

Harmful algal bloom management: A global perspective



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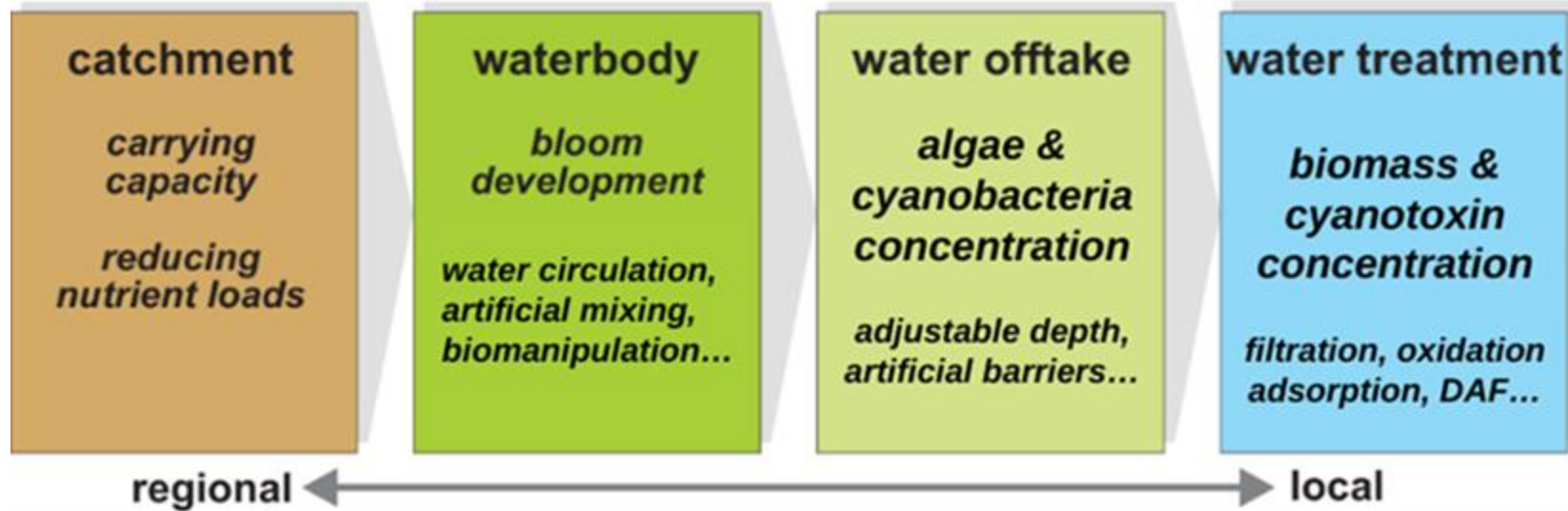


