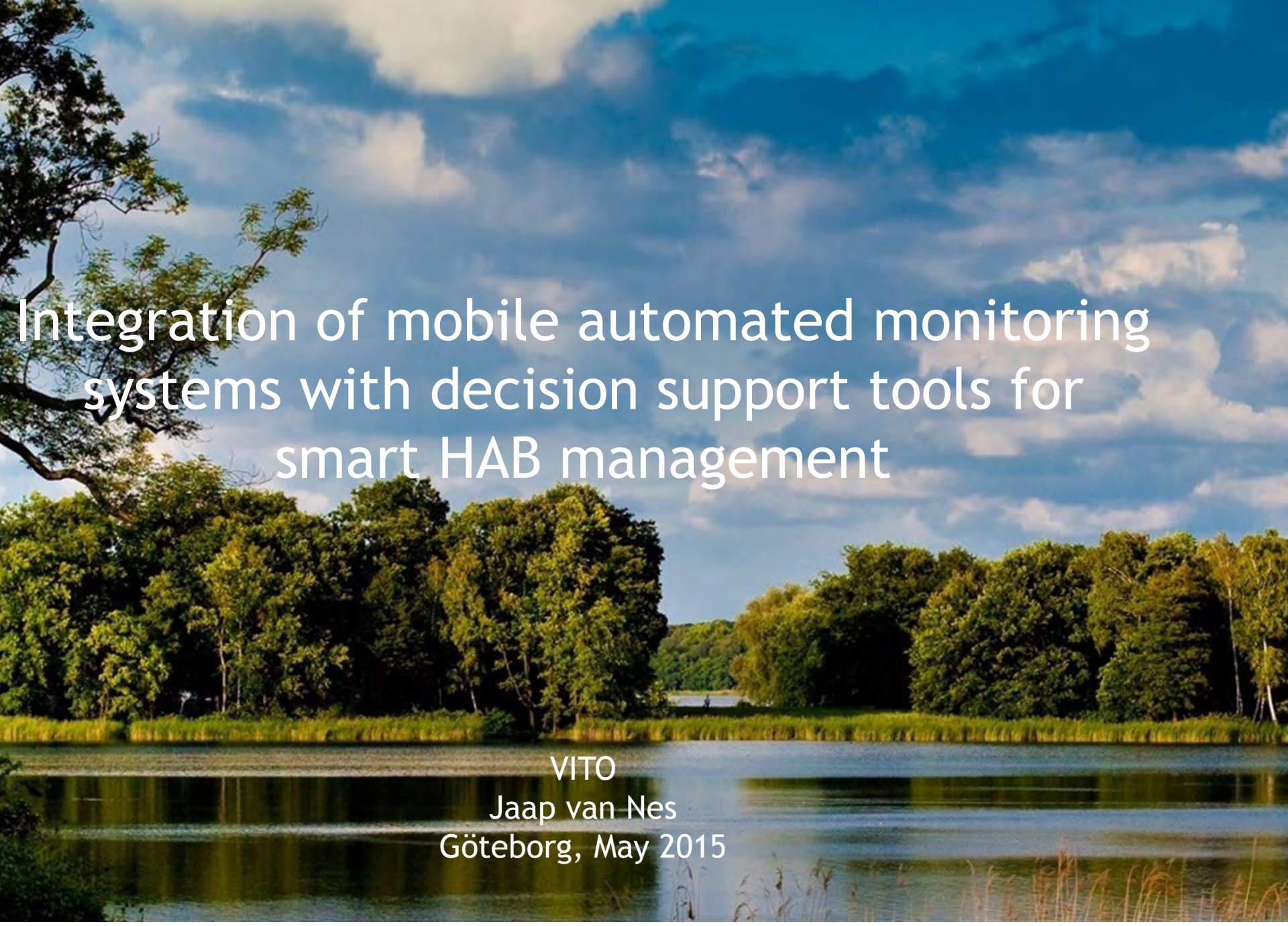
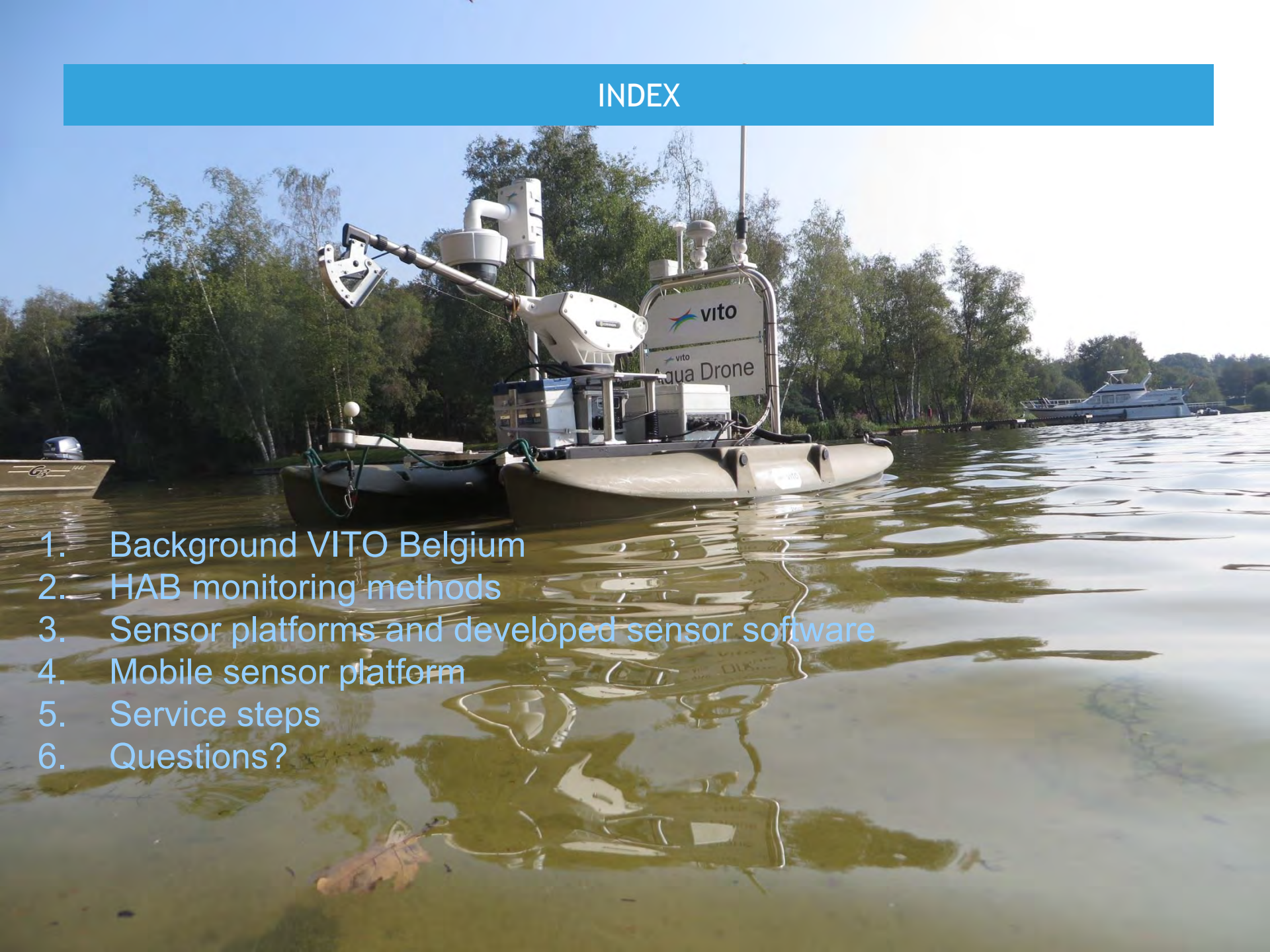


Integration of mobile automated monitoring systems with decision support tools for smart HAB management

VITO
Jaap van Nes
Göteborg, May 2015

INDEX



1. Background VITO Belgium
2. HAB monitoring methods
3. Sensor platforms and developed sensor software
4. Mobile sensor platform
5. Service steps
6. Questions?

INTRODUCTION

- *Activities of VITO's land & water team*: study spatial environmental aspects in soil, groundwater and surface water by monitoring, modelling and risk assessment.
- *HAB*: cyano monitoring in surface water, data management, visualization and interpretation through sensor techniques on km scale for water boards, recreational lakes and drinking water companies.

- *Topic*: a general overview of VITO's operational experience with sensor monitoring systems for cyano bacteria in fresh/brackish water reservoirs.

vito

1. VITO: A RESEARCH & TECHNOLOGY ORGANIZATION

- Foster innovation:
  - -To improve quality of life
  - -To build economic competitiveness.

- Bring together key players across the whole innovation chain.

vito

1. VITO: NUMBERS

- 750 researchers
- 26 nationalities

» Headquarters in Belgium (5 Locations)

» Subsidiary in China

» 1000 research projects

» More than 500 research partners

» More than 400 patents worldwide

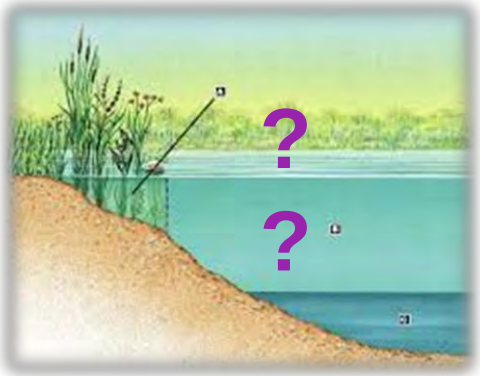
» 200 scientific articles (2014)

» € 140 M turnover in 2014

2. HAB MONITORING: WHERE AND WHEN?

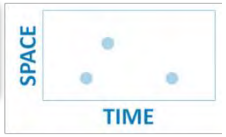
Many variables to consider:

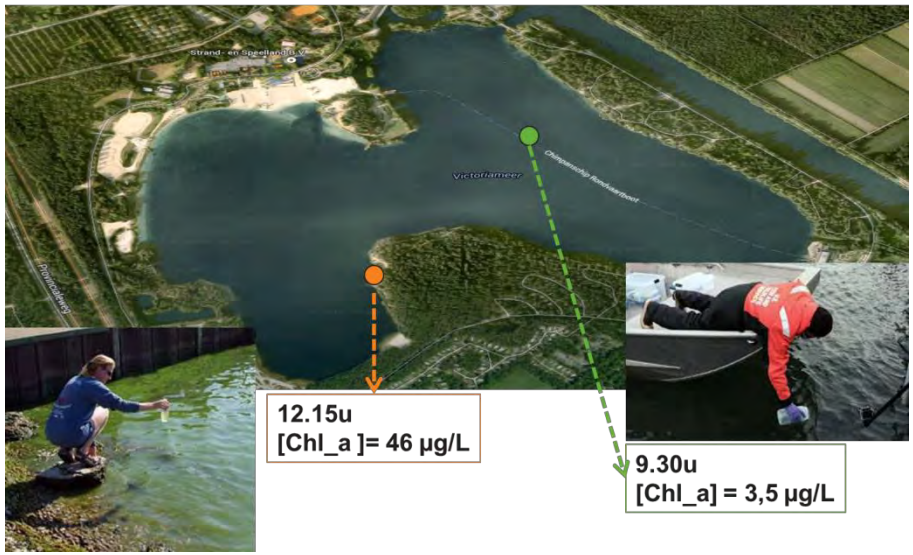
- ❑ Sun, shadow, precipitation?
- ❑ Open water, close to shores?
- ❑ Wind direction and velocity?
- ❑ Spatial variation, patterns?
- ❑ Temporal variation trends?
- ❑ Distance to emission sources?
- ❑ Water and sediment depth?
- ❑ Insight and system knowledge
- ❑ Available budget
- ❑ Targeted management.



