香港城市大學
City University of Hong Kong

Global Estuaries Monitoring Programme

SKLMP
海洋污染國家重點實驗室

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

The Global Estuaries Monitoring (GEM) Programme for Cleaner and Safer Coastal Marine Environments

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2021 2030 United Nations Decade of Ocean Science for Sustainable Development

The Global Estuaries Monitoring (GEM) Programme for Cleaner and Safer Coastal Marine Environments

1. Rationale and Motivation
2. Introduction of GEM
3. Research Progress

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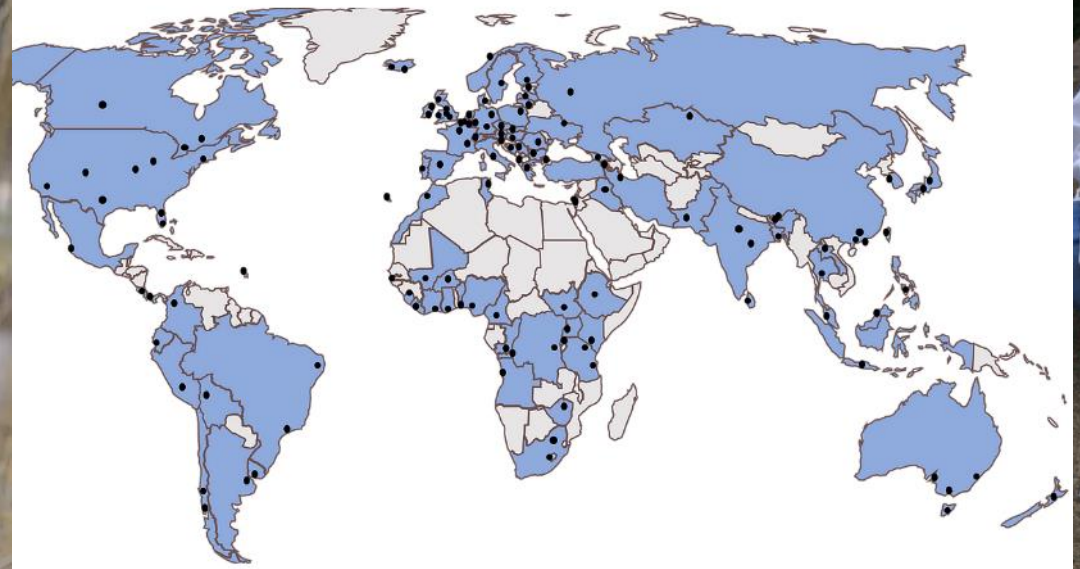
GLOBAL MONITORING OF PHARMACEUTICALS PROJECT

https://www.globalpharms.org

Prof Alistair Boxall & his postdoc Dr John Wilkinson (insert)



127 scientists; 104 countries (36 never been studied); 258 rivers; 1053 sampling locations

- Led by the University of York in the United Kingdom
- Standardized methods for sampling with a kit and courier service, and centralized chemical analysis
- Revealing pollution patterns and their association with socioeconomic status, informing environmental policy

Source: Wilkinson JL, Boxall ABA, Kolpin D, Leung KMY, et al. (2022). Pharmaceutical pollution of the world's rivers. *PNAS*. 19, e2113947119

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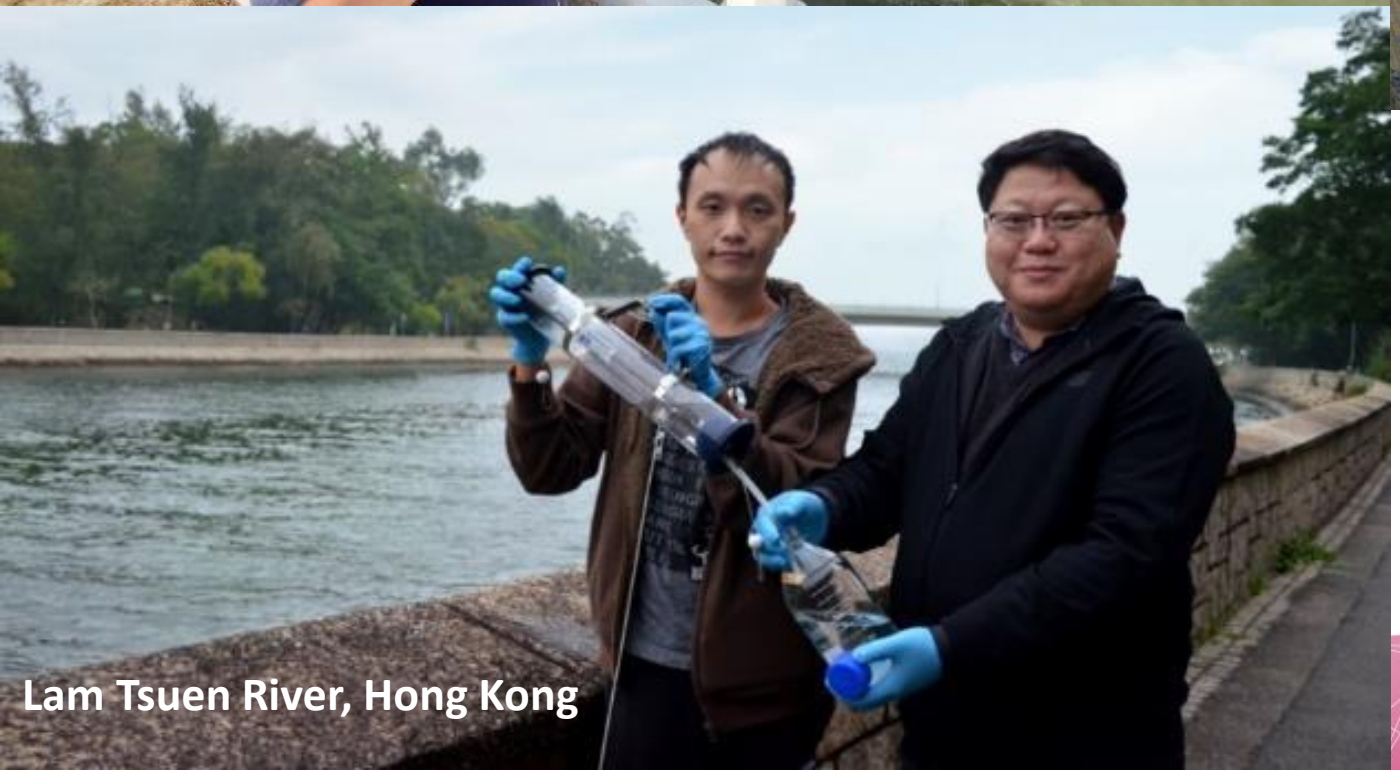
Bhutan


Kai Tak River, Hong Kong


Lam Tsuen River, Hong Kong

Editorial *by SCMP Editorial*

A sea of medicines is flooding our rivers

- Hong Kong people must be taught to properly dispose of unwanted or expired medications rather than flushing them down the toilet

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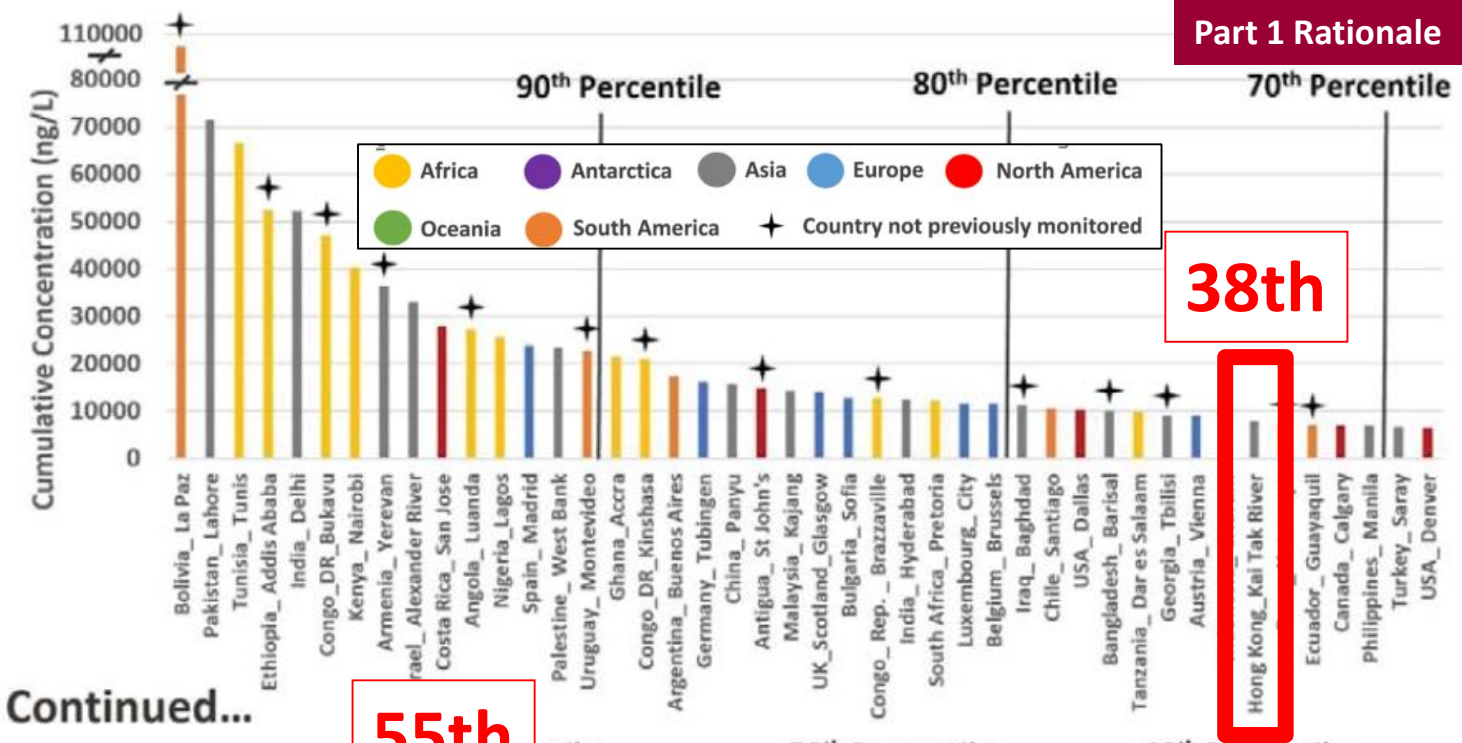
Global pharmaceutical pollution

- Ten most polluted rivers locate in: Bolivia, Pakistan, Tunisia, Ethiopia, India, Congo, Kenya, Armenia, Israel and Costa Rica.
- Rivers in South America, Africa and Asia had higher medicines pollution.
- Two rivers in Hong Kong, Kai Tak River and Lam Tsuen River, were studied, and ranked as the top 38th and 55th most polluted rivers out of the 258 rivers around the globe.