Algae and HABs are a worldwide issue

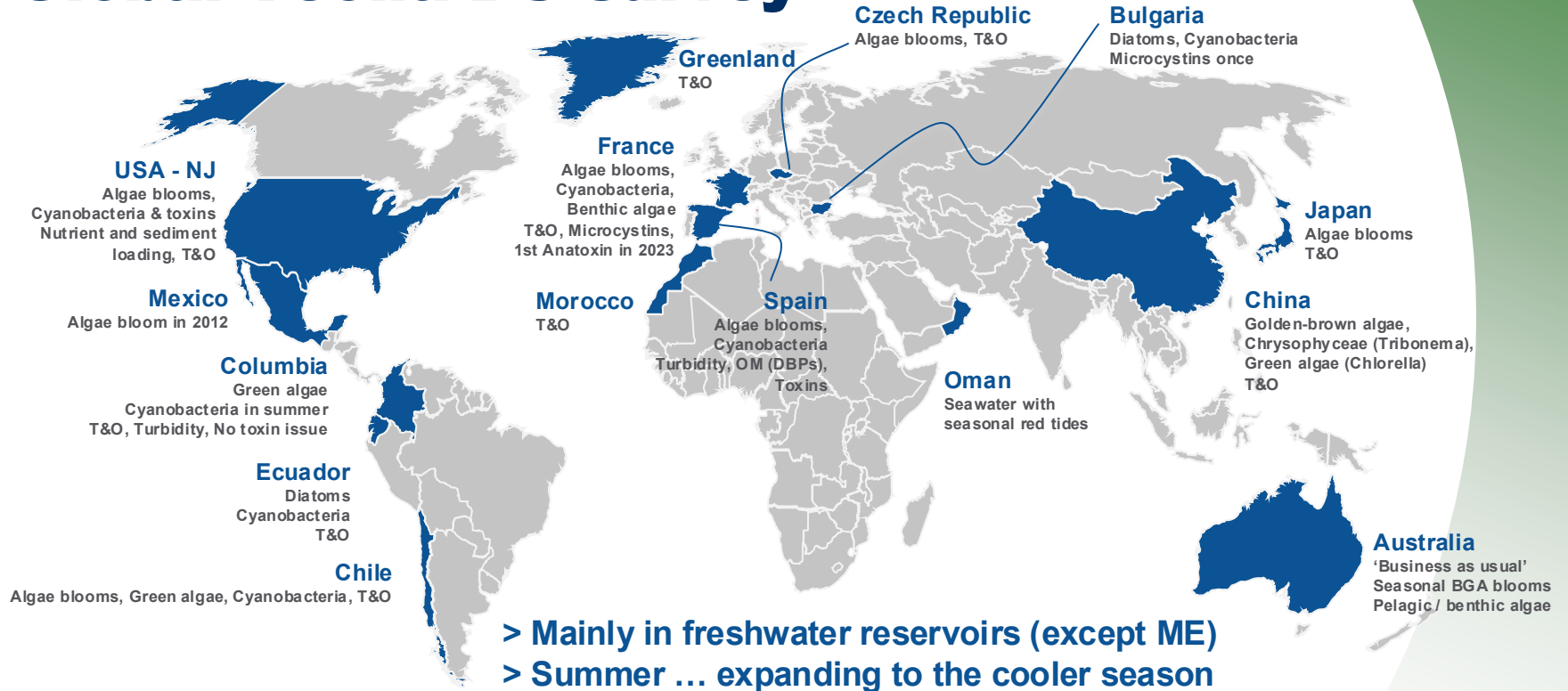
- Harmful Algal Blooms (HABs) present a critical challenge to drinking water supplies worldwide.
- Algae can cause process fouling, sludge management issues, generate taste and odour compounds and/or toxins that contaminate water making it unsafe for human and animal consumption.



Harmful algae management strategies



Global Veolia BU survey



- > Mainly in freshwater reservoirs (except ME)
- > Summer ... expanding to the cooler season
- > Mostly Planktonic ... but questions on Benthic

Methods

- 13 Global BUs surveyed - Australia, Bulgaria, Chile, China, Colombia, Czech Republic, Ecuador, France, Japan, Mexico, Oman, Spain, USA
- Survey questions in following categories:
 - Algae types, water sources and issues
 - Solutions for monitoring, early warning and/or prediction
 - On-site control solutions
 - Treatment solutions and operational responses
 - Other challenges and needs

Results - types, water sources and issues

Australia :	regular occurrence of cyanobacteria/BGA blooms in summer (+ increasingly during 'cooler' months)
Bulgaria:	Diatoms, Cyanobacteria, Microcystins
Chile:	Algae blooms, Green algae, Cyanobacteria, T&O
China:	Golden-brown algae, Chrysophyceae (Tribonema), Green algae (Chlorella), T&O
France:	Algae blooms, Cyanobacteria, Benthic algae, T&O, Microcystins, Anatoxin
USA:	Algae blooms, Cyanobacteria & toxins, Nutrient and sediment loading, T&O