A) Spot sampling

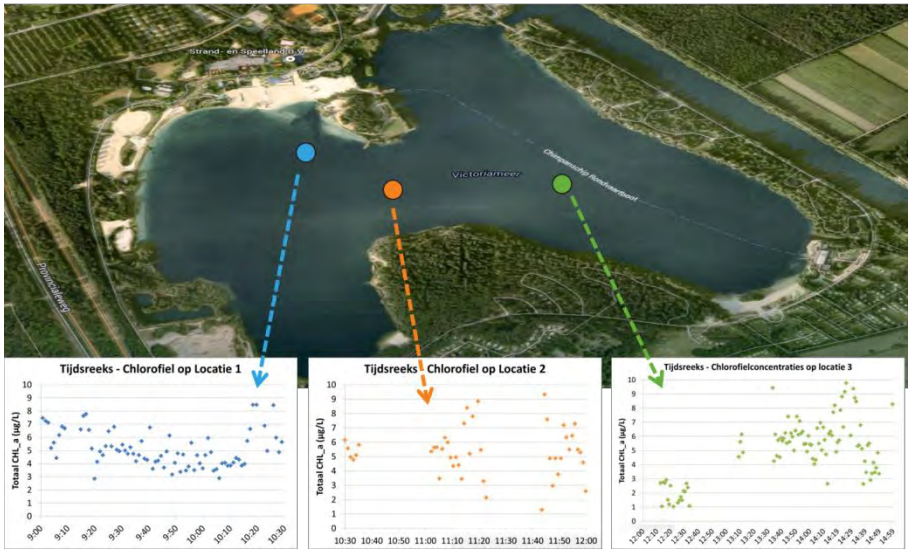




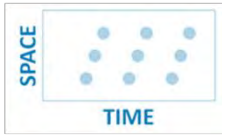


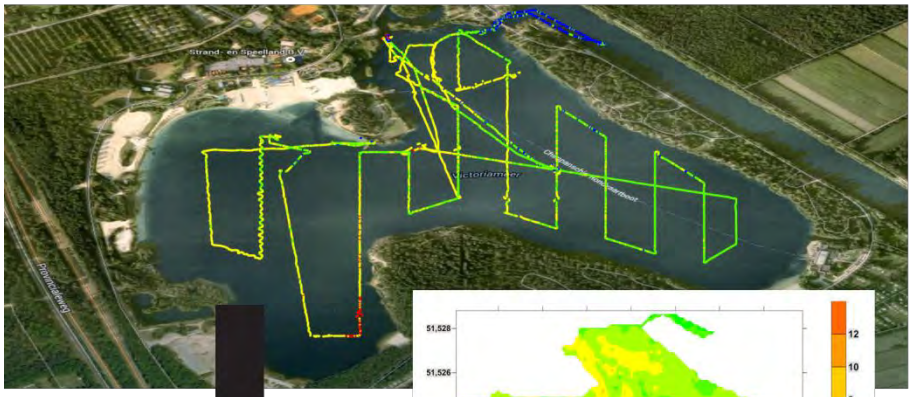
B) Fixed sensors



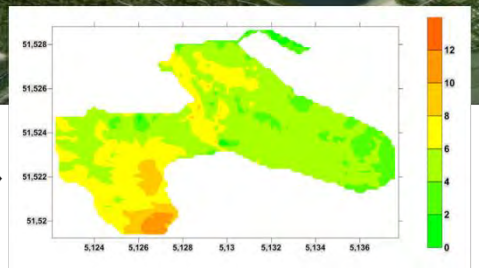


C) Mobile sensor platform

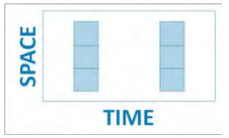



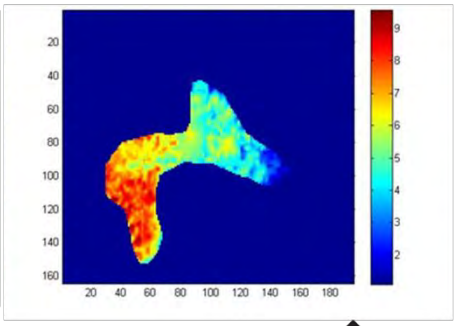


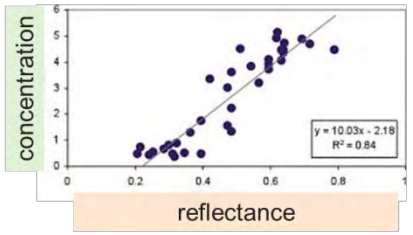
Interpolatie



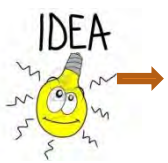
D) Earth observation





3. DEVELOPMENT PROCESS OF SENSOR SOFTWARE *SENSORVIEW*



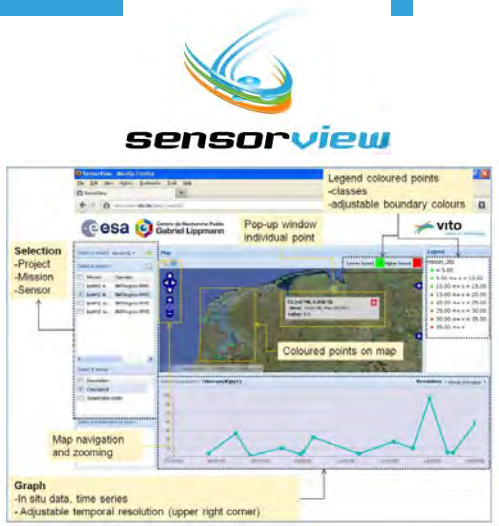
2008

2009

2010

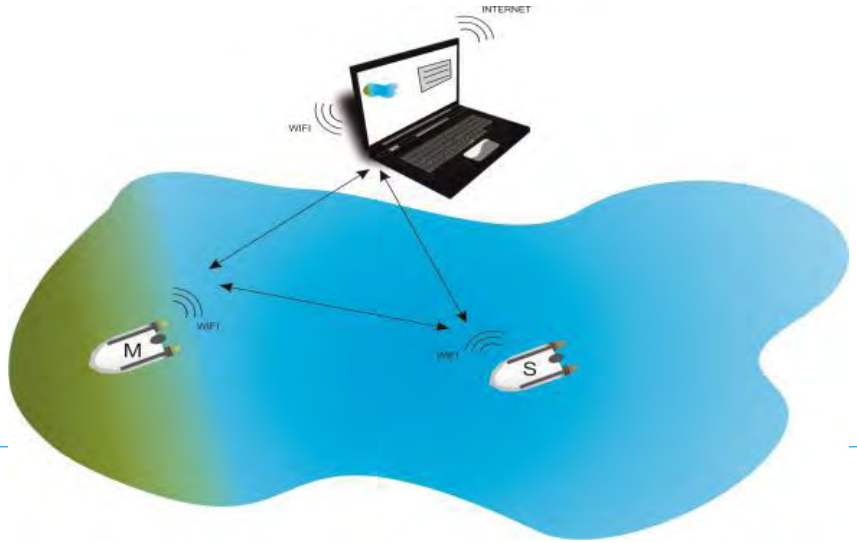
2011

2012



2013

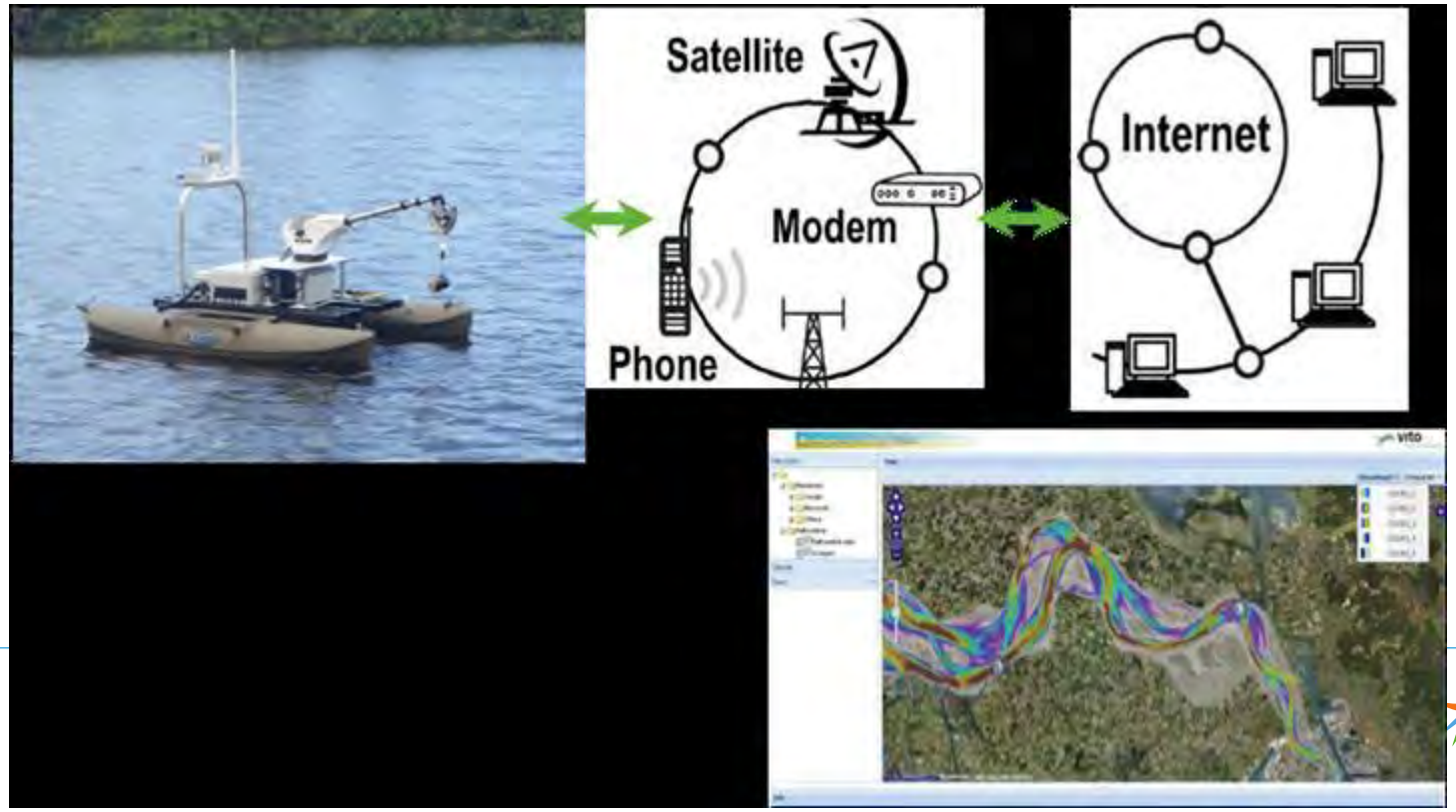
2014



vito

3. DEVELOPED SOFTWARE FOR SENSOR MONITORING

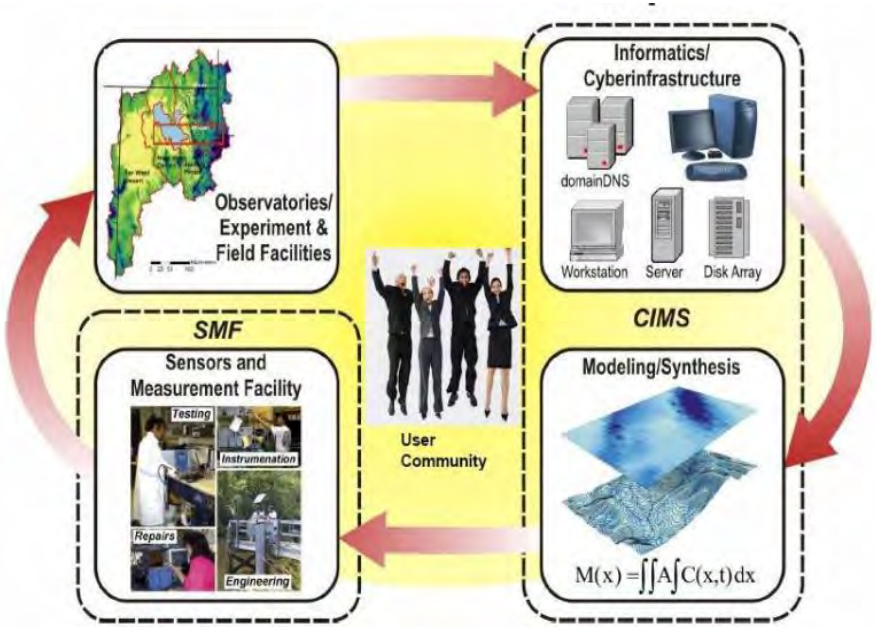
- VITO developed within an ESA (EU Space Agency) funded program the Sensorview software and assembled the Unmanned Surface Vessel Aqua Drone.
- The unique approach of Sensorview is the architecture around the integration of data collection, mobility, (near) real time data processing, data visualization and interpretation.
- The general architecture for Aqua Drone with 4D mapping services:

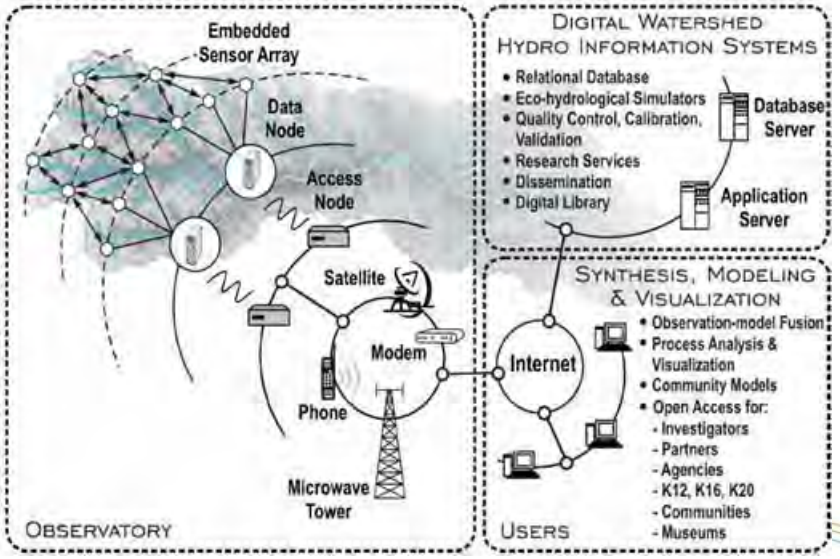


