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Hydro-environmental Challenges from an Asian Pacific Perspective – Are We Ready to Respond?

By

Professor Joseph Hun-wei Lee
Vice-President Designate
(Research & Graduate Studies)
Hong Kong University of Science and Technology

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Journal of Hydro-environment Research

The Journal of the International Association of Hydraulic
Engineering and Research, Asia and Pacific Division

- *Joint venture between IAHR, KWRA, IAHR-APD*
- *Financially sponsored by KWRA*
- *Brain child of a team of Asian-pacific water experts, whose vision is to provide a forum for promising young Asian researchers to develop and contribute to new knowledge and thinking on the world stage*

Accepted for SCI (Expanded)
Listing August 2010

IAHR
APH

Hong Kong and Greater Pearl River Delta



Retail sales in Greater PRD is 25% higher than Beijing & Shanghai combined

HK firms employ 10 million workers in PRD

One third of the mainland exports are from Greater PRD

GDP of Greater PRD is more than Singapore, Malaysia plus Philippines

Hong Kong and the Pearl River Delta



Water and environment challenges

- Urban flood control
- Water shortage and security
- Water pollution and sustainable environment

Engineering Challenges

- Complex inter-disciplinary problems related to sustainable development
 - Densely populated coastal cities
 - Rapid urbanisation & industrialisation
 - Climate change
 - Need for public accountability and public engagement

Public Engagement in Infrastructure Projects

“Every project that involves stakeholder participation exists in two ‘worlds’ – an outer world of the physical project and an inner world of the minds and associated social interactions of the stakeholders.”

Abbott, M. “Managing the inner world of infrastructure”, Proc. ICE 2007

It is a challenge for engineers to use predictive models and ICT to create an environment of discourse in which some congruence between these two worlds can emerge

1) Urban Flooding

Belvedere Garden, Tsuen Wan, June 2001

Smithfield Road Flooding, June 2005



*Rainfall in Hong Kong
Annual average 2200 mm
Heavy in short duration*

Flooding in Belvedere Garden on 9 June

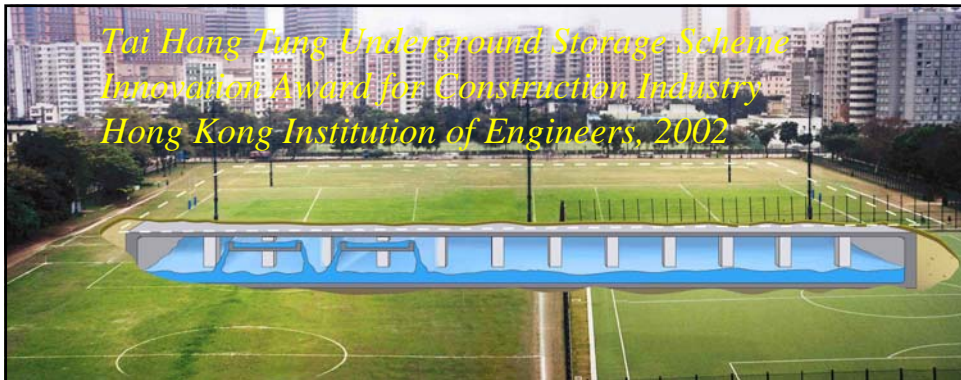


*Guinness Book of Records:
Mong Kok is the most
densely populated place on
earth, cramming in 130,000
humans per sq. km*

(78,000 persons/km² 1996-2001)

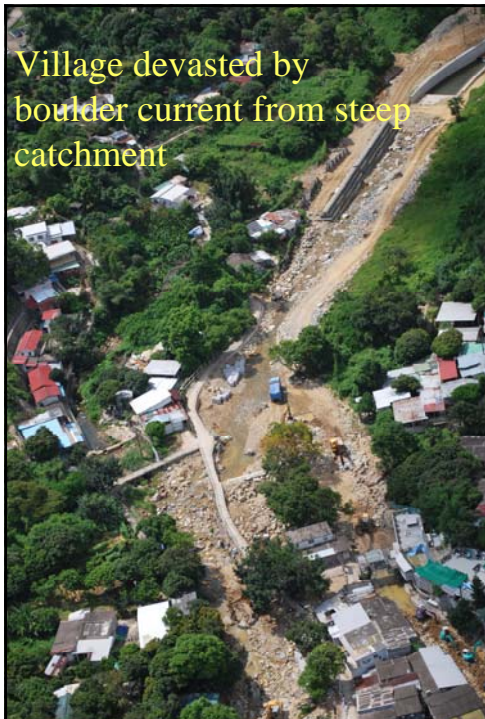


Urban Flooding (Mong Kok, West Kowloon)



