of reefs under climate-induced sea-level rise is virtually unknown. The intertidal community of calcifying animals can extend upward naturally to keep up with the sea surface, thus forming extensive areas of reef flat overlain by living organisms, but they can also catch up when sea levels stabilise, or even give up in vertical growth relative to the sea surface. Ominously, the future of the deepest corals is even less predictable because the extent of the reef is determined by its depth, topography, temperature and light availability. In this project, we will integrate palaeoclimatological, field ecological and geospatial methods to test the widely-assumed hypothesis that coral reefs, under sea-level rise, will face declines at the shallow and deep ends of the reef. Focusing on the biodiverse and productive reefs of the South China Sea region, we will characterise the growth rates of shallow coral species and the relationship between coral diversity and reef light regime, and furthermore use regional sea level projections and water clarity to estimate losses of reef habitats. Specifically, we will investigate the growth rates of reef-flat coral species to determine if they will keep pace with the rising sea levels. We will also characterise the association between coral diversity and light regime along the reef slope to better understand the variable tolerances between species. Finally, we will use regional sea level projections, reef topography and water clarity data to estimate losses of reef habitats and shallowing of reef limits in the South China Sea. Our spatially precise findings could reduce costs of climate change mitigation by accounting for the coastal protective function of coral reefs able to keep pace with the sea level.

10. MSRDP theme: Marine ecosystems and biodiversity (MEB)

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8. One paragraph Bio

   A/P Karina Gin is an Associate Professor with the Department of Civil and Environmental Engineering, National University of Singapore. She received her Bachelor degree in Civil Engineering from the University of Melbourne in 1988 and M.Eng Degree from the National University in Singapore in 1991. She obtained her Doctor of Science (ScD) Degree jointly from the Massachusetts Institute of Technology and the Woods Hole Oceanographic Institution in 1996. Her research specialisation is in the area of water quality and ecosystem processes. A/P Gin is a Principle Investigator of research projects totalling more than $16.5m and received the Dean's Chair Award, Faculty of Engineering (NUS) (2017). She is co-author of a book on 'The Environment in Asia Pacific Harbours' which received a UN Atlas of the Ocean award (2006); a co-recipient of the Technology Enterprise Challenge (TEC) Innovator Award for Enhanced Engineered Wetland Technology for the Removal of Nutrients from Stormwater at Kranji Reservoir (2005). She has published more than 90 international-reviewed journals, 90 conference papers and co-authored 5 book chapters. A/P Gin's research and professional experience includes the following: Member, Expert panel on antimicrobial resistance for WaSH (WHO), Chairman, National Committee of the International Geosphere-Biosphere Programme (IGBP); Member, Steering committee for antibiotic mapping workshop (USGS, US State Dept and SETAC),

9. Write up on the possible project
   Pathogens and the spread of antimicrobial resistance in the marine environment

10. State the MSRDP theme falls under: EIM.

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8. One paragraph Bio
   Dr. Elita Li joined the Department of Civil and Environmental Engineering at the National University of Singapore as an assistant professor in 2016. Before coming to Singapore, Dr. Li did her postdoctoral research at Massachusetts Institute of Technology, holding a joint position in the Earth Resources Laboratory and the Department of Mathematics. Dr. Li received her Ph.D. and M.S. degrees in Geophysics from Stanford University in 2014 and 2010, respectively. She obtained her B.S. degree (Highest Honors) in Information and Computational Science from China University of Petroleum, Beijing in 2008.

9. Write up on the possible project

   Seabed stability and subsurface monitoring using distributed fiber optical sensing technology
   This project aims at monitoring the stability of seabed and shallow subsurface by passively listening to ocean waves and ambient noise using the distributed fiber optical sensors. The fiber sensors provide a low-cost solution to data acquisition and real-time data without any intrusion to the environment. Application of this technology is important to monitor the reclaimed islands and near-shore constructions.

10. State the MSRDP theme falls under
    - environment impact and monitoring (EIM) and marine technology and platforms (MTP)

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8. One paragraph
   Dr LOW Ying Min is currently an Assistant Professor in the Department of Civil and Environmental Engineering. His research area is in offshore engineering, with particular focus on stochastic dynamic analysis of moorings and risers. He is a member of the editorial board for the journals, Marine Structures, and Ocean Engineering. He is also in the technical committees of ISSC and the annual OMAE conference. He is the programme manager of MSc Offshore Technology.