3. SENSORVIEW SOFTWARE

"Smart" software
for water quality analysis:

- Data quality assurance
- Screening/Alarm setting
- From data to information
- From information to decision support
- (VITO-wide) expertise with sensors →client support.



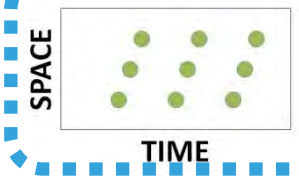


vito
vision on technology

4.MOBILE AUTONOMOUS SENSOR PLATFORM: AQUA DRONE

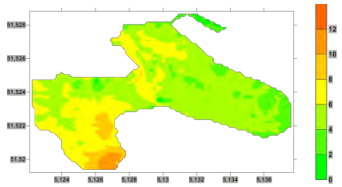
- Points in time & space:
  Spot samples + lab analysis

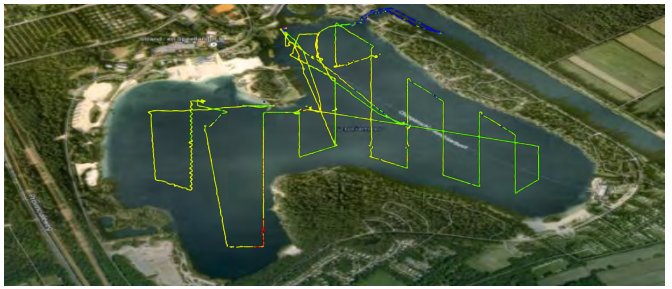
- Time series on fixed locations:
  Fixed Sensors



- Time-space series:
  Mobile sensor platforms

Aqua Drone ®



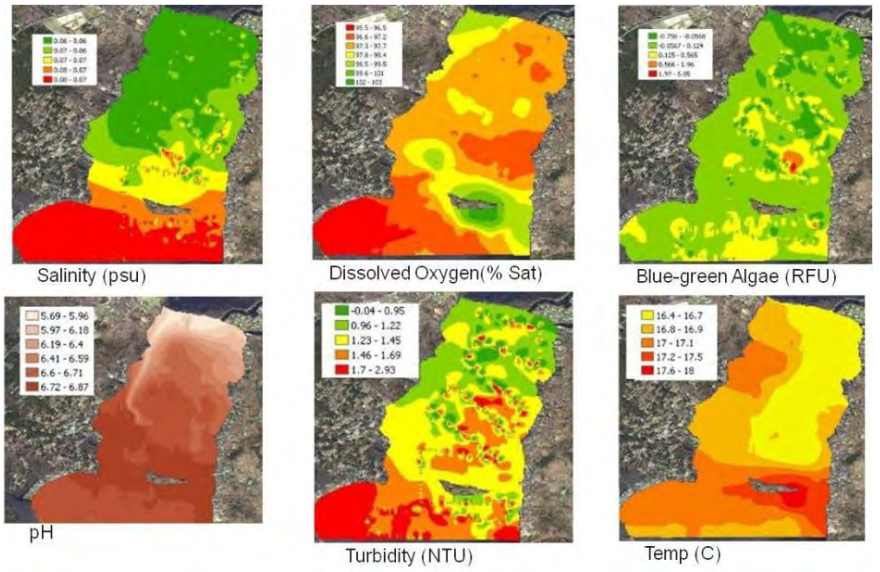


- Large Area coverage:
  Remote sensing, earth observation

vito

4. MOBILE PLATFORMS

- Aqua Drone operates autonomously and produces survey data. It is programmed with a mission plan and uses an advanced GPS system, along with onboard intelligence to retrieve the information. It can move itself auto correctively in case of obstacles on the designed track.
- Web based information system
- Generic interface between end user and sensor
- Bathymetry and water quality



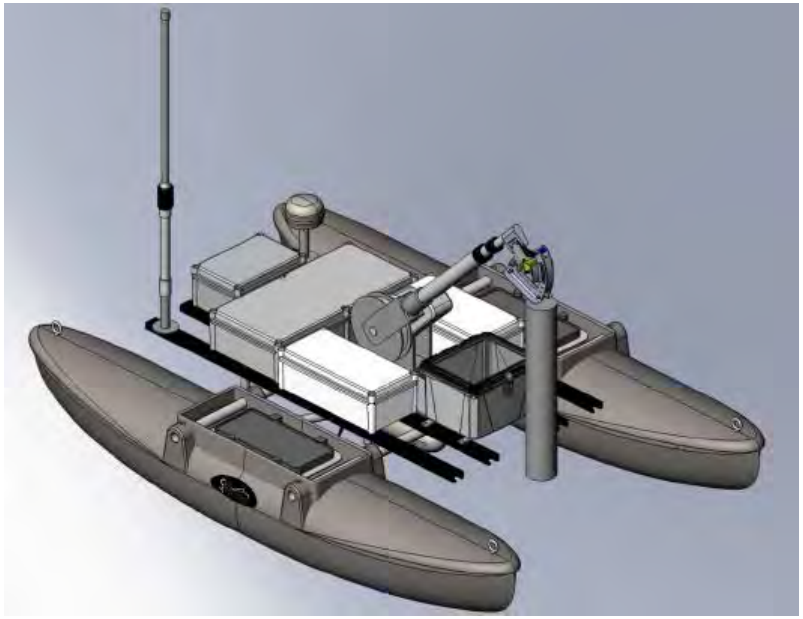
4. MOBILE PLATFORMS: WHEN USING THEM?

