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Threat from Acid Sulfate Soils:

Currency Creek, Finniss River and Black Swamp region

Rob Fitzpatrick[1,2,3] Gerard Grealish, Paul Shand, Steve Marvanek, Brett Thomas, Nathan Creeper, Richard Merry and Mark Raven

[1]Chief Research Scientist: CSIRO Land and Water

[2]Director and Professor: Centre for Australian Forensic Soil Science (CAFSS)

[3] National Committee for Acid Sulfate Soils (NatCASS)

January, 2009

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What are acid sulfate soils (ASS)?

The nastiest soils in the world!

- **Why?**

AND

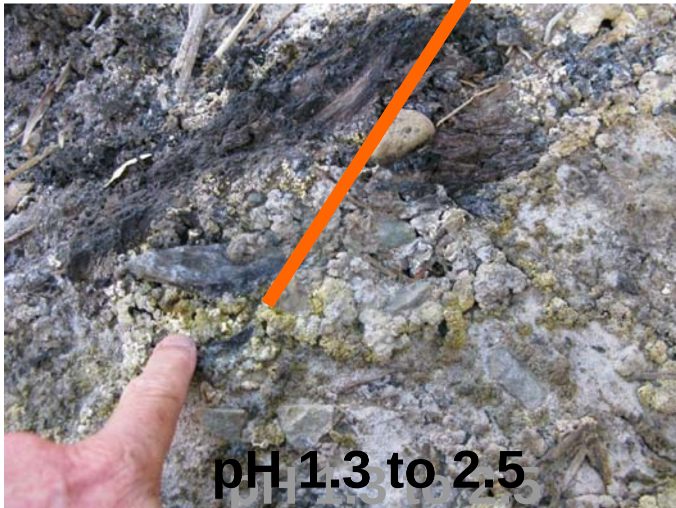
The most benign soils in the world!

- **Why?**

Benign and nasty types of ASS materials in the Finniss river

Release of:

- **Sulfuric acid**
- **Iron**
- **Aluminium**
- **Mg-sulfate salts**



What are acid sulfate soils?

What happens when pyrite in soils or sediments are disturbed or exposed?

pyrite + oxygen + water → iron (aq) + sulfuric acid (aq)

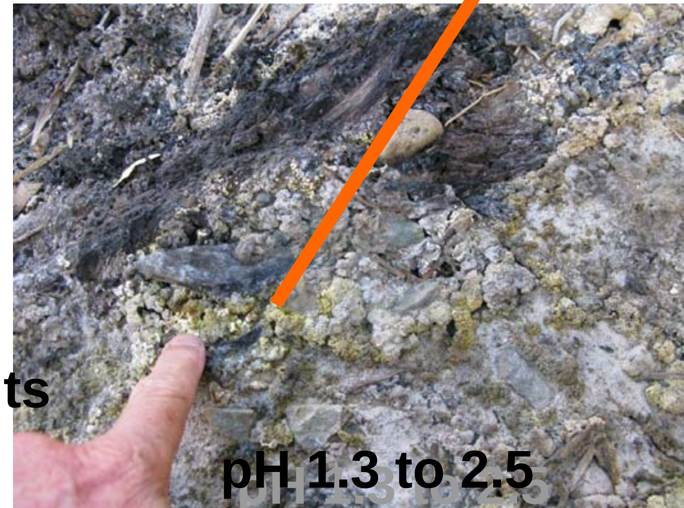
Release and export of:

- Acid
- Iron
- Aluminium
- Other metals and heavy metals

- Consumption of oxygen
- Generation of monosulfidic black ooze

Sulfidic (= potential ASS material)
Sulfuric (= actual ASS material)

Release of:
- **Sulfuric acid**
- **Iron**
- **Aluminium**
- **Mg-sulfate salts**



