Establishment of RTRC on Coastal Contaminant Monitoring and Marine Innovative Technologies (RTRC-Coastal COMMIT)

PROPOSED BY State Key Laboratory of Marine Pollution, City University of Hong Kong, Hong Kong SAR, China

14th Intergovernmental Session of the UNESCO/IOC Sub-Commission for the Western Pacific, Jakarta, Indonesia, 4-7 April 2023
SKLMP has been run since 2010 (well funded – USD 2.5m/yr)
Interuniversity & Multidisciplinary (70 Members; 13 Advisors; 281 PhD/MPhil; 87 Postdocs)
State Key Laboratory of Marine Pollution (SKLMP)

Vision

• To be a key international research center in advancing marine environmental research that contributes to the protection and management of the marine environment and generates positive societal impact.

Mission

• To protect marine environments through high quality multidisciplinary research and innovations
• To build capacity by nurturing and training environmental scientists, managers, and entrepreneurs in the region
• To support governments in the management of environmental quality and protection of marine ecosystems

https://www.cityu.edu.hk/sklmp/about-us/annual-reports
Our Platforms and Facilities

1. Trace and Ultratrace Level Instrumental Analysis Platform

- Thermo Orbitrap LC-MS
- Thermo Hybrid Quadrupole-Orbitrap GC-MS
- Agilent UPLC - SCIEX 6500 Triple quadrupole MS


- BD FASC Aria III Flow Cytometer
- Illumina MiniSeq System
- Illumina NextSeq 550 System
- BD FASC Aria II Flow Cytometer
- Thermo Hybrid Quadrupole-Orbitrap GC-MS

3. Aquatic Toxicology Research Platform

- Thermo Hybrid Quadrupole-Orbitrap GC-MS
- Agilent UPLC - SCIEX X500R QTOF MSMS
- Model Organisms-Marine Medaka
- Aquarium

4. Field-based Integrated Research Platform

- Fish Raft
- Research Vessel
- Scientific Buoy

USD 0.9m
USD 0.65m
USD 0.4m
USD 0.5m
Innovative Technology for Pollution Monitoring and Control

A Practical and High-throughput Aptasensing Device for Antibiotics Detection

**Figure 3.** Proposed mechanism for a universal aptamer-based detection platform based on AptaSwitch using (A) molecular beacons, (B) organic dyes and (C) hemin/G-quadruplex DNAzyme system as the signal transducer.

**Figure 4.** (A) Schematic diagram of the proposed detection strategy; (B) design of the palm-sized portable microplate system; (C) layout of a reagent-coated microplate for the detection of SMX, SDI, OFX, ERY and DOX. S1-S7 are standards containing various concentrations of different antibiotics.
Innovative Technology for Pollution Monitoring and Control

A Novel Dissolved Oxygen Sensor – Overcoming Biofouling

**Example**

- **DO sensing film**
- **sensing tape**
- **Control unit**
- **Water level**
- **Optical part**
- **Auto-sampler**
- **Light source**
- **Optical detection unit**
- **DO sensor**
- **DO sensing material**
- **Fish farm**
- **Air pump**
- **Cloud**
- **IoT**

**DO content (Prototypes) / mg L⁻¹**

- 6.6
- 6.8
- 7.0
- 7.2
- 7.4
- 7.6

**DO content (Clark electrode) / mg L⁻¹**

- 6.6
- 6.8
- 7.0
- 7.2
- 7.4
- 7.6

**Synthesis of DO sensing compounds**

- Filed for US, EU and CN patents

**DO Sensing glass slide**

**O₂ Oxidized**

**light**

Profs. Rudolf Wu & Vincent Ko

*Inventions Geneva*
If you have a question or need further clarification, feel free to ask!
Carrying capacity of contaminants of emerging concern (CECs)

- Reveal and forecast the occurrence of CECs
- Derive water quality criteria, assess their risk and determine environmental carrying capacity
- Formulate risk reduction measures

Example
Eco-safety and Environmental Risk Assessment

Assessing Antibiotic Resistome Flows from Pollution Hotspots to Environments and Explore the Control Strategies

Mission, Goals, and Deliverables

Work Package Ia
- Novel ARGs and Reference Database
  - In silico via models
  - Wet lab screening and validation
  - Database construction
  - A catalogue of novel ARGs
  - A reference database

Work Package Ib
- One-stop Online Analysis Platform
  - Deep-learning algorithm
  - Integrated analysis pipeline
  - Big data analysis
  - An online analysis & sharing platform

Work Package II
- Transfer Flow in Human Related Environments
  - A standardized framework
  - Large-scale local surveillance
  - Source & pathogenic host tracking
  - A local antibiotic resistance map
  - A list of pollution sites for control

Work Package III
- Risk Ranking & Control Strategy
  - ARGs risk ranker
  - Site risk ranker
  - Control at critical sites
  - A risk-ranking model
  - Feasible control techniques

Welcome to ARGs-OAP Galaxy!
https://smile.hku.hk/SARGs

USD 4.5 million Theme-based Project

Prof. Tong ZHANG, XD LI, Kenneth LEUNG
We monitored 1,052 sampling sites along 258 rivers in 104 countries, covering 471m people.

