Cyanobacteria Bloom in Warragamba Dam in 2007

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Presentation Outline / Scope

- Background
- Nature of Warragamba cyanobacteria bloom in 2007
- Cyanobacteria data – monitoring and modelling
- Preliminary results
Sydney Catchment Authority - SCA

- The SCA is a New South Wales state Government agency, created in 1999.

- The SCA's functions are to protect the quality and quantity of water in catchment areas.

- The SCA manages 20 reservoirs and provides raw water for over 4 million people.
Warragamba Dam (Lake Burruragorang)

- **Physical properties**
  - 2050 GL
  - 105 m depth (max)
  - 7500 ha
- **Catchment**
  - 9050 sq. km
  - Forrest, agricultural and semi-urban
- **Characteristics**
  - 2 major arms + the gorge
  - Stratification
  - Turnover
  - Variable off-take
- **Generally good quality water**
2007 bloom

Strong media interest

Algae swamps chief water supply
Algae covering most of Warragamba Dam
Sydney dam algae 'doubles again'
Inflow to Warragamba in June 2007

- Inflow 2007 – June 9 onwards
- Water level near record low
- SCA monitored for turbidity spikes near the off-take (indicator for inflow)
- Inflow volume of 490 GL – Reservoir volume from 680 to 1170 GL
2007 inflows

- Three major peaks – maximum daily value of 58,400 ML
Monitoring and modelling (SS and temp)

June 17

June 21

June 28

LDS (actual measured temperature)

MOVIE

11  18  25  02  09

June 07  July 07
2007 Cyanobacteria Incident

- Off-take was moved closer to surface (within -7 m) to avoid turbid water
- Cyanobacteria cell numbers increased: 20 August
- Monitoring regime was modified
- Off-take moved down to -22 m: 20 August
- Incident Management Team was established
- Major incident declared: 28 August
- Off-take moved down to -40 m: 29 August
Historical bloom data near the Dam

Presence of cyanobacteria near the dam wall: rare

(0 – 12 m compositied samples)
2007 Cyanobacteria data

0 – 12 m composite sample

Not Microcystis aeruginosa, but a relatively smaller species
Monitoring for cells and toxins

- Toxin analysis
  - ppi analysis *detected* Microcystin (LReq/L) in 4 out of 120 samples, but at well below guideline values
  - HPLC analysis did not detect any toxins

- Polymerised Chain Reaction (PCR) Assay
  - Percentage of cells with toxin producing genes was generally below 1%

- Preliminary result of remote sensing investigation is promising

- Cyanobacteria probes were used to study the distribution of cell population
Historical inflow

1. Total Inflow
2. Inflow to Storage Volume Ratio

Inflow of 490 GL into the Storage Volume of 680 GL (72%)
Cyanobacteria bloom forecasting

A bloom in Warragamba Reservoir with over 10 μg/L of chlorophyll is very likely, if

Based on Hassan et al 1994

- An inflow event between April and August
- An inflow peak of >50,000 ML/day
- Total inflow between April and August of greater than 600,000 ML
- Total inflow volume is greater than 50% of initial storage volume

A bloom with > 10 μg of chlorophyll is very likely
Nitrogen and Phosphorus – DWA2

- TN (micrograms/L)
- TP (micrograms/L)

TN Criterion
TP Criterion
2007 Investigation – Conceptual model

DO (mg/L) and Temp (deg C)

Depth (m)

05 June

DO

Temp

27 June

02 July

20 July

LDS(15min)

Height (m)

Temperature (°C)

05 June

DO

Temp

02 July

Temp

20 July

Temp

LDS(15min)

Height (m)

Temperature (°C)

05 June

DO

Temp

20 July

Temp

LDS(15min)

Height (m)

Temperature (°C)
Cyanobacteria bloom: solutions?

• Following 2007, a number of solutions were suggested
  – Physical (destratification, aeration, sonication, SolarBee®)
  – Chemical (additives, algicides)
  – Biological (zooplanktons, fish, reed beds)
  – Others (algae harvesting)

• The main question should be WHY not HOW

• The role of catchment management
• No quick-fix catchment processes to reduce the contaminant loads
• Multi-barrier approach
• Reservoir is a dynamic biological system
Key messages

• 2007 was the first major cyanobacteria bloom at Warragamba Dam wall
• 2007 event was managed without any threat to public health
• Likelihood and consequences are not well known
• A major inflow, particularly when stored water volume is relatively low, may lead to a cyanobacteria bloom
• Reservoir models can assist
• Inflow monitoring (quality and quantity) is critical
• The investigation of 2007 bloom is providing valuable insights
• Learning from other’s experience is wise
Thank you....
RESOURCES - backup
LDS / SCARMS Output
Warragamba: Initial and Inflow Volumes

Underflow Special
Nitrogen and Phosphorus – DWA2

A value of 220 micrograms/L on 6 May 1996 in the 0 - 18 m layer

July - August 2004 and 2005
2007 Investigation – Conceptual Model

- **DO (% saturation); Turbidity (NTU)**

- **EC (μS/cm)**

- **Temperature (°C)**

**5 June 2007**
- Epilimnion
- Hypolimnion
- Thermocline

**27 June 2007**
- Epilimnion
- Hypolimnion
- Thermocline