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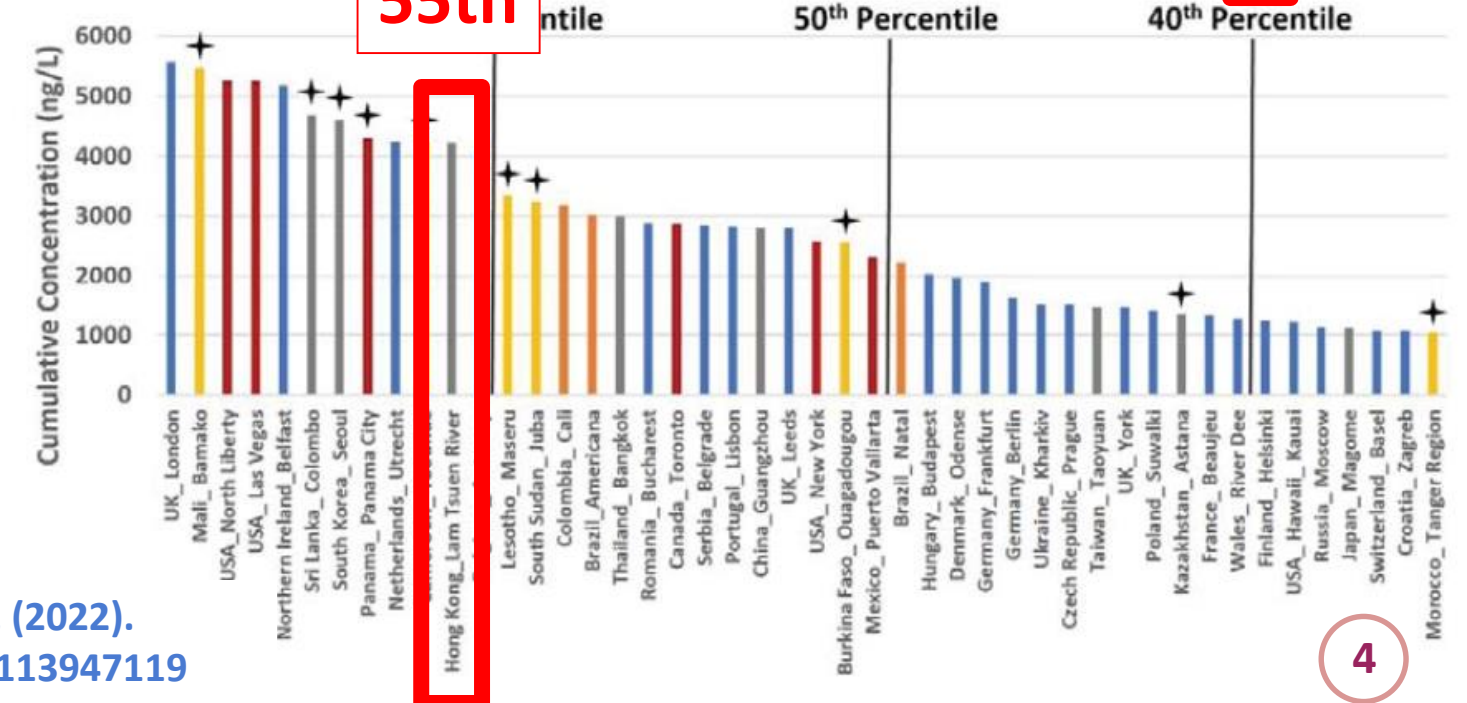
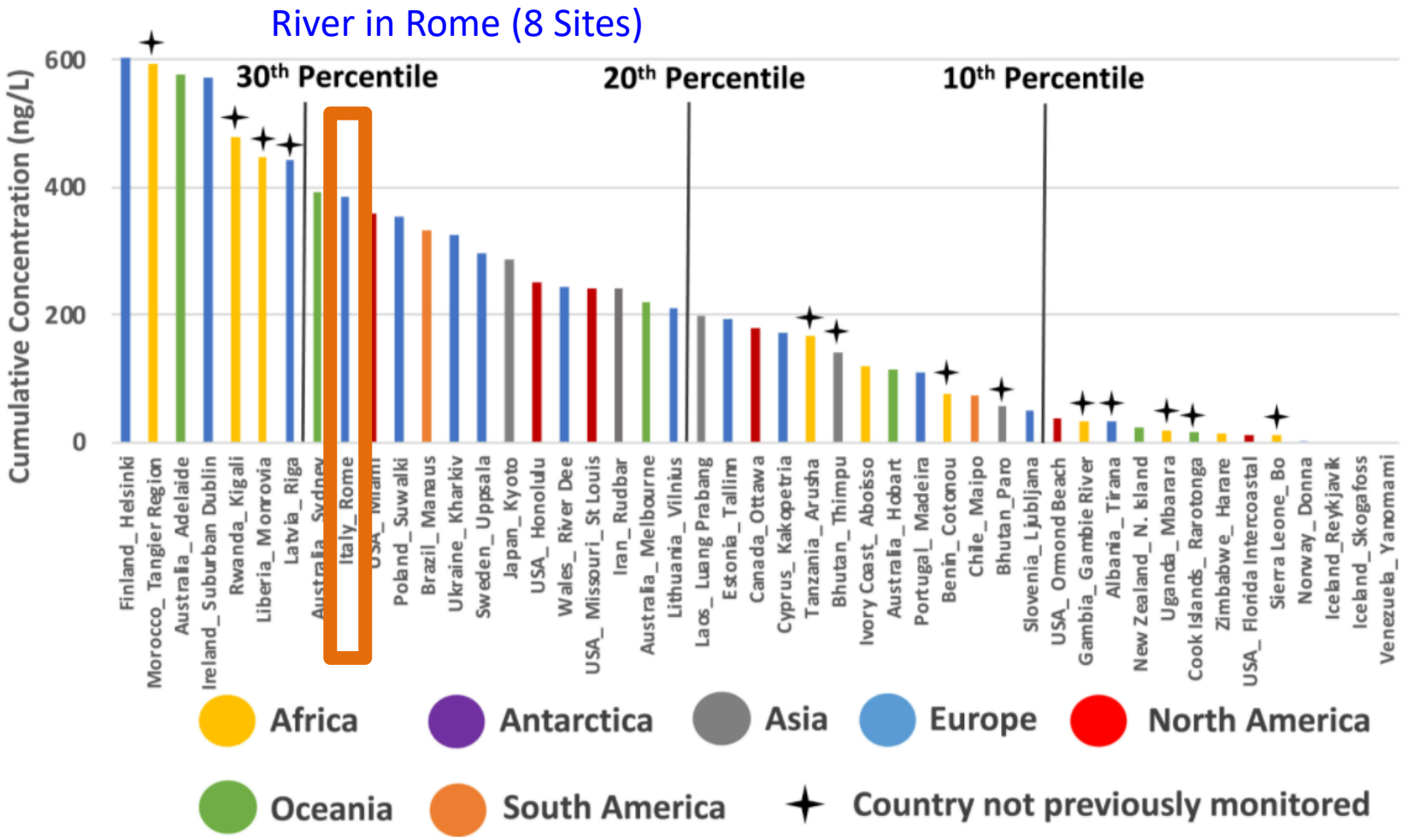


Source: Wilkinson JL, Boxall ABA, Kolpin D, Leung KMY, et al. (2022). Pharmaceutical pollution of the world's rivers. *PNAS*. 19, e2113947119

Pharmaceutical pollution in the Rome River in Italy

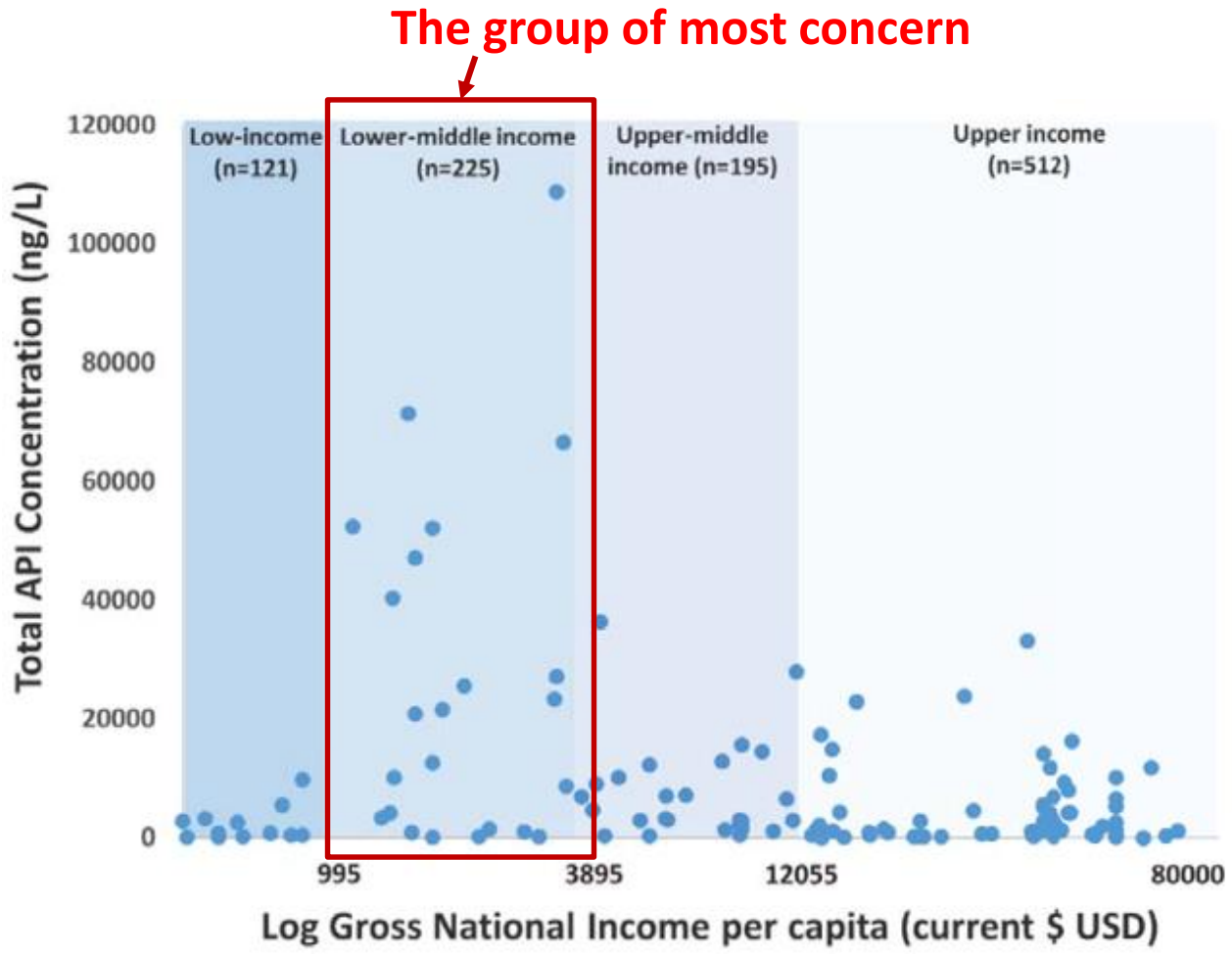
- **Relatively clean** (among top 30 cleanest rivers in the world)
- contained Atenolol (high blood pressure), Carbamazepine (nerve pain), Desvenlafaxine (depression), Fexofenadine (allergies), Gabapentin (nerve pain), Metformin (diabetic), **Paracetamol (pain killer)**, and Trimethoprim (antibiotic)