- First large scale underground flood alleviation scheme in HK
- Robust, sustainable, unobtrusive, and environmentally acceptable
- Minimum use of space
- Minimum construction cost and time
- Minimum operation and maintenance cost
- Public support

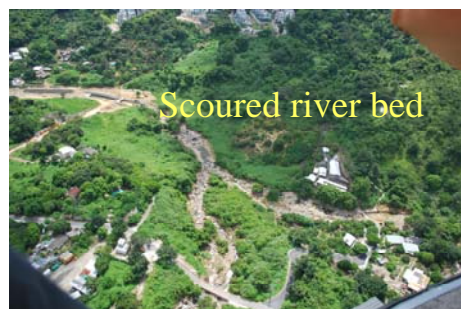
Challenges of Urbanisation
Flooding in Sha Po Tsai Village,
Tai Po, 22 July 2010



Village devastated by
boulder current from steep
catchment

Debris flood and boulder
current in Tai Po River

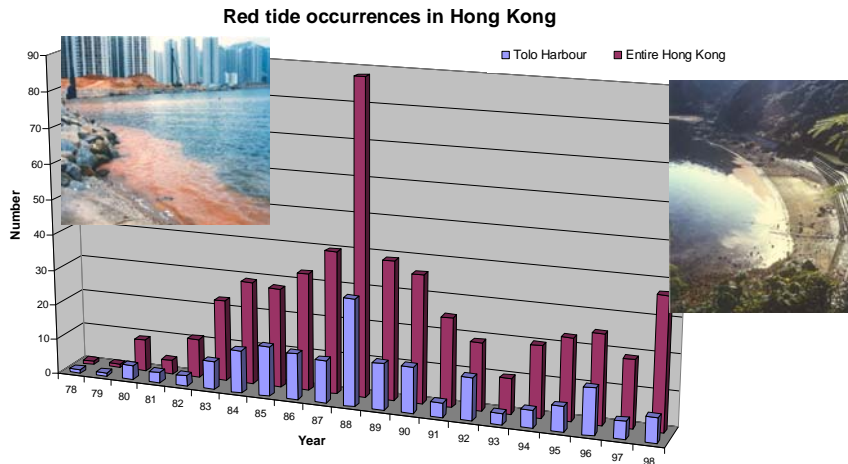
Rainfall on 22/7/2010
(225 mm/d)
114.5 mm/hr
(record maximum)



Scoured river bed

2) Eutrophication, algal blooms and red tides 水體富營養化、藻華和紅潮

Increased frequencies of harmful algal blooms, red tides, and fish kills around the world over the last decade



Red Tide and Harmful Algal Bloom (HAB)

紅潮和“有害”藻華

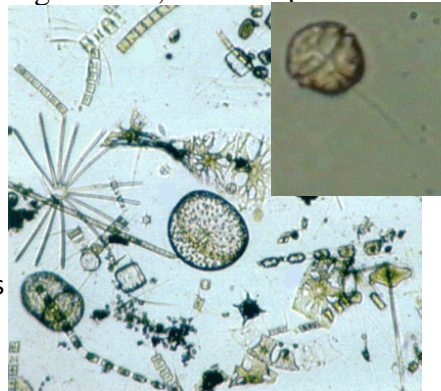
Red tide - red discoloration of the sea by micro-organisms (mainly micro-algae) 紅潮是因藻類大量生長而令海水變色的現象

Algal Bloom - rapid growth/ germination of micro-algae (phytoplankton) to concentration as high as 100,000 cells per ml

Harmful Algal Bloom (HAB)

- Oxygen depletion
- Cause shellfish to contain toxins
- Cause mass mortality of fish, invertebrates etc.
- Cause fish to contain toxins
- Cause skin or respiratory irritations

紅潮可導致魚類死亡、泳灘封閉及海產食物中毒



紅潮襲港

Massive red tide and fishkill Mar/Apr 1998

港海歷來最大型紅潮示意圖

3,400 tonnes of fish loss; HK\$312 M

*Most serious red tide in Hong Kong's history
Toxic Karenia digitata*

Massive algal bloom in Taihu lake (Apr-Jun, 2007) 2007年太湖大範圍藻華（藍潮）

- China's 3rd largest lake, with flushing time of 309 days
- Blue tide: a bloom of cyanobacteria (blue-green algae)
- The 2007 algal bloom covered 1/3 of the lake and disrupted severely the water supply system (e.g., Wuxi City).



