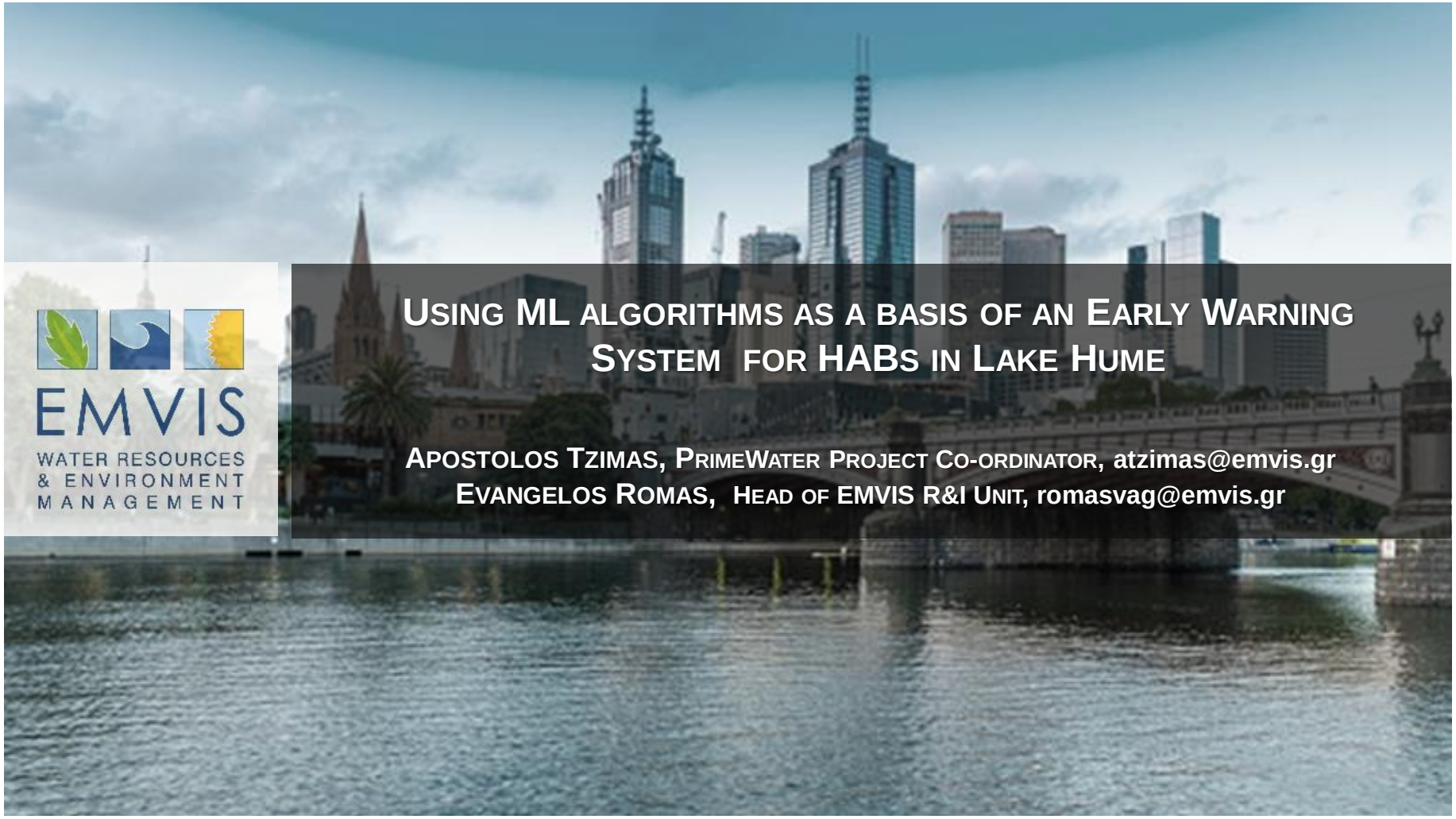
PrimeWater

AUSTRALIAN END-USERS WORKSHOP: HAB'S EARLY WARNING TOOLS

THURSDAY 20TH APRIL 2023 | 11:30 AM – 2:30 PM AEST
DEP. OF CIVIL ENG., MONASH UNIVERSITY, MELBOURNE



USING ML ALGORITHMS AS A BASIS OF AN EARLY WARNING SYSTEM FOR HABS IN LAKE HUME

APOSTOLOS TZIMAS, PRIMEWATER PROJECT CO-ORDINATOR, atzimas@emvis.gr
EVANGELOS ROMAS, HEAD OF EMVIS R&I UNIT, romasvag@emvis.gr