Source: Wilkinson JL, Boxall ABA, Kolpin D, Leung KMY, et al. (2022). Pharmaceutical pollution of the world's rivers. *PNAS*. 19, e2113947119

Pharmaceutical pollution in the world's rivers

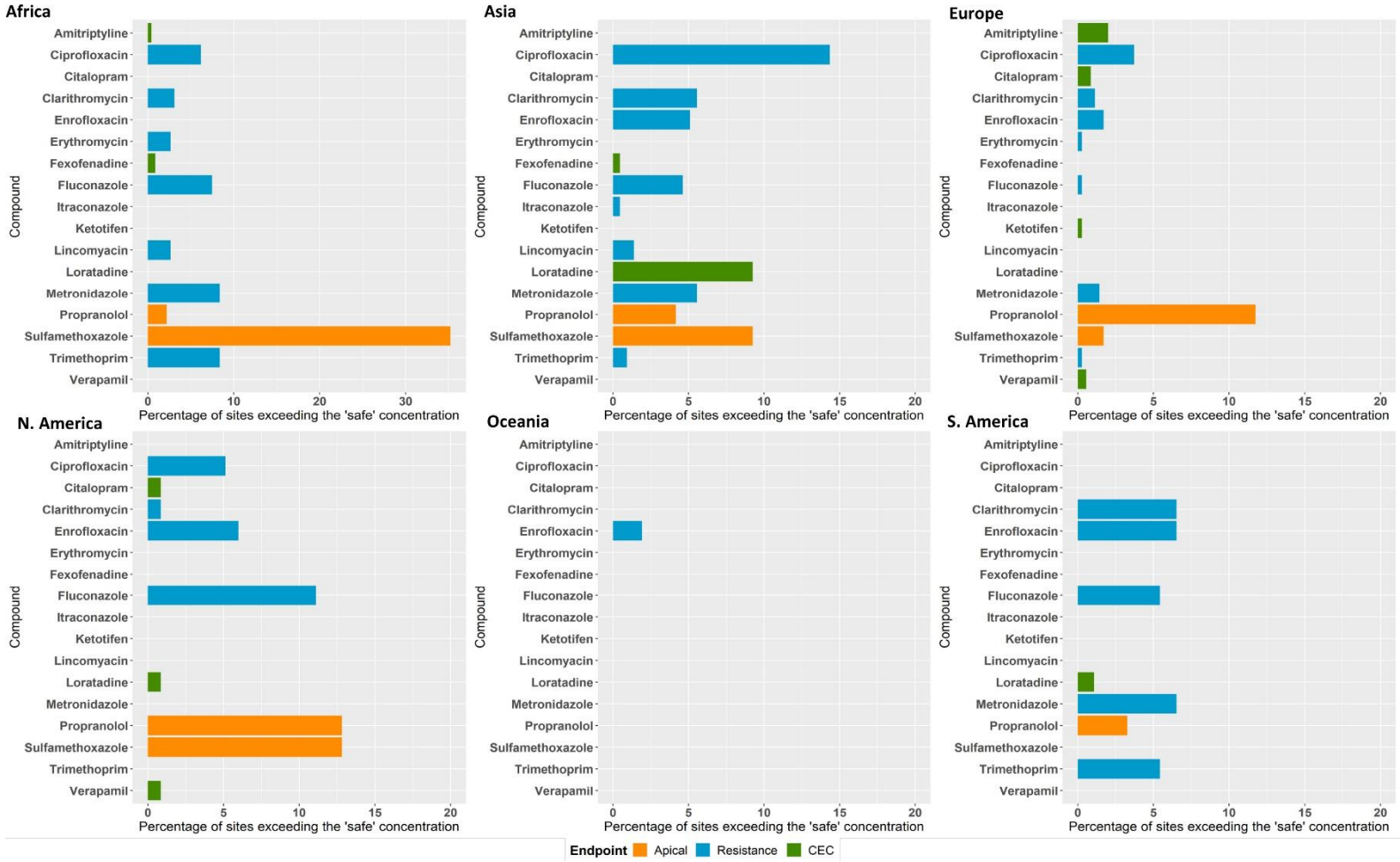
- Closely related to the socio-economic status.
- Countries with the **lower-middle income** are the most polluted.
- Pollution level generally increased with median age and poverty rate.
- In low-to-middle income countries, the most common drugs in rivers are painkillers and antibiotics whereas diabetic drugs and antidepressants are more common in high-income countries.



Source: Wilkinson JL, Boxall ABA, Kolpin D, Leung KMY, et al. (2022). Pharmaceutical pollution of the world's rivers. *PNAS*. 19, e2113947119

Potential ecological risks of pharmaceutical pollution

- Globally, concentrations of at least 1 pharmaceutical at **25.7%** of 1053 sampling sites were **greater than their safety threshold**.
- Comparatively, Asia had more sites with pharmaceuticals exceeding the safety thresholds.
- **8 out of the 13 antibiotics in Asia had a high risk** to induce antimicrobial resistance (Blue bars), especially for ciprofloxacin.



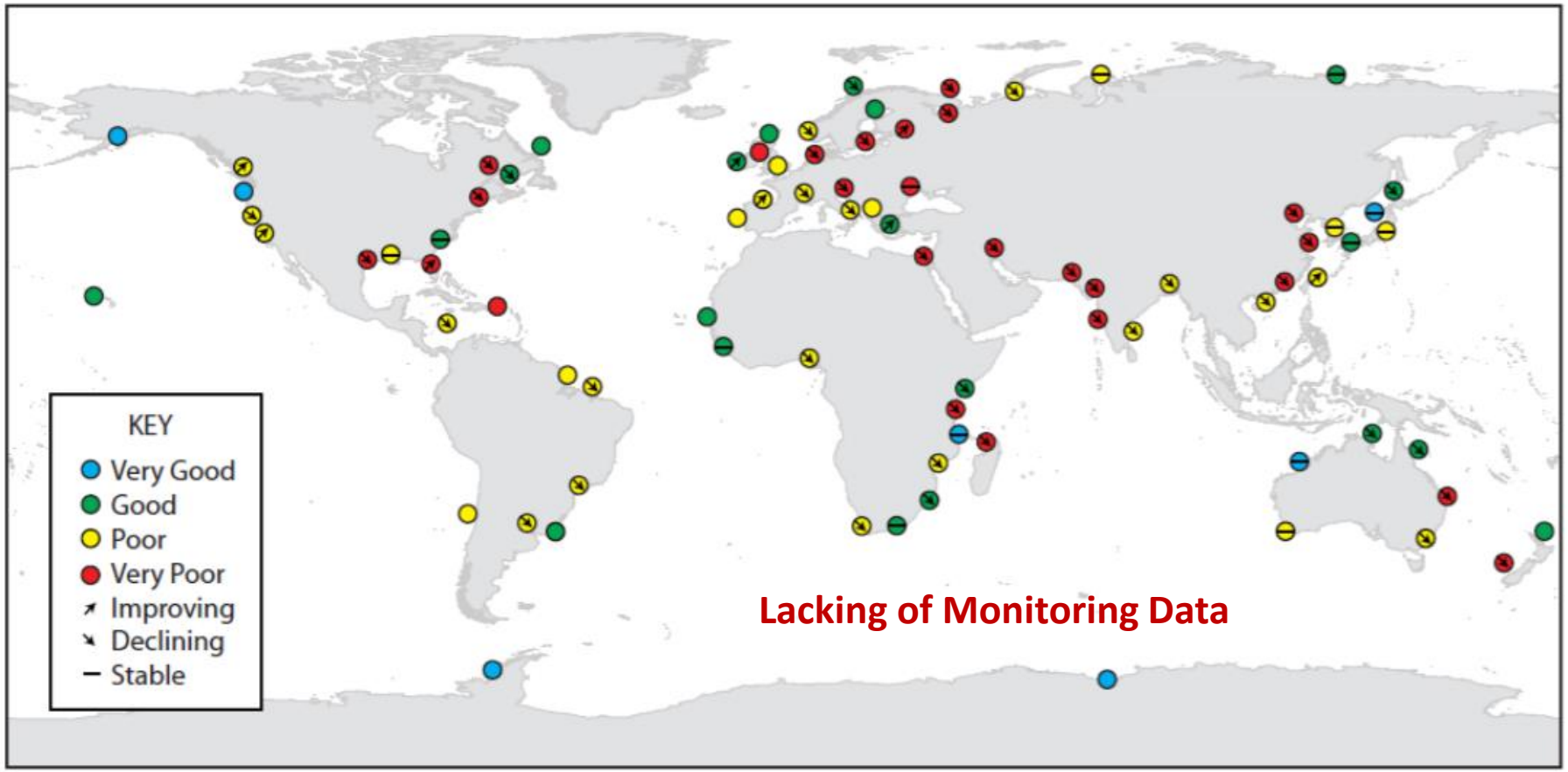
In Oceania, only Enrofloxacin (antibiotic) may lead to antibiotic resistance

