

# Hydrogen peroxide in mitigation of cyanobacteria – experiments with water from 11 European lakes

Hans C.P. Matthijs†, J. Merijn Schuurmans, Maria G. Antoniou, Luc Brient, Christine Edwards, Fatma Gurbuz, Iwona Jasser, Latife Koker, Jussi Meriluoto, Jelica Simeunovi , Zorica Svir ev, Elena Stoica, Gabor Vasas, Irma Vitonyte, Veerle M. Luimstra, Erik F. J. Weenink, Petra M. Visser

Ljubljana 2 Dec 2016

# Dutch pioneers

WATER RESEARCH 46 (2012) 1460–1472



ELSEVIER

Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

SciVerse ScienceDirect

journal homepage: [www.elsevier.com/locate/watres](http://www.elsevier.com/locate/watres)



## Selective suppression of harmful cyanobacteria in an entire lake with hydrogen peroxide

Hans C.P. Matthijs<sup>a,1</sup>, Petra M. Visser<sup>a,\*,1</sup>, Bart Reeze<sup>b</sup>, Jeroen Meeuse<sup>c</sup>, Pieter C. Slot<sup>a</sup>, Geert Wijn<sup>b</sup>, Renée Talens<sup>b</sup>, Jef Huisman<sup>a</sup>

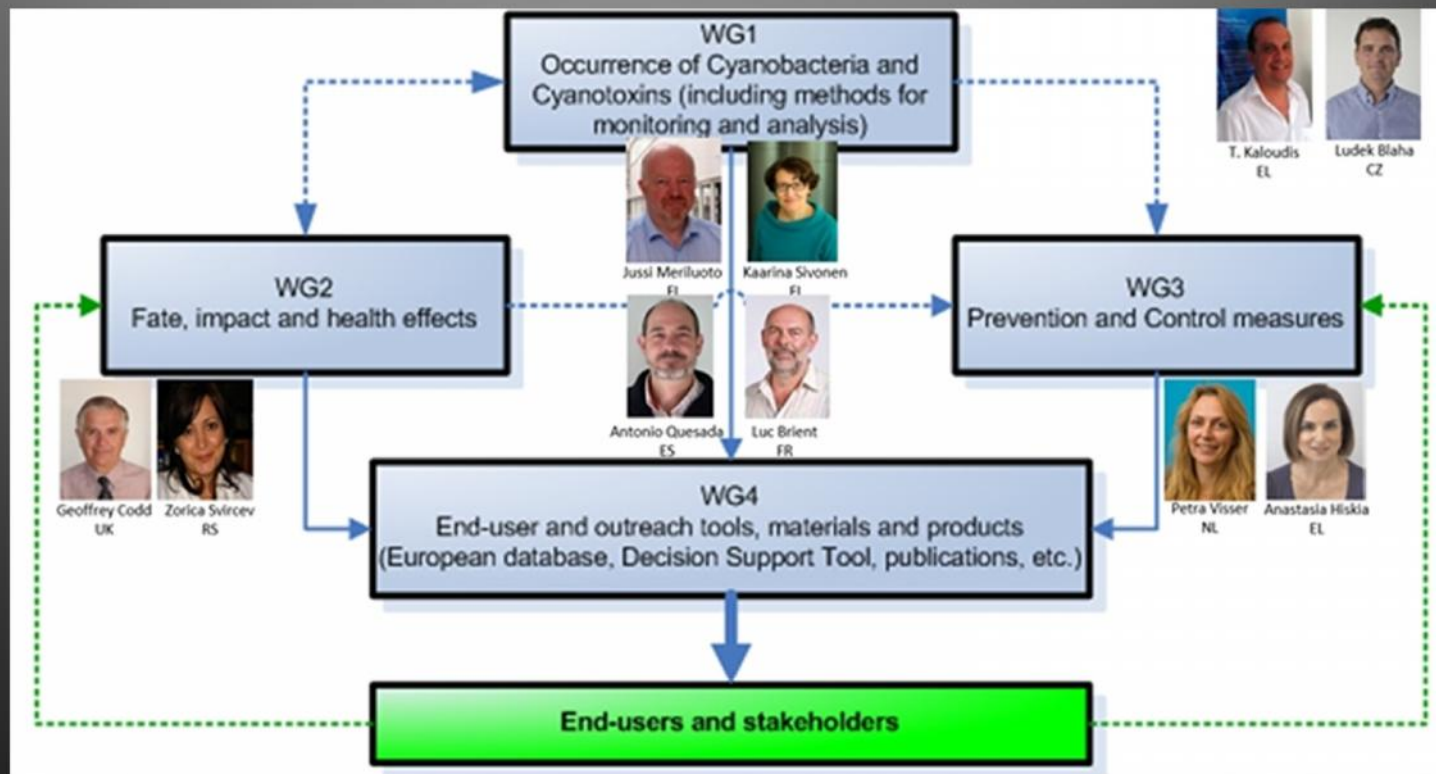
<sup>a</sup> Aquatic Microbiology, Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, P.O. Box 94248, 1090 GE Amsterdam, The Netherlands