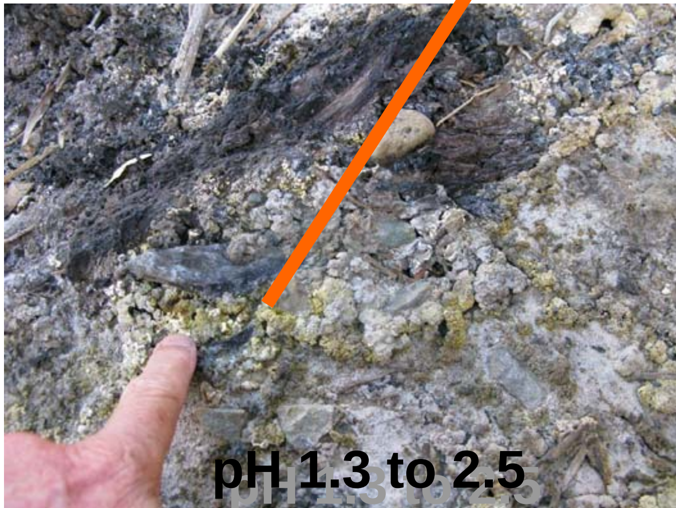
Impacts of disturbing or exposing sulfides in ASS

Impacts of ASS disturbance may be:

- Environmental
- Engineering
- Human or animal health
- Economic

Environmental
– Acidification, salinity and metal release

Release of:
- **Sulfuric acid**
- **Iron**
- **Aluminium**
- **Mg-sulfate salts**



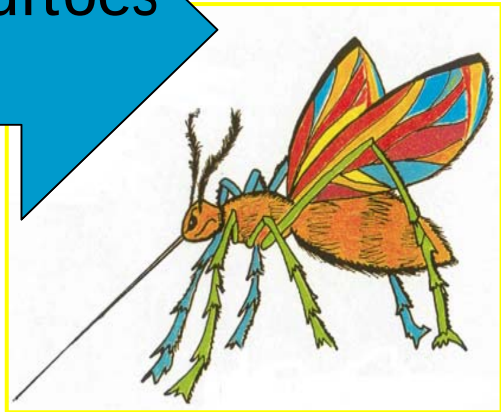
Human health

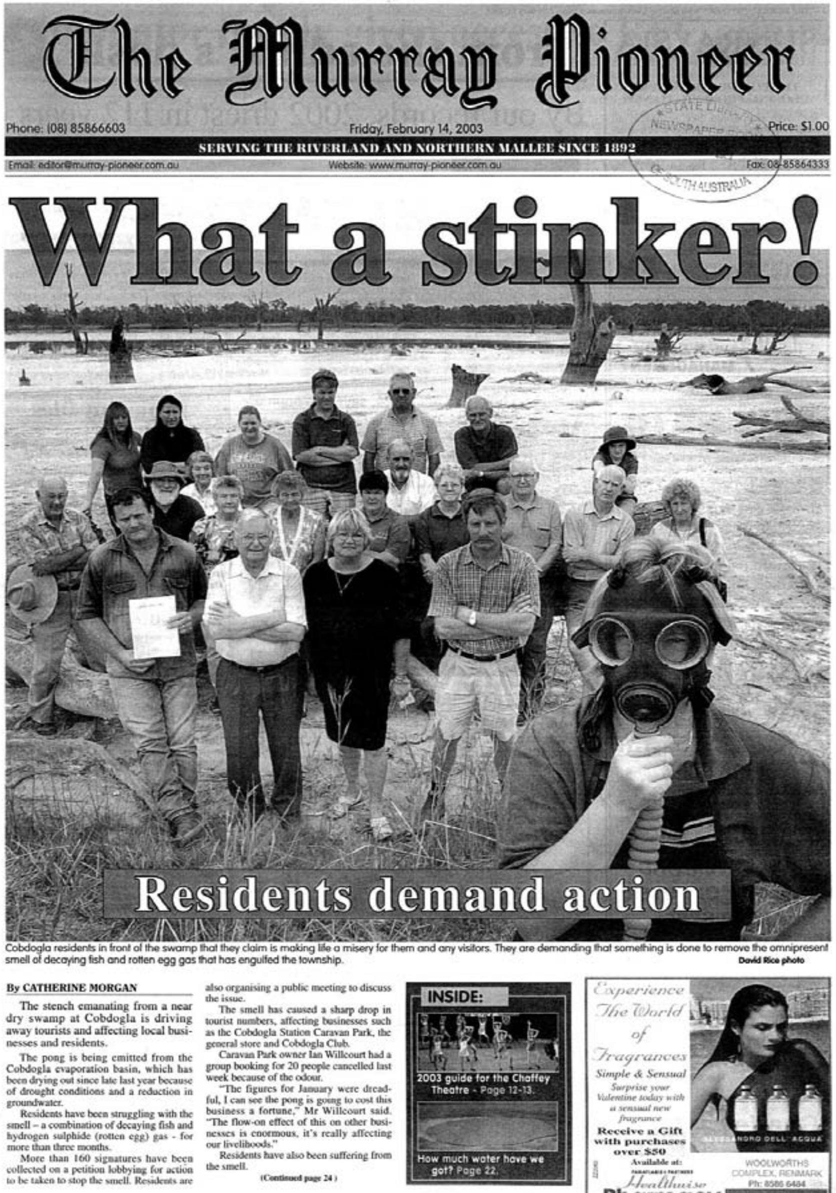
RISKS: Metal release following oxidation

