Regulating cyanotoxins: WHO guidance and national approaches

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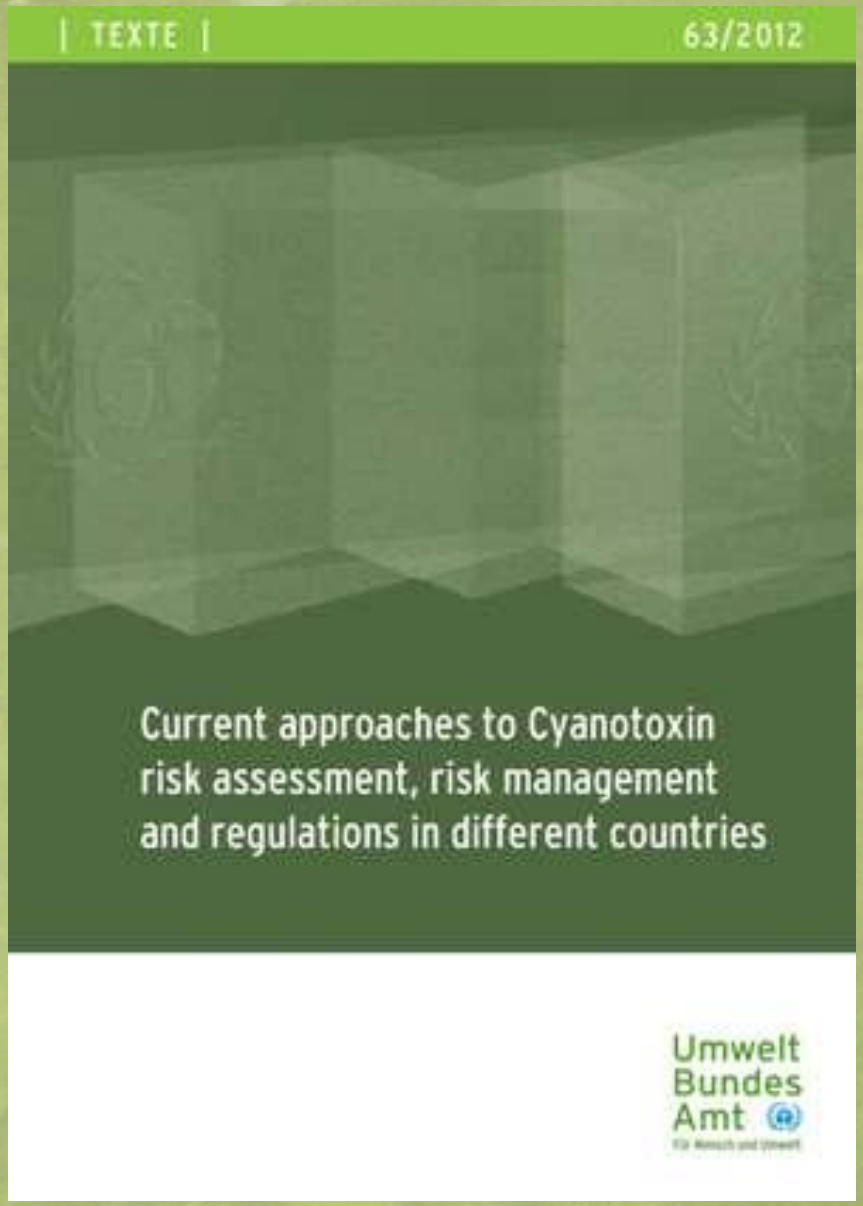
National approaches



ICTC VIII 2010 in Istanbul:

http://www.umweltdaten.de/publikationen/bilder/4390.jpg

- Argentina
- Australia
- Canada
- Cuba
- Denmark
- Finland
- France
- Greece
- Italy
- Netherlands
- New Zealand
- Poland
- Singapore
- Spain
- Turkey
- Uruguay
- USA

Tab. 1: Drinking-water

Tab. 2: Recreation

2005 report includes some other countries: **http://www.umweltbundesamt.de/uba-info-medien/2910.html**

National approaches, general

Development of regulatory approaches through:

increasing awareness through different combinations of activities, e.g.