9. Write up on the possible project
   Study on wave impact forces below the deck of multi-column floating structures

   The Gulf of Mexico disaster has accentuated the importance of risk assessment in offshore engineering. Risk is defined as the failure probability multiplied by the consequence. For multi-column offshore floating structures such as semi-submersibles, wave impact on the underdeck can cause severe structural damage. However, the consequence is not straightforward to evaluate due to the complicated physics of wave impact loads on a moving platform. The airgap is an important design parameter, as zero airgap results in wave impact. Most research studies and current design practice focus on predicting the minimum airgap under extreme environmental conditions, with a view to avoiding wave impact at all costs. However, elevating the deck to increase airgap is very expensive, as it decreases the stability of the structure, reduces payload capacity, and also impairs other functional requirements. If the consequence is known, the target probability of wave impact can be appropriately selected to balance safety and economy.

   The broad objective of the proposal is to investigate the consequence of irregular wave loads impacting a semi-submersible, for the purpose of developing a reliability assessment methodology. The more specific aims are:

   (1) Carry out laboratory tests to obtain a set of reliable and well-documented experimental data on wave impact forces on the underdeck of floating structures under extreme wave conditions.

   (2) To develop semi-empirical methods for predicting the extreme wave impact force under various design wave conditions.

   (3) To develop a statistical model to predict the probability of wave impact, and the probability distribution of the wave impact forces, conditional on the event of wave impact.

10. State the MSRDP theme falls under
    marine technology and platforms (MTP).

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One paragraph Bio

Mandar Chitre received B.Eng. and M.Eng. degrees in electrical engineering from the National University of Singapore (NUS) in 1997 and 2000, respectively, an M.Sc. degree in bioinformatics from Nanyang Technological University (NTU), Singapore, in 2004, and a Ph.D. degree from NUS in 2006. From 1997 to 1998, he worked with the Acoustic Research Laboratory, NUS. From 1998 to 2002, he headed the technology division of a regional telecommunications solutions company. In 2003, he rejoined ARL, initially as the deputy head (research) and now head of the laboratory. He also holds a joint appointment with the Department of Electrical and Computer Engineering at NUS as an Associate Professor. His current research interests are underwater communications, underwater acoustic signal processing, and marine robotics. He is currently Co-Chair of the IEEE Ocean Engineering Society Technology Committee on Underwater Communication, Navigation and Positioning, and an Associate Editor for the IEEE Journal of Oceanic Engineering.

Write up on the possible project

Our oceans are noisy places. Some noise is from natural physical phenomenon such as waves, wind, rain, lightening, etc, while other noise is biological in origin (e.g. marine mammals, fish, snapping shrimp, etc). In recent decades, anthropogenic noise from shipping, reclamation, seismic exploration and other human activities has been on the rise. Since light and other forms of electromagnetic waves do not propagate well in water, our primary means of sensing underwater is acoustic. As the oceans become noisy, we need to use more acoustic power for sensing, to be heard above the noise. This is a vicious cycle, ever increasing the amount of noise that humans add to the oceans. The impact of noise on the ocean ecosystem is significant. As noise increases, animals in the oceans (e.g. Dolphins, whales, fish, etc) that rely on acoustic sensing, navigation and communication are adversely affected. What if we could sense in water with the natural noise, rather than having to add noise? Wouldn't that be wonderful. It would not only be beneficial to the environment, but would also make the sensing equipment smaller, lighter, lower cost, and less energy-consuming. This essential idea is dubbed as "ambient noise imaging" or "ambient noise sensing", and has been explored a little over the past three decades. It has been shown that ambient noise can indeed be used for sensing, but the techniques to do so are not well developed. As ambient noise bounces around the oceans, it embeds information about the environment (e.g. wind speed, sea surface wave spectra, seabed type, water currents, bathymetry, etc) in its structure. With the right tools and processing, it is possible to tease out some of these environmental parameters from recorded noise data. In this project, we will explore how various types of ambient noise can be used for sensing purposes. We will develop tools and techniques for rapid environment assessment using ambient noise, in an effort to reduce cost and complexity of sensing equipment, improve quality of sensing, and reduce anthropogenic impact on the environment.