Source: Wilkinson et al. (2022). Pharmaceutical pollution of the world's rivers. *PNAS*. 19, e2113947119

Implications of this global study

- **We can only manage what we can measure.** Monitoring is, therefore, crucial. Many polluted rivers (1/3) have never been monitored using a standardized method.
- Such a study can **reveal the global situation** and identify pollution hotspots and issues.
- **Pharmaceutical pollution in rivers is widespread**. Concentrations of at least one pharmaceutical at 25.7% of 1053 sites were greater than concentrations considered safe.
- **Levels of antibiotics in rivers**, which exceed their safety thresholds, may have a high risk in inducing antimicrobial resistance.
- **Countries with Lower-Middle Income** have higher levels of pharmaceuticals in their rivers, and need urgent improvement in their chemical and waste management.
- **We can learn from best practices.** Advanced wastewater treatment and proper waste disposal as well as education, policy and law enforcement are essential.
- **Extend it to estuaries?**

UN Decade of Ocean Science Call for Proposal in Late 2020



Estuarine condition assessments carried out by United Nations based on literature review (https://www.un.org/Depts/los/global_reporting/WOA_RPROC/Chapter_44.pdf)

- UN conducted the First Global Integrated Marine Assessment in 2015 to evaluate the conditions of 103 estuaries around the world.
- The conditions of 31 and 32 of them were found to be "Very Poor" and Poor" respectively in terms of water quality and fisheries resources, indicating that **overall conditions of most estuaries (61%) in the world were generally poor**.

The Global Estuaries Monitoring (GEM) Programme (#176)

Global Estuaries Monitoring Programme

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

- An extension of the Global Monitoring of Pharmaceuticals Project – **Effective monitoring can inform policy**
- **Supporting SDG 14.1**: To prevent and significantly reduce marine pollution of all kinds by 2050
- **Endorsed as one of the UN Decade of Ocean Science for Sustainable Development (2021-2030) Programmes in June 2021**

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Xiamen University
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THE GLOBAL GOALS
For Sustainable Development

14 LIFE BELOW WATER

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Global Estuaries Monitoring (GEM) Programme

Since June 8, 2021

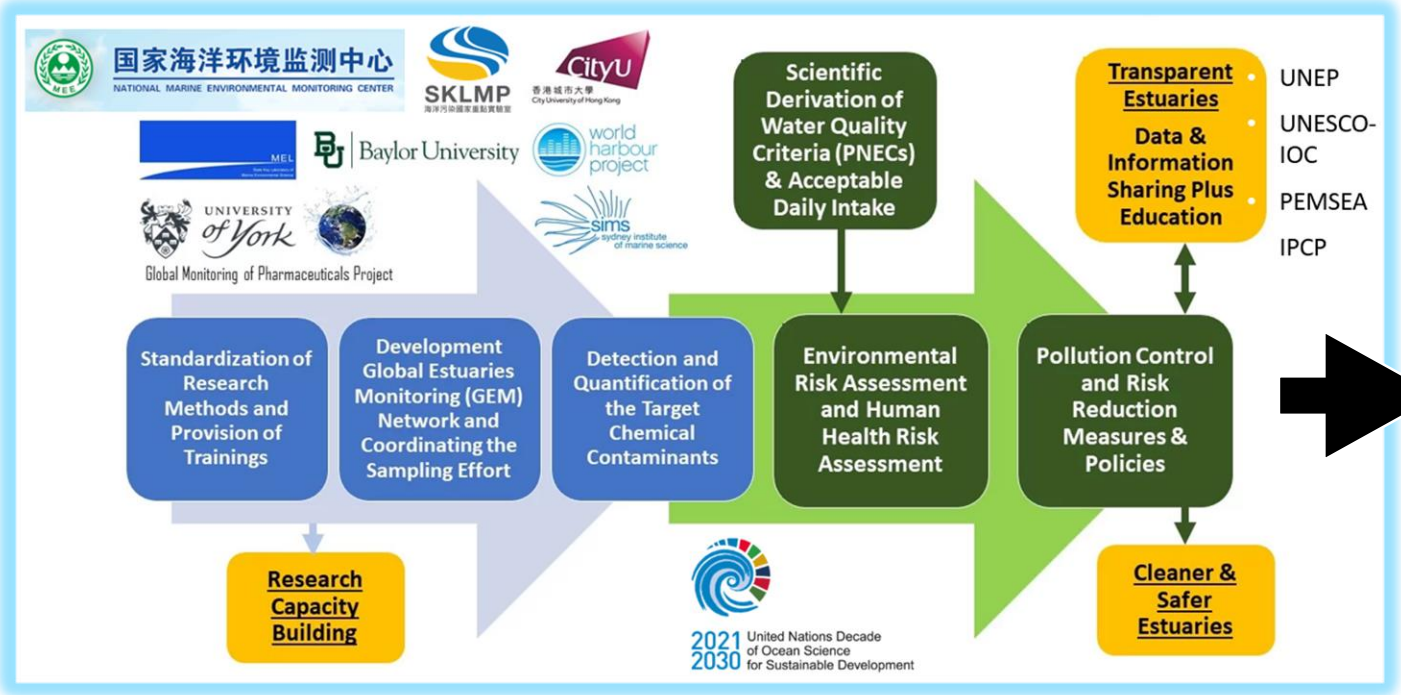
Key Partners: SKLMP (City University of Hong Kong), York University, Sydney Institute of Marine Science, Baylor University, MEL (Xiamen University), National Marine Environmental Monitoring Centre (China)

- Develop a global monitoring **network** to monitor contaminants in major urbanized estuaries worldwide.
- **Build capacity** for pollution monitoring with training for sampling and analysis.
- Reveal pollution situation, **share** data, identify global estuaries for improvement and priority contaminants for control.
- Promote best practices to combat pollution problems, thereby achieving **cleaner and safer estuaries** for all.

GEM Website: https://www.globalestuaries.org/

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

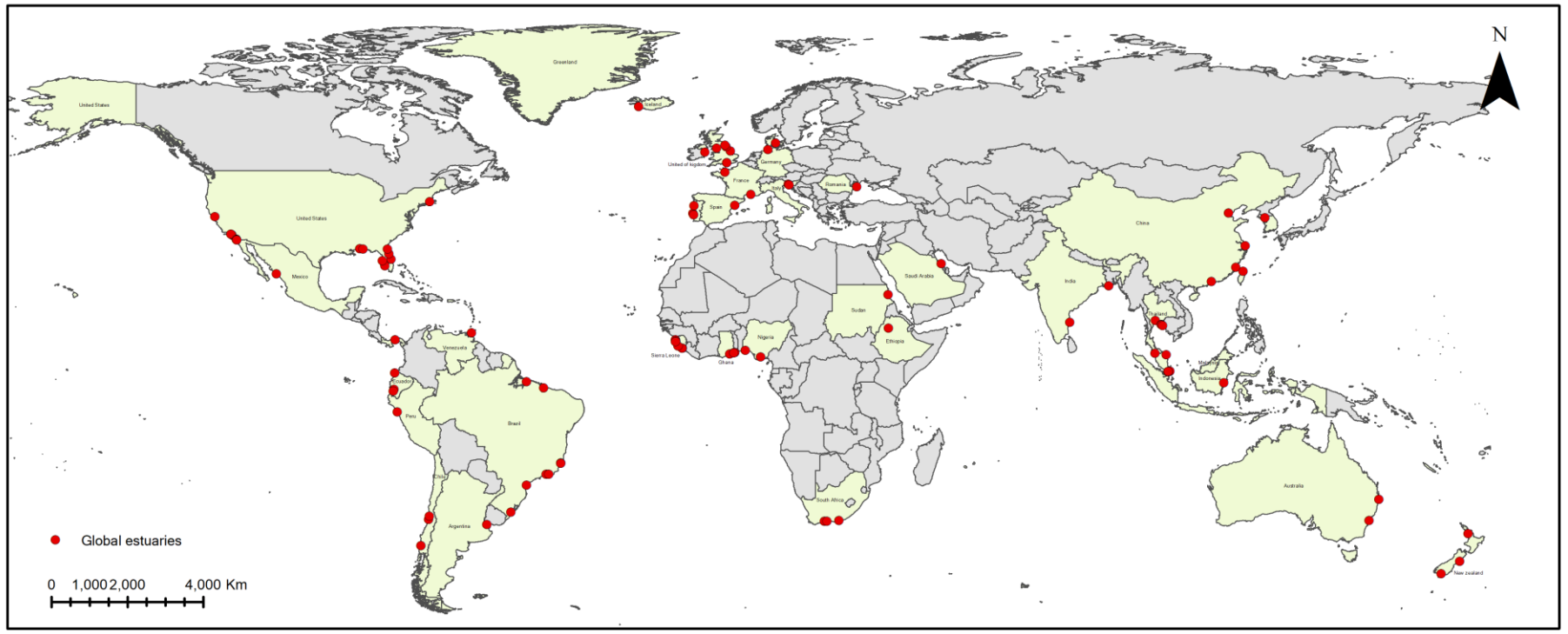
GEM Video: https://youtu.be/iSoTgz6roKA

GEM Website: https://www.globalestuaries.org/

What have we done since June 2021?

- Set up the platform (**https://www.globalestuaries.org/**)
- Work with UN Decade Office (to develop governance structure)
- Hire PhD students and research staff
- Recruit global partners
- Solicit funding support
- Develop standard methods for sampling and analysis of target contaminants (**still ongoing**)
- Carry out pilot studies in various estuaries in China

Recruiting Global Partners



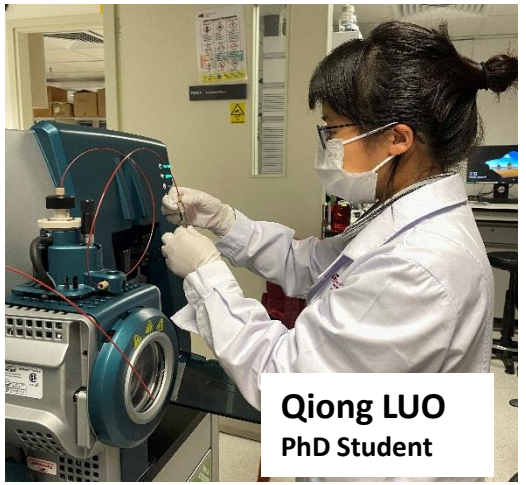
So far, we have....