- long-standing phytoplankton and/or cyanobacterial monitoring programmes,
- cyanotoxin research activities,
- public information,
- programmes for reducing eutrophication in order to improve the ecological quality of aquatic habitats.

➔gradual transition from collecting information to taking action !

National approaches, general

- The role of **risk-based management frameworks** is increasing:

  e.g. for drinking-water: Australia, France, Finland, New Zealand, Singapore; for recreation: if regulations or guidance available, the basis is some sort of assessment of bloom likelihood; in Europe based on the ‚bathing water profiles‘ demanded by EU bathing-water directive

  Where applied, they often use some parameter reflecting the concentration of cyanobacterial biomass: cell numbers, biovolumes, cyanobacterial pigment (phycocyanin, detectable by fluorometry).

  Values guide responses (e.g. intensified monitoring) or interventions (e.g. upgrading treatment)

- Most countries that regulate cyanotoxins use some „**number**“, i.e. : guideline values, standards, maximum acceptable values, maximum acceptable concentrations, health alert levels – sometimes explicitly designated as ‚provisional‘.

National approaches, general

„Risk-based“ approaches in regulations:

use defined values for cyanotoxin concentrations, but are not driven by compliance; rather, they focus on

- understanding of potentially occurring hazards in specific, individual supply systems
- the system’s efficacy in controlling them,
- development of management plans to ensure controls are working,
- emergency and contingency strategies exist,
- lines of communication are clear,
- assessments as well as records of system performance are documented.

➔regulatory approach requires a **comprehensive management system**, within which guideline values determine the target.

National approaches: drinking-water

- Most countries that regulate cyanotoxins use some „number“: guideline values, standards, maximum acceptable values, maximum acceptable concentrations, health alert levels – sometimes explicitly designated as ‚provisional‘.
- Point of departure for MCYST is provisional WHO GV of 1 µg/L or underlying TDI of 0.04 µg/kg body-weight, sometimes with some national adaptations (for amount of water consumed and/or typical body-weight); range is 1.0-1.5 µg/L
- Some regulate explicitly only MCYST-LR; others keep it vague; yet others use the value for MCYST-LR as default value for other MCYSTs as well.
- Other toxins „regulated“ – though not as legally binding standards – in some countries include CYN (1 µg L^{-1} in Australia and New Zealand or 15 µg L^{-1} in Brazil), STX (3 µg L^{-1} in Australia, New Zealand and Brazil) or ATX-a (3.7 µg L^{-1} in Canada, 6 µg L^{-1} in New Zealand)

National approaches: drinking-water

Increasing demand for a WHO Guideline value for Cylindrospermopsin because

- found frequently also in temperate climates (albeit at low levels, < 1-2 µg/L)
- high extracellular fraction challenges drinking-water treatment
- can be very persistent; slow biodegradation!

• Having a WHO GV available can allow countries NOT to define their own !

National approaches: recreation

- Guidance is usually based on a parameter reflecting cyano-bacterial biomass.
- Biomass levels set are guided by limits for MCYST; target is to avoid exposure to potentially hazardous concentrations.
- MCYST as basis is justified because of high concentrations accumulationg in scums.
- Where MCYST concentrations are used to trigger interventions, they range from 12.5 to 100 µg/L.
- Debate about whether neurotoxins are the more relevant risk because of pronounced acute toxicity (see animal deaths): acute intoxication from ingesting scum could reach acutely hazardous levels more readily than with MCYST.
- Benthic mats on stream surfaces, detaching, as risk: included in New Zealand framework; proposed for Cuba.