MSRDP theme: MTP

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8. One paragraph Bio: Dr. Tai-Shung (Neal) Chung is the Provost's Chair Professor at the Department of Chemical and Biomolecular Engineering, National University of Singapore. His research focuses on polymeric membranes for clean water and clean energy. In 2005-2008, he worked as a Senior Consultant for Hyflux, led and built its membrane research team. He became a Fellow in the Academy of Engineering Singapore in 2012 and received IChemE (Institute of Chemical Engineers, UK) 2014 Underwood Medal for exceptional research in separations and Singapore President's Technology Award in 2015.

9. Write up on the possible project

   We aim to develop high performance membranes with a high flow rate, rejection, and excellent robustness for ballast water treatment. Ballast water contains many microorganisms, phytoplankton, zooplankton and particle-associated bacteria. They pose threats to the local marine ecological system when being discharged to new marine environments. Invasive aquatic species is one of the four greatest threats to the world's oceans. Therefore, we propose to develop high-flux and high-strength ultra-filtration and nano-filtration membranes which target to remove almost all (≥ 99%) small particles with sizes ≥ 0.1 μm. As a result, the membrane unit is able to provide clear water with acceptable quality for the subsequent UV treatment to meet the IMO regulation.

10. State the MSRDP theme falls under
    - Marine ecosystems and biodiversity (MEB) and marine technology and platforms (MTP).

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8. One paragraph Bio

A/P Peter Todd is an experimental marine ecologist who focusses on organism-environment interactions in tropical seas. His research is multidisciplinary, synthesising elements of biology, geography and engineering to answer ecological questions. He is fundamentally concerned with increasing understanding of the ecology and functioning of Southeast Asian tropical marine organisms and communities, including those impacted by human activities. His coastal urbanisation studies have comprised quantifying habitat loss due to land reclamation, fragmentation and connectivity in invertebrate populations, the effects of sediment pollution, and enhancing biodiversity on seawalls. He has published over 100 ISI-listed papers on coastal systems and his research is featured regularly in both local and international media.

9. Write up on the possible project

The overall aim of this MSRDP funded project "Ecologically engineering Singapore's seawalls to enhance biodiversity" is to increase native biodiversity on coastal defences in Singapore using ecological engineering principles. The combination of coastal urban development and climate change associated threats has resulted in a rapid and worldwide increase in the construction of hard defences such as seawalls. These are generally designed with civil engineering goals and do not function as surrogates for the natural habitats they replace. Therefore, ecosystem services and resilience are lost. The 'grand challenge' of how to enable seawalls to support an abundant and diverse array of species will be addressed through a unique synthesis of ecology, materials science, microbiology, and fluid mechanics. The Research Fellow will be expected to contribute towards the goals of the project via the application of fundamental ecology to green engineering. Areas of particular interest include thermal ecology, population genetics, ecosystem services, and ecological modelling. New knowledge will incorporated into the design of artificial substrates to be retrofitted onto existing seawalls.

10. State the MSRDP theme falls under: Coastal ecological engineering (CEE): "Ecologically engineering Singapore's seawalls to enhance biodiversity" MSRDP-05

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One paragraph Bio:
Philip L.-F. Liu has been a Distinguished Professor in the Department of Civil and Environmental Engineering at NUS since August 2015. After graduating with a B.S. degree in Civil Engineering from National Taiwan University in 1968, Liu received a S.M. degree in Civil Engineering in 1971 and a ScD degree in 1974 from Massachusetts Institute of Technology. He joined Cornell faculty as an Assistant Professor in the School of CEE in 1974 and was promoted to Full Professor in 1983. He retired from Cornell as the Class of 1912 Professor, emeritus in July 2017. Liu's research interests are in Coastal Oceanography and Engineering. He has made significant contribution in the fields of water wave theories, tsunamis dynamics, wave-breaking processes, sediment transport processes, and interactions of water waves with structures. His research approach integrates analytical, computational and experimental methodologies. Liu is a member of the National Academy of Engineering (NAE), an Academician of Academia Sinica (Taiwan), a Fellow of the American Geophysical Union (AGU), and a distinguished member of the American Society of Civil Engineers (ASCE).