36 countries

65 collaborators

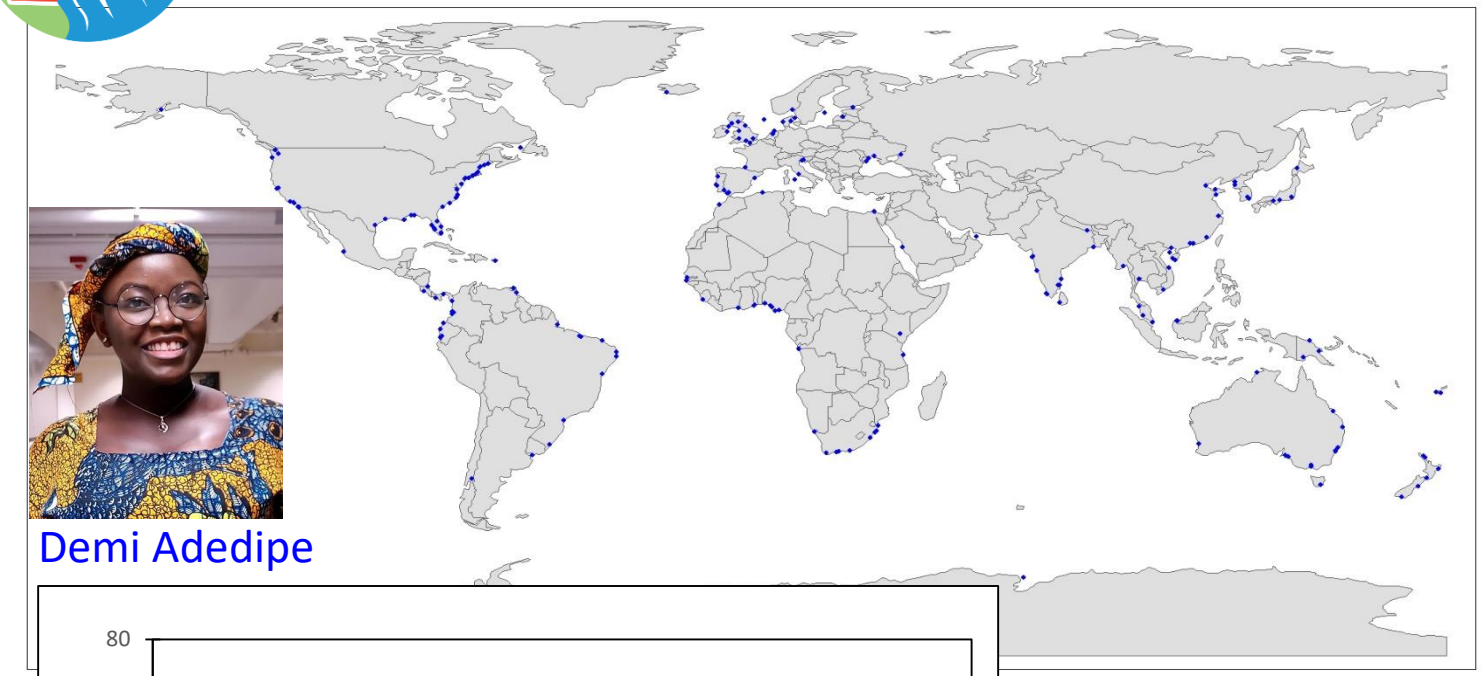
99 estuaries

Hiring PhD Students and Postdocs

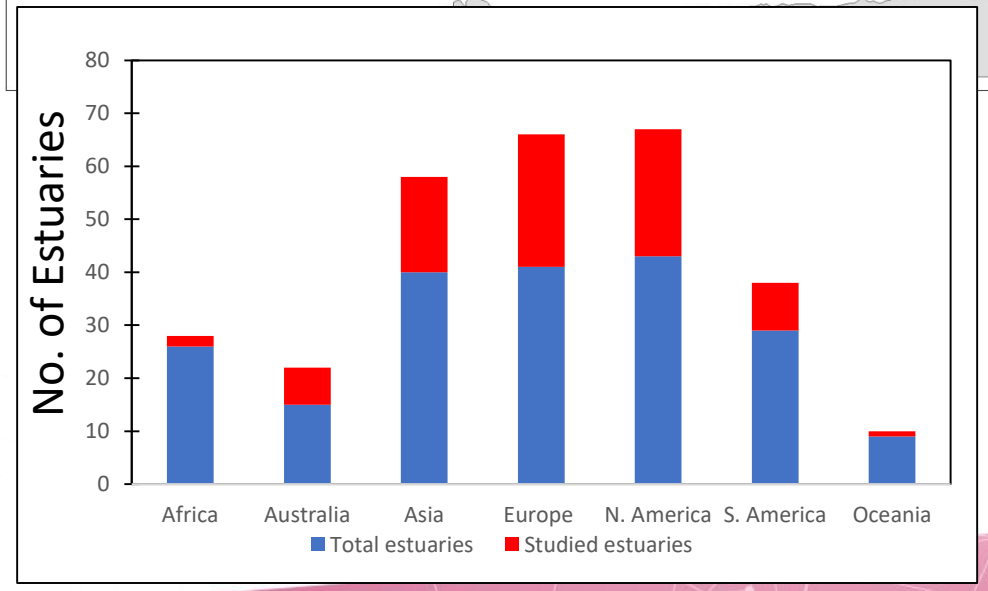


- A new postdoc, Dr. Chong Chen as Hong Kong Scholar, will join us in February 2023.
- We will recruit more postdocs and RAs.

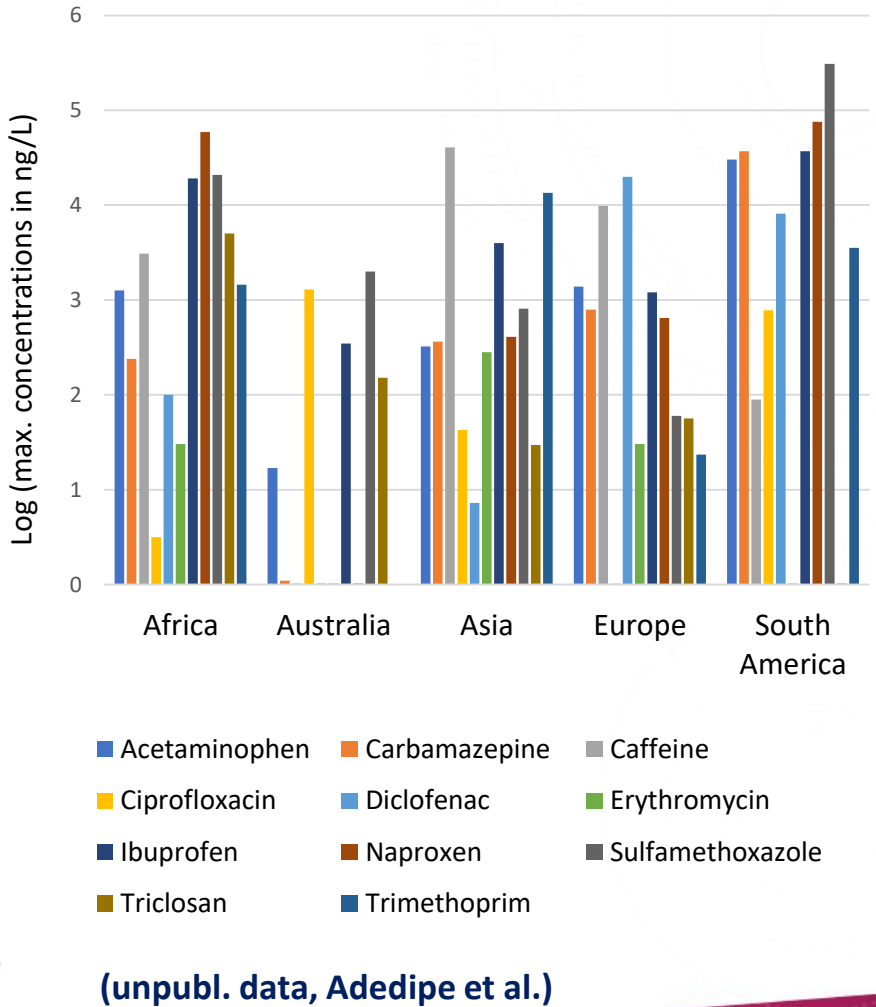
Carrying Out Comprehensive Literature Review



Demi Adedipe



Among 203 major urbanized estuaries, only 42% of them were monitored for medicine pollutants



(unpubl. data, Adedipe et al.)