National approaches: recreation

EU draft Bathing-water Directive

Article 8 Cyanobacterial risks:

1. When the bathing water profile indicates a potential for cyanobacterial proliferation, *appropriate monitoring* shall be carried out to enable *timely identification* of health risks.
2. When cyanobacterial proliferation occurs and a health risk has been identified or presumed, *adequate management measures* shall be taken immediately to prevent exposure, including *information to the public*.

National approaches: recreation

ANNEX III THE BATHING WATER PROFILE

1. The bathing water profile referred to in Article 6 is to consist of:

(a) a description of the *physical, geographical and hydrological characteristics* of the bathing water, and of other surface waters in the catchment area of the bathing water concerned that could be a *source of pollution*, which are relevant to the purpose of this Directive and in accordance with Directive 2000/60/EC;

(b) an identification and assessment of causes of pollution that might affect bathing waters and impair bathers' health;

(c) an assessment of the *potential for proliferation of cyanobacteria*

(d) an assessment of the potential for proliferation of macro-algae and/or phytoplankton

WHO Guidance for recreational exposure – *proposed*:

Guidance level or situation	How guidance level was derived	Health risks
Guidance level 1: Cyanobacterial scums in areas used for recreation	From oral animal lethal poisonings and case histories of human illness; cyanotoxin concentrations may be in the range of mg/L in heavy scums	Potential for acute poisoning Potential for long-term illness after exposure to some cyanotoxins
Guidance level 2: >15 mm^3/L cyanobacterial biovolume *or* >50 µg/L chlorophyll-*a* with dominance of cyanobacteria	From provisional TDI for microcystin-LR and data on other cyanotoxins; cyanotoxin concentra-tions may exceed 50 µg/L	Potential for long-term illness after exposure to some cyanotoxins, particularly with frequently repeated exposure (e.g. at daily intervals) Potential for rapid increase of risk if scums form
Guidance level 3: 3 – 15 mm^3/L cyanobacterial biovolume *or* 10 – 50 µg/L chlorophyll-a with dominance of cyanobacteria	From provisional drinking-water guide-line for microcystin-LR and data on other cyanotoxins; cyanotoxin concentrations may reach up to 25-50 µg/L	Low risk, except for predis-posed persons with allergy; Potential for rapid increase of risk in large water-bodies if scums form

WHO Water Safety Framework

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Define health-based targets

System assessment:
can the supply chain, from catchment to consumer, meet the health-based targets at all times ?

Monitoring
the measures critical for controlling the system

Management and communication plans
for normal operations and incidents

WSP

GOV

Independent surveillance
to verify the functioning of the system

WHO water safety plan: preliminary steps / prerequisites

1. **Support of leading management**
2. **Forming a Water Safety Plan team**
3. **Describe water supply (flow chart)**