De-oxygenation of water column

Noxious smells

Acid tolerant mosquitoes & arboviruses





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What a stinker!

Residents demand action

Cobdogla residents in front of the swamp that they claim is making life a misery for them and any visitors. They are demanding that something is done to remove the omnipresent smell of decaying fish and rotten egg gas that has engulfed the township.

David Rice photo

By CATHERINE MORGAN

The stench emanating from a near dry swamp at Cobdogla is driving away tourists and affecting local businesses and residents.

The pong is being emitted from the Cobdogla evaporation basin, which has been drying out since late last year because of drought conditions and a reduction in groundwater.

Residents have been struggling with the smell – a combination of decaying fish and hydrogen sulphide (rotten egg) gas - for more than three months.

More than 160 signatures have been collected on a petition lobbying for action to be taken to stop the smell. Residents are also organising a public meeting to discuss the issue.

The smell has caused a sharp drop in tourist numbers, affecting businesses such as the Cobdogla Station Caravan Park, the general store and Cobdogla Club.

Caravan Park owner Ian Willcourt had a group booking for 20 people cancelled last week because of the odour.

"The figures for January were dreadful, I can see the pong is going to cost this business a fortune," Mr Willcourt said. "The flow-on effect of this on other businesses is enormous, it's really affecting our livelihoods."

Residents have also been suffering from the smell.

(Continued page 24)

INSIDE:

2003 guide for the Chaffey Theatre - Page 12-13.

How much water have we got? Page 22.

Monosulfidic Black Ooze (MBO) - accumulation along barrages

➔monosulfides (FeS)

De-oxygenation of water column

Noxious smells

Engineering impacts
Cracking, shrinking, subsidence

Low bearing capacity
High moisture content

- irreversible shrinking
- mosaic cracking effect
- unevenly dry out

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Engineering impacts
Cracking, shrinking, subsidence