“Pea soup” at a water intake area of Wuxi city



local residents seeking for bottled drinking water

Massive Red Tide in Mirs Bay (August 2010)



WATERMAN – a Water Quality Forecast and Management System for Hong Kong

Principal
Investigators:

Prof. Joseph Hun-Wei Lee
Principal Investigator
Department of Civil Engineering

Prof. Wenping Wang
Co-Principal Investigator
Department of Computer Science

Supporting
Organizations:



Agriculture, Fisheries
and Conservation
Department



Drainage Services
Department



Environmental
Protection
Department



Hong Kong
Observatory



Leisure and
Cultural Services
Department

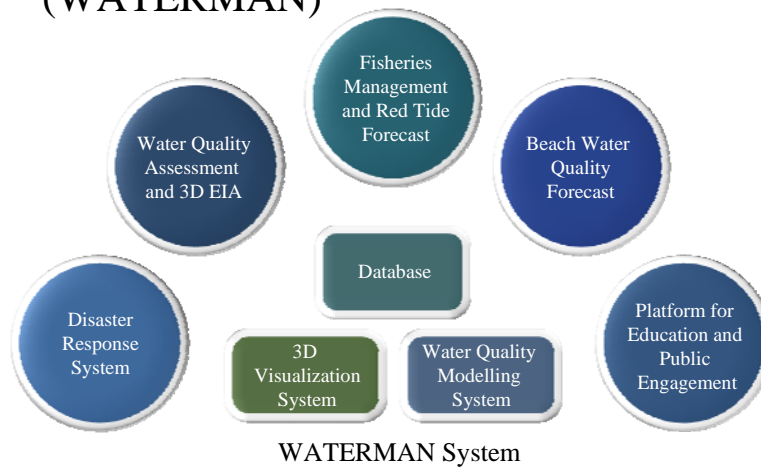
捐助機構
Funded by:



香港賽馬會慈善信託基金
The Hong Kong Jockey Club Charities Trust

Our Goal

- To develop an Internet and GIS-based water quality forecast and management system (WATERMAN)



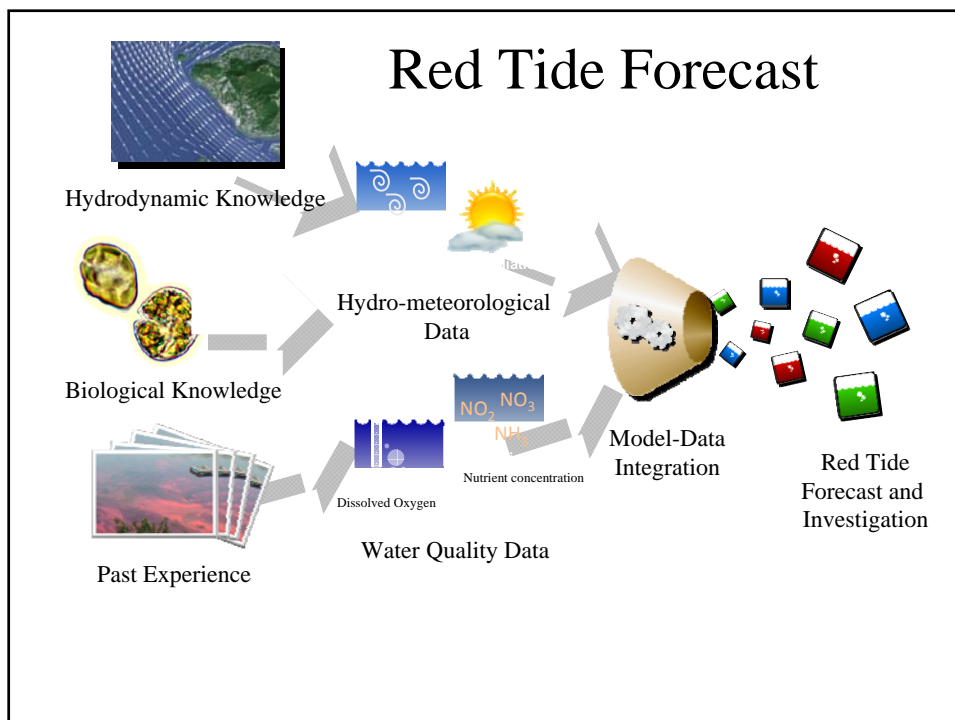
Beach Water Quality Forecast System

- Integrated data platform for beach information
- Daily beach water quality forecast
- Model-data assimilation to assist beach quality grading
- Information related to the marine environment (e.g. tide, rainfall, wind)