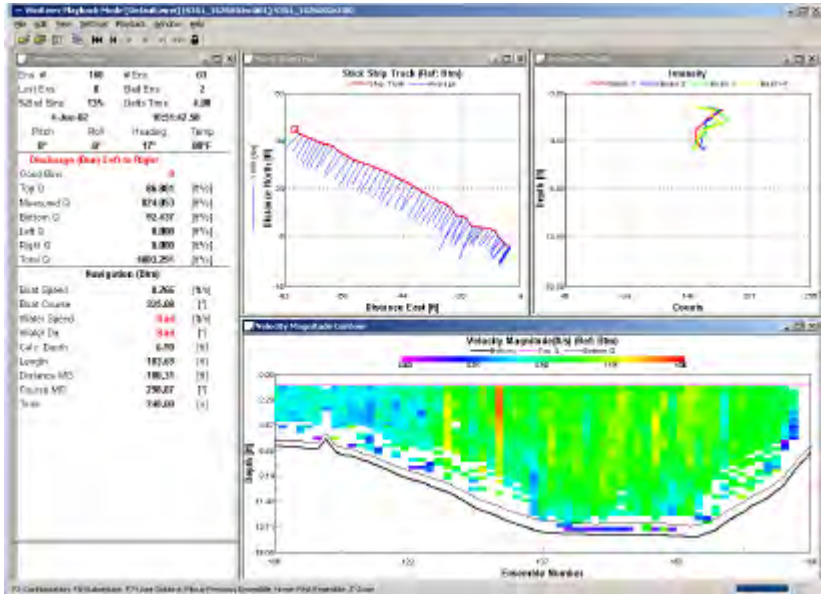
- When there is a need for high frequency temporal and spatial data; for instance elevated risk for human toxicity: drinking water, recreational water, fish/shellfish production sites. The sensors are used as part of an early warning system.
- Difficult to reach (shallow) areas.
- HAB areas with limited RS coverage (smog, clouds, shores).

4.MOBILE AUTONOMOUS SENSOR PLATFORM: AQUA DRONE

Sensors are mounted on an autonomous surface vessel (ASV):

- ❑ Autopilot navigation based on way points & GPS
- ❑ Winch for water quality sensor measurements and sampling over depth.





4. MOBILE PLATFORM: SENSORS FOR ALGAE DETECTION

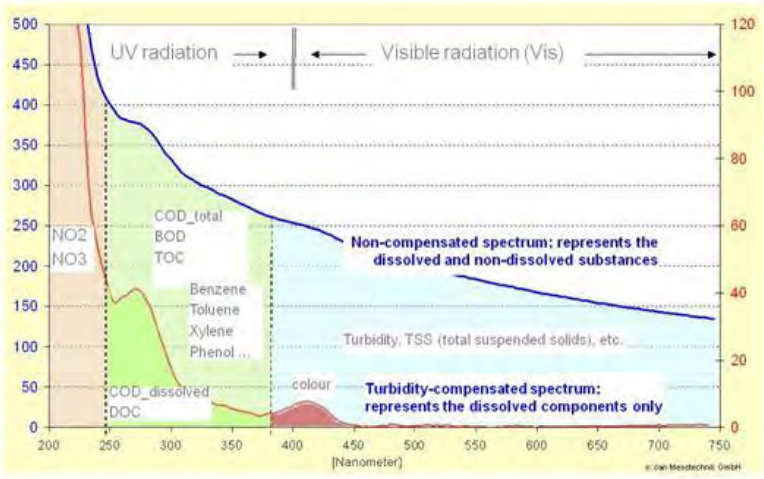
Sensors on board:

- YSI multi parameter water quality probe

- BBE fluoroprobe: Chlorophyl → class determination: green algae, cyano, diatoms, cryptophytes

- S:CAN spectrolyser: in-situ spectrometer for nitrate measurements in the visible UV spectrum

- ADCP: velocity



vito

4. MOBILE AUTONOMOUS SENSOR PLATFORM: HARDWARE AQUA DRONE

Technical Specifications

USV Aqua Drone®		Units	Comment		
Mechanical					
Length	1.92	Meters	Single piece central hull construction		
Width	1.32	Meters			
Height	1	Meters	Height above water with RF antenna down		
Draft	0.35	Meters	Waterline to bottom of skeg		
Weight	109	kg	With payload		
Speed over water (max.)	5	kts			
Endurance					
1 kts	40	hr			
2 kts	16	hr			
3 kts	6	hr			
4 kts	1	hr			
Water quality parameters					
Dissolved oxygen	Conductivity (EC)	ORP (Redox)	Temperature	Salinity	pH
Depth	Turbidity	Nitrate Nitrogen	Nitrite Nitrogen	Chloride	Rhodamine
Blue-Green Algae - Phycocyanin	Blue-Green Algae - Phycoerythrin	Chlorophyll	SAC UV254 (organic load)		
Water quantity parameter				Optical backscatter	
ADCP					
Smart Water Sampling					
Triggered sampling when user-defined threshold is exceeded					
Camera (real time video +recording)					

vito

5. AQUA DRONE: SERVICE STEPS

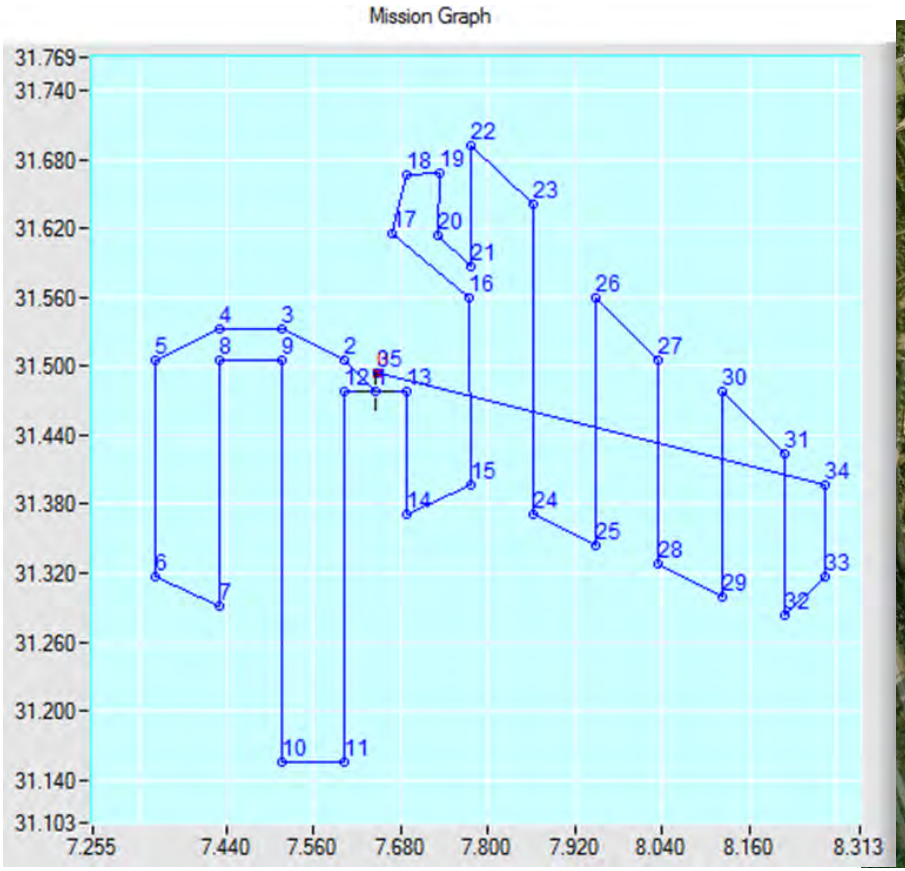
1. • Tailored design of specific sensor platform
2. • Route / Survey planning
3. • Survey
4. • Data download and processing
5. • Visualization of data
6. • Interpretation and follow up
   - Predictions, decision support
   - Mitigation measures

