Continuous monitoring and modelling of cyanobacteria dynamics in urban lakes
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To cite this version:
Talita Silva, Brigitte Vinçon-Leite, Bruno J. Lemaire, Bruno Tassin, Martin Seidl, et al.. Continuous monitoring and modelling of cyanobacteria dynamics in urban lakes. 2nd IWA Symposium on Lake and Reservoir Management, Jun 2011, Grenade, Spain. hal-00674661

HAL Id: hal-00674661
https://hal-enpc.archives-ouvertes.fr/hal-00674661
Submitted on 28 Feb 2012

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Continuous monitoring and modelling of cyanobacteria dynamics in urban lakes

Application to Lake Enghien, France and Lake Pampulha, Brazil

Talita Silva, Brigitte Vinçon-Leite, Bruno Lemaire, Bruno Tassin, Martin Seidl, Nilo Nascimento

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
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
**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)

[Image of a measuring buoy and various environmental sensors such as atmospheric pressure, chlorophyll-a, dissolved oxygen, water temperature, pH, depth, solar radiation, rainfall, wind speed, relative humidity of air, and meteorological sensors.]

[Link to website: http://leesu.univ-paris-est.fr/proliphyc]
LAKE ENGHFIEN-LES-BAINS

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

(Escoffier 2008)
MODELLING

- DYRESM-CAEDYM model (Centre for Water Research, University of Western Australia)
- 1 phytoplankton group: cyanobacterium *Planktothrix agardhii*
- Model calibration and validation
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 chl-a (μg L$^{-1}$)

- $r = 0.96$
- $\text{rmse} = 15.6 \mu g L^{-1}$

- $r = 0.74$
- $\text{rmse} = 19.8 \mu g L^{-1}$

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 × 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

![Graph showing temperature and cyanobacteria data over time]
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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