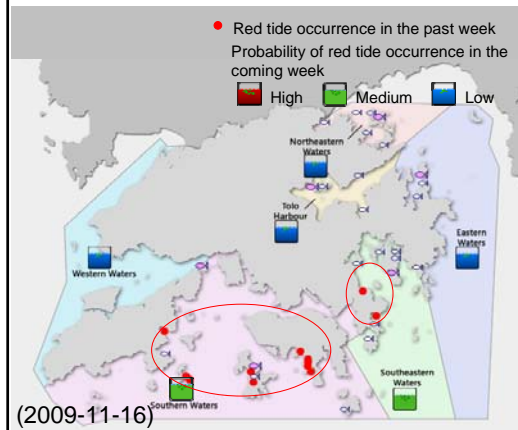


Fisheries Management and Red Tide Forecasting

- Sustainable fish farming
- Red Tide Early Warning System – minimize fish kills and optimize environmental management
- Determination of fish culture zone carrying capacity – maximize harvest



Red Tide Prediction and Alert on WATERMAN website (Nov 2009)

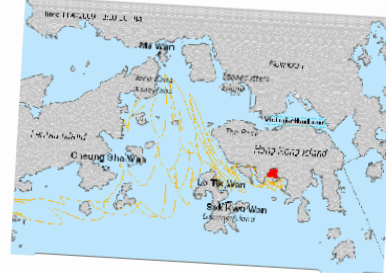


Red Tide Alert from the Agriculture, Fisheries and Conservation Department

(10th Nov 2009) Numerous were sighted in Hong Kong waters over the past few days.

A red tide was formed by *Phaeocystis globosa* was observed in Deep Water Bay on 6th November and Middle Bay on 8th November. The red tide is predicted to be transported southwest towards Lamma Island and Lantau Island affecting Silver Mine Bay Beach, Lo So Shing Beach, Hung Shing Yeh Beach, Cheung Chau Tung Wan Beach, Kwun Yam Beach, Repulse Bay Beach, South Bay Beach and Chung Hom Kok Beach.

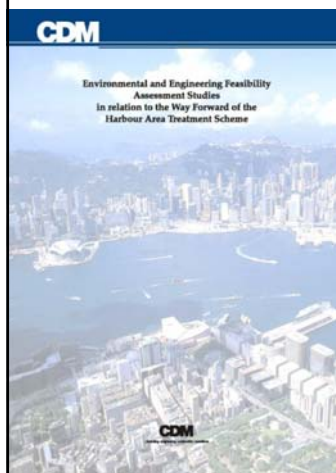
[Click here](#) to see the red tide locations and predicted red tide tracks.



3) Public engagement through virtual reality

- *Quantitative environmental impact and risk assessment;*
- *Sustainable infrastructure development*

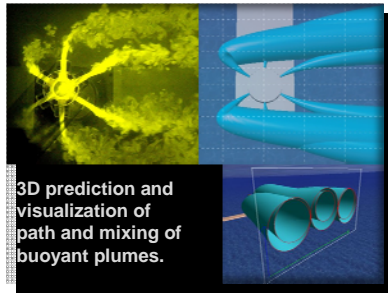
Harbour Area Treatment Scheme (HATS) Stage 1



3D Environmental Impact Assessment System

GIS-based ocean outfall design system

3D EIA from near to far field



Real time system for control of disinfection dosage
Two nearby beaches have very different bacteria levels!



Angler's
Hoi Mei Wan
Lido
Casam
Ting Kau
Approach

Harbour Area Treatment Scheme (HATS) Outfall

$Q_f = 1.6 \times 10^6 \text{ m}^3/\text{day}$ (19 m³/s)

Chemically enhanced primarily treated sewage

Faculty career advancement

- An academia dominated by citations and journal impact factors
- Universities driven by corporate management that crave for world rankings
- Faculty members under pressure to publish profusely in SCI journals
- Postgraduate students as paper mills
- Is this the route to world class university?



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裘槿水力實驗室

Citations and impact factors: pitfalls

- Need to interpret performance indicators in the proper context
- Difference in culture among different disciplines
- Academic integrity under threat
- Individual academic research perceived by society as irrelevant and low impact
- Hindrance to scientific and technological capacity building



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Engineering

- The art of approximation
- Ingenuous simple elegant solution to complex problems
- Formulation in terms of tractable models
- Can “engineering” survive in the age of citations, impact factors, and H-indices?



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Conclusion

- Water and environment problems present grand engineering challenges
- Modern engineers are needed
 - Rigorous training in fundamentals
 - Inter-disciplinary thinking
 - Curiosity and ability to understand problems in socio-economic context
 - Ability to solve complex problems with simple tractable models
- Are we ready to respond?



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