Write up on the possible project
Title: Modeling the effects of vegetation on coastal environment

Extreme geo-hydrological events, such as tropical cyclones, storm surges and tsunamis, and rising sea level have intensified our concerns on the health of coastal eco-system as well as the effectiveness of shoreline protection measures. Coastal vegetation has been considered as a natural means of protecting coastal zone from ocean waves and currents. Basically, coastal vegetation can serve as an area of energy dissipater and can be used as a buffer between ocean and land. On the other hand, coastal vegetation also modifies the coastal current and sediment transport system and potentially has significant impacts on coastal morphology and eco-system.

The objective of this project is to advance the state of the art of understanding on wave-flow-vegetation-sediment interactions in the coastal environment. The research project will examine the fluid dynamics and sediment transport within vegetated areas. Various types of vegetation will be considered; rigid or flexible vegetation, and submerged or surface piercing. The hydrodynamic forces acting on each vegetation unit, turbulence and sediment transport in the vicinity of the unit will be investigated. These small-scale processes will then be up-scaled to the wave and current length scale so that the effects of coastal vegetation on the environment can be assessed.

The research project will utilize analytical, experimental and numerical methodologies. The project will produce tools for evaluating the effectiveness of various vegetation types as coastal shoreline protection measures, and the vulnerability of coastal vegetation subject to hazardous wave/current conditions.

MSRDP theme: CEE

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8. One paragraph Bio:
   Praveen Linga is an associate professor in the Department of Chemical and Biomolecular Engineering at NUS and also the co-lead for natural gas research in the centre for energy research and technology (CERT) at NUS. He works on both fundamental and applied aspects of research. Praveen Linga has been working on gas hydrates for the past 12 years (2004-present) and has successfully collaborated with scientists (locally and internationally) correlating results at macro, micro and molecular level on a number of projects in the past. His main area of expertise is in the field of gas hydrate applications specific to gas separation processes, gas storage, desalination and for recovery of methane trapped in natural gas hydrate deposits. Up to date, he has published more than 70 research articles and delivered about 50 keynote/invited talks and seminars. His publications have received five "most cited paper" awards from highly reputed journals in the field of engineering. His research work has been conferred the Applied Energy Awards in 2016 and 2017. He has won numerous local and international awards including the 2017 NUS Young Researcher Award, 2017 NUS Engineering Young Researcher Award, 2017 Energies Young Investigator Award and the 2017 Donald W. Davidson Young Researcher Award for outstanding contributions to gas hydrate research.
9. Write up on the possible project
   A large amount of natural gas hydrates are found in marine locations around the continental margin, which are potential source of energy for the future. With the recent success in Shenhu marine hydrate deposit field test, it is projected that production of natural gas from marine hydrates would take place in the next decade or so. However, the current state of understanding on hydrate dissociation in sediments is incomplete, and more experimental data is required to elucidate the production behaviour from marine sediments as well as to calibrate reservoir simulators.
   The objective of this project is to develop marine technology for the production of natural gas from hydrate deposits. In this project, the dissociation behaviour of hydrates in marine locations will be experimentally simulated and coupled with numerical reservoir simulator. 99% of the hydrate deposits are in marine locations around the world. In the first phase, marine hydrate bearing sediments will be formed in the laboratory under high pressure conditions. The sediments would then be dissociated under various production schemes and well bore designs with the aim of maximizing gas recovery from the marine hydrate deposits. The acquired production data will be matched with a reservoir simulator, TOUGH+HYDRATE, to improve the numerical code as well as to devise strategies to maximize gas production from the developed technologies. We have world-class facilities built in NUS for developing production technologies for harvesting energy from marine gas hydrates and a multi-disciplinary research team is working on this marine technology development.
10. State the MSRDP theme falls under
    - Marine technology and platforms (MTP)

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8. One paragraph Bio
   I received a PhD from Imperial College London on bioeconomic modeling before moving to the National University of Singapore. I try to answer questions related to tropical conservation and sustainability, chiefly, how can we reconcile agricultural production with biodiversity conservation in the tropics? To answer this question I use a range of spatial models that integrate land-use change, ecosystem services valuation, deforestation and agricultural production.

