Ultrasonic control of cyanobacteria in lakes and reservoirs -7FP DRONIC-

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Univerza v Ljubljani

SEVENTH FRAMEWORI PROGRAMME

36. Goljevščkov spominski dan
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DRONIC
USV for Ultrasonic Water Treatment

DRONIC (http://dronicproject.com)

- Type: Collaborative project
- Duration: January 2014 - June 2016
- Project cost: € 3,273,879
- EC funding: € 2,199,820
- 8 beneficiaries
  1. LG SONIC, Netherlands
  2. ACSA, France
  3. CNRS, France
  4. SEPTENTRIO, Belgium
  5. VITO, Belgium
  6. UL, Slovenia
  7. MINISTRY OF AGRICULTURE, Cyprus
  8. SCOTTISH WATER, United Kingdom

Cyanobacteria (blue-green algae)

- Aquatic, photosynthetic organisms
- One of the largest and most important groups of bacteria
- Usually unicellular, though they often grow in colonies large enough to see
- They occupy a broad range of habitats across all latitudes, widespread in freshwater, marine, and terrestrial ecosystems

Cyanobacteria blooms

- Occurence when natural ballance is disturbed
- Bioactive substances production (e.g. cyanotoxins, volatile organic compounds)
- Helath risk to humans and animals

DRONIC system

- A new, innovative cyanobacteria monitoring and treatment robotic system
- Prevention and abatement of harmful algae blooms in lakes and in inland water reservoirs used for drinking water production by
  1. Localization of hotpots of algae blooms
  2. Ultrasonic treatment of algae blooms

DRONIC system

1. Master USV
   - Sampler
   - Sensors (temperature, oxygen, turbidity, redox, chlorophyll-a, phycocyanin)
2. Slave USV
   - Electro-acoustic system consisting of an ultrasonic transducer and an electronic generator
3. Web-based viewer to assess and map water quality

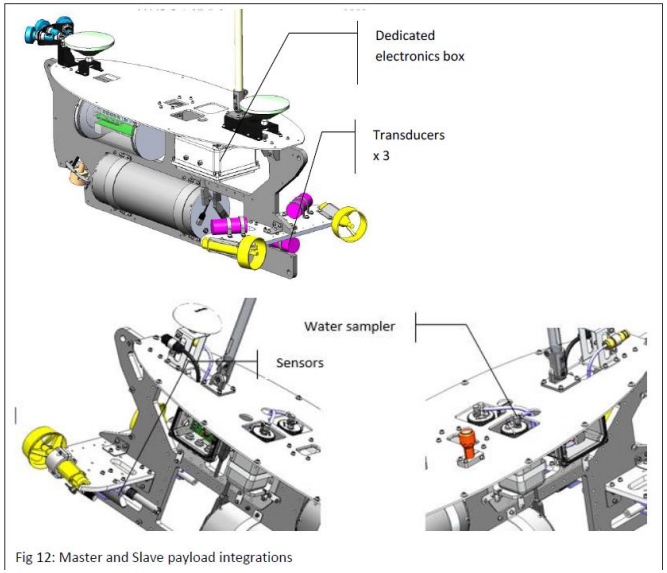
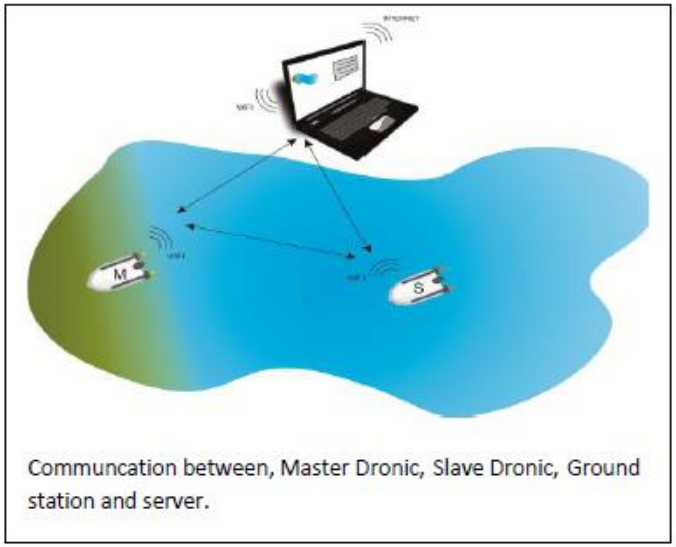


