Continuous monitoring and modelling of cyanobacteria dynamics in urban lakes
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Continuous monitoring and modelling of cyanobacteria dynamics in urban lakes

Application to Lake Enghien, France and Lake Pampulha, Brazil

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Granada, June 16th 2011
OUTLINE

- Cyanobacteria monitoring
- Proliphyc project
  - Measurement buoy
- Lake Enghien
  - Monitoring
  - Modelling
- Lake Pampulha
  - Monitoring methodology
  - Integrated modelling approach
  - Expected results
- Conclusions
LIMITS OF THE USUAL MONITORING

- Cyanobacteria monitoring
  - How it is usually done
  - How we propose to do it

Leesu (2010)
BENEFITS OF HIGH-FREQUENCY MONITORING

French protocol (European WFD)

- 4 sampling campaigns/year
  - Including 3 during the summer
- 3 weeks = minimum interval between the campaigns

![Box plot showing chlorophyll-a concentration (μg L⁻¹) for different months: F-M, A-M, J-J, A-S. The plot includes upper quartile, median quartile, lower quartile, and outliers.](image)
PROLIPHYC PROJECT

- A measuring buoy
  - High-frequency data (15-30 min)
  - Data teletransmission (daily)

- Warning system
  - Based on the weather forecast and buoy measurements
  - Short-term predictive modelling (1 week)
LAKE ENGHIE-N-LES-BAINS

- 41 ha, mean depth = 1.5 m
- Rainwater storing, sport, landscape
- Inappropriate wastewater discharges
- *Planktothrix agardhii* blooms
MODELLING

- DYRESM-CAEDYM model (Centre for Water Research, University of Western Australia)
- 1 phytoplankton group: cyanobacterium *Planktothrix agardhii*
- Model calibration and validation

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![Graph showing Chl-a concentration over time for Lake Enghien](image_url)
DYCD RESULTS

- Model results show good agreement with measurements
- High frequency data → thorough assessment of results
  - Gal et al. (2009); Burger et al. (2008); Hornung (2002)
  - Medium-term simulations, hourly time step

Calibration period 1-16 June 2009

- Water Temp. (°C)
  - $r = 0.92$
  - $\text{rmse} = 0.9°C$

Validation period 2-16 July 2009

- Water Temp. (°C)
  - $r = 0.97$
  - $\text{rmse} = 0.6°C$

- Cyanobacteria chla (µg L$^{-1}$)
  - $r = 0.96$
  - $\text{rmse} = 15.6 \mu g L^{-1}$

- Cyanobacteria chla (µg L$^{-1}$)
  - $r = 0.74$
  - $\text{rmse} = 19.8 \mu g L^{-1}$

Depth: 0.75 m
Lake Pampulha

- Belo Horizonte, Minas Gerais, Brazil
- 197 ha, 10 hm³, 5,0 m (mean depth)
- Former drinking water source

Urbanization + no sanitation infrastructure + no erosion control

Lake silting and storage capacity reduction

- Cyanobacteria blooms and macrophyte growth
- Touristic spot
  - Fishing, sailing, landscape
WATERSHED AND LAKE MONITORING

- High frequency data*
  - Two main tributaries and lake outlet:
    - Rain gauges
    - Flow rate
    - Temperature, conductivity and turbidity
    - Automatic samplers: nutrients and dissolved oxygen

- Measurement buoy:
  - Temperature, conductivity, pH, $O_2$ and chl-a

- Meteorological forcing: INMET

*MAPLU project: Funded by FINEP (Brazilian Research Agency)
INTEGRATED APPROACH

- Watershed hydrological model + Lake ecological model

Why a modelling approach?
INTEGRATED APPROACH

- Watershed hydrologic model + Lake ecological model

Lake response x Different scenarios of watershed evolution: Land-use changes, impervious area expanding…
LAKE ECOLOGICAL MODEL

- Belo Horizonte municipality data
- Cyanobacteria species:
  - Nostocaceae, Microcystis wesenbergii, Sphaerocavum sp.
- Cyanobacteria modelling: on-going
CONCLUSIONS

- Lake Enghien
  - Warning system
  - High frequency lake monitoring
  - Cyanobacteria dynamics modelling
  - Few data about the catchment

- Lake Pampulha
  - Management tool
  - High frequency watershed monitoring in progress
  - High frequency lake monitoring from September/2011
  - Cyanobacteria dynamics modelling preliminary results
  - Watershed modelling and scenarios
THANK YOU FOR YOUR ATTENTION!

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