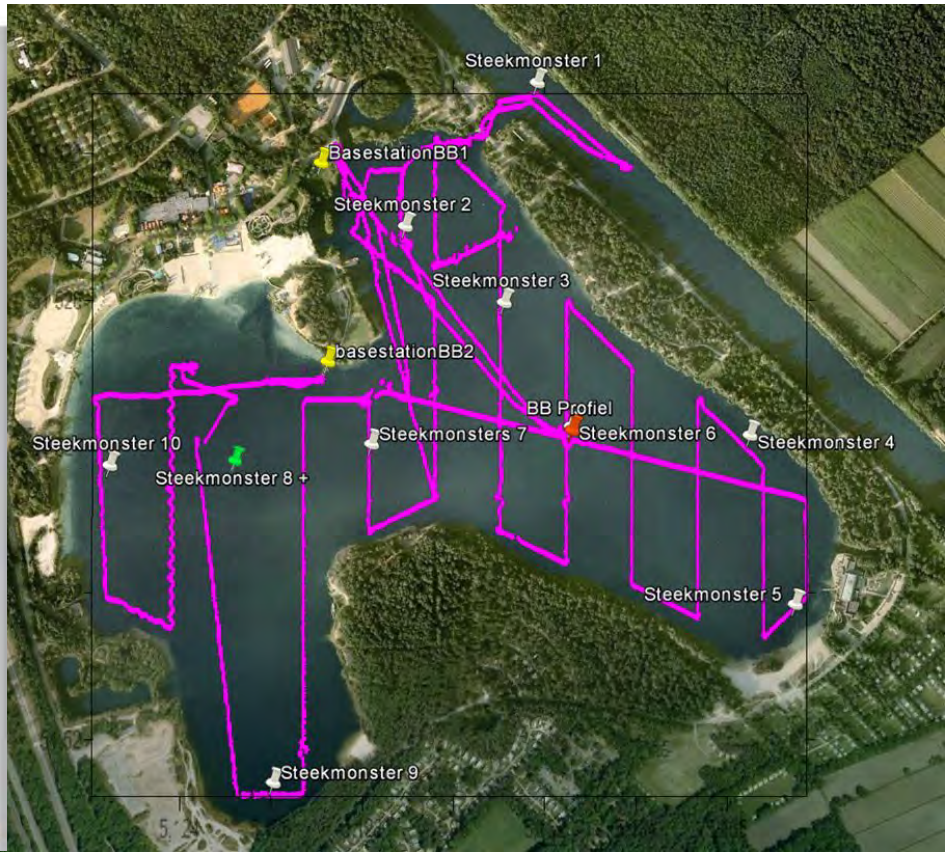
vito

5. AQUA DRONE: TAILORED DESIGN

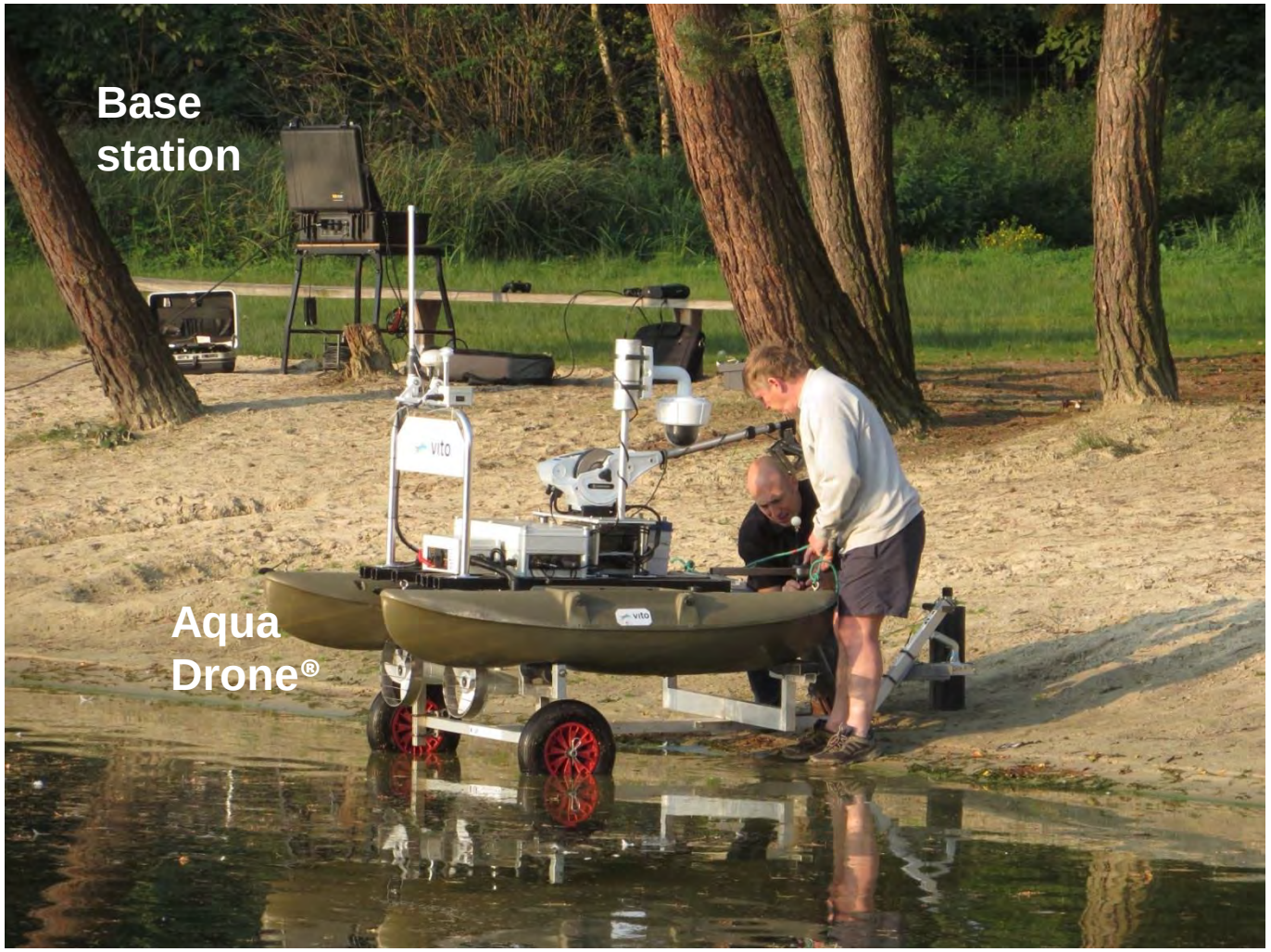
vito

5. AQUA DRONE: SURVEY PLANNING



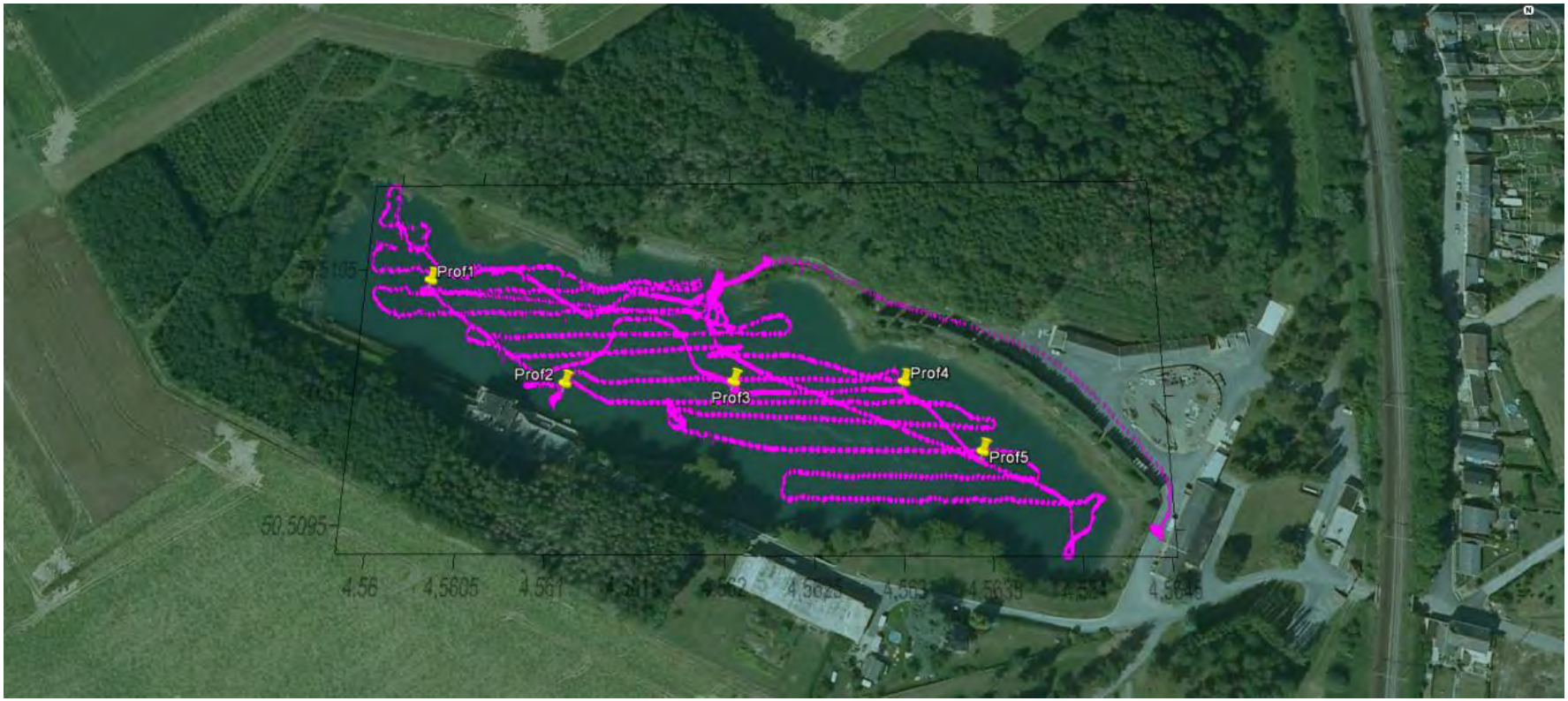


MISSION / SURVEY EXECUTION

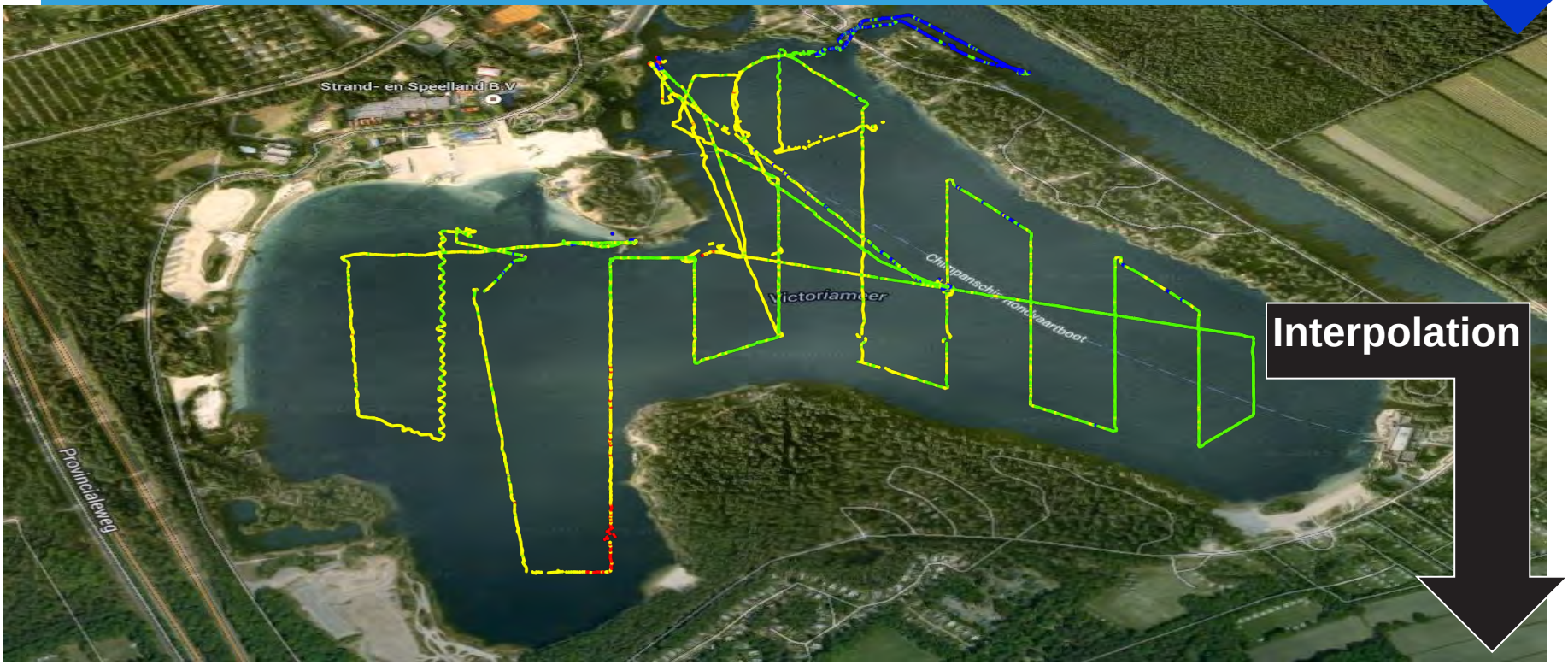


MISSION / SURVEY EXECUTION

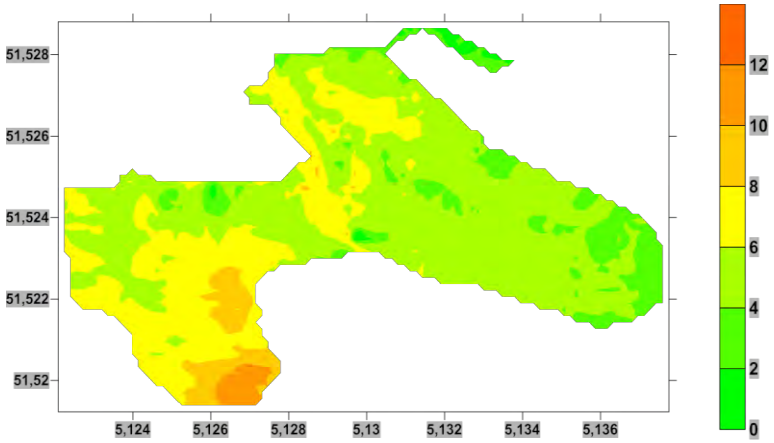
SURVEY WITH VERTICAL PROFILING LOCATIONS - DRINKING WATER RESERVOIR



DATA PROCESSING – RECREATION LAKE



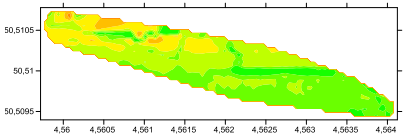
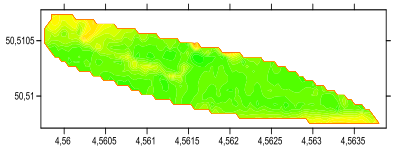
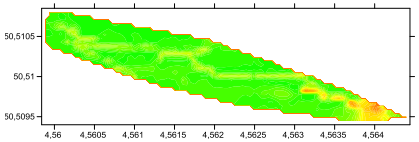
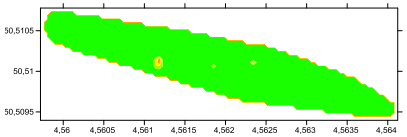
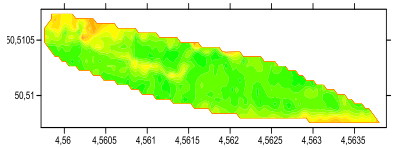
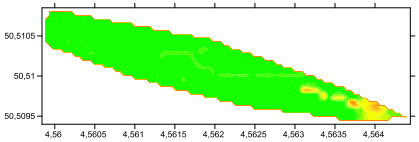
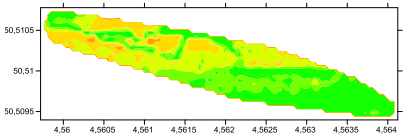
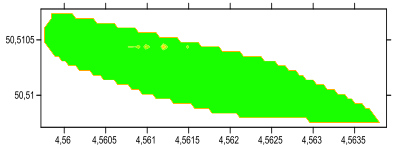
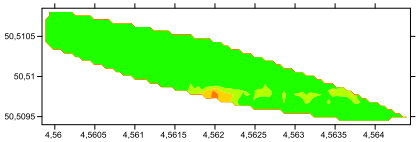
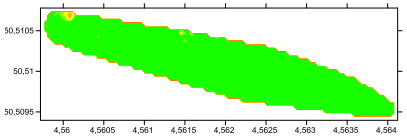