9. Write up on the possible project
   Monitoring progress towards meeting the Sustainable Development Goals in the Tropics
   The Sustainable Development Goals (SDGs) proposed by the United Nations include 17 Global Goals and 169 targets. Some of the Global Goals and their targets are bound to pose strong trade-offs between each other if monitoring of environmental impacts are not an integral part of development policies. For instance, Goals 1 No Poverty, 2 Zero Hunger and 8 Decent Work and Economic Growth may be at odds with Goals 14 Life Below Water and 15 Life on Land. Whereas monitoring of progress towards meeting the health related SDGs is well in place building on the Global Disease Burden project, spatial monitoring of the progress towards meeting economic development related SDGs 1, 2, 8 while accounting for their trade-offs with environmental related Goals 14 and 15 is largely lacking.
   This project would aim to develop spatial analysis to monitor the level of progress towards the SDGs targets related to economic growth and food production while accounting for the environmental impact generated in attaining them. The project will then inform policies to attempt to simultaneously achieve both sets of goals or at least mitigate the strength of their trade-offs.

10. State the MSRDP theme falls under
    - Environment impact and monitoring (EIM).

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One paragraph Bio:
My research focuses on the interaction between marine organisms and man-made materials. It has often been said that we are living in the era of the "Anthropocene", highlighting an epoch wherein humans have significantly impact on the Earth's geology and ecosystems. In almost all every marine ecosystem on Earth, man-material materials are present, from massive man-made seawalls bordering the oceans to microplastics in sediments. I am interested in how marine organisms interact with man-made materials: how they use them, as well as how synthetic materials have altered the structure and function of marine ecosystems. Applications of my research include: marine biofouling and antifouling R&D, marine invasive species, green engineering, biomaterials.

Write up on the possible project:

1. Tropical marine fouling communities on (non-biocide) antifouling materials. [MEB/MTP]
With the limitation on use of toxic chemicals in marine antifouling coatings, many new approaches to next generation antifouling materials focus on properties that minimize organism adhesion. These include a diverse plethora of physical and chemical approaches. Our research lab collaborates with many material researchers involved in development of novel antifouling surfaces, in addition to supporting industry antifouling coating evaluations. Project of interest: to understand interaction between different surface properties that shape marine communities forming on a surface, and elucidate potential synergism that may be applied to advance performance of marine antifouling coatings for tropical marine environment.

2. Biodegradation of antifouling biocides/polymers in the tropical marine environment. [EIM/MTP]
More than 70% of maritime industry continues to rely on biocidal antifouling chemicals, in coatings and by direct dosing into seawater. This remains the most cost-effective and efficient approach to manage unwanted marine pests. However, the cost of development of safe chemicals has increased substantially as a result of increasing health and safety legislation. The proposed projects aims to study ecotoxicology and biodegradation of synthetic chemicals and polymers used in antifouling industry, with aim to develop novel experimental approaches that assist to profile the environment safety of novel compounds during early R&D stage. Such approaches will reduce investment in R&D of compounds which are unlikely to be safe for environment applications, as well as provide new leads for green chemistry.

3. Tropical marine microalgal slimes. [MEB]
Benthic diatoms form a substantial and ubiquitous component of the microbial community on tropical marine antifouling coatings. It has been observed that some microalgae produce allelopathic substances that modulate settlement and community development. A study is proposed to characterize these communities, and examine the relationships with other members in the microbial community, and interaction with invertebrate macro-foulers. This information will enable the development of more effective marine antifouling coatings.

MSRDP theme: EIM, MTP, MEB

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After his Ph.D. from U. Saarbrücken/Germany in 1992, Stefan Adams worked as Post-Doc at the Max-Planck Institute for Solid State Research and as Lecturer at Göttingen University, before joining National University of Singapore in 2005, where he is Assoc. Professor for Materials Science and Engineering. Adams also serves the Asian Society for Solid State Ionics as their Secretary, and the Materials Research Society of Singapore as Joint Secretary. He is a member of the Singapore National Committee for Crystallography as well as of the Editorial Boards of various related Journals (Solid State Ionics, Ionics; Acta Cryst. B, …). His research focuses on the effect of structure and interface variations in nanostructured oxides and chalcogenides for sustainable energy applications incl. advanced batteries.