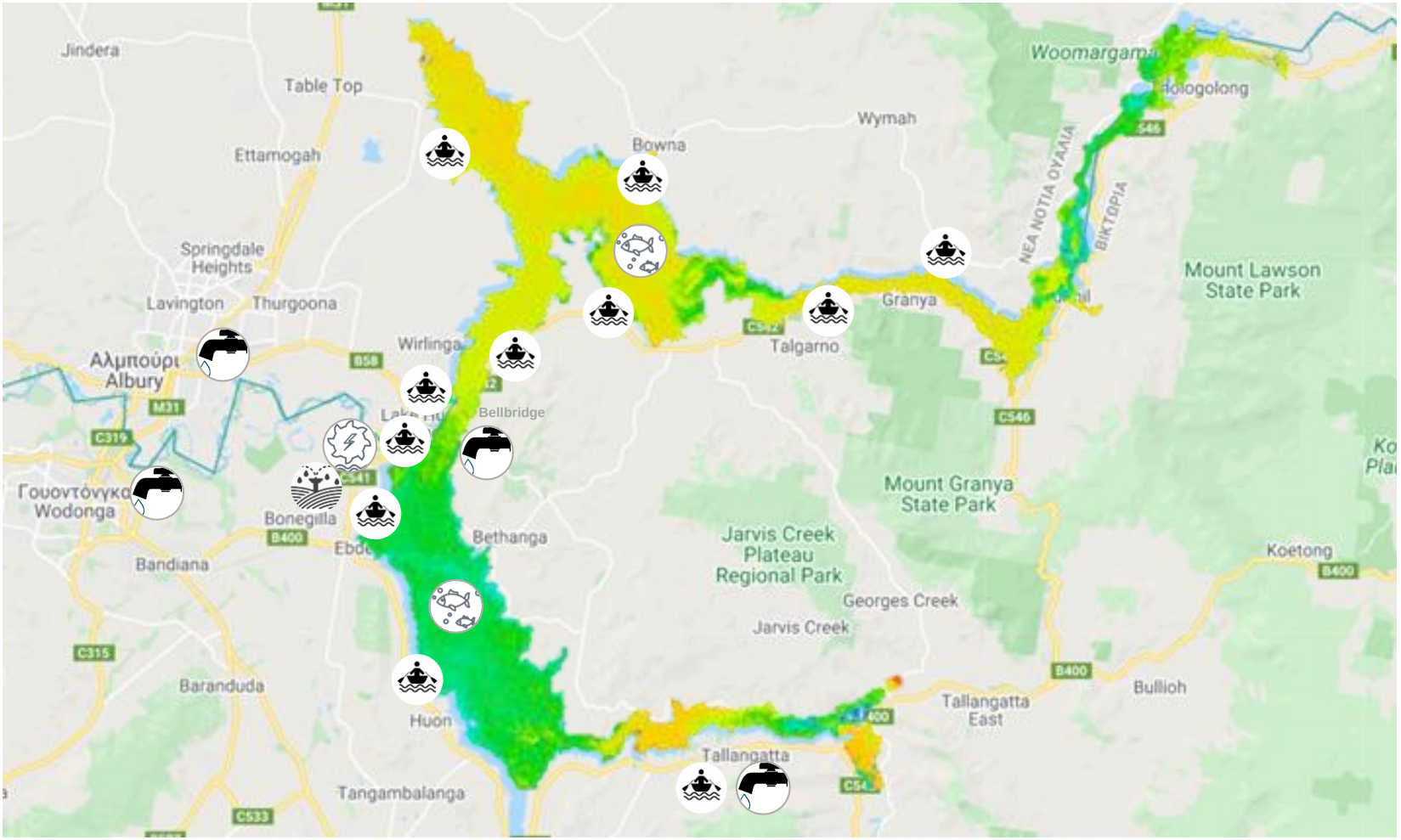
EMVIS
WATER RESOURCES & ENVIRONMENT MANAGEMENT

Organized by:

IWA the international water association

In collaboration with:
Monash University &
CSIRO

Introducing Water Quality Forecasts for Phytoplankton Bloom Alerts



About Hume Lake

Lake Hume which is a major reservoir on the Murray River (25,000 Km) seeing more frequent cyanobacterial blooms in recent years. Lake Hume's purpose includes flood mitigation, hydropower generation, irrigation, water supply and conservation.

Introducing Water Quality Forecasts for Phytoplankton Bloom Alerts

Nowcast based Early Warning

Information base for Phytoplankton Bloom warnings

Time resolution for Phytoplankton Bloom warnings

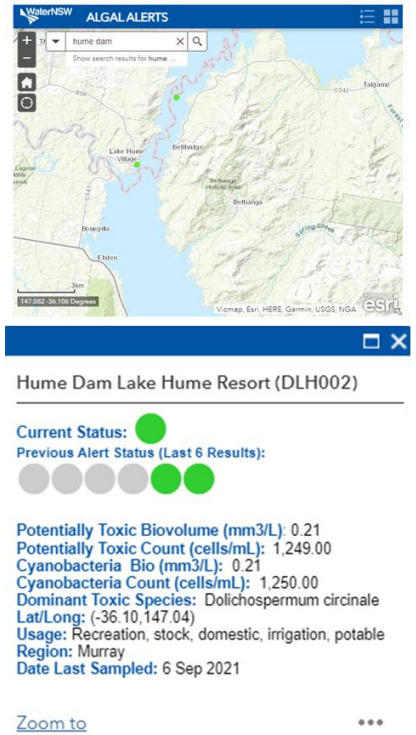
Spatial coverage for Phytoplankton Bloom warnings

Grab Samples & Lab Analysis

Monthly sampling campaigns

Hume Dam Lake Hume Resort (DLH002)
Lake Hume at Heywoods (DLH001)

Algal alerts in NSW



A quick look into the HAB Early Warning Practices in Australia

Indicators used as proxy for HAB, respective thresholds and impact

- Microcystis aeruginosa are present in concentrations >50,000 cells/mL or
- The biovolume exceeds 4 mm3/L where toxin producing cyanobacteria are dominant (>75%), or
- The biovolume exceeds 10 mm3/L where toxin producing cyanobacteria are not dominant (<75%).

- Microcystis aeruginosa concentrations are between 5000 and 50,000 cells/mL or
- The biovolume is between 0.4 and 4 mm3/L where toxin producing cyanobacteria are dominant (>75%), or
- The biovolume is between 0.4 and 10 mm3/L where toxin producing cyanobacteria are not dominant (<75%).

- Microcystis aeruginosa are present in concentrations > 500 cells/mL or
- The total cyanobacteria biovolume >0.04 mm3/L but below the amber alert level.

Algal alerts for **recreational water** use.

Guidelines for Managing Risk in Recreational Waters published by the National Health and Medical Research Council (NHMRC 2008).

ALARM LEVEL 3 – VERY HIGH ALERT

- Microcystis aeruginosa concentrations are > 65,000 cells/mL or
- The total biovolume is > 6 mm3/L

ALARM LEVEL 2 – HIGH ALERT

- Microcystis aeruginosa concentrations are > 6,500 cells/mL or
- The total biovolume is > 0.6 mm3/L

ALARM LEVEL 1 – MEDIUM ALERT

- Microcystis aeruginosa concentrations are between 2,000 and 6,500 cells/mL or
- The total biovolume is between 0.2 and 0.6 mm3/L

DETECTION LEVEL – LOW ALERT

- Microcystis aeruginosa concentrations are between 500 and 2,000 cells/mL or
- The total biovolume is between 0.05 and 0.2 mm3/L

Alert Levels Framework for **drinking water**.