Low bearing capacity

High moisture content

- irreversible shrinking
- mosaic cracking effect
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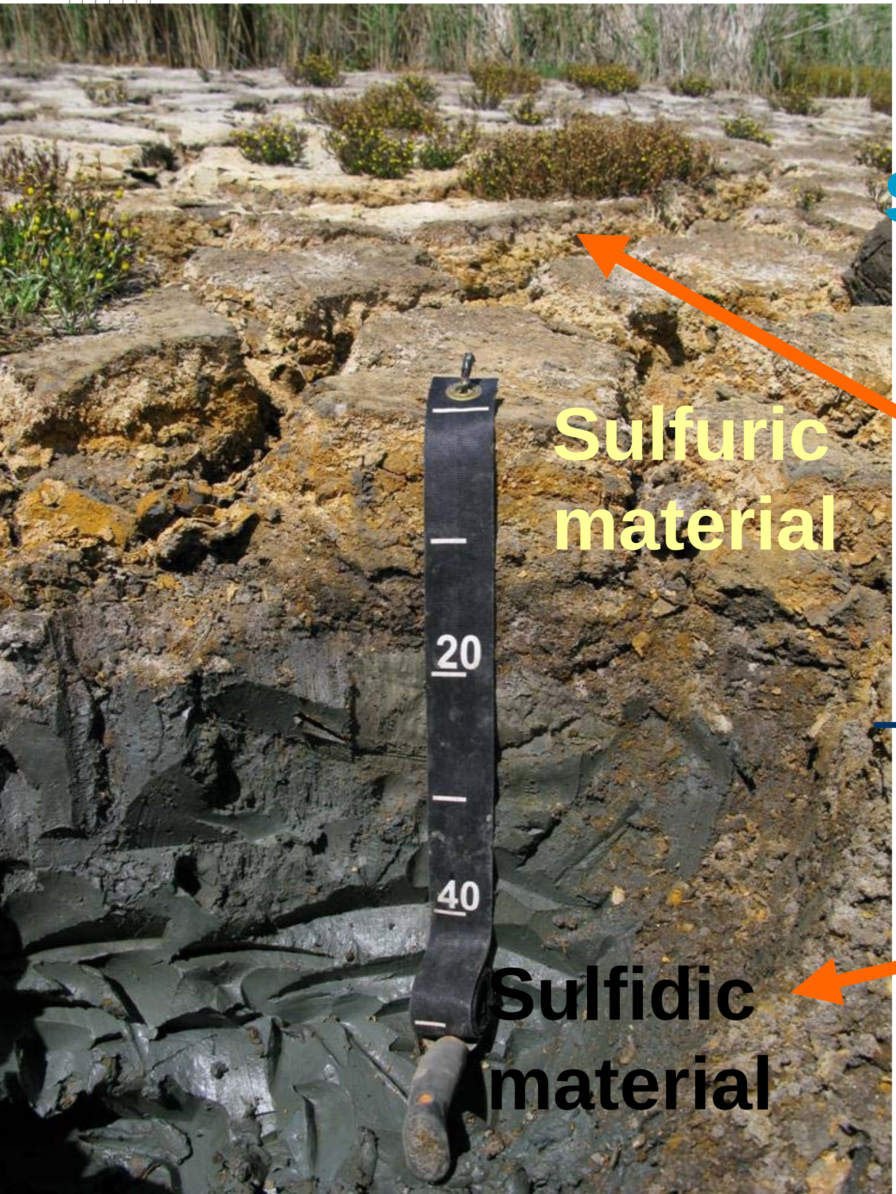
Extensive soft sulfidic material
+ Monosulfidic Black Ooze:

Human health hazards

Sulfuric cracking clay soil
(drained wetlands adjacent to Finniss river)



Sulfuric material

pH < 3

Sulfidic material

pH > 7

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Sulfuric material with cracks + water (pH 3.5)

Finniss river – November 2008

pH 3.5

Saline

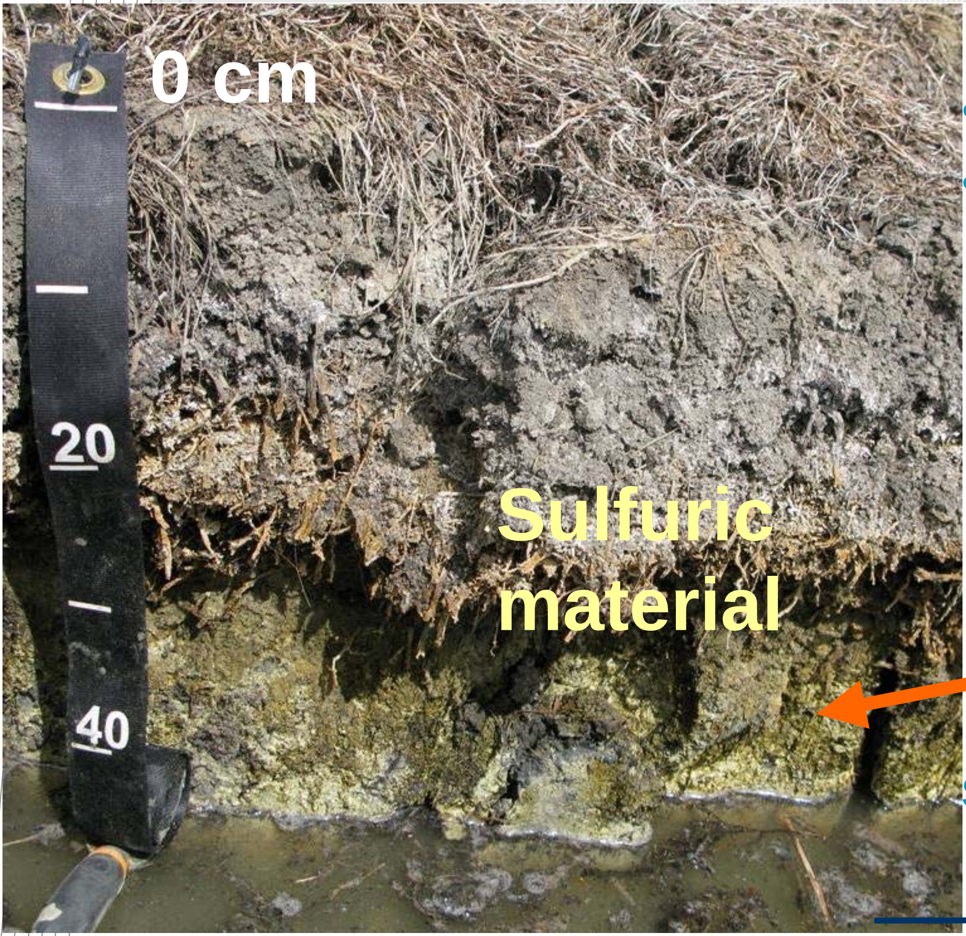
(31 dS/m)

Sulfuric cracking clay soil with acid (pH 3.5) water in the cracks - adjacent to Finniss river)

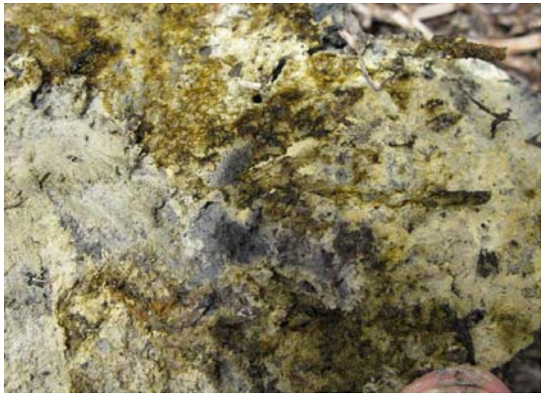
pH 3.5

Saline (31 dS/m)

Sulfuric cracking clay soil + standing water (pH 3.4) - drained wetlands adjacent to Finniss river



- **Sulfuric material = pH < 3**
- Light yellowish mottles + precipitates
  - = oxidised iron sulfides
  - Yellow jarosite (iron sulfate mineral)



STANDING WATER = pH 3.4

Sulfidic material = pH > 7= Unoxidised Iron sulfides: Dark grey and black

Sulfidic material
Depth > 90cm

Sulfuric cracking clay soil with coatings of iron minerals (= store of acidity when rewetted)

Collecting coatings of iron minerals (pH 3.2), which stores acidity because when the soil is rewetted the mineral transforms and releases more acidity

Light yellowish iron sulfate mineral = “jarosite”

Sulfuric cracking clay and sandy ASS materials
Currency Creek – Goolwa North = VAST

November 2008

Sulfuric cracking clay and sandy ASS materials
Currency Creek: yellow and orange colours

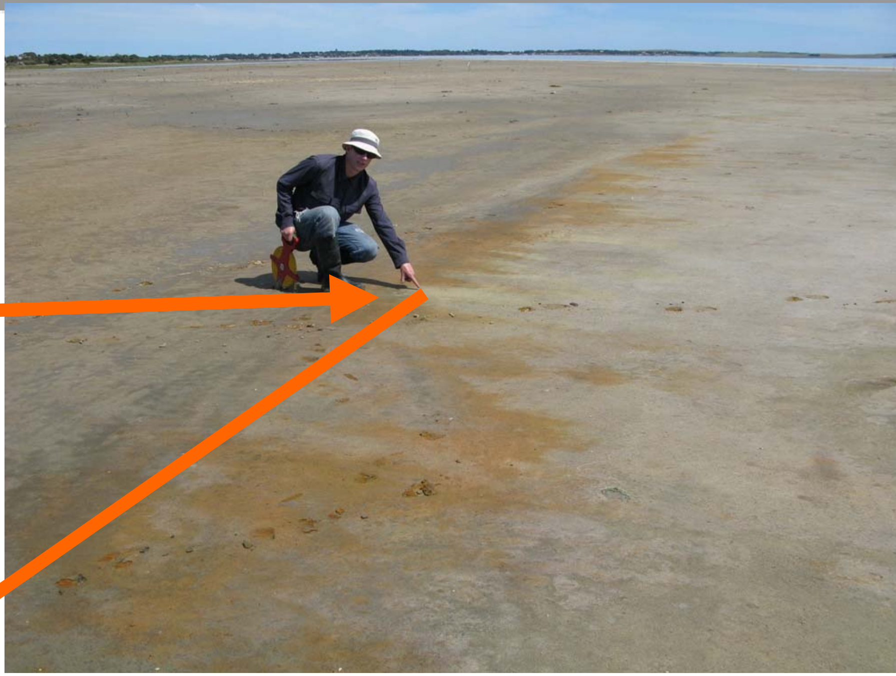
Rewetting by rainfall events = yellow and orange colours

November 2008

pyrite + air (oxygen) => acid (pH 1– 3) + iron oxides (yellow-green iron mineral)
yellow-green iron mineral + water => orange iron oxide mineral

Sulfuric soils with “stored acidity” in coloured iron minerals

Sandy in drained beaches



Oxidation of pyrite to form yellowish-green areas with pH <2 (sideronatrite mineral)

In presence of rain water the yellowish-green mineral transforms to the orange mineral (schwertmannite mineral)

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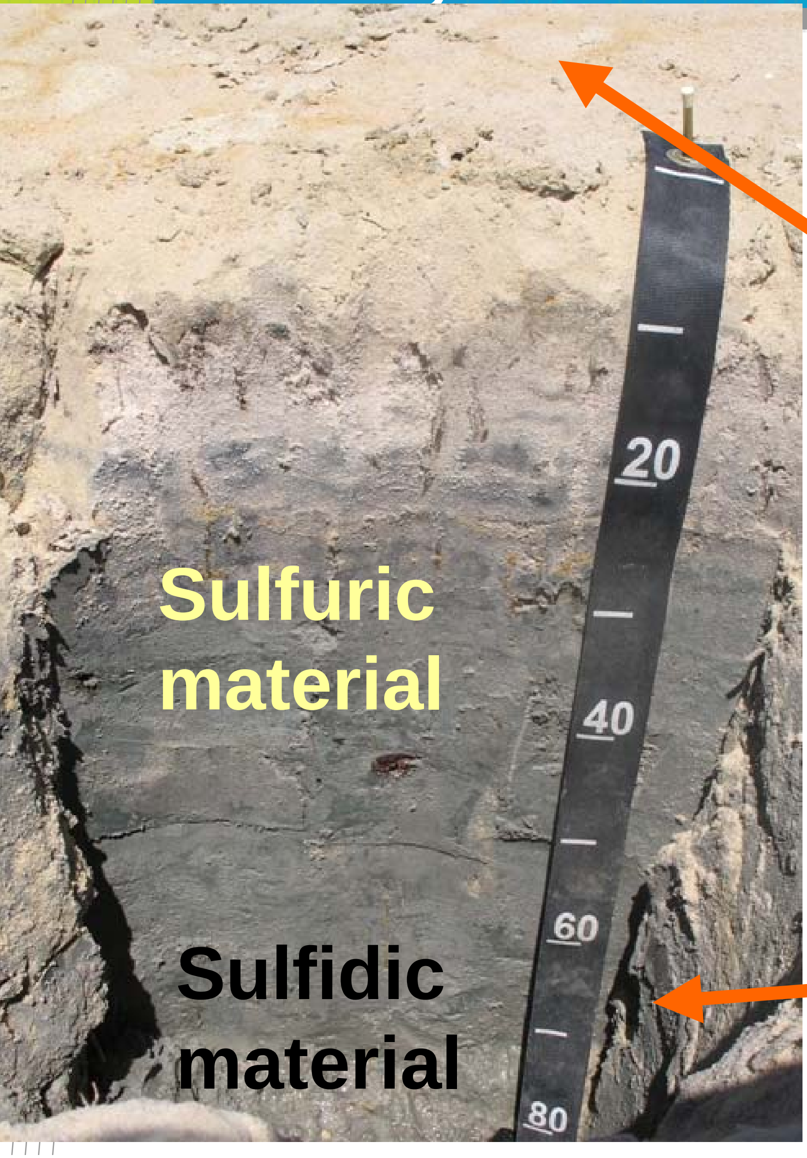
Sulfuric soil (Sandy in drained beaches)

Contain **“stored acidity” in coloured iron minerals**

Sulfuric material
Sandy in drained beaches



Sulfuric material

(Has become acidic after drainage)

- **pH < 4 (usually ranging from 3.5 to 2.5)**
- Oxidised iron sulfides
  - with yellow mottles
  - Yellow jarosites and other iron-sulfate salts

Sulfidic material

(If disturbed becomes acidic)

- **pH >4 (e.g. pH 6 to 7 = sea water)**
- Unoxidised iron sulfides: Dark grey and black

Water table level = 85 cm (February 07)

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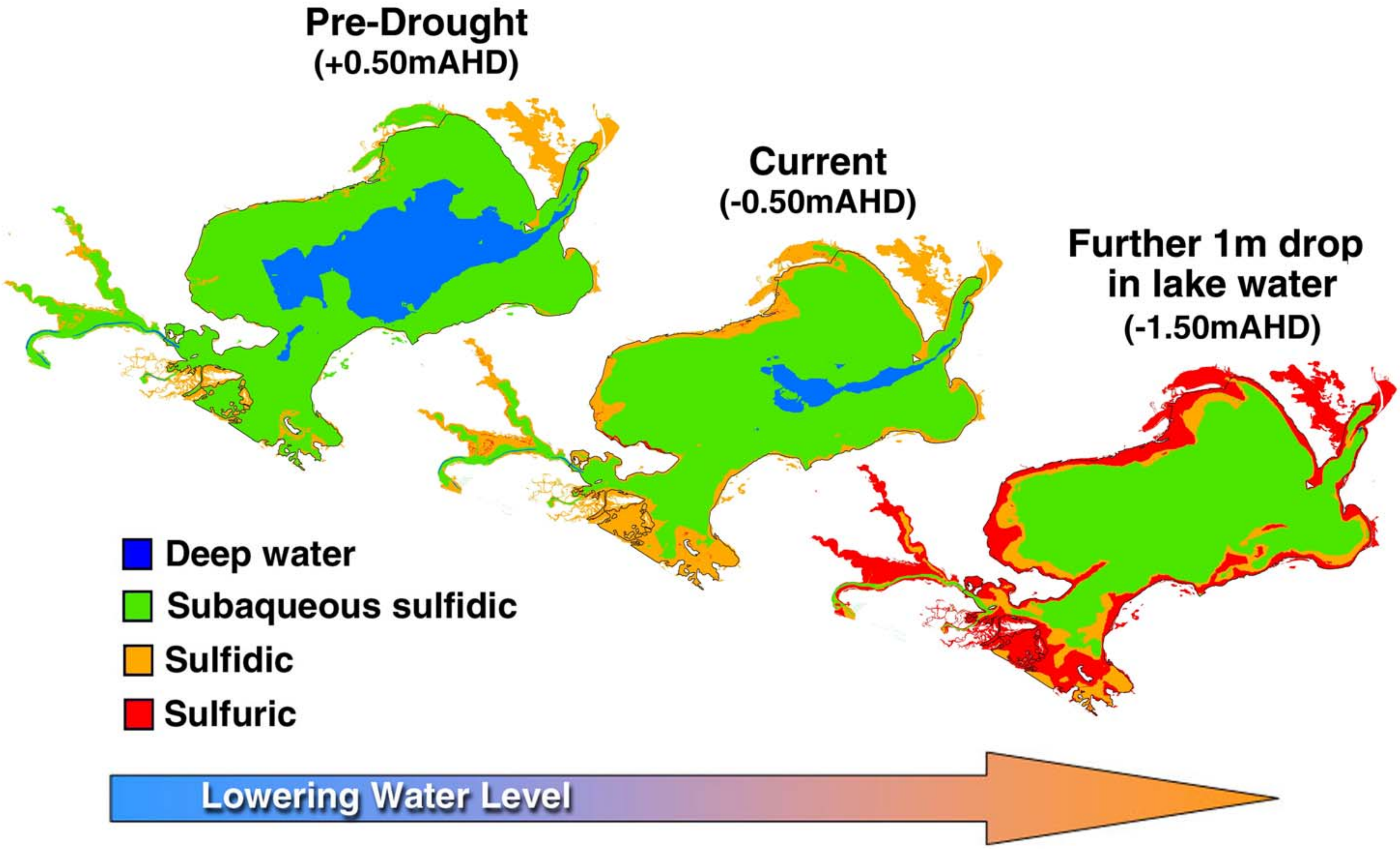
Excavation of sulfidic material in Finniss River - Acid and metal mobilisation after rain event

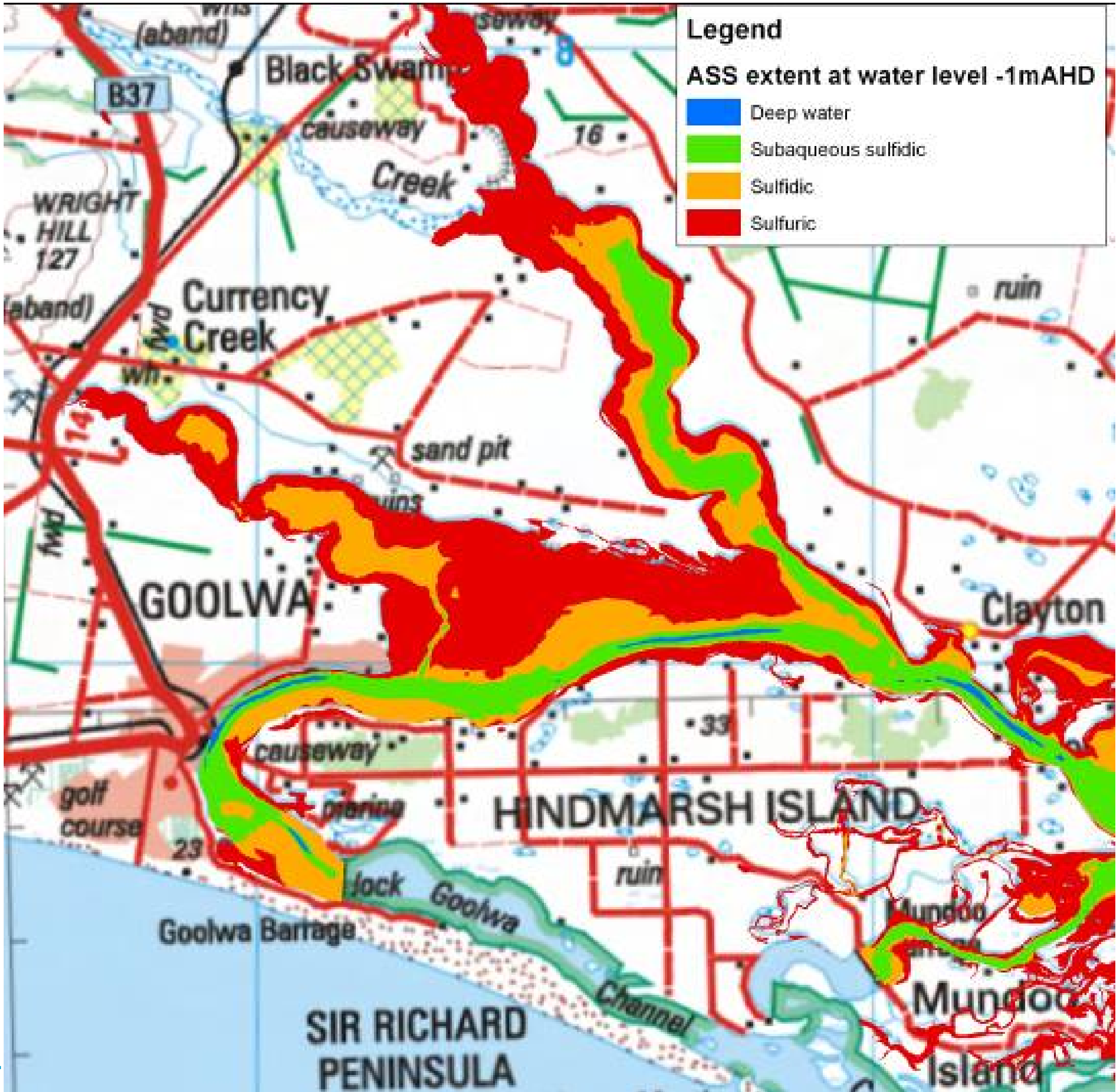
Simulation of rewetting

pyrite + air (oxygen) => acid (pH 1– 3) + iron oxides (e.g. yellow-green sideronatrite)
iron oxide (e.g. sideronatrite) + water => orange iron oxides (e.g. schwertmannite)

Changes in extent of ASS in Lake Alexandrina resulting from lowering water levels



Map showing "current" distribution of ASS in Currency Creek, Finniss River, and Black Swamp



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