9. *Write up on the possible project*

In marine drilling "measurement while drilling" (MWD) tools are commonly used to provide the operator of an (e.g. oilfield exploration) drilling with real-time information about tilt and position of the wellbore, the conditions at the drill bit (rotational speed, torque, weight on the bit, vibration, temperature,…). A direct cable link between the surface and the operating MWD tool is impractical, so the MWD electronics must be powered by onboard battery systems, while the data collected can be transmitted to the surface by mud pulse or electro-magnetic telemetry. MWD is a highly demanding application for batteries, as the battery must operate over a wide temperature range –from well below 0°C at the surface in Arctic oil and gas exploration projects to above 150°C during drilling. They must also endure very high vibrations, yet provide complete reliability and most of all high safety for long periods.

Currently, MWD tools companies still have to resort to primary batteries, mostly based on lithium-thionyl chloride (Li-SOCl2) cells. Each time the bottom hole assembly has to return to the surface the downtime costs may, depending on drilling depth, range from S$30,000-$300,000., while costs could be significantly reduced if the battery could be recharged on site utilizing mud flow generators. Rechargeable batteries could thus be much smaller in size and lighter than the currently employed single-use primary batteries and extend the oeration from ca 80 h to >3000 hours. So far there is however no rechargeable battery on the market that can cover the required temperature range and can deliver a sufficient power to allow for such a revolutionary design.

Low-cost all-solid-state Na-ion rechargeable batteries utilizing non-flammable superionic ceramic electrolytes are prime candidates for safer high-performance batteries. We recently demonstrated at coin-cell level the first rechargeable all-solid state sodium-ion full cell with competitive power densities both at room temperature and elevated temperatures. In this project we progress to develop a prototype of a battery system for MWD in industry-standard 18650 cell format with further enhanced cycle life by advanced interface engineering.

10. *MSRDP theme:* MTP

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8. One paragraph Bio
   Dr. Xiaonan Wang is an Assistant Professor at Department of Chemical and Biomolecular Engineering, National University of Singapore (NUS). She is leading a Smart Systems Engineering research group to build a more systematic and inclusive planning platform for smart city and engineering development that combines model-based and data-driven approaches for overall economic, environmental and social benefits improvements. More specifically, we have a focus on the advanced operation, control, optimization, and supply chain management strategies of distributed renewable energy systems. The group has close collaboration with governments in several Commonwealth countries, globally renowned universities (e.g., Stanford, Imperial College London) and many industrial companies. Our work is reported and presented on 5 continents and brings huge potential of increasing energy efficiency and cost-effectiveness applied to a wide variety of systems.

9. Write up on the possible project
   The project aims to realize the simultaneous design and operational optimization of offshore renewable energy (ORE) systems, such as wind and floating Photovoltaic (PV) solar, as the most promising distributed sustainable energy platforms in a coastal region. To deal with challenges of the intermittency and uncertainty in renewable power supply, resource modelling and forecasting will be adopted along with the system design and operation to improve power management. This detailed topics could include:
   - Spatial and temporal characterization and forecasting of variable resources (e.g., wind, solar, and wave resource) based on existing data from remote sensing as well as atmospheric/ weather/ climate modelling.
   - Multi-scale modelling framework for the optimal power management with reduced uncertainty and improved economic and environmental performance.
   - Environmental monitoring and impacts mitigation for offshore renewable energy systems through local, regional, and global ecological systems analysis and management.

   This project can also explore the integrated offshore natural resource systems to optimize multi-scale use of natural resources. For example, hybrid renewable energy generation and storage can perform as an efficient micro-grid to better serve the whole smart grid. Meanwhile water, food, and other product can be obtained by co-location of desalination or aquaculture to form a complete value chain of ecosystems services. Both systematical design and operation will be conducted, enhanced by cost and benefit analysis to aid local economic development and policymaking.

10. MSRDP theme:
    - ✓ environment impact and monitoring (EIM)
    - ✓ marine technology and platforms (MTP)

(partially related to Marine ecosystems and biodiversity (MEB) and coastal ecological engineering (CEE))

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8. One paragraph Bio

   Dr Yang Wenming has been dedicated to the development of greener and sustainable transportation and power generation for the past 20 years. As one of the three institutes around the world, he and his research team have developed an advanced numerical simulation platform for IC engines and marine engines with detailed chemical reaction mechanisms incorporated for various fuels such as marine oil, biofuels and natural gas. It is able to accurately simulate the air flow, fuel spray development, combustion process and emissions formation in the engines. Furthermore, an advanced engine test bed with built-in-house data acquisition system and control system has been built in the lab, making it possible to optimize the fuel injection strategy according to our own design, thereby maximizing the performance and minimizing the emissions of the engine. So far, he has published more than 200 papers in reputable peer-reviewed journals, and his team has strived to be one of the leading groups in this area.