Australian Drinking Water Guidelines (NHMRC/NRMMC)

Introducing Water Quality Forecasts for Phytoplankton Bloom Alerts

Nowcast based Early Warning

Deterministic Forecasting based Early Warning

Probabilistic Forecasting based Early Warning

Information base for Phytoplankton Bloom warnings

Time resolution for Phytoplankton Bloom warnings

Spatial coverage for Phytoplankton Bloom warnings

Grab Samples & Lab Analysis

Monthly sampling campaigns

Hume Dam Lake Hume Resort (DLH002)
Lake Hume at Heywoods (DLH001)

Algal alerts in NSW

Modeled measures of physical, chemical, and biological contaminants

Sub-daily time step – up to 10 days in advance

From selected points to the entire water body

An ensemble of modeled measures of physical, chemical, and biological contaminants

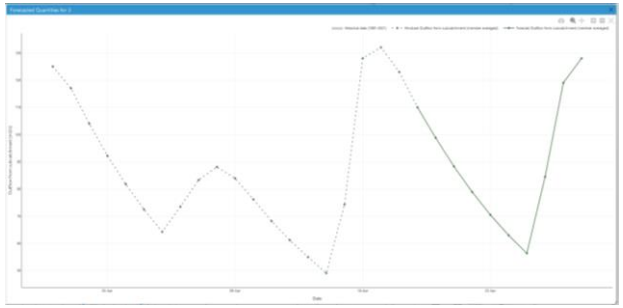
Sub-daily time step – up to 10 days in advance

From selected points to the entire water body

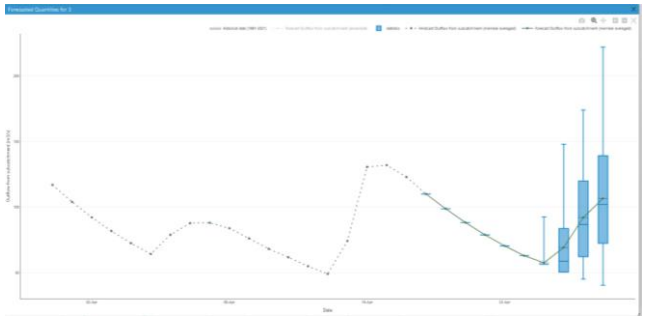
Provide an assessment of the forecasted WQ hazard including:

The **magnitude, when** and **where** the hazard will occur

The **magnitude, when where** and the **probability** the hazard will occur

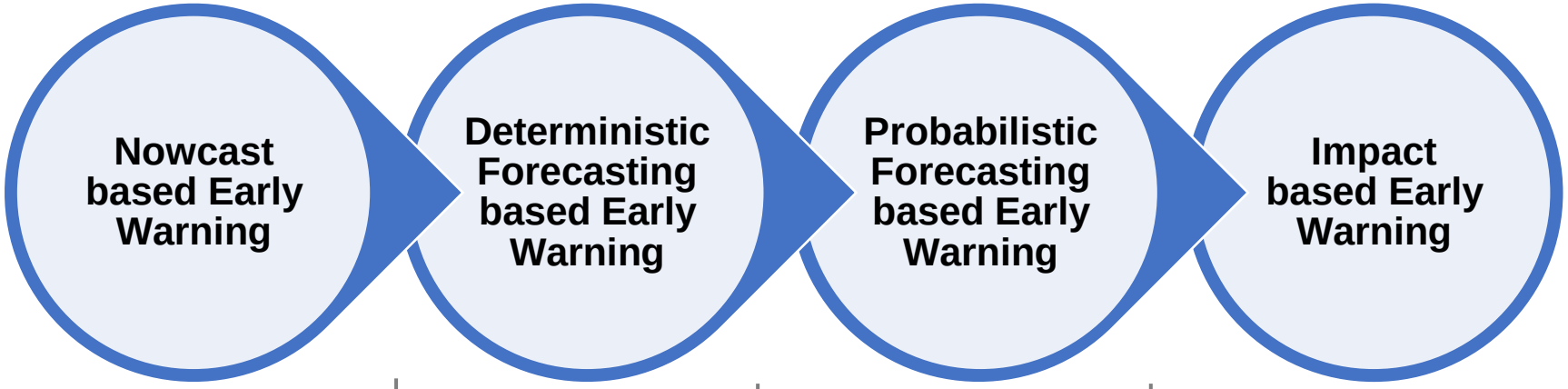


Deterministic forecasting



Probabilistic forecasting

Introducing Water Quality Forecasts for Phytoplankton Bloom Alerts



	Nowcast based Early Warning	Deterministic Forecasting based Early Warning	Probabilistic Forecasting based Early Warning	Impact based Early Warning
Information base for Phytoplankton Bloom warnings	Grab Samples & Lab Analysis	Modeled measures of physical, chemical, and biological contaminants	An ensemble of modeled measures of physical, chemical, and biological contaminants	Phytoplankton Bloom Impact Indicators
Time resolution for Phytoplankton Bloom warnings	Monthly sampling campaigns	Sub-daily time step – up to 10 days in advance	Sub-daily time step – up to 10 days in advance	Dailly time step – up to 10 days in advance
Spatial coverage for Phytoplankton Bloom warnings	Hume Dam Lake Hume Resort (DLH002) Lake Hume at Heywoods (DLH001)	From selected points to the entire water body	From selected points to the entire water body	From selected points to the entire water body

Algal alerts in NSW

Provide an assessment of the forecasted WQ hazard including:

The **magnitude, when** and **where** the hazard will occur	The **magnitude, when where** and the **probability** the hazard will occur	The **expected impact from the forecasted hazard**

Introducing Water Quality Forecasts for Phytoplankton Bloom Alerts

Nowcast based Early Warning

Deterministic Forecasting based Early Warning

Probabilistic Forecasting based Early Warning

Impact based Early Warning

Grab Samples & Lab Analysis

Monthly sampling campaigns

Hume Dam Lake Hume Resort (DLH002)
Lake Hume at Heywoods (DLH001)

Algal alerts in NSW

Modeled measures of physical, chemical, and biological contaminants

Sub-daily time step – up to 10 days in advance

From selected points to the entire water body

An ensemble of modeled measures of physical, chemical, and biological contaminants

Sub-daily time step – up to 10 days in advance

From selected points to the entire water body

Phytoplankton Bloom Impact Indicators

Dailly time step – up to 10 days in advance

From selected points to the entire water body

Provide an assessment of the forecasted WQ hazard including:

The **magnitude, when** and **where** the hazard will occur

The **magnitude, when where** and the **probability** the hazard will occur

The **expected impact from the forecasted hazard**

Is the Impact of a HAB event across the various environmental, societal and economic sectors (or even within the same sector) the same?