WHO Water Safety Framework

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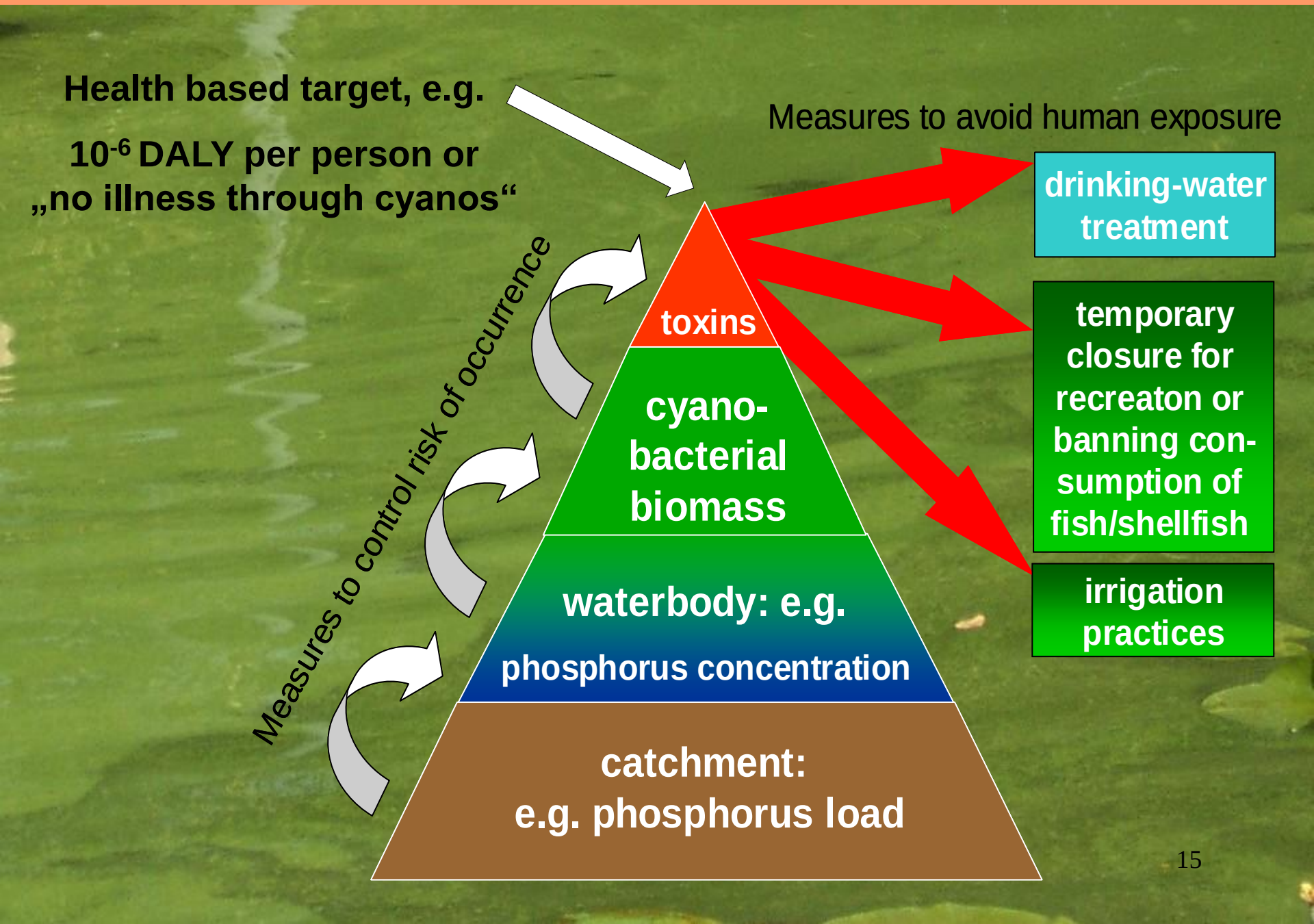
WHO water safety plan: setting targets, system assessment



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WHO Water Safety Framework: System and Risk Assessment

Direct indication		N	O	F	U	assessment	uncertainty
Humans / animals	**Illness indicating cyanotoxins**						
Cyanotoxins > 1 µg/L	**Observed in water-body**						
Cyanobacterial proliferation	**Visible blooms, green turbidity**						
Cyanobacterial biomass > 1 mm^3/L or 1 µg/l Chl.-*a*	**Microscopy, Chl.-a analyses Pigment fluorescence**						

N = no indication, O = occasional, F = frequent, U= uncertain information basis

WHO Water Safety Framework: System and Risk Assessment

Water-body conditions		N	P	Y	U	Assessment ?	Uncertainty ?
General condition of water-body	e.g. eutrophic, deep with stable thermal stratification or shallow, mixed? retention time > 1 month ?						
Current conditions in water-body	e.g. elevated temperature; stratified? TP-conc. > 10-30 µg/L; low transparency ?						
... ? ...	... ? ...						