Fig 12: Master and Slave payload integrations



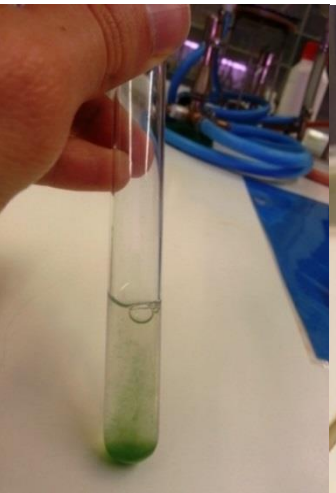
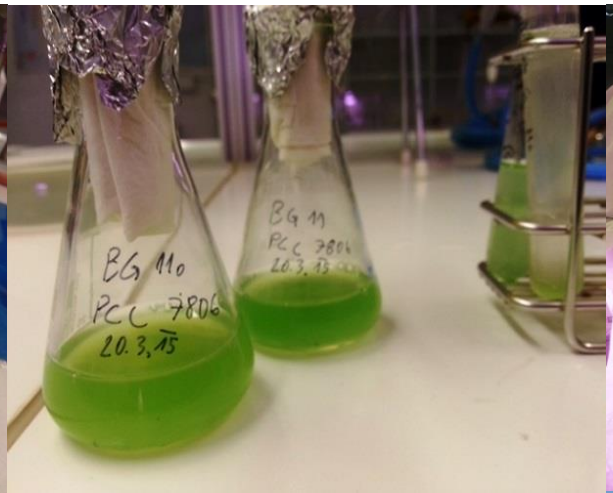
Communcation between, Master Dronic, Slave Dronic, Ground station and server.

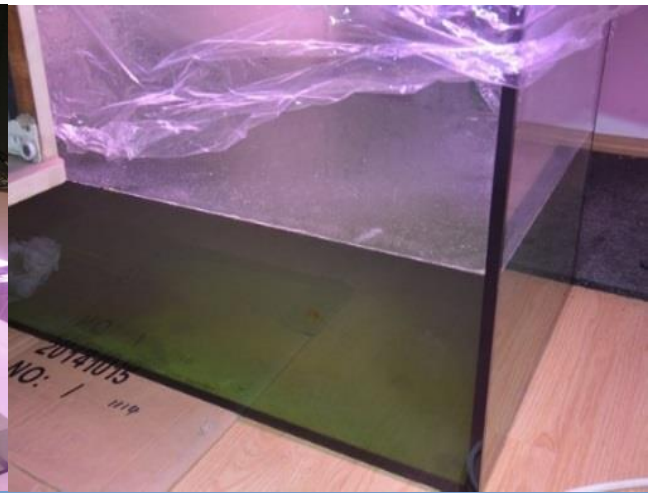
Electro-acustic system

- LG SONIC, Netherlands
- Piezoelectric ceramic based transducers
- Broad radiation pattern
- Two individual working programmes
  1. Low frequency of 25 kHz with high power input
  2. High frequency of 100 kHz and cavitation

Testing of the electro-acusting system

- In the big volume setting simulating reservoir or lake
- With the use of strain of *Microcystis aeruginosa*, one of the most common bloom-forming cyanobacteria in Europe
- At high *M. aeruginosa* density conditions simulating cyanobacterial bloom

Experimental set-up (1)

- Custom-made PVC foam pond: width 70 cm, length 180 cm, height 45 cm, volume 350 L, coated with PVC foil to ensure water tightness
- Illumination with FLUORA lights 33W/77 (Osram, Germany), 60 µmol photon/m^2/s in 16/8 hours day-night intervals



Experimental set-up (2)

- Dense *M. aeruginosa* culture was diluted to 10^6 cells/mL by adding fresh nutrient medium BG11
- Diluted *M. aeruginosa* culture was transferred into the PVC pond for US treatment
- US device was immersed into *M. aeruginosa* culture and switched on for 48 hours

US device

Analyses and sampling intervals

- Cell counting
- Chlorophyll a
- Cell growth inhibition test
- Microcystin concentration (HPLC)