9. Write up on the possible project

   To meet the stringent gas emissions legislation in marine industry achieving green shipping, the ship operational behavior in actual sailing condition is one of the major concerns for designers and ship owners. When sailing encounters heavy weather, the severe ship motion induced by irregular waves bring the thruster very close to water surface, making propeller susceptible to ventilation and causing huge thrust loss. In this study, an extensive assessment of fuel consumption and pollutant gas emissions during a container ship operating scenarios will be carried out by a hydrodynamic vessel movement model capable of representing the vessel propulsion behavior. Step modulation strategy of power management system will be employed to save thrust loss and improve fuel efficiency.

   Meanwhile, an advanced platform will be developed to promote the application of an innovative reactivity controlled compression ignition (RCCI) technology in marine engine. This strategy uses in-cylinder fuel blending with at least two fuels of different reactivities and multiple injections to control in-cylinder fuel reactivity to optimize combustion phasing, duration and magnitude. The process involves introduction of a low reactivity fuel (natural gas) into the cylinder to create a well-mixed charge. The high reactivity fuel (marine oil) is then injected directly into the combustion chamber. As the major combustible substance is well mixed mixture, the combustion process will be faster than conventional IC engines, resulting in a significant higher efficiency. At the same time, as the major fuel has been premixed with air to form a homogeneous mixture before combustion, there is no rich fuel zone, as a result, the peak temperature will be lower than that of conventional marine engine, and the NO_x and soot emissions will be close to zero.

10. MSRDP theme: MTP

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Please indicate research theme: MTP

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One paragraph Bio:
Dr. Valdivia y Alvarado is an Assistant Professor in the Engineering Product Development Pillar at the Singapore University of Technology and Design, and a Research Affiliate in the Mechanical Engineering Department at MIT and the Singapore-MIT Alliance for Research and Technology. He is the director of the Bio-Inspired Robotics and Design Laboratory, a multidisciplinary research group that studies soft robotics, bio-inspired design, novel additive manufacturing processes for soft composites, and unsteady locomotion and sensing in fluid media. Dr. Valdivia y Alvarado was recognized with an MIT's Technology Review TR35 Young Innovator Award for South East Asia, Australia and New Zealand (2012) for his contributions to novel vehicles for long-term exploration of harsh environments.

Write up on the possible project:
The proposed project falls under the marine technology and platforms (MTP) theme. The work focuses on the development of Soft robotic platforms for monitoring, sampling, and characterizing the spatiotemporal evolution of ecosystems, biodiversity, and pollution activity in marine coastal zones. Marine impact assessment and biodiversity studies require periodic data collection in places that are often hazardous and cumbersome to access. Relevant data is crucial to understand ocean physics and to conduct environmental impact assessments. Marine ecosystems are constantly changing both temporally and spatially. Current marine data collection uses static, discrete, and sparse measurements and periodic human involvement is required for data retrieval and sensor maintenance. These measurements provide a limited perspective of the complex ocean physics at a relatively high cost. New dynamic, adaptive, real-time, and long-term robust approaches are needed. Autonomous systems are becoming a key enabling technology and soft robotic systems in particular promise unique hardware capabilities to: (i) survive long-term deployments in marine environments, and (ii) perform pervasive pollution monitoring.
In this project the main objective is to design and develop advanced soft robotic technologies, including mobile platforms and sampling technologies, to improve the monitoring and response capabilities of local agencies against pollution and other ecosystem and biodiversity challenges.

