Highlights of HKU Research Activities

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THE UNIVERSITY OF HONG KONG
Highlights of HKU Activities

- Water Environment has been identified as one of HKU’s strategic research themes

- Interdisciplinary research participated by colleagues from Engineering and Social Science

- Two main areas:
  - Environmental hydraulics and hydrology
  - Water quality and treatment technologies
Environmental Hydraulics and Hydrology
Environmental Impact of Coastal Effluent Discharges

Sewage slick in Victoria Harbour

Modelling buoyant spreading in immediate field by DESA method

Top-view of a rosette jet group comparison of the near field jet trajectory

Surface gravitational spreading of a rosette jet group discharge in the intermediate field

Prediction

Laboratory Observation

Prediction

Laboratory Observation
Forecasting Risk of Algal Blooms/Red Tides in Semi-enclosed Coastal Waters

Decision model for predicting algal bloom occurrence

- Start
- Difusivity < Critical Turbulence?
  - Y
    - Nutrient > Threshold?
      - Y: Blooms likely
      - N: Blooms unlikely
  - N

Algal Bloom Risk Map
Vortex Intakes for Urban Stormwater Drainage

Air core in dropshaft

Tangential vortex intake
Flash Flooding in Hong Kong

- to investigate the roles of basin topography, soil, land cover, and drainage area on flash flood runoff generation
- to conduct an experimental field study for establishing relationships between rainfall intensity-duration and flash flood hydrographs at a time step in minutes
- to couple the rainstorm forecast system of the HKO with the numerical scheme for forecasting flash floods in real time with an aim to improve the accuracy and effectiveness of flash flood warnings in Hong Kong.
Climate Change and Urbanization in Pearl River Delta

1. to investigate the features of climate change and urbanization in the PRD
2. to examine the features of future climate change through evaluating the regional details of climate projections for the rest of the 21st century with the different scenarios
3. to study the trends of floods and droughts in the PRD for the rest of the 21st century

Global land surface Tmean & Regional Tmean in South China

South China mean temperature compared with global mean temperature (1960 – 2005)

Regional Climate Projection


South China Climate Variables in rural and urban areas
Integrated Physical and Ecological Management of the East River

Water Quality Index

\[ WQI = 0.01 \left( \sum_{i=1}^{n} W_i Q_i \right)^2 \]

Shanon – Weiner Index

\[ H = -\sum_{i=1}^{n} \frac{n_i}{N} \ln \left( \frac{n_i}{N} \right) \]
Integrated Physical and Ecological Management of the East River

- Hydrological Simulation Program
  - Streamflow calibrated by field data
  - Pollution loading inputs
  - Hydro-meteorological input, i.e. evaporation, rainfall, wind, temperature, dew point, solar radiation, cloud cover
  - Water quality parameters
- Class 2 water quality standard
  - $\text{BOD}_5 = 3 \text{ mg/L}$
  - $\text{NH}_4^+ = 0.5 \text{ mg/L}$

- Water supply $Q_s - 150 \text{ m}^3/\text{s}$
- River habitat $Q_2 - 76 \text{ m}^3/\text{s}$
- Sea water intrusion $Q_4 - 150 \text{ m}^3/\text{s}$
- Water quality $Q_1 - 317 \text{ m}^3/\text{s}$
- Navigation $Q_3 - 210 \text{ m}^3/\text{s}$

Minimum East River Flow for sustainability

$= Q_s + \text{Max} (Q_1, Q_2, Q_3, Q_4)$

$= 150 + \text{Max} (317, 76, 210, 150) = 467 \text{ m}^3/\text{s}$

This daily flow is exceeded with a frequency of only 55%
WATERMAN
Water Quality Forecast and Management System for Hong Kong
Water Quality and Treatment Technologies
Bio-Energy Production from Wastewater
Bio-Hydrogen Production from Wastewater

- micro-structure of bio-aggregate
- interactions of bacteria and EPS

Photo-biohydrogen production

Bacteria and EPS in hydrogen-producing biogranules
Biofilm in Drinking Water Distribution System

DWDS flow simulators

A new bacteria *Bacillus macaensis* isolate from drinking water

Bacteria and EPS in drinking water
Emerging Pollutants in Wastewater and Water

- Antibiotics
- Antibiotic resistance gene
- Endocrine disrupters
- Perfluorocompounds (PFCs)
Biodegradation of Endocrine Disrupters
Saline Wastewater Biological Treatment and Electrochemical Disinfection

New species: *Salibacillus hongkongensis*
Biofilm and Bio-corrosion

\[ \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{EPS (C}_6\text{H}_{10}\text{O}_5) \]

\[
\begin{align*}
\text{Fe(III)-EPS} & \quad \text{e}^- \\
\text{Fe} & \quad \text{Fe}^{3+} \\
\text{Cathode} & \quad \text{Anode} \\
\text{Steel} & \quad \text{Pit}
\end{align*}
\]
Bio-fouling in Membrane Bio-reactors for Wastewater Reclamation

- foulants - biopolymer clusters (BPC)
- fouling mechanisms
- anti-biofouling strategies
- cost-effective strategy for wastewater reuse
Bioremediation of Sediment

- Increase in Mobility and Bioavailability

<table>
<thead>
<tr>
<th>Exchangeable</th>
<th>Bound to Carbonates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced,</td>
<td>Bound to Fe/Mn oxides</td>
</tr>
<tr>
<td>Oxidizable,</td>
<td>Bounds to Sulfide or Organic</td>
</tr>
<tr>
<td>Residual</td>
<td></td>
</tr>
</tbody>
</table>

- SO$_4^{2-}$, NO$_3^-$, S$^2-$, N$_2$, CH$_2$O, CO$_2$
Particle Dynamics for Water Quality Modeling

- Particle dynamics, fate and transport of particulate pollutants in waters
- Achievement:
  - Characterization of particle interactions and aggregations
  - Modeling of particle dynamics in water
Novel Photocatalysts for Pollutants Degradation

- **Bathochromic Shift**
  - (Visible-Light Active)
  - Cr, Co, N...
  - PN junction
  - Nanocomposite

- **Delay e/h+ Recombination**
  - (High Efficiency)
  - Nd, Pd, Pt, Au, Ag...
  - Binary phases
  - Quantum dots
  - Nanowires

**Catalyst Synthesis**
- Doping Methods
  - (Durability & Activity)
  - Sol-gel, CVDs
  - Micro-emulsion
  - Ion Implantation
  - Nanocrystallites
  - Nanostructures

**Choices of Supporting Materials**
- (Operation, Durability, Economy & Efficiency)
  - Oxides, Zeolites, Silicates, Glass, Thin films, porous materials

- **Durability & Activity**
Thank You!