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Mining in the Magela Creek catchment, Northern Territory, has occurred for over 20 years with the operation of ERA Ranger uranium mine. This is an area identified as having World Heritage status as well as a high conservation value, and therefore requires reliable measures of protection from mining activities. In addition to uranium, magnesium sulphate ($MgSO_4$) is a common mine contaminant arising from runoff over waste rock. However very little data existed on the toxicity of $MgSO_4$ to local aquatic species. Concern over potential increase in salinity downstream from the mine from $MgSO_4$ has resulted in an investigation of $MgSO_4$ toxicity to local aquatic organisms, with the aim to derive a site-specific high reliability trigger value (TV) for $MgSO_4$ in Magela Creek.

$MgSO_4$ toxicity was assessed using five freshwater species: a green alga (*Chlorella* sp.; 72-h population growth), cladoceran (*Moinodaphnia macleayi*; 3-brood reproduction), cnidarian (*Hydra viridissima*; 96-h population growth), snail (*Amerianna cumingii*; 8 day reproduction) and fish (*Mogurnda mogurnda*: 96-h survival). No-observed-effect concentrations of $MgSO_4$ varied from 11 mg/L for green hydra to 1086 mg/L for *Chlorella* sp However, green hydra were more than 15 times more sensitive than the other test organisms.An interim trigger value for $MgSO_4$ in Magela Creek is 0.81 mg/L. The implications of this will be discussed. Further research effort is required to better understand the relative contributions of the anion and cation to $MgSO_4$ toxicity, as well as the effect of the Mg:Ca ratio on $MgSO_4$ toxicity.

Toxicity of magnesium sulfate to local tropical aquatic species: derivation of a site-specific trigger value

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Outline

- Background - WQG, U TV, salinity
- Magela Creek - $MgSO_4$ source
- Site-specific toxicity data
- Site-specific trigger value derivation
- Issues and limitations

Background: *The Aust/NZ Water Quality Guidelines for Toxicants*

- Provide default/generic ***trigger*** values for Toxicants
- Encourage derivation of site-specific ***trigger*** values

Decision trees:

- Sample filtration
- Practical quantitation limit (PQL)
- Natural background concentrations
- Bioaccumulation
  - **Locally important species**
  - Water chemistry (eg pH, hardness, DOM)
- Multiple contaminant effects

Background: *Default Trigger Values*

High reliability
- Statistical extrapolation
- calculated from chronic no-observed-effect concentration (NOEC) data

Moderate reliability
- Statistical extrapolation
- calculated from acute toxicity data (eg LC_{50}) after applying acute-to-chronic conversion factors

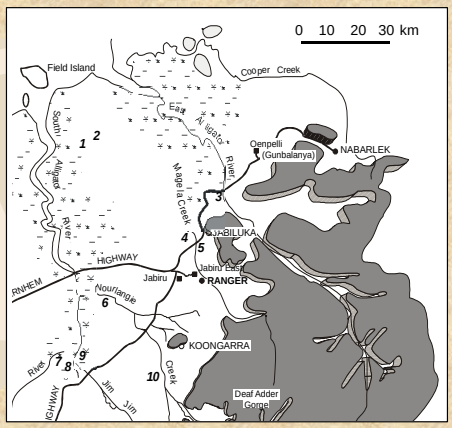
Low reliability
- Assessment factor method
- interim working levels - require further data

RP1 spillway,29-03-02

ERA Ranger mine July 1999

Magela Creek (Alligator Rivers Region)

- High conservation/ecological value area - World Heritage Listing, National Park.
- Seasonally flowing tributary of the East Alligator River
- Characterised by very soft, low EC water, pH 6-7
- Passes near Ranger Uranium Mine and Jabiluka lease
- Major toxicants of concern → Uranium,
  → Magnesium



Magnesium sulfate & Magela Creek

$MgSO_4$ in Magela Ck:

- Upstream Ranger (98-99) → **0.1-0.8 mg L^{-1}**
- Downstream Ranger (wet season) → **0.1-2.4 mg L^{-1}**

Current "very" interim guideline for Magela Ck d/s of Ranger:

→ **1.1 mg L^{-1}**

WQGs (2001) default trigger value:

- Low reliability trigger value
- Inadequate for an area of high conservation/ecological value

→ site-specific assessment essential

Magnesium sulfate toxicity studies in the region

Number of local species tested for magnesium sulfate toxicity

Organism type	No. species tested	No. relevant for site-specific trigger value
Cnidaria (hydra)	1	1 (1992-93, 2002)
Mollusca (Snail)	1	1 (2001)
Crustacea (water flea)	1	1 (1092-93, 2002)
Chordata (fish)	1	1 (2002)
Chlorophyta (Chlorella sp)	1	1 (2002)
Total	*5*	*5*

→ Chronic toxicity data for 5 local species from at least 4 trophic levels/taxonomic groups in Magela Ck water

Single-species toxicity tests

Species: purple spotted gudgeon, *Mogurnda mogurnda*

Test duration: 96 h

Endpoint: sac fry survival

Exposure: acute

Single-species toxicity tests

Species: water flea, *Moinodaphnia macleayi*

Test duration: 5-6 d (production of 3 broods)

Endpoint: reproduction

Exposure: chronic

Single-species toxicity tests

Species: green hydra, *Hydra viridissima*

Test duration: 96 h

Endpoint: population growth

Exposure: chronic

Single-species toxicity tests

Species: single-celled green alga, *Chlorella* sp.

Test duration: 72 h

Endpoint: cell division

Exposure: chronic

Single-species toxicity tests

Species: Freshwater snail, *Amerianna cumingi*

Test duration: 8 days

Endpoint: fecundity (embryos)