Vulnerability and exposure

Potable Water Treatment **vs** Hydropower Production

WTP 1

Filtration only

vs

WTP 2

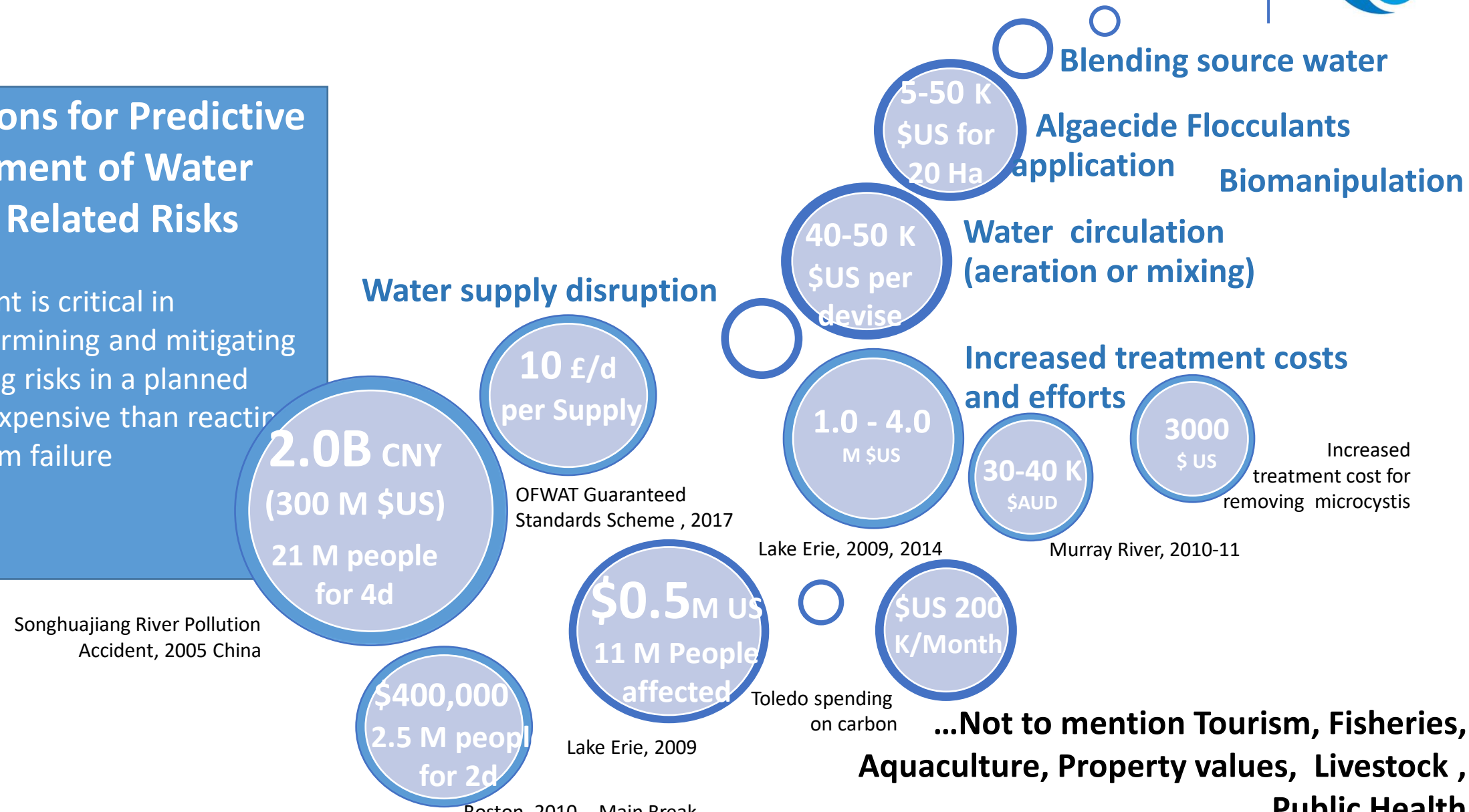
Filtration + GAC

Lake Management Perspective

Cost of Inaction and Opportunities

Trigger actions for Predictive management of Water Quality Related Risks

Risk management is critical in proactively determining and mitigating issues. Mitigating risks in a planned manner is less expensive than reactin to a major system failure