N = no indication, P= probable, Y = yes, U= uncertain information basis

WHO Water Safety Framework: System and Risk Assessment

Nutrient loading	C	P	N	U	Assessment	Uncertainty
Assessment by catchment inspection						
Assessment through measuring and/or modelling nutrient loads						

C = control quite certain, P= probable, N = control not given,
U= uncertain information basis

WHO Water Safety Framework: System and Risk Assessment

Bank Filtration Slow Sand Filtration	**Y**	**P**	**N**	**U**	Assessment	Uncertainty
Oxidising conditions						
Travel time > 4 weeks						
Fine-grained substrate						
Temperature > 10 C						
Low accumulation of lysing cells on sediment						
… ? …						

Y = Yes, P = Partially, N = No, U = lack of information

WHO Water Safety Framework: System and Risk Assessment

Reservoir offtake strategy	**Y**	**P**	**N**	**U**	Assessment	Uncertainty
Is offtake depth / site variable ?						
Is offtake continuously monitored for cells (e.g. fluorescence; particle counting; turbidity; daily sampling and microscopy)?						
Can adaption of offtake sites effectively avoid cell intake						
.... ? ...						

Y = Yes, P = Partially, N = No, U = lack of information

WHO Water Safety Framework: System and Risk Assessment

Drinking-water Treatment	Y	P	N	U	Assessment	Uncertainty
No pre-oxidation Step						
Flocculation and Filtration						
Flocculation and Flotation						
Post-oxidation						
Powdered activated carbon						
GAC (granular activated carbon filtration)						
… ? …						

Y = Yes, P = Partially, N = No, U = lack of information

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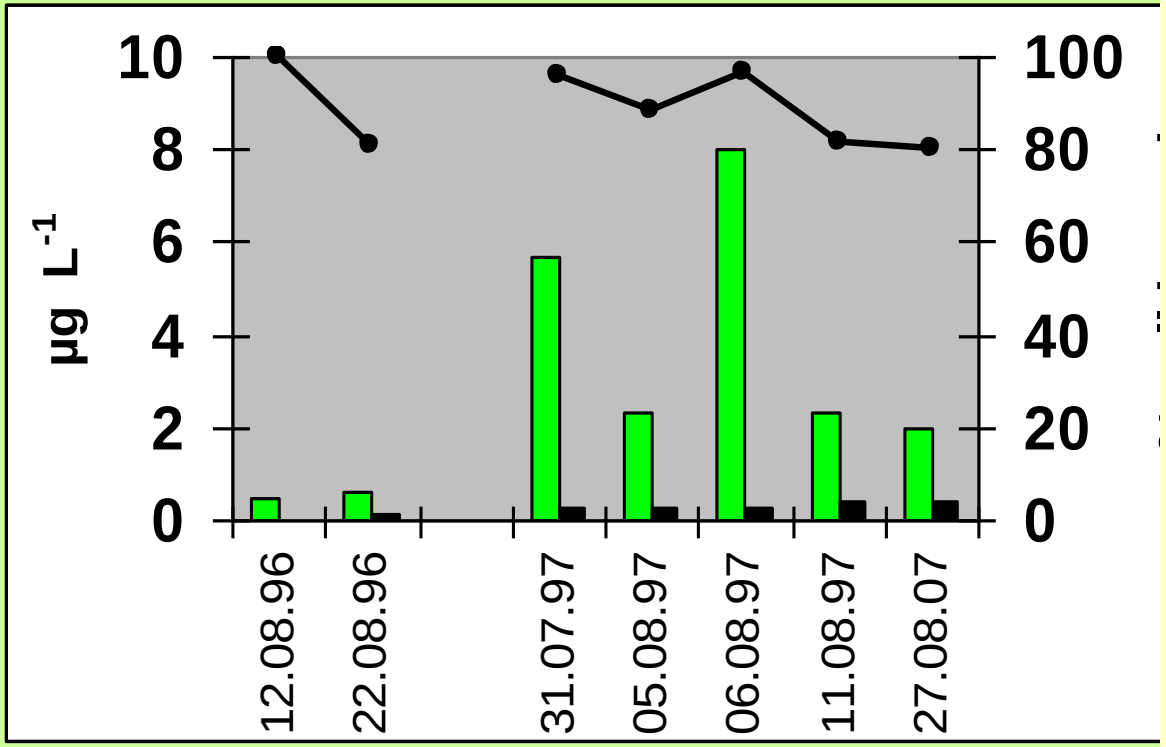
WHO water safety plan: defining control measures