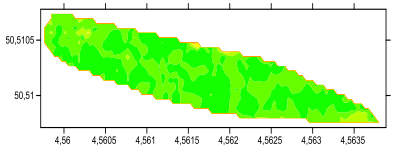
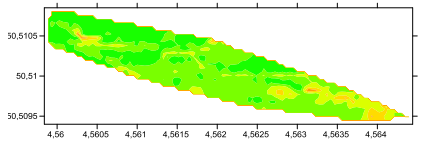
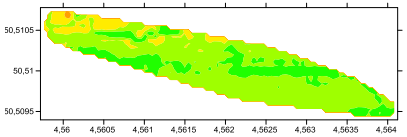
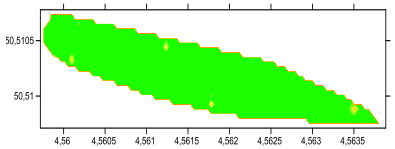
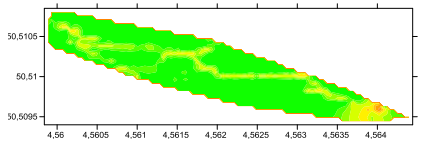
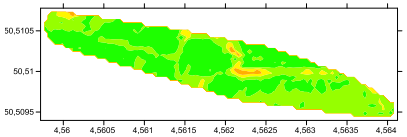
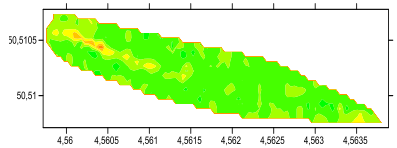
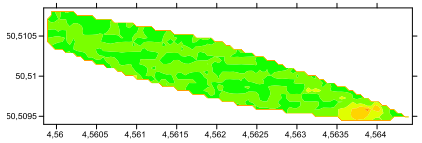
- Sensor measurements along the track
- High density point data set along navigation lines → interpolation (Kriging) → map



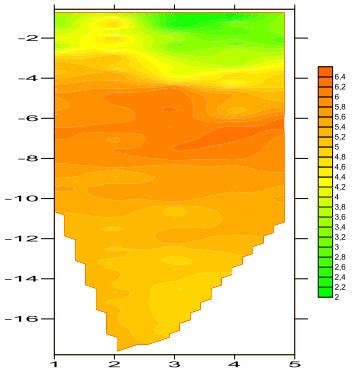
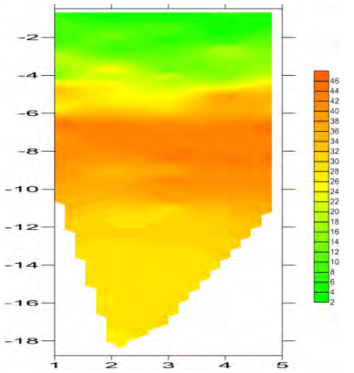
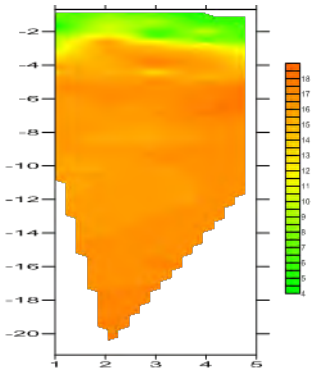
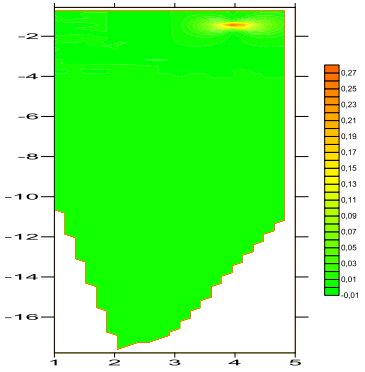
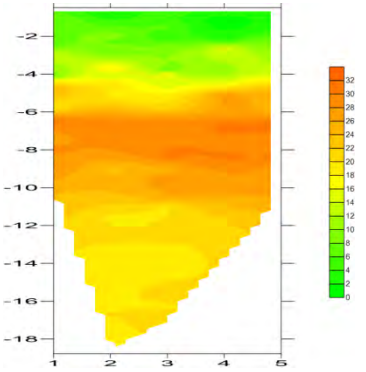
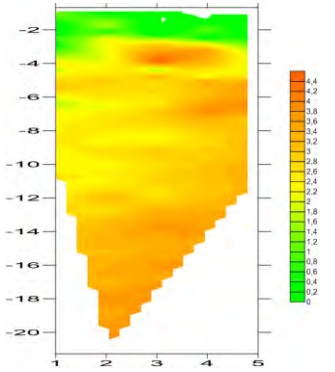
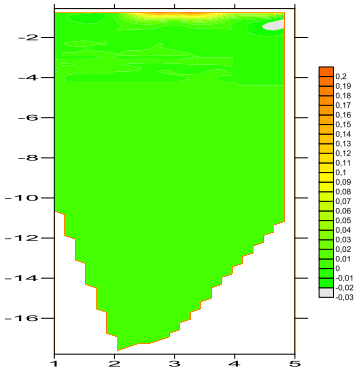
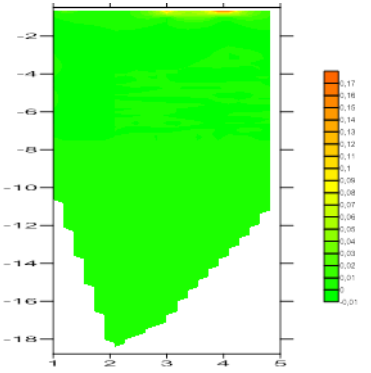
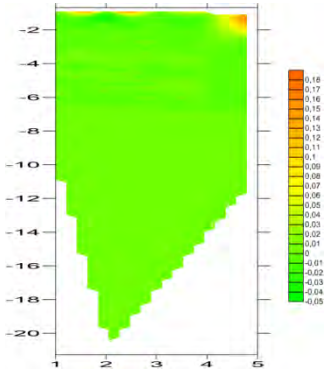
VISUALIZATION OF MONITORING RESULTS