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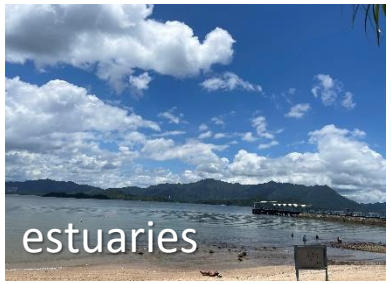
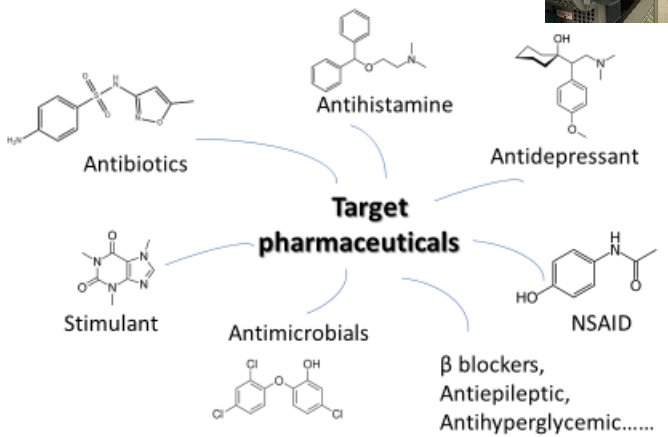
Development of Methods

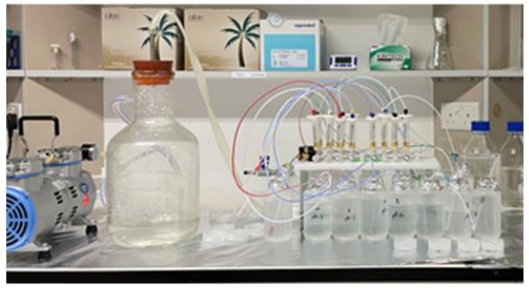


Collecting samples

Standard protocols & training materials



Volume (20, 30, 50, 100, 150, 200 mL) **pH** (3,4,5) **Salinity** (10, 20, 30 ‰)



Sample preparation

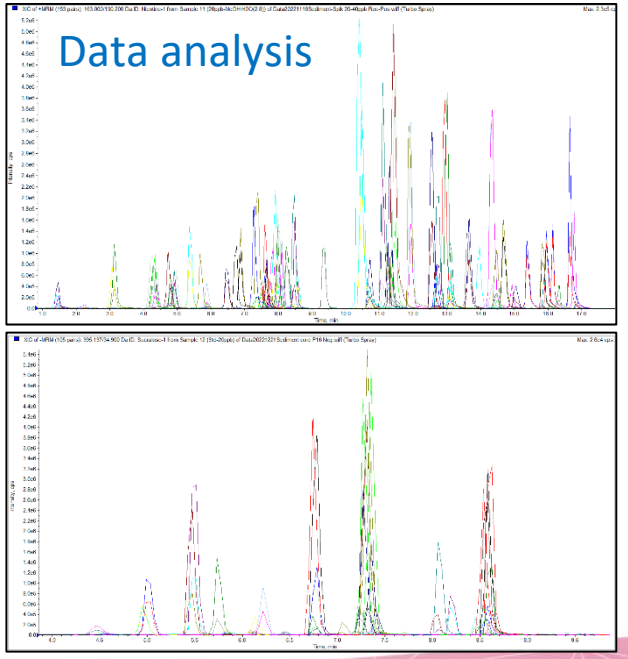
Optimization

LC condition
mobile phase
gradient

MS parameters
Q1, Q3, CE, DP, CXP
ion source

Instrumental analysis

Optimization



(unpubl. data, Luo et al.)

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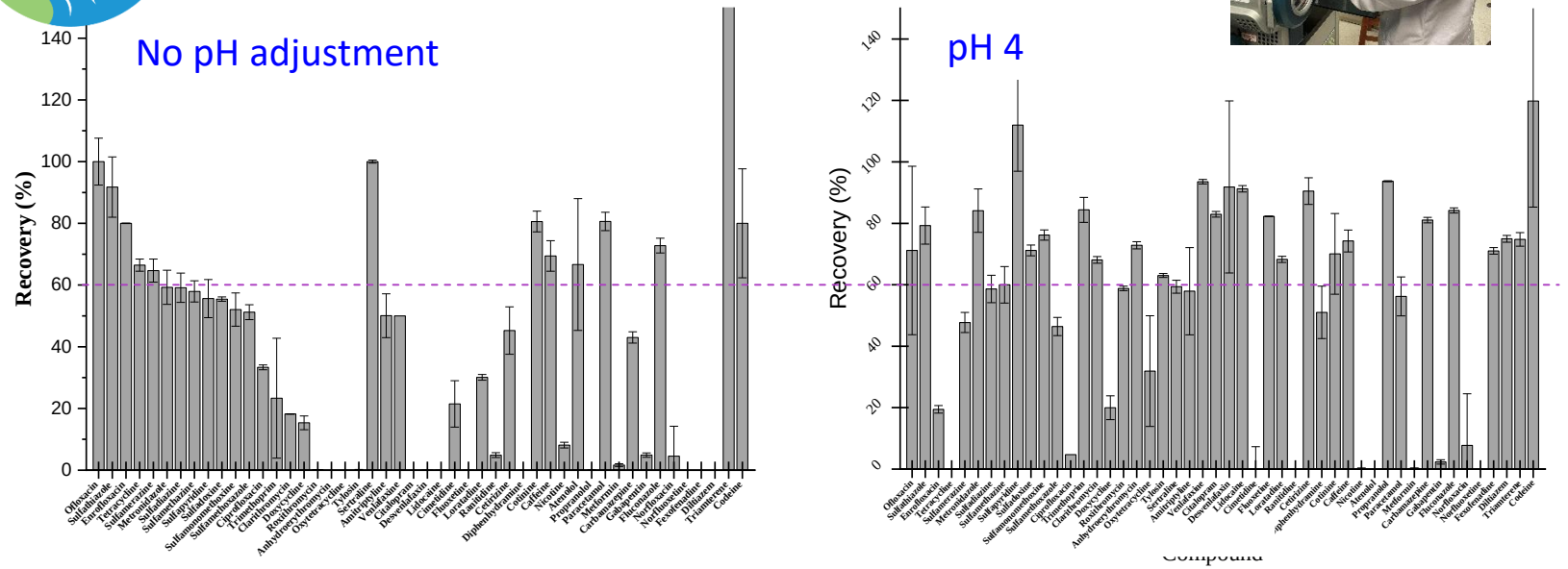
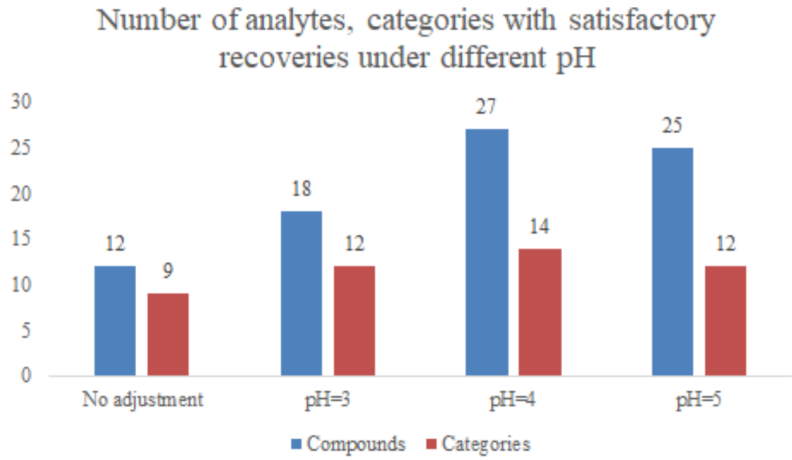
Development of Methods





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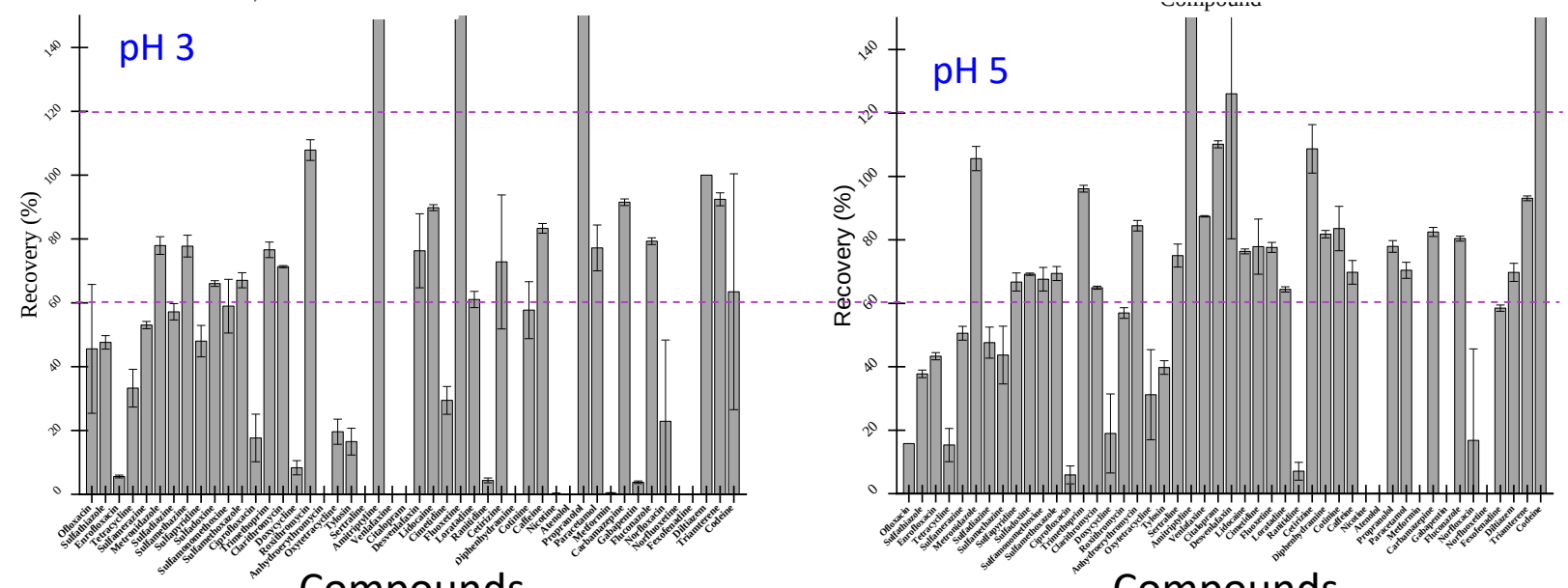

Extraction at **pH 4** allowed satisfactory recoveries of most target pharmaceuticals at 100 ng/L.