1. **Determine the measures critical for controlling the system "control measures"**
2. **For each, determine operational limit not to be exceeded**
3. **Determine monitoring system for that limit**
4. **Determine corrective action in case the limit is exceeded**

Example treatment: Rostock treatment plant – microcystin in raw and filtered water

***Microcystis* or *Planktothrix agardhii* in the raw water (biovolume once 19 mm³/L, otherwise < 2 mm³/L; flocculation and rapid filtration)**



1. **Control Measure:** **Filtration**
2. **Operational limit:** **turbidity** (fluorescence) **threshold level**
3. **Monitoring system:** **continuous on-line turbidity** (fluorescence) **reading**
4. **Corrective action if limit is exceeded:** **immediate filter backwashing**

Chorus (ed.) 2001

WHO water safety plan: control measure example offtake

Example offtake: Microcystins in Deesbach Reservoir

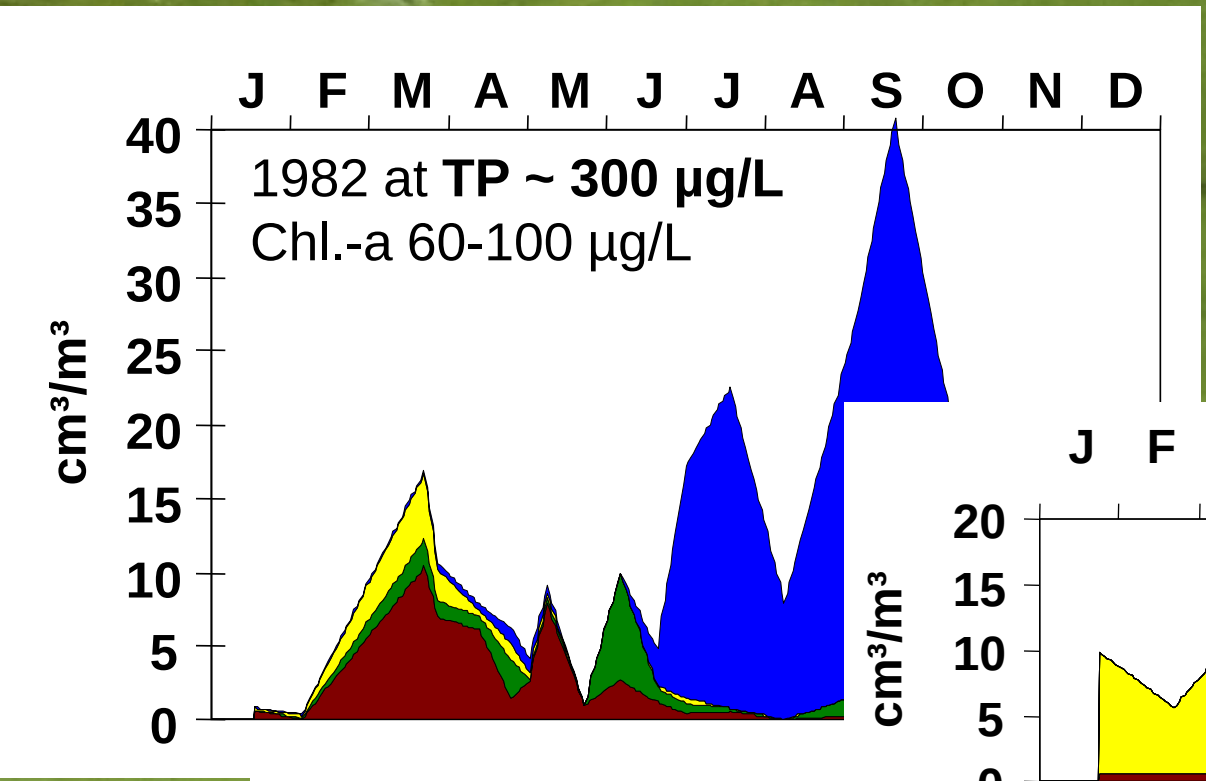
Heavy *Microcystis* blooms, abstraction at 15 – 20 m