<sup>b</sup> ARCADIS Nederland BV, P.O. Box 673, 7300 AR Apeldoorn, The Netherlands

<sup>c</sup> Waterschap Hunze en Aa's, P.O. Box 195, 9640 AD Veendam, The Netherlands



European Cooperation in Science and Technology, COST Action ES 1105 “CYANOCOST—Cyanobacterial blooms and toxins in water resources: Occurrence, impacts and management”



# Amsterdam September 2014 Hydrogen peroxide training school



# Objective of the study

- The main objective was to test the usefulness of the H<sub>2</sub>O<sub>2</sub> method for the treatment of cyanobacterial populations from a variety of lakes.
- Samples from 11 different European lakes were collected and treated simultaneously at the University of Amsterdam during a training school organised by the CYANOCOST Action.

-

#	Lake, Location	Country	Dominant species
1	Polemida Dam	Cyprus	<i>Microcystis sp.</i>
2	Lake Köyliönjärvi	Finland	<i>Dolichospermum (Anabaena), Microcystis, Planktothrix</i>
3	Rennes	France	<i>Woronichinia naegeliana , Aphanizomenon flos aquae, Anabaena</i>
4	Fancsika	Hungary	<i>Cylindrospermopsis raciborskii</i>
5	Sirvys	Lithuania	<i>Planktothrix agardhii</i>
7	Lubiaskie	Poland	<i>Planktothrix</i>
8	Ciuperca	Romania	<i>Planktothrix</i>
10	Ludas	Serbia	<i>Microcystis aeruginosa</i>
12	Kovada	Turkey	<i>Microcystis aeruginosa, M.wesenbergii</i>
17	Szeged pond	Hungary	<i>Anabaena spiroides Planktothrix sp.</i>
25	Burdur	Turkey	<i>Nodularia</i>

# Methods

- The lake waters were treated with various  $\text{H}_2\text{O}_2$  concentrations (2-50 mg/L). Samples were taken at 0, 1, 2, 4 and 24 hours, filtered on glass fiber filters and the photosynthetic yield, an indicator of the vitality of the phytoplankton, was measured with a mini-PAM instrument directly on the filters.
- The residual  $\text{H}_2\text{O}_2$  was measured with a spectrophotometric assay based on the formation of di-nitrophenol from *p*-nitrophenyl boronic acid.
- The vitality of zooplankton and moving phytoplankton was followed microscopically.

# Results

- The optimum dose of  $\text{H}_2\text{O}_2$  varied from lake to lake.
- $\text{H}_2\text{O}_2$  degraded readily, in a few hours, in the lake waters.
- Adequate  $\text{H}_2\text{O}_2$  addition caused a loss of cyanobacterial photosynthetic yield quickly.
- Morphological changes (disintegration of colony structure) were observed with *Microcystis wesenbergii*.
- The dosing of  $\text{H}_2\text{O}_2$  at  $>5$  mg/L caused damage to zooplankton and at higher doses also to moving phytoplankton.



# Conclusions

- It is generally recommended to use 2-5 mg  $\text{H}_2\text{O}_2$  per litre, which is efficient against cyanobacteria and not harmful to other plankton.
- However, cyanobacteria in some of the tested waters were not killed by the use of  $\text{H}_2\text{O}_2$  at the recommended dosing as shown by the photosynthetic vitality remaining at a high level.

# Steps for successful hydrogen peroxide treatment

1. Knowledge of the effects of hydrogen peroxide and its safe use on organism and ecosystem level.
2. Pretreatment analyses of water samples.
3. Right timing and right dosing of the treatment (before high bloom density, avoidance of damage to other biota).
4. Functional equipment for the dispersion of hydrogen peroxide.
5. Follow-up of treatment effects (lysis of cells, released toxins => field and laboratory analyses).

Major challenge in H<sub>2</sub>O<sub>2</sub> treatments: how to treat all the cyanobacterial population in a (stratified) lake -- or is it enough to treat only part of the lake???

Spatial and depth variation of cyanobacteria and their toxins