vito

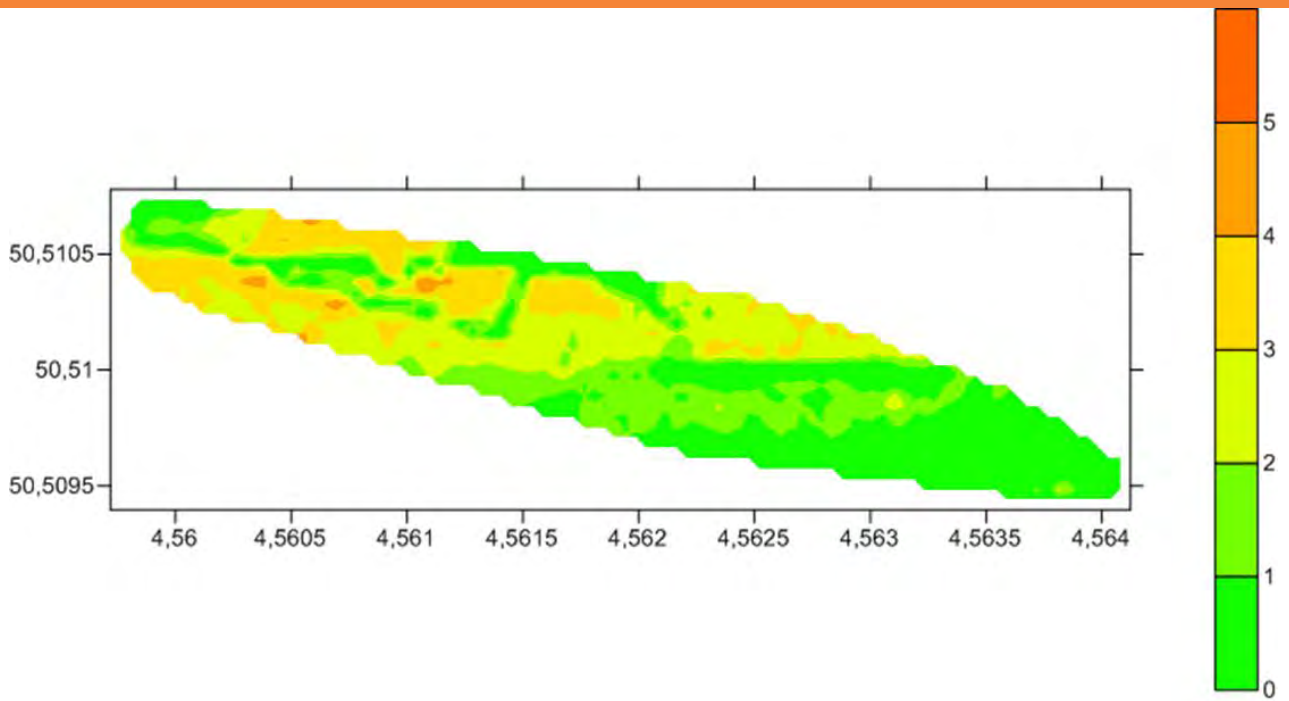
VISUALIZATION RESULTS – TOP VIEW

	spring	*summer*	*autumn*
Total Clorophyl			
Green algae			
Cyanoclorophyl			
Diatomea			
Cryptophytes			
Yellow substances			

VISUALIZATION RESULTS – VERTICAL VIEW

	spring	summer	autumn
Total Clorofyl			
Green algae			
Cyanoclorofyl			

CYANOCLOROPHYL (µG/L)



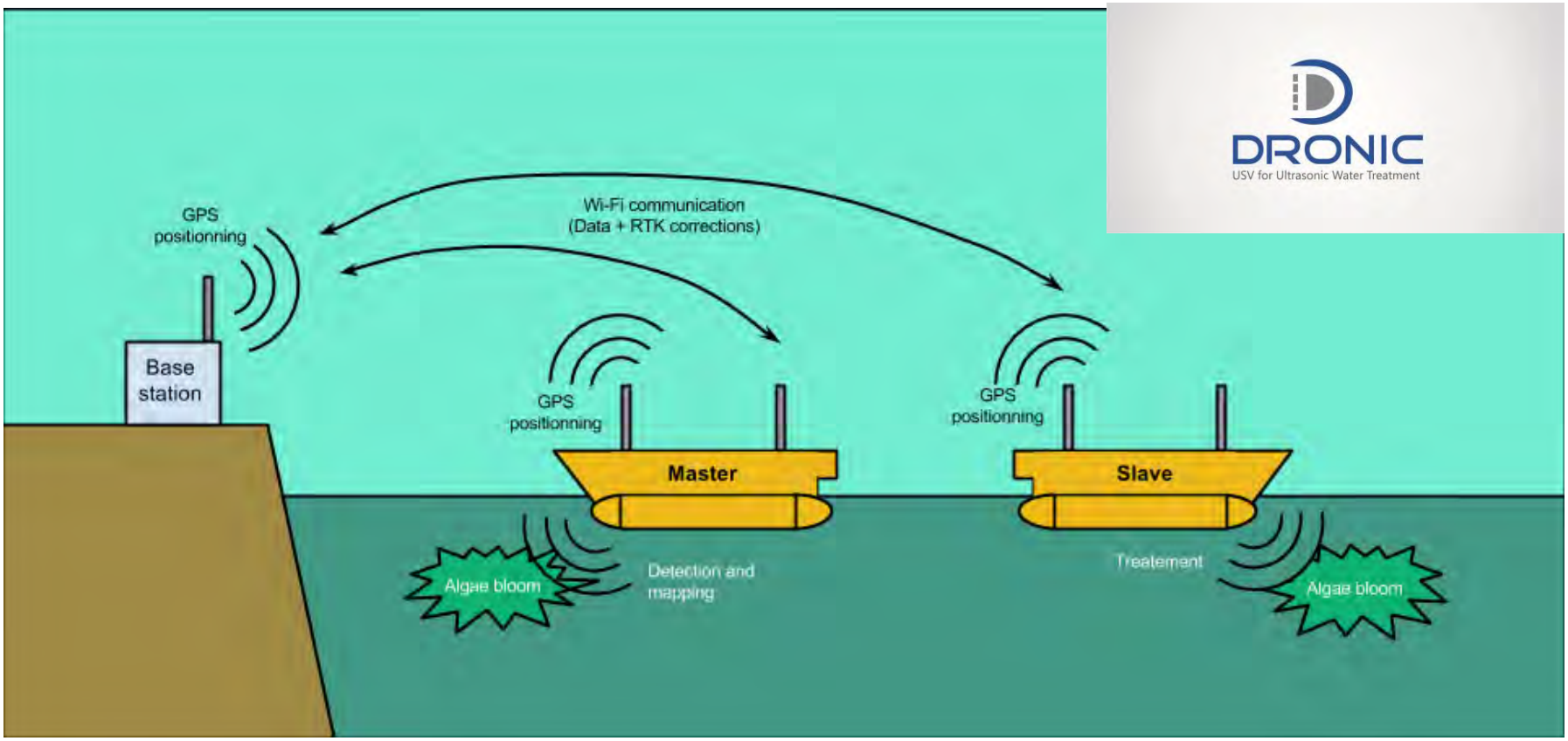
Dutch framework (blue algae protocol)	Cyano clorofyl
No Risk	< 12,5 µg/l
Low Risk (risk level 1)	12,5 µg/l – 75 µg/l
Health risk (risk level 2)	> 75 µg/l

vito

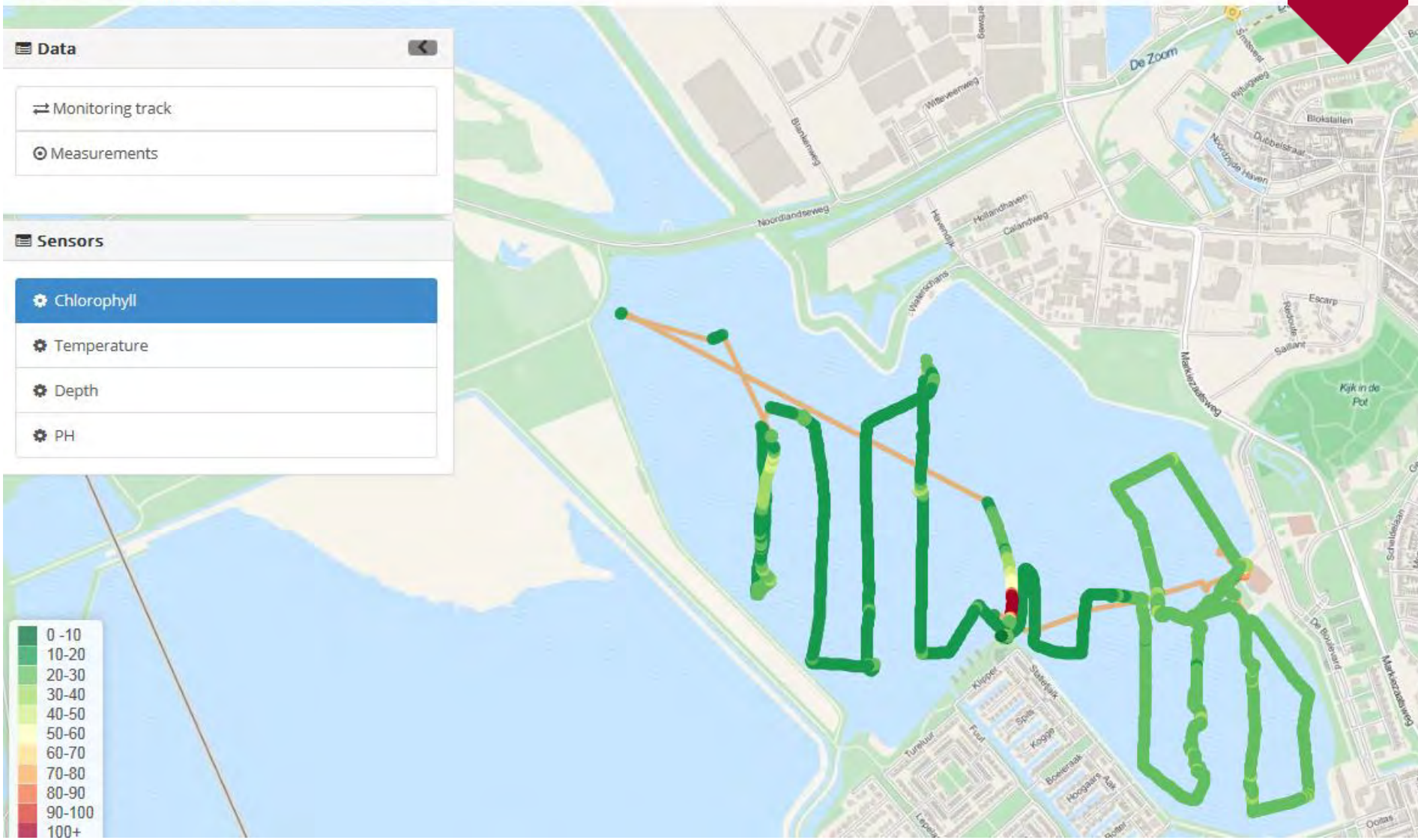
INTEGRATED MOBILE MONITORING, DECISION SUPPORT, TREATMENT

-Upstream reduction of N and P, flushing, ..