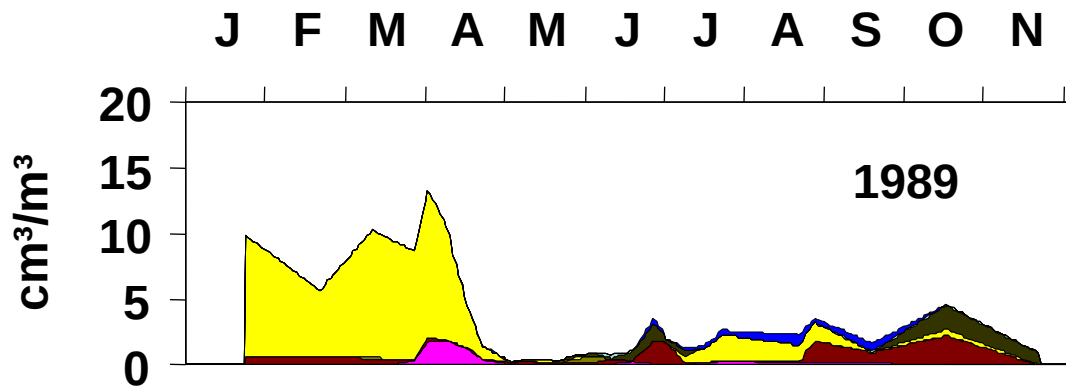
Date	MCYST concen-tration	Reservoir surface	offtake (17 m)
14.07.98	Cell-bound	**75**	0.30
	Dissolved	0.01	n.d.
21.07.98	Cell-bound	**566**	0.10
	Dissolved	0.13	0.02
28.0.7.98	Cell-bound	0.05	0.23
	Dissolved	**3.63**	0.07
05.08.98	Cell-bound	0.28	n.d.
	Dissolved	0.11	0.02

1. Control Measure: Manage offtake depth in relation to scum
2. Operational limit not to be exceeded ? Pigment fluorescence signal at offtake depth
3. Monitoring system for that limit ? Continuous recording of vertical profiles of fluorescense
4. Corrective action ? Shift of offtake depth