These contaminants in surface water pose a threat to environmental and human health in 25% of the studied locations globally.

Most polluted rivers are found in low-middle income countries.

This work paved the way for the Global Estuaries Monitoring (GEM) Programme.

This is a hot paper (among top 0.1% most cited papers) recognized by WoS, and will receive the Cozzarelli Prize on 30 April 2023.

Global Estuaries Monitoring (GEM) Programme

Since June 8, 2021

Key Partners: SKLMP (City University of Hong Kong), York University, Sydney Institute of Marine Science, Baylor University, MEL (Xiamen University), National Marine Environmental Monitoring Centre (China)

Expected outcomes

1. Global network for pollution monitoring
2. Advanced passive samplers
3. Capacity building
4. Data sharing (transparent estuaries)
5. Co-designed solutions for reducing pollution
6. Supporting informed decisions on water quality management
7. Cleaner estuaries

GEM Video: https://youtu.be/iSoTgz6roKA

GEM Website: https://www.globalestuaries.org/
Recruiting Global Partners, launching in May 2023

So far, we have:

- 46 countries
- 80 collaborators
- 116 estuaries
Passive Samplers and Biomonitoring

Global Artificial Mussel Watch for Metals and POPs

Applying Organic DGT for Emerging POPs

Global Oyster Watch for Micro-plastics and Chemicals of Emerging Concern
The study reports that copepods can adapt to ocean acidification through epigenetic changes.

Publication:
Dr. Leo Lai Chan
Associate Director, SKLMP

Example

Dr. Vicky Jiajun Wu
European Commission has adopted our research outcomes to inform their environmental policy.

Supporting the China’s National Master Plan for Ecosystem Restoration and UN Decade on Ecosystem Restoration
Innovative Technology
Our Track Record and Commitment

• SKLMP has ample experience in hosting international conferences and workshops.
• SKLMP is the PEMSEA Regional Centre of Excellence in Marine Pollution Research.
• We will be able to provide partial or even full financial support to participants from the WESTPAC region, depending on the funding availability.
• We have funding for hosting visiting professors and young researchers to work in our lab.
IOC/WESTPAC Training Workshop on Introductory Scientific Diving for Marine Benthic Dinoflagellates Sampling and Processing

17-21 September 2018
Phuket Marine Biological Center (PMBC), Phuket, Thailand

Our Track Record and Commitment
SKLMP Led the SETAC Global Horizon Scanning

Critical Review

Toward Sustainable Environmental Quality: Priority Research Questions for Asia

Kenneth M.Y. Lam1,2,3,a, Katie W.Y. Young,2,3,b, Jing You,,2,3,c Kyungho Choi,2,3,d Kwan-Wen Chang,2,3,e Ross Smith,2,3,f Guang, Jin Zhao,2,3,g Mano M.N. Yung2,3,h Carlos Aris Ramirez,2,3,i Yuan Jie Ai,2,3,j S. Rehanbok Burkul2,3,k Robert Drew2,3,l Nathalie Candoll2,3,m Yi Seng K,2,3,n Tranh Huan,2,3,o Chris Humphrey2,3,p Chul-Young Boon-thai,2,3,q Seung Min Jeong,3,r Guillaume Juchs,3,s Ali Karimi,3,t Katarina Kysilova,3 u, Kuan-Chun Liu3, v, Bin-Le Lin3, w, Ben Lu3, x, Patrick Martin3, y, Mac Grace Zuk,3 z, Katharina Oegelba,3 a3, F.V. Rathnapala3, b3, Yenky Rojai3, c3, Mohammad Shokh3, d, Chin Hon Tian3, e3, Maria Clarice Tacchella,3 f3, Gerald T. Antley3, g3, Alvaro R.A. Razzari3, h3, Murray A. Rudolf3, i3, and Jeffrey W. Brock3, j3

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7Open University of Hong Kong, Hong Kong, China
8PETRONAS, Kuala Lumpur, Malaysia
9IIUC, Seoul, South Korea
10Bay Area University, Wuxi, Texas, USA
11International Copper Association, Washington, DC, USA
12Nanyang Technological University, Singapore
13University of Malaysia, Terengganu, Malaysia
14Kogakuin University, Chiba, Japan
15Supervising Scientific Branch, Canberra, Australian Capital Territory, Australia
16Nestle Korea Ltd., Seoul, South Korea
17Mamine National University, Gunma, Japan
18National University of Singapore, Singapore
19University Putra, Serdang, Malaysia
20Gentex Corporation, Cerritos, California, USA
21Orange County, Irvine, California, USA
22Rutgers University, New Brunswick, New Jersey, USA
23International Copper Association, Shanghai, China
24College of Fisheries and Ocean Sciences, University of the Philippines, Mindanao State University, Philippines
25Irrigation Institute, University of Science of South Carolina, USA
26University of Brunei Darussalam, Brunei
27University of Brunei, Brunei
28University of the Philippines-Visayas, Cebu, Philippines
29E. Environmental Protection Agency, Washington, DC
30University of York, United Kingdom
31World Maritime University, Malmo, Sweden