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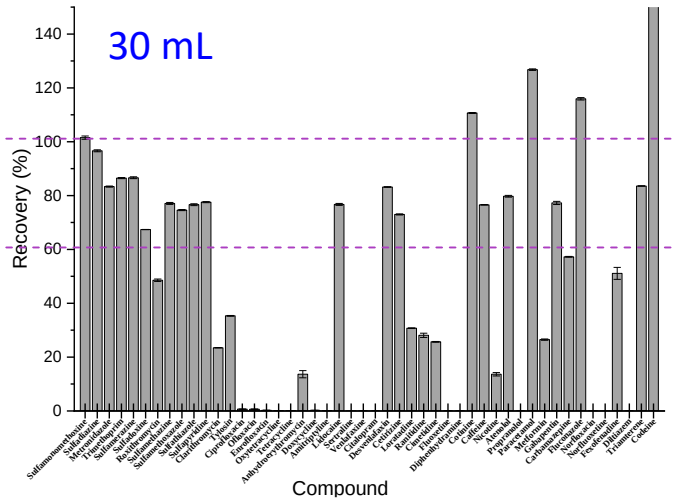
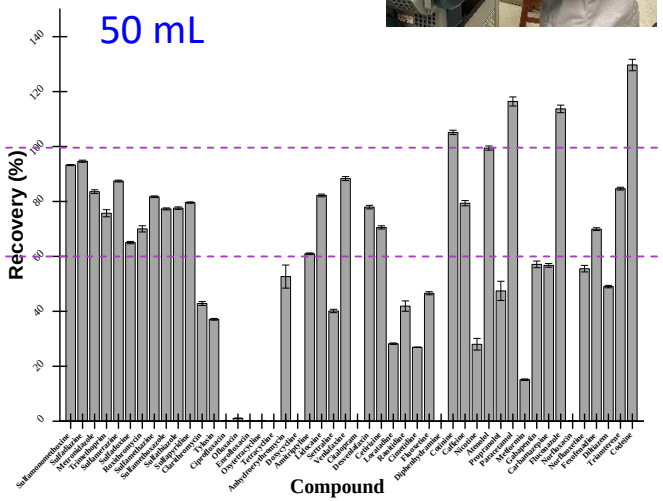
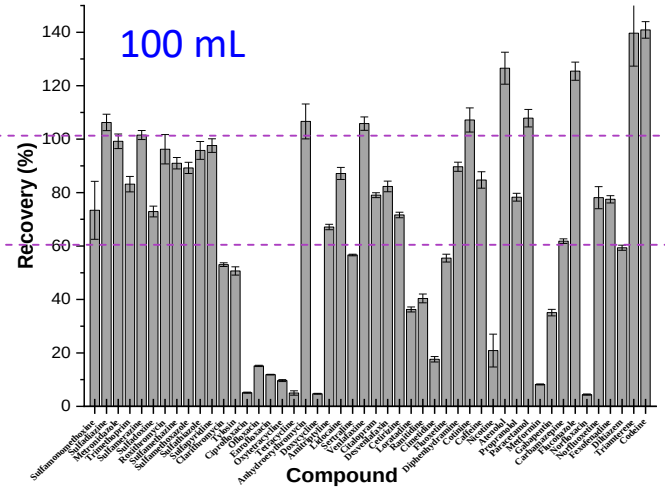
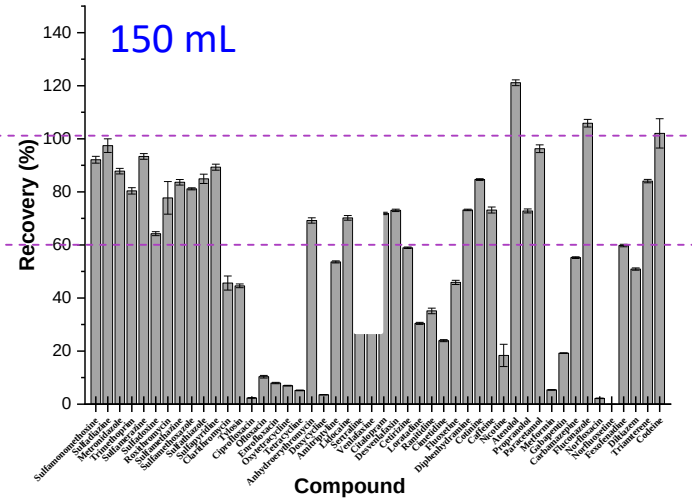
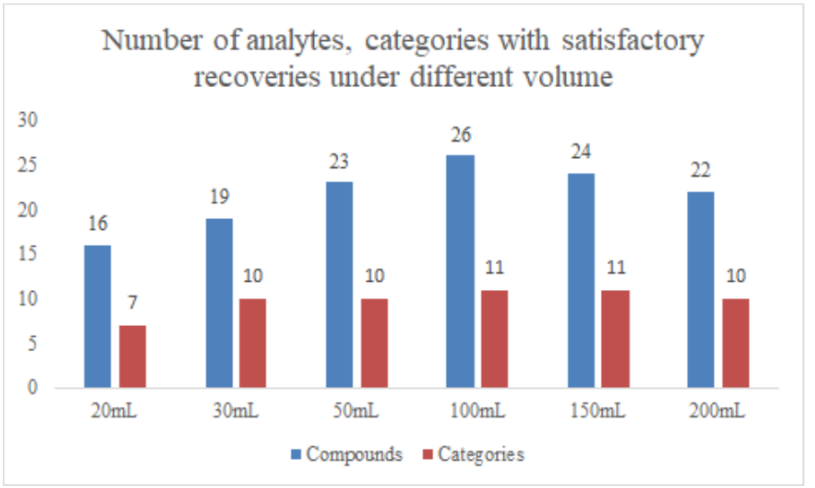
Development of Methods











(unpubl. data, Luo et al.)

- **100 mL** sample volume allowed satisfactory recoveries of most target pharmaceuticals at 100 ng/L.
- **50 mL** could also be used.

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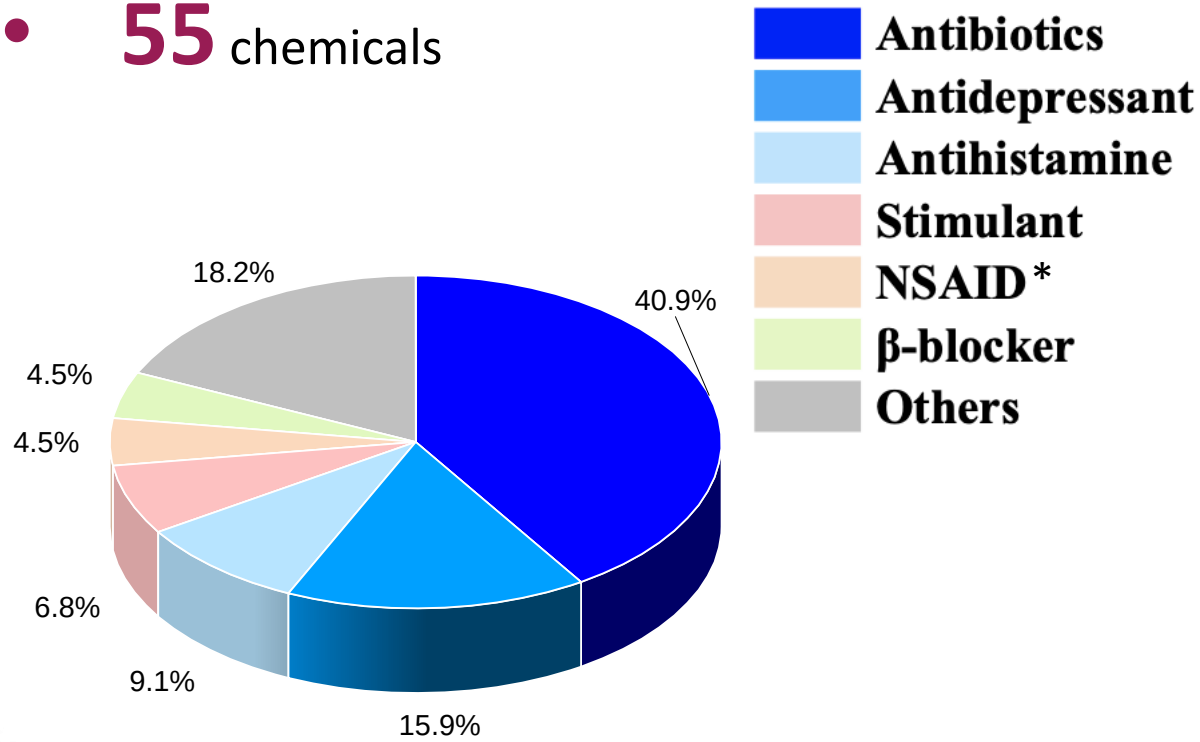
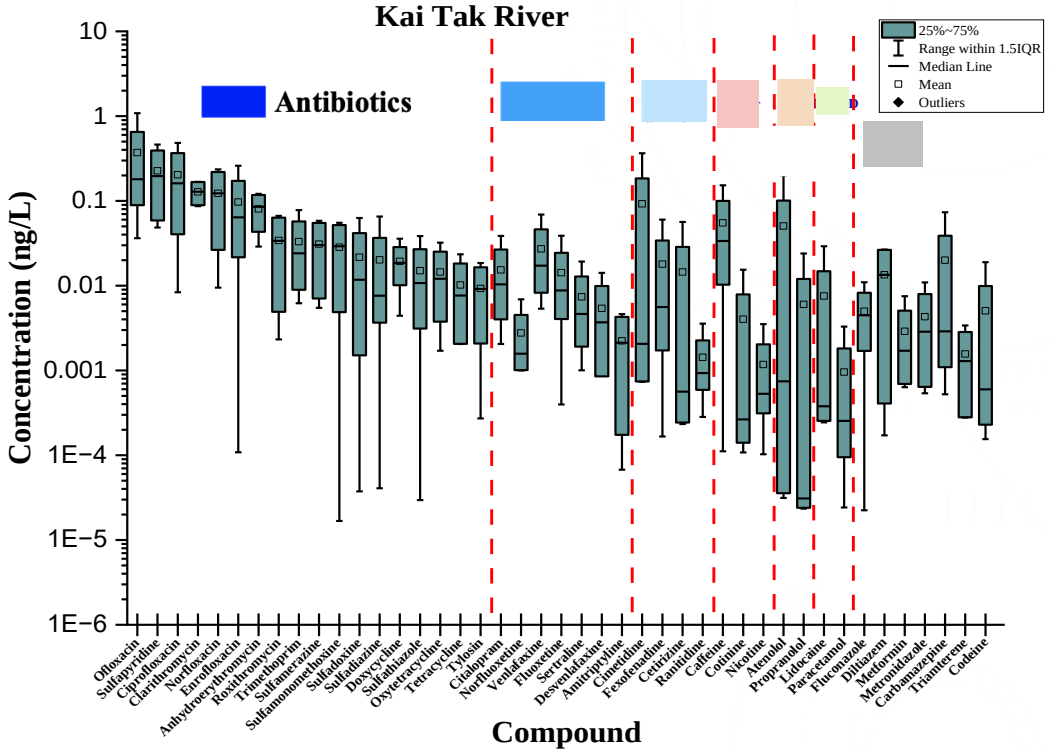
Development of Methods

LC-MS/MS method optimization

- **55** chemicals





43 kinds of pharmaceuticals were detected, compared to 34 in Kai Tak River in Wilkinson et al., 2022.