MSRDP theme: MTP

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One paragraph Bio:

Dr. Ping Wu received a Ph.D degree (Chemical Engineering) from the University of Montreal (Canada) in 1992. He joined the Singapore University of Technology and Design in 2011 as an Associate Professor (with tenure). Dr. Wu has extensive expertise and research experience in the theory and application of materials chemistry. He has published a few patents, and over 200 papers in high impact international refereed journals (like Nature Nanotechnology, Physical Review Letters and Nano Letters) which have received over 4000 cross citations and a h-index (web of science) of 35. Dr. Wu is a world expert in thermodynamic modeling. His research interest includes design and development of electronic devices, thermodynamics (theory and practice), chemomechanics for marine applications, solar energy, environment and biomedical applications. He teaches both undergraduate and graduate courses and supervise a few Ph.D students in the Singapore University of Technology and Design.

Write up on the possible project: Bio-inspired design of coating structures and development of chemomechanical database for self-cleaning and antifouling applications in marine science

Surface self-cleaning is a widely explored technique to overcome biofouling problems. It is crucial to supress the contact between metal surfaces and water, which is well represented by the high contact angles between a water drop and a lotus leaf. Inspired by the excellent surface dewetting and self-cleaning properties of fish skins, we propose to develop metallic coatings to supress the area of contact between water and metal surfaces. When a fish swims, its skins around the head range exhibit excellent dewetting property to break the water apart, in correspondence to the compression stress on skins exerted by water waves. It is further reported, by using a molecular dynamics simulation, that the contact angles of water on graphene vary significantly from 0^{o} to 74.8^{o} caused by stress loading. We aim to design and develop new metallic coatings with reversible wetting/dewetting properties, using the tensile/compression stress caused by sea waves. A chemomechanical database will be developed based on first principles thermodynamics and nanomechanics, which will be used to design the chemistry and nanostructure of antifouling coatings.

MSRDP theme: MTP

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One paragraph Bio

Henning Seedorf obtained his university diploma and doctoral degree at the Philipps-University in Marburg (Germany). He spent his postdoctoral periods in the laboratories of Rolf Thauer (Max Planck Institute for terrestrial Microbiology, Marburg, Germany), Jeffrey Gordon (Washington University, St Louis, USA), and Peter Janssen (AgResearch Ltd., Palmerston North, New Zealand). In 2015 he was appointed as Principal Investigator at Temasek Life Sciences Laboratory and has an adjunct appointment at the Department of Biological Sciences at NUS. HS is an author/co-author of over 20 articles (citations: >3100, h-index: 18) dealing with microbiology, microbial ecology and bioinformatics.

Project:

Aim of the project will be to develop an approach that will allow to detect members of the different organisms groups in Singaporean marine water samples simultaneously and with great sensitivity. For this we will utilize samples and data that are collected as part of the MEB CODEFISH-SG program which aims at barcoding the ichthyofauna in coastal waters
Water and sediment samples will be collected from different areas around Singapore and subjected to DNA extraction. This environmental DNA (eDNA) contains DNA from all different organism groups (ranging from microbial single cells to multicellular organisms, such as fish). The eDNA will serve as a template for PCR using primers that are specific for different marker genes and different organisms groups. The PCR-generated amplicons will be pooled and sequenced on a NGS platform and sequence data will be compared to public databases, such as NCBI, FISH-BOL and BOLD as well as the new database that is generated as part of the CODEFISH-SG program. We expect that our results will provide first insights into prevalence and relative abundance of different single and multicellular species in the analyzed water samples and that this approach will serve as proof-of-principle for future studies.

MSRDP theme: MEB

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One paragraph Bio: Lianghui Ji got his first degree in 1984 in China. He obtained his Ph.D under the supervision of Prof. Peter Langridge at the University of Adelaide, Australia. From 1997-2002, he was a Research Fellow in Dr Ding Shou-Wei and later in Dr Zhang Lian-Hui's laboratory working on virus-plant interaction and fungal genomics respectively. He joined TLL in 2003, starting as a Research Associate and was promoted to Laboratory Manager shortly after. He became an Assistant Director in 2005. He is currently a Program Director and Senior Principle Investigator.

Write up on the possible project

My laboratory currently focused on developing red yeast (*Rhodosporidium toruloides*) as an industrial platform for the production of high-value oils, fatty acid derivatives and terpenoids through metabolic engineering and synthetic biology.

The potential new research area may include the interaction of fish gut microbiota on the fate of polyunsaturated fatty acids, carotenoids and chlorophylle. We hope to exploit such knowledge for the development of fish feed to improve fish health, productivity and aroma quality.

MSRDP theme: MTP, MEB