https://setac.onlinelibrary.wiley.com/doi/epdf/10.1002/etc.4788
To meet the needs of the WESTPAC region for ensuring ecological safety, and thereby protecting essential marine habitats and conserving biodiversity and natural resources therein.

**Objectives**

1) To enhance the capacity building for monitoring and risk assessment of chemical contaminants as well as marine innovative technologies via *training and technology transfer*;

2) To catalyze and co-design *regional research collaborative projects* (e.g. GEM);

3) To understand the current situation of chemical contaminants;

4) To promote marine environment protection and facilitate sustainable development, and

5) To recommend regulatory measures to protect marine environments of the WESTPAC region.

Cost-effective & easy-to-use technologies
Our Strategy

- Transfer knowledge on contaminants of emerging concern (CECs)
- Transfer cost-effective, novel technologies to address the needs of the WESTPAC region
- Coordinate and co-design regional research collaboration
- Co-develop research collaboration and training workshops with other RTRCs in cross linked areas (e.g., benthic algal toxins; micro- and nano-plastics)

Core Business

- Transfer knowledge on contaminants of emerging concern (CECs)
- Transfer cost-effective, novel technologies to address the needs of the WESTPAC region
- Coordinate and co-design regional research collaboration

Partnership

- Co-develop research collaboration and training workshops with other RTRCs in cross linked areas (e.g., benthic algal toxins; micro- and nano-plastics)
### Proposed Major Activities

<table>
<thead>
<tr>
<th>Year</th>
<th>Proposed Activities</th>
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<tbody>
<tr>
<td>2023/2024</td>
<td>Training workshop on “analytical method for per- and poly-fluoroalkyl substances (PFAS) characterization and quantification”</td>
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<tr>
<td>2024</td>
<td>The 10(^{th}) International Conference on Marine Pollution and Ecotoxicology (ICMPE-10) (3-6 Jan 2024)</td>
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<td>Training workshop on “underwater survey technology for coral ecosystem” (summer 2024)</td>
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<tr>
<td>2025</td>
<td>Training workshop on “standard protocol and methods for sampling and analysing active pharmaceutical ingredients”</td>
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<tr>
<td>2026</td>
<td>Training workshop on “environmental risk assessment”</td>
</tr>
<tr>
<td>2027</td>
<td>Training workshop on “sampling, isolation, culturing, and identification of lipophilic phycotoxin producing algal species” in collaboration with RTRC - Marine Toxins and Seafood Safety</td>
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</tbody>
</table>
SKLMP will be keen to support ICO-WESTPAC and UN Ocean Decade
Great minds unite to protect oceans with innovation!

Go together, we go far!
Expected Outputs

✓ Provision of research protocols and training on the instrumental analysis and toxicity assessment of chemical contaminants.

✓ Demonstration and provision of protocols for ecological investigation and assessment of marine biodiversity and ecosystem health using innovative underwater technologies.

✓ Recommendations of appropriate management measures and monitoring protocols to governments for enhancing future regional environmental protection and conservation management.

✓ Strengthening the regional network and capacity building for knowledge exchange, data sharing, technology transfer and research collaboration.
Implementation Strategy

a. Management
  - Non-profit-making and self-sustaining;
  - Led by SKLMP director and steered by Advisory Committee.

b. Capacity building (with the support from IOC/UNESCO)
  - Full utilization of complementary expertise and facilities from different institutions;
  - Develop cooperation in the WESTPAC region;
  - Strengthen national and international networks.

c. Sustainability
  - Produce environmental professionals to meet future demands in the region;
  - Establish an academic and technology exchange platform within and outside the region;
  - Annual funding support from CityU and the Innovation and Technology Commission of Hong Kong;
  - Develop new partnerships and opportunities through regular trainings and research activities;
  - Promote training courses, collaboration opportunities and research excellence through website and social media

d. Knowledge sharing
  - Skills and knowledge will be transferable and replicable.
  - Data can be shared, exchanged, and published together based on the principle of voluntariness.
SKLMP designated as a PEMSEA-RCOE and a member of the PNLC

On 27 July 2022, the Partnership Council of the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) officially endorsed SKLMP as an Regional Centre of Excellence (RCOE) in Marine Pollution Research. As a PEMSEA-RCOE, SKLMP automatically becomes a member of the PEMSEA Network of Learning Centres (PNLC).