*NSAID: Non-steroidal anti-inflammatory drugs

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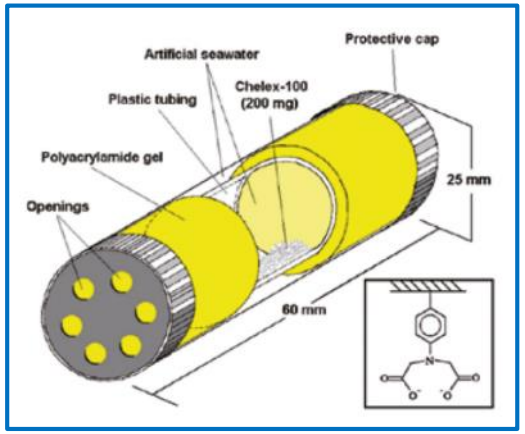
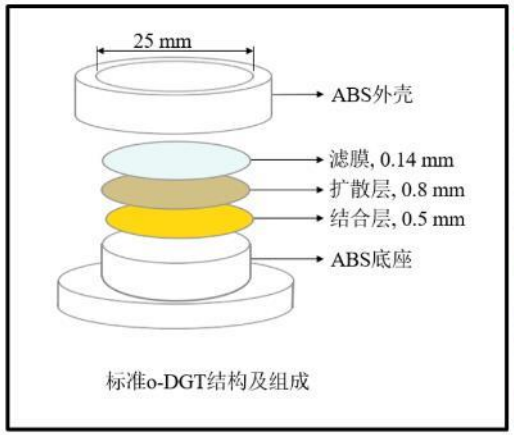
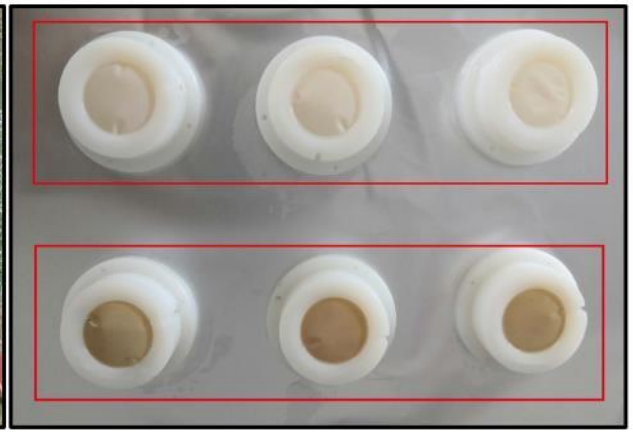
Passive Samplers and Biomonitoring

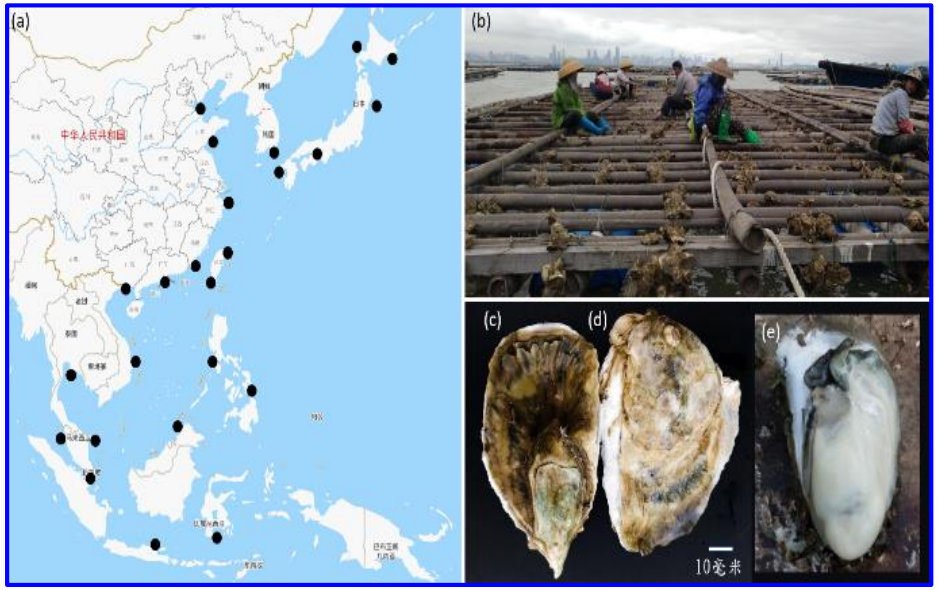


Global Artificial Mussel Watch for Metals





Applying Organic DGT for Emerging POPs



Global Oyster Watch for Micro-plastics and Chemicals of Emerging Concern

GEM – 1st Phase

Now
Method Development and call for global collaborators

Mar – Oct 2023
Sampling in southern hemisphere

Nov 2023 – Mar 2024
Sampling in northern hemisphere

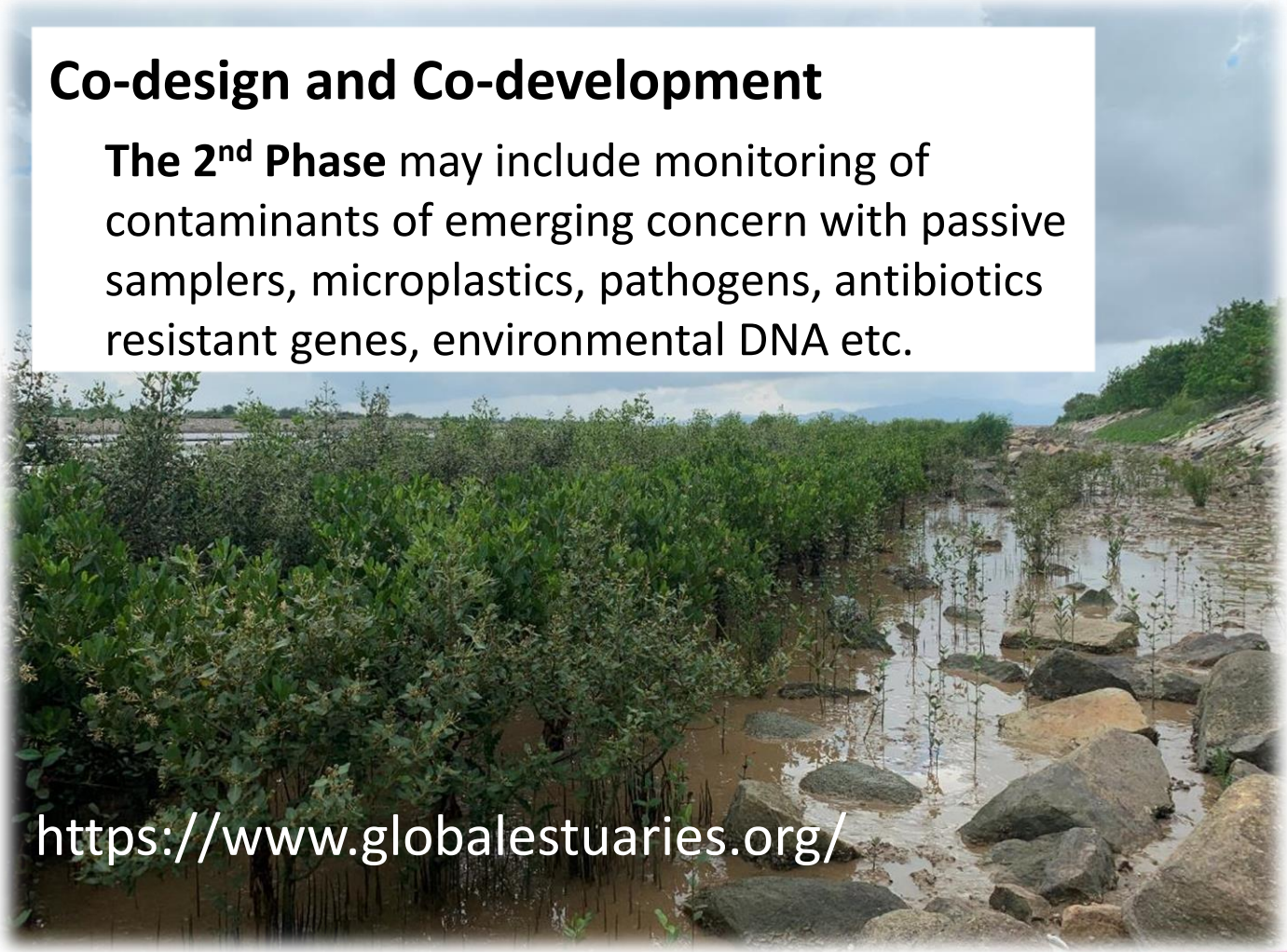
Summer 2024
Share the latest findings and co-design 2nd phase of GEM

End of 2024
Complete all data analysis

GEM – 2nd Phase

Co-design and Co-development

The 2nd Phase may include monitoring of contaminants of emerging concern with passive samplers, microplastics, pathogens, antibiotics resistant genes, environmental DNA etc.



UN Decade of Ocean Science for Sustainable Development (2021-2030)

Collaborative Centre on Coastal Resilience ?

Community of Practice (CoP-8)

Coastal Ecosystems and Communities Resilience

Decade Programme

- Ocean Cities
- Mega-Delta Programme
- GEM Programme

Open for application before 31st Jan 2023

Decade Project

Estuarine Ecological Knowledge Network

Decade Activity

2nd International Conference BECoME 2022

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The Global Estuaries Monitoring Programme

The United Nations Decade of Ocean Science for Sustainable Development (2021-2030)
Endorsed Ocean Decade Action

We are now calling for global collaboration of sampling!
Learn more and join us by scanning the QR code and visit the website:
https://www.globalestuaries.org/

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If you are interested in joining GEM or partnering with us as a Decade Action, please email us at:
sklmp.info@cityu.edu.hk

Video: https://youtu.be/iSoTgz6roKA

Concluding Remarks

- Clean estuaries are vital to marine biodiversity, fisheries resources, blue economy and also our survival.
- GEM promotes global joint effort in monitoring estuaries health, and reducing marine pollution.
- **Good science can help develop good policy and solutions**.
- With more global initiatives like those of **UN Decade of Ocean Science**, the future of our oceans is hopeful and optimistic.