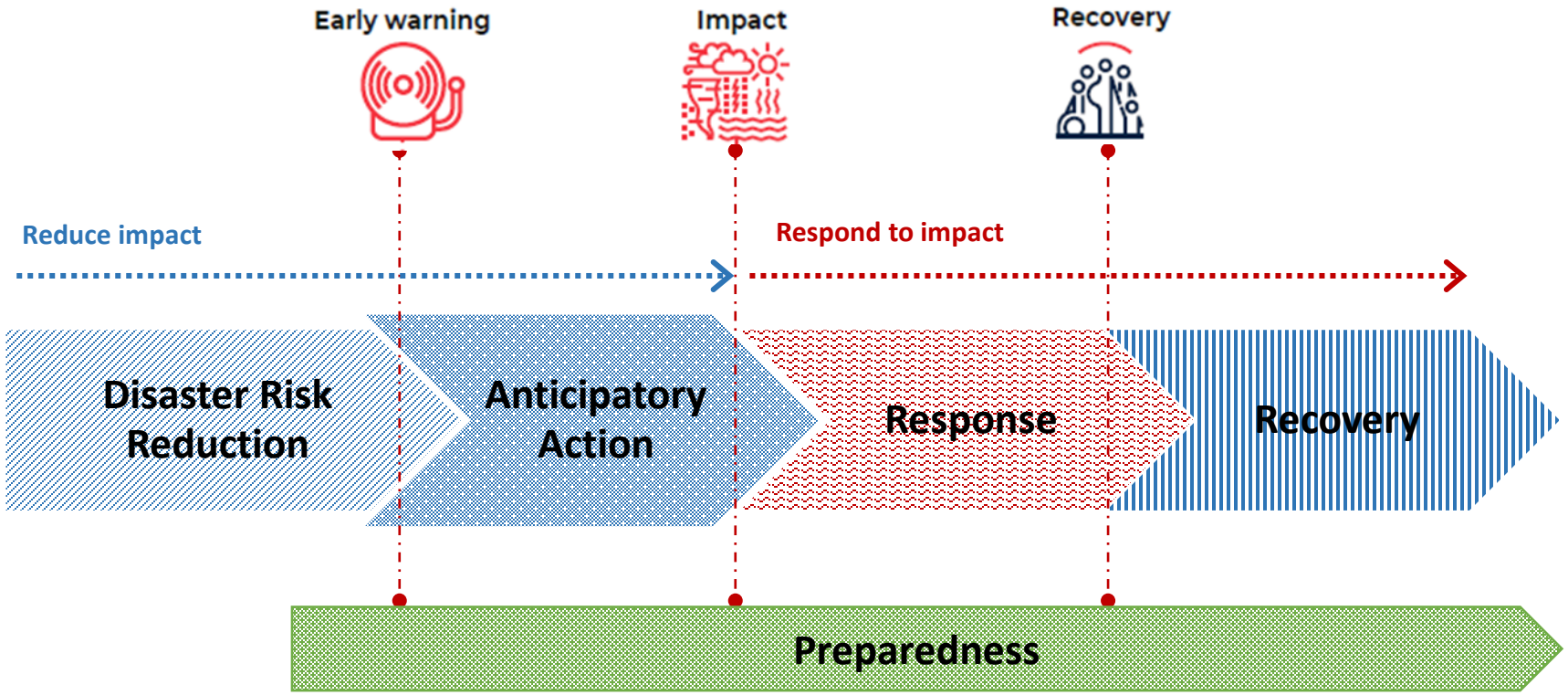


…Not to mention Tourism, Fisheries, Aquaculture, Property values, Livestock , Public Health

The Disaster Risk Management Perspective

Trigger Anticipatory Action

Warn and Protect against an impactful forecasted event and prepare for effective response.



(adapted from IFRC, 2020)

The Perspective of water dependent sectors

Trigger activities to improve operational planning

The value of foresight to economic activities consists of better informed environmental and risk management choices; hence the ability to achieve improved operational and strategic planning in businesses with economic rational

Potable Water Treatment Operations

-Change abstraction depth
-Switch to alternative source water
-Prepare assets and mobilize personnel (complete maintenance, increase redundancy, supply chemicals, etc)
-Inform customers
…

Amenity and Recreation

-Inform public
…

Irrigation

Address limitations imposed to certain crops
block irrigation equipment and reduce your system's efficiency
…

Freshwater Fishing or Aquaculture Operations

- Sell fish stock earlier than planned
- Apply off flavor depuration techniques

…

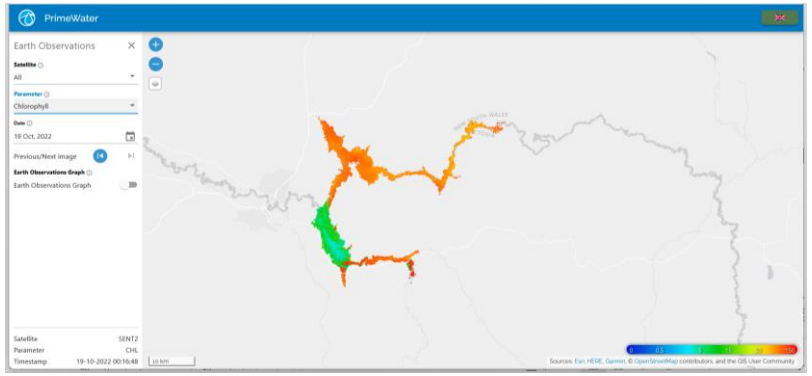
Thermal Plants Cooling Operations

-Change abstraction depth
-Switch to alternative source water
-Prepare assets and mobilize personnel (complete maintenance, increase redundancy, supply chemicals, etc)
-Inform network operator/customers
…

Hydropower Production

…

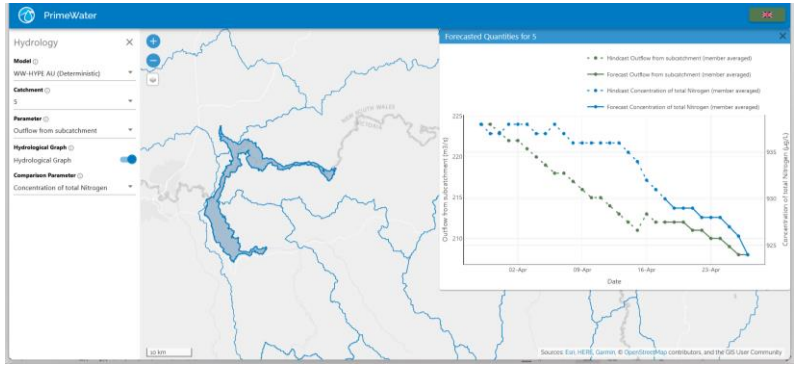
Introducing Water Quality Forecasts for Phytoplankton Bloom Alerts



EOMAP's Modular Inversion & Processing System (MIP)
- Sentinel-2 & Landsat

EOMAP

- ○ Turbidity
- ○ Chlorophyll-a
- ○ Secchi Disc
- ○ Total absorption
- ○ Total Suspended Matter



SMHI's Hydrological Simulation System (HYSS)
- HYPE Short-term forecasts (10days)

SMHI

Medium-Range Weather Forecasts
- Deterministic weather forecasts
- Probabilistic ensemble forecasts

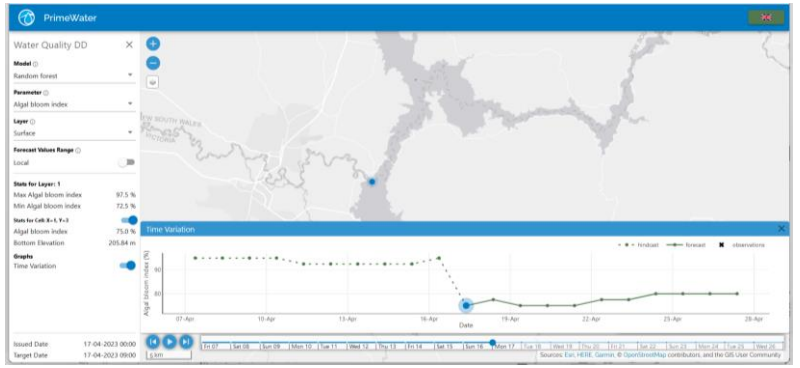
ECMWF

- ○ World-Wide HYPE catchment model
- ○ Downscaled WWHYPE Local data calibrations

Provide Forecasts of:

- ○ **Hydro-climatic** (e.g. water outflow from the sub-basin or water temperature etc.) and
- ○ **water quality-related** (e.g. suspended solids or nutrients) parameters

for the upstream sub-basins of the reservoir.



EMVIS Water Automation Shell (wASH)
- Data-driven WQ forecasts

EMVIS
WATER RESOURCES & ENVIRONMENT MANAGEMENT

Meteoblue global weather forecasting services
GFS, GFS ensemble, NEMS, meteoblue

meteoblue
weather close to you

- ○ Random Forest model
- ○ Gaussian Process Regression model

Provide Forecasts of:

- ○ **Chlorophyll-a concentrations**
- ○ **Probability of exceeding or being below a selected threshold**

PrimeWater

Thank you for attending!

PrimeWater Team:

European Commission

The project has received funding from the European Union's Horizon H2020 Research and Innovation Programme under Grant Agreement No 870497