Results - algal bloom monitoring

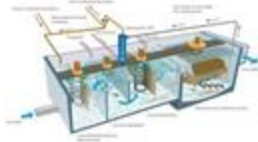
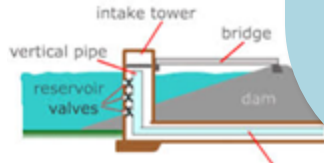


Example: Early warning with the MAGO Water Monitoring Tool (EU Collaborative Research Project) - Water quality parameters in lakes, reservoirs, and irrigation ponds using Sentinel-2 satellite images

Results - algal bloom control

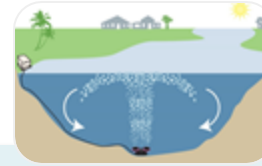
Hydraulic management

Pre-storage management
Adjustable water offtake
Water layer extraction
Water circulation



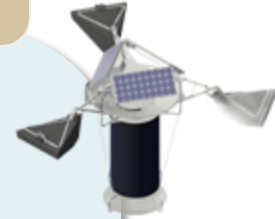
Nutrient reduction

P trapping & inactivation
P uptake & removal
Sediment-bound P
removal



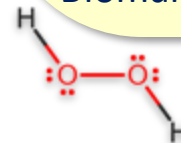
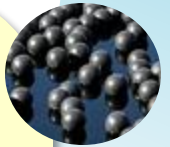
Improved oxygenation

Destratification
Diffusion aeration
Lower water layer aeration



Algae control

Algaecides
Ultrasound devices
Covering
Biomanipulation



Results - catchment and raw water supply

A vast array of control solutions to be considered within the scope of a management strategy:

- **Where:** Catchment - Waterbody - Water offtake - DWTP
 - Act at source when possible, implement a multi-barrier approach
- **What:** Nutrient Reduction - Hydraulic Management - Improved Oxygenation - Algae Control
 - Favour preventive action vs. curative actions (only when needed)
- **How:** Physical control - Chemical control - Biological control
 - Depend on regulatory & local constraints

Results - catchment and raw water supply

In practice, BUs have only limited scope to implement control solutions:

- Catchment management is rarely in contractual scope (except US & Chile)
- Waterbody & water offtake management is not always in contractual scope (e.g. Australia, China, Japan, Czech Republic, Morocco)

But, BUs can provide advice and propose solutions to help their clients managing algae

Results - operational responses

Feedback from BUs

- Pre-oxidation (China, Colombia, Oman)
- PAC (all BUs)
- Coagulation / Flocculation with aluminium sulphate / chloride / polymer (most BUs)
- DAF (China, Czech Republic, Oman, USA)
- Oxidation : KMNO₄ (China), Ozone (USA)
- GAC filtration (Japan)
- Disinfection : UV, chlorine-based (Australia, Czech Republic)
- Ultrafiltration, nanofiltration (Czech Republic)
- Operational issues
 - Increased filter backwash
 - Increased washing of settling tanks
 - High pressure water blasting (HPWB) of impacted processes
- Sludge management issues (volume & handling, potential toxicity)



**Increased
OPEX**

Recommendations

Waterbody diagnosis is recommended prior to any action:

- **Identify**; nutrient sources, waterbody shape and hydrology, climate.
- **Monitor** known cyanobacteria, T&O and toxins locally.
- **Investigate** emerging cyanotoxins when potential producers are detected.

How to build resiliency?

Key HAB management areas:

- **Risk assessment** is necessary for designing successful HAB management strategies.
- **Early detection of bloom events** is key for efficient response to HAB events.
- **Effective management strategies** rely on a combination of mitigation measures.
- Long-term management of HAB requires **stakeholder cooperation and alignment**.

Conclusions

- HAB management requires a multifaceted strategy;
 - **prevention, early detection, and rapid response.**
- Survey results highlighted the need for **strong stakeholder cooperation** for successful and long-term management of HABs.
- Water supply operators rarely have full control on the underlying causes of HABs;
 - Often only able to manage bloom events when they occur rather than prevent them in the long term.

**Thanks and
questions**