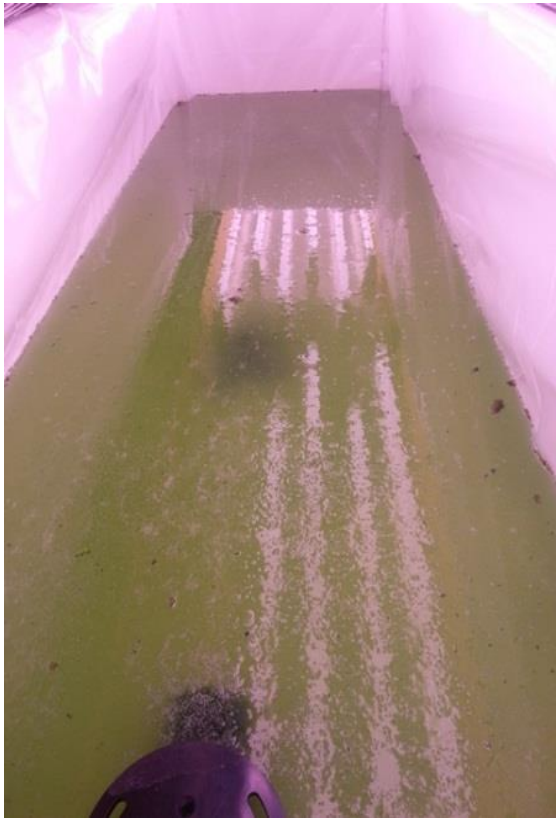
1st trial:

- **t0: before US treatment**
- **t1: after 15 minutes of US treatment**
- **t2: after 60 minutes of US treatment**
- **t3: after 300 minutes of US treatment**
- **t4: after 24 h of US treatment**
- **t5: after 48 h of US treatment**