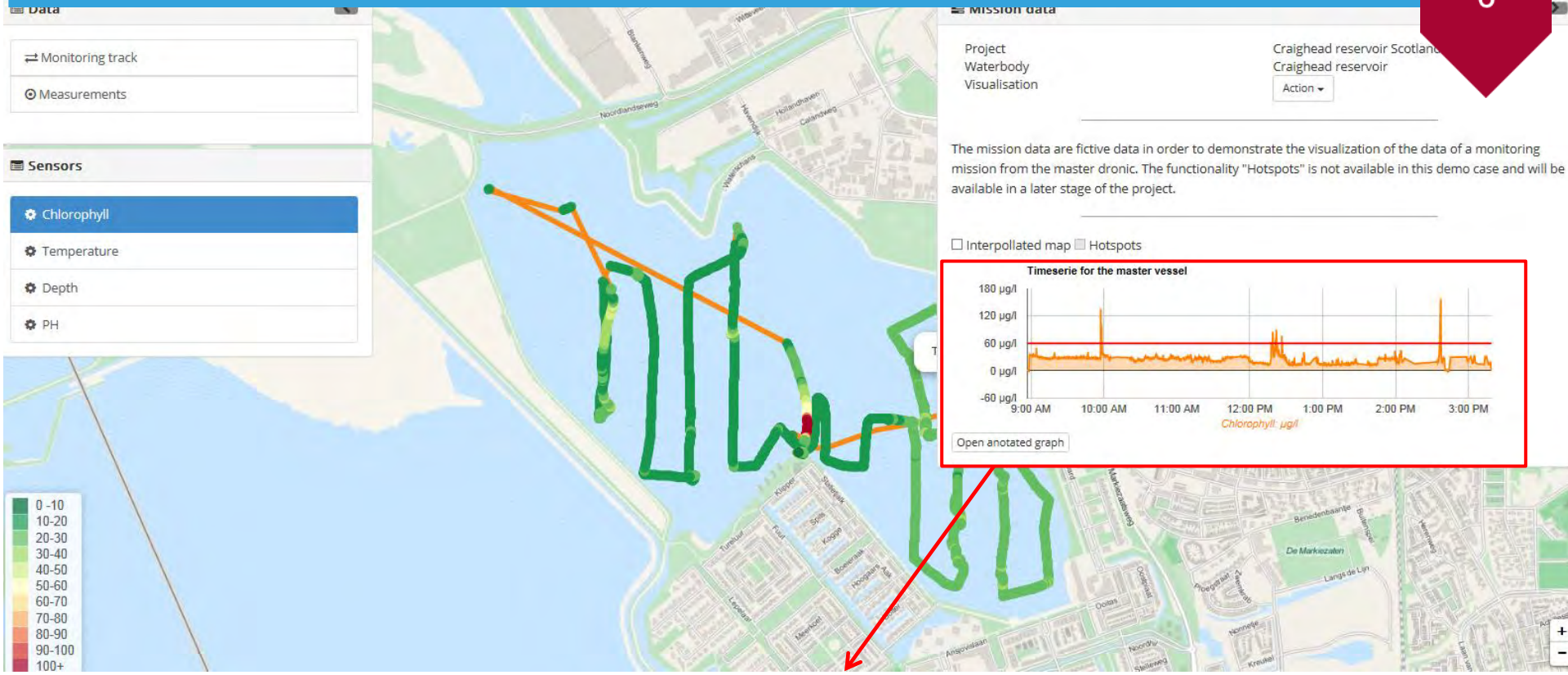
-Insitu treatment of algae of surveyed HAB hotspots (H2O2, ultrasonic, dredging, harvesting,..)

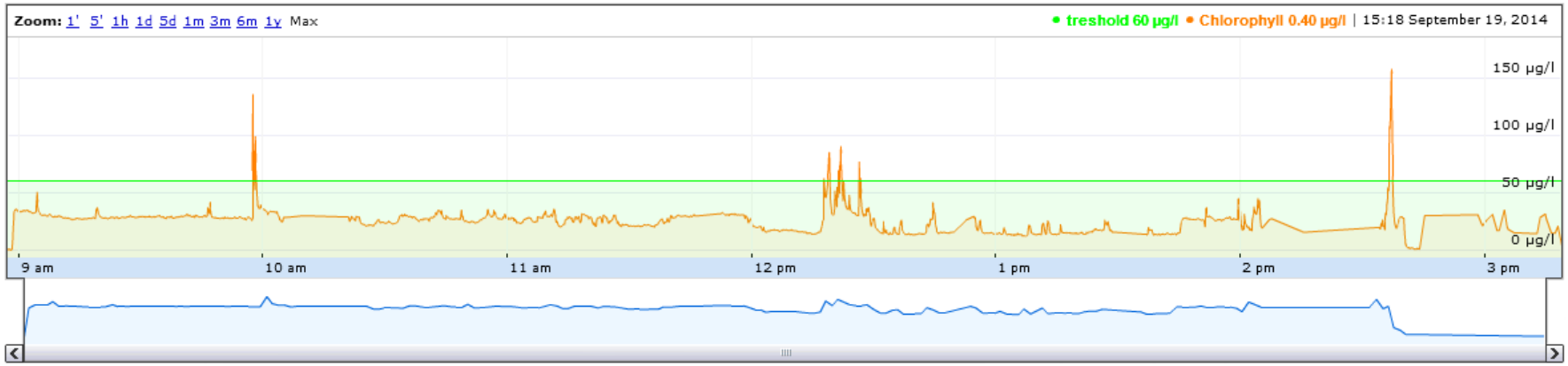


INTEGRATED MOBILE MONITORING, DECISION SUPPORT, TREATMENT

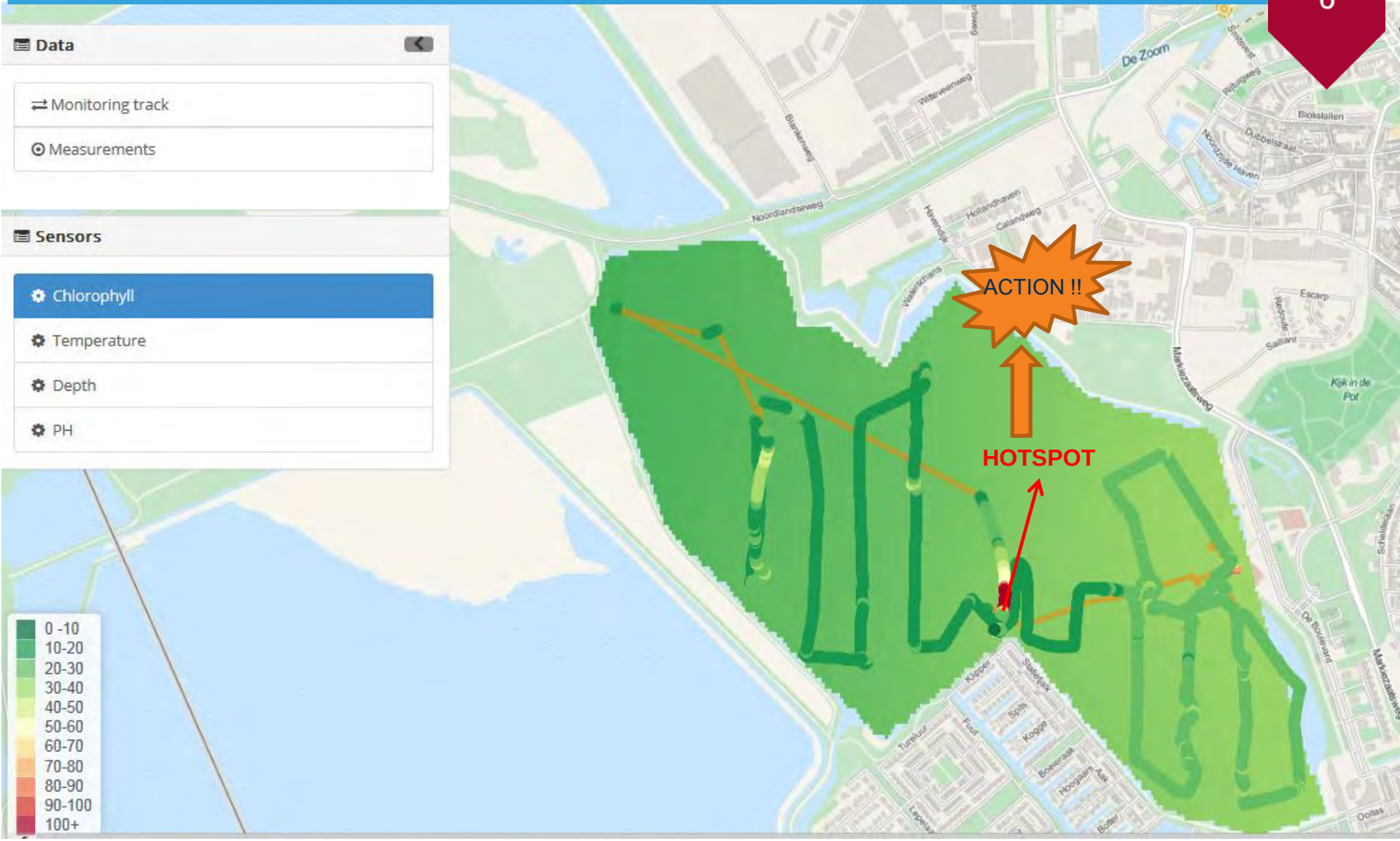


INTEGRATED MOBILE MONITORING, DECISION SUPPORT, TREATMENT





INTEGRATED MOBILE MONITORING, DECISION SUPPORT, TREATMENT



SUMMARY

Mobile sensor platforms

- Successful proven method for gathering and processing high temporal and spatial resolution data (4D) through sensor platforms controlled by sensor software (near real time transfer).
- Use for rapid environmental assessment of risk areas that can be repeated in time on same locations
- Profiling and sampling in depth is possible
- User defined data sensors (flexibility): Algae or other water quality parameters, depth / velocity profiles.
- Use in areas with low RS coverage (clouds, smog, shores) and difficult access.
- Adaption to real time data transfer is in process.

From monitoring to management

- Visualisation
  - Data set, graphs, maps
- Interpretation and decision support

EXTRA INFO

Dronic

- www.dronicproject.com

Questions ?

Jaap.vannes@vito.be
www.vito.be