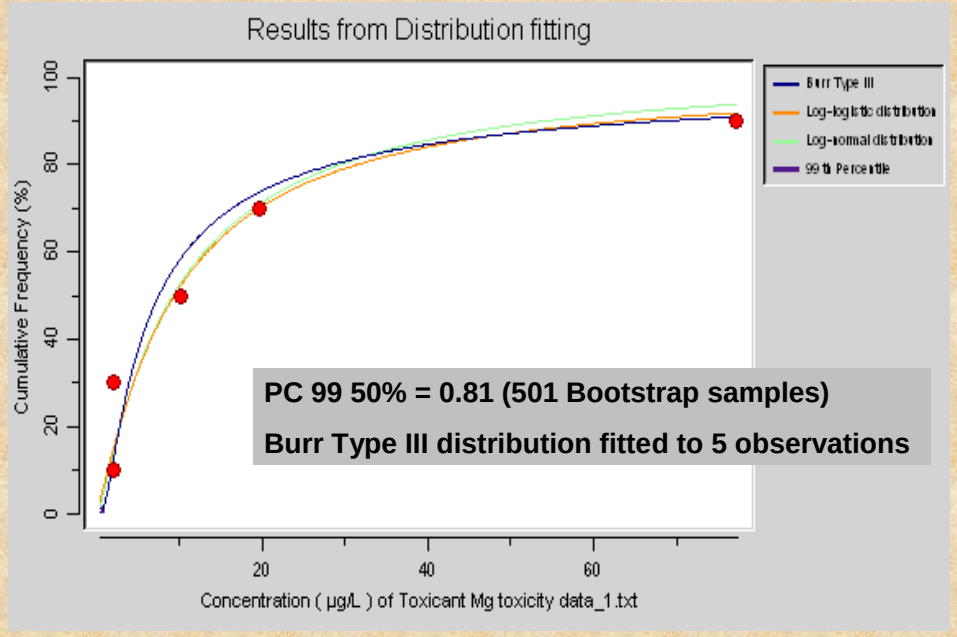
Exposure: Chronic

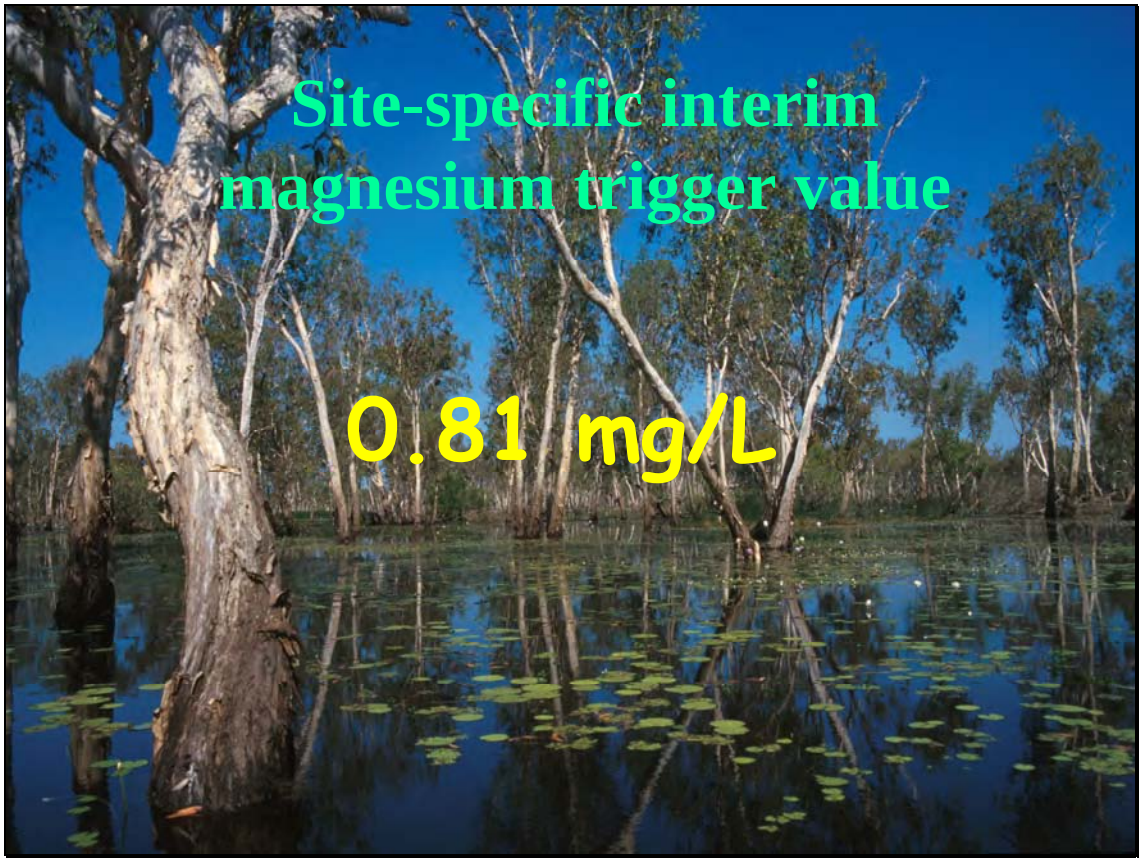
Magnesium sulfate toxicity studies in Magela Creek

Chronic toxicity of magnesium sulfate to local species, using Magela Creek water as diluent

Species	Test endpoint (mg L^{-1})	NOEC	Reference
Chlorella sp.	Cell division rate	77.2	in progress
Hydra viridissima	Population growth	2.2	in progress Internal Report (1994)
Moinodaphnia macleayi	Reproduction	10.2	in progress (IR 1994)
Mogurnda mogurnda	Growth	25.2	in progress
Amerianna cummingi	*Reproduction*	*2.0*	in progress

Derivation of a site-specific trigger value for magnesium: *Burr Type III distribution*





Issues and limitations

- Worst-case scenario TV for Mg
- Calculation uses two values based on one NOEC result & an IC_{50}
- Assumes the distribution describes the range of sensitivities of all species in the environment
- High error/uncertainty due to small sample size

Further toxicity assessment required:

→ aquatic macrophytes (Lemna in Magela Creek water)

→ snail test protocol

Summary

- Interim 99% protection level trigger value for magnesium in Magela Creek is 0.81 mg L^{-1}
- The represents a worst-case scenario for this site
- Another 'real life' trial of the new WQGs approach to deriving site-specific trigger values
- First assessment of salinity toxicity using a site-specific approach
- Further toxicity assessment planned