WHO water safety plan: control measure example P-load

Restoration Schlachtensee

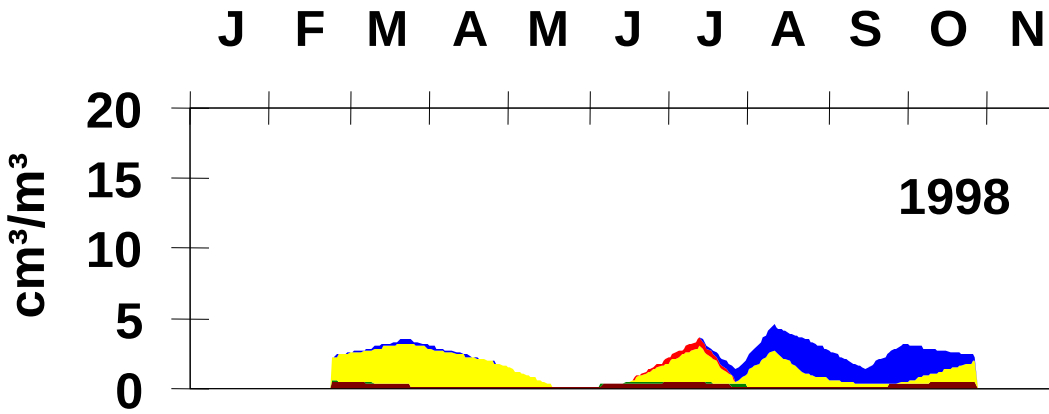




1989, 1998 at

TP ~ 20 µg/L

Chl.a 10-20 µg/L and



WHO water safety plan: control measure example P-load

Can nutrient loading from the catchment be defined and monitored as WSP cpntrol measure ?

Target: Total P < 30 – 40 µg/L in the lake

2. **Control Measure(s) ?** **Usually more than one:**
   - **sewage effluent**
   - **fertiliser and manure application**
   - **land use and erosion protection measures**
3. **Operational limits ?** **maximum TP concentrations in sewage effluent; nutrient budgets; % vegetation cover**
4. **Monitoring systems ?** **Yes, but often not online:**
5. **Corrective action ?** **Usually not as immediate as in technical systems**

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WHO Water Safety Plans: Worked Examples

hazardous event	hazard	risk; basis for assess-ment	uncertainty of assessment	control measures	residual risk; basis for assess-ment	uncertainty of assessment	measures
***Case 1: Microcystis* bloom**	**MCYST in DW at several µg/L**	high; conc. in previous blooms	low; good understanding of WB from 10 years data				

WHO Water Safety Plans: Worked Examples

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***Case 1: Microcystis* bloom**	**MCYST in DW at several µg/L**	**high**; conc. in previous blooms	**low**; good understanding of WB from 10 years data	**1. DW treatment (ozone + GAC);**	**medium**; experience with MCYST, removal **but no 2. barrier!**	**low**; MCYST, was always effectively removed; literature confirms this	**1. mainten-ance ozone and GAC;**

WHO Water Safety Plans: Worked Examples

hazardous event	hazard	risk; basis for assess-ment	uncertainty of assessment	control measures	residual risk; basis for assess-ment	uncertainty of assessment	measures
***Case 1: Microcystis* bloom**	**MCYST in DW at several µg/L**	**high**; conc. in previous blooms	**low**; good understanding of WB from 10 years data	**2. farm ma-nagement**	**medium**; fertilisation management plans are just beginning to work	**low**; good loading model; confidence in prediction of load development	**2. Strengthen collabora-tion with farmers**

WHO Water Safety Plans: Worked Examples

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***Case 2: Planktothrix agardhii* proliferation**	**Cyano-toxins; MCYST**	high; Secchi < 0.5 m; greenish	high; no phytopl. or cyanotoxin data	**Poor** DW treat-ment insuf.; intensive farming	high	high; no phytopl. or cyanotoxin data	**1. Phyto-plankton analyses 2. Introduce bank filtrat.**

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***Case 3: Planktothrix rubescens* at offtake**	**high MCYST intake**	high; lit. = contain a lot	medium; cell data but no tox data	**Variable offtake**	medium; winter mix; Only PAC	medium; no own data	**1. tox data 2. catchm.**

WHO Water Safety Framework: Challenge for Governments

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Summary:

WHO Water Safety Framework and Water Safety Plans:

➔The upcoming tool for implementing systematic, site-specific approaches for effective management

➔Defining regulatory requirements for WSP is challenging, surveillance of implementation is particularly challenging !

Current national approaches:

- Increasingly many countries address cyanotoxins and cyanobacteria in their guidance and/or regulations.
- Cyanotoxin Standards or Guideline Values are important for setting targets, and they can be translated into targets for cyanobacterial biomass, nutrient concentrations, or nutrient loads.
- Risk-based approaches are increasingly emerging.

Thank you for your attention !