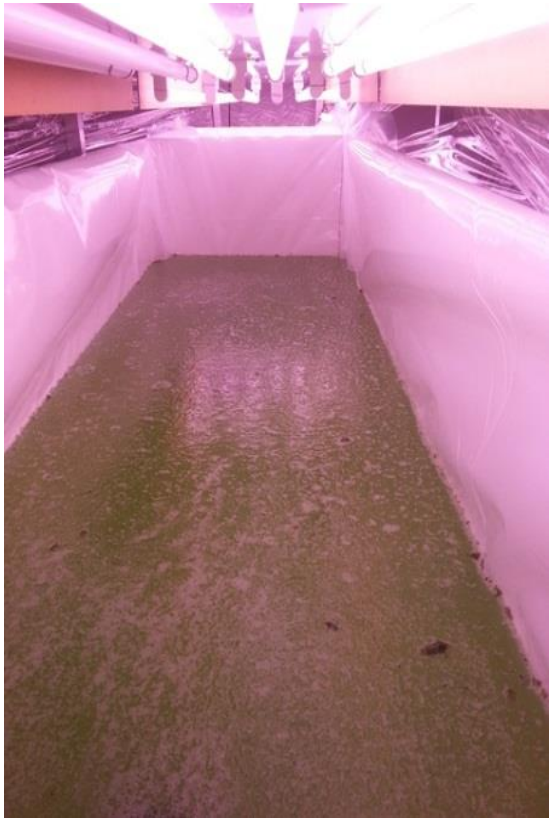
Results - visual observations

Before US treatment

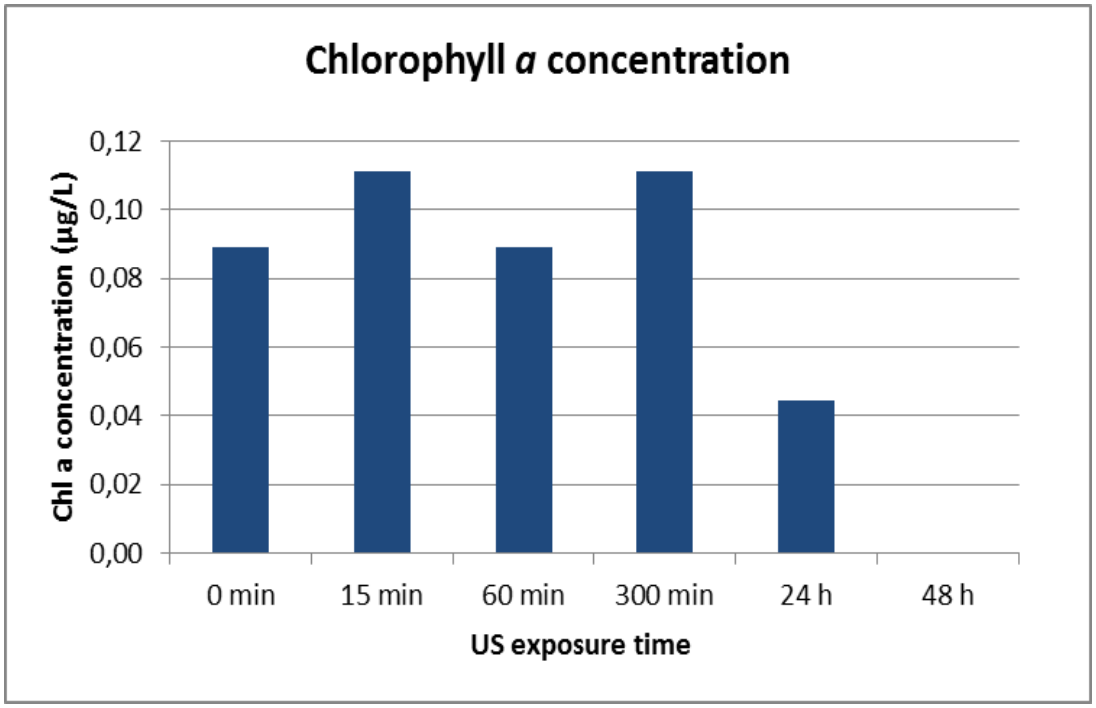
After 24 h



After 48 h

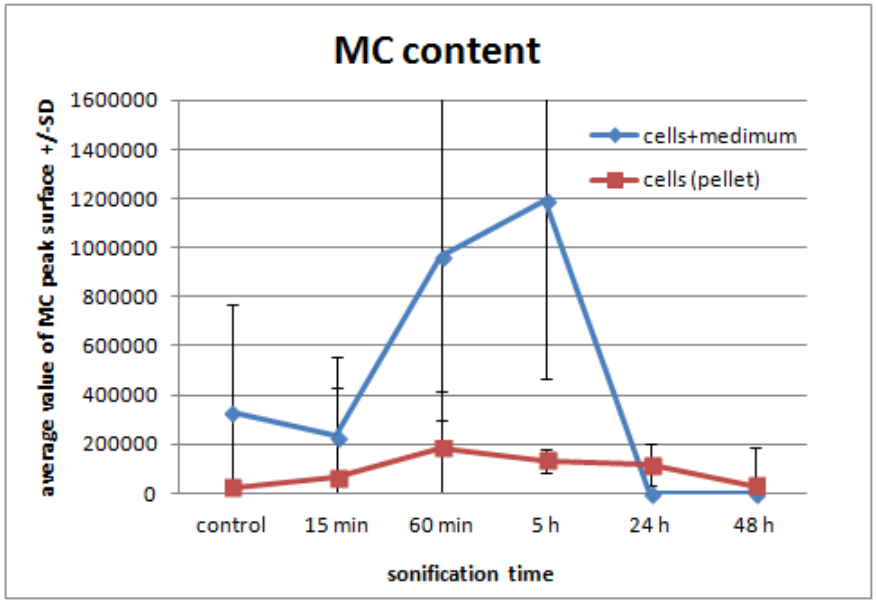


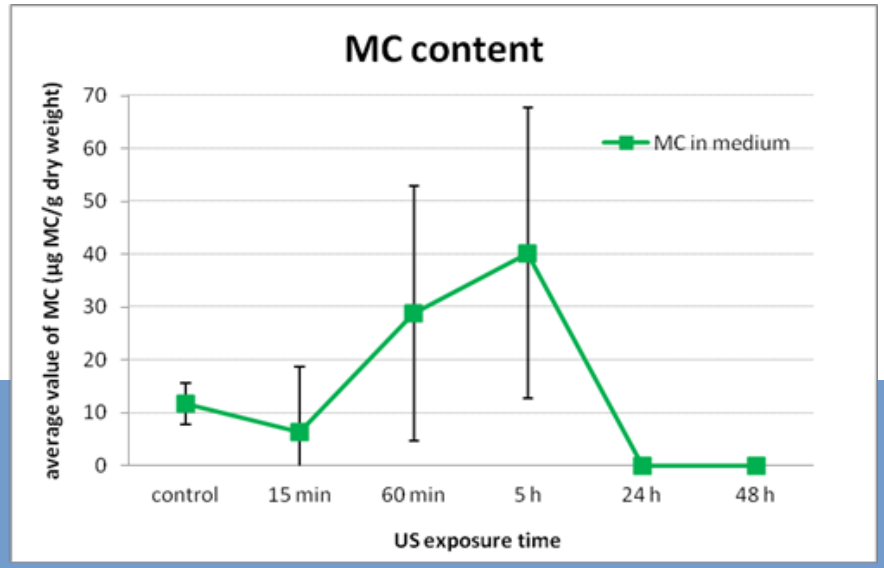
Results – cell concentration



Algal cells sank to the bottom of the pond

Results – microcystins (MC)

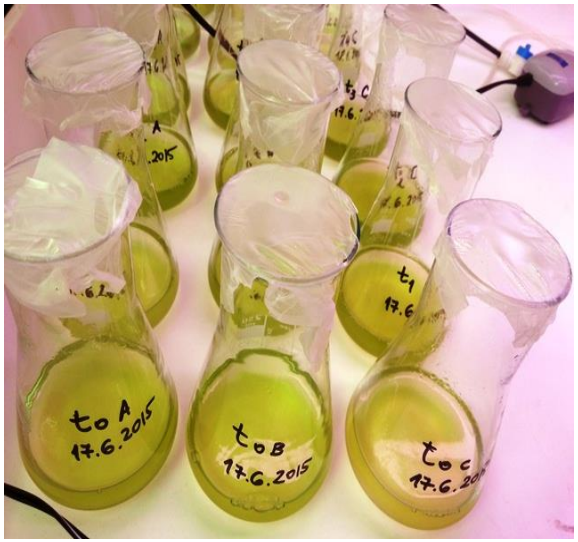




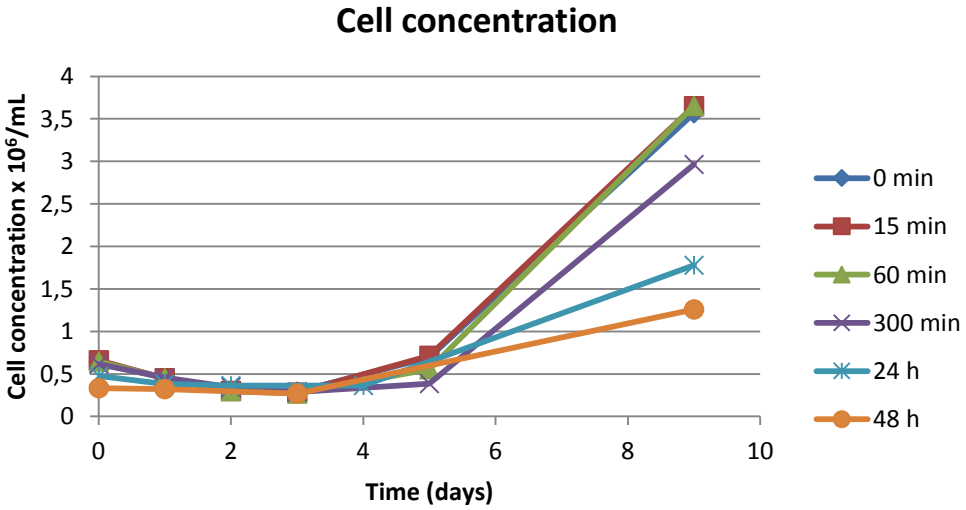
- Increase of dissolved MC concentration after 5 h of US treatment
- After 24 h MC concentration was uder HPLC detection limit
- MC content in the cells more or less constant

Results – growth inhibition

Day 0



Day 9



- In all US treated samples growth was inhibited for first 3 days
- US treatment longer than 300 min (5 h) inhibited algae growth
- Longer US treatment higher growth inhibition

Conclusions

- US treatment had effect on *M. aerugionosa* cells if they are treated continously for at least 5 h
- Longer is US treatment higher reduction of *M. aeruginosa* can be achieved
- After 5 h of US treatment 30% decline of MC concentration can be achieved
- It can be assumed that in natural conditions US will effect *M. aeruginosa* cells much quicker due to gas vacuoles colapse and sinking of the cells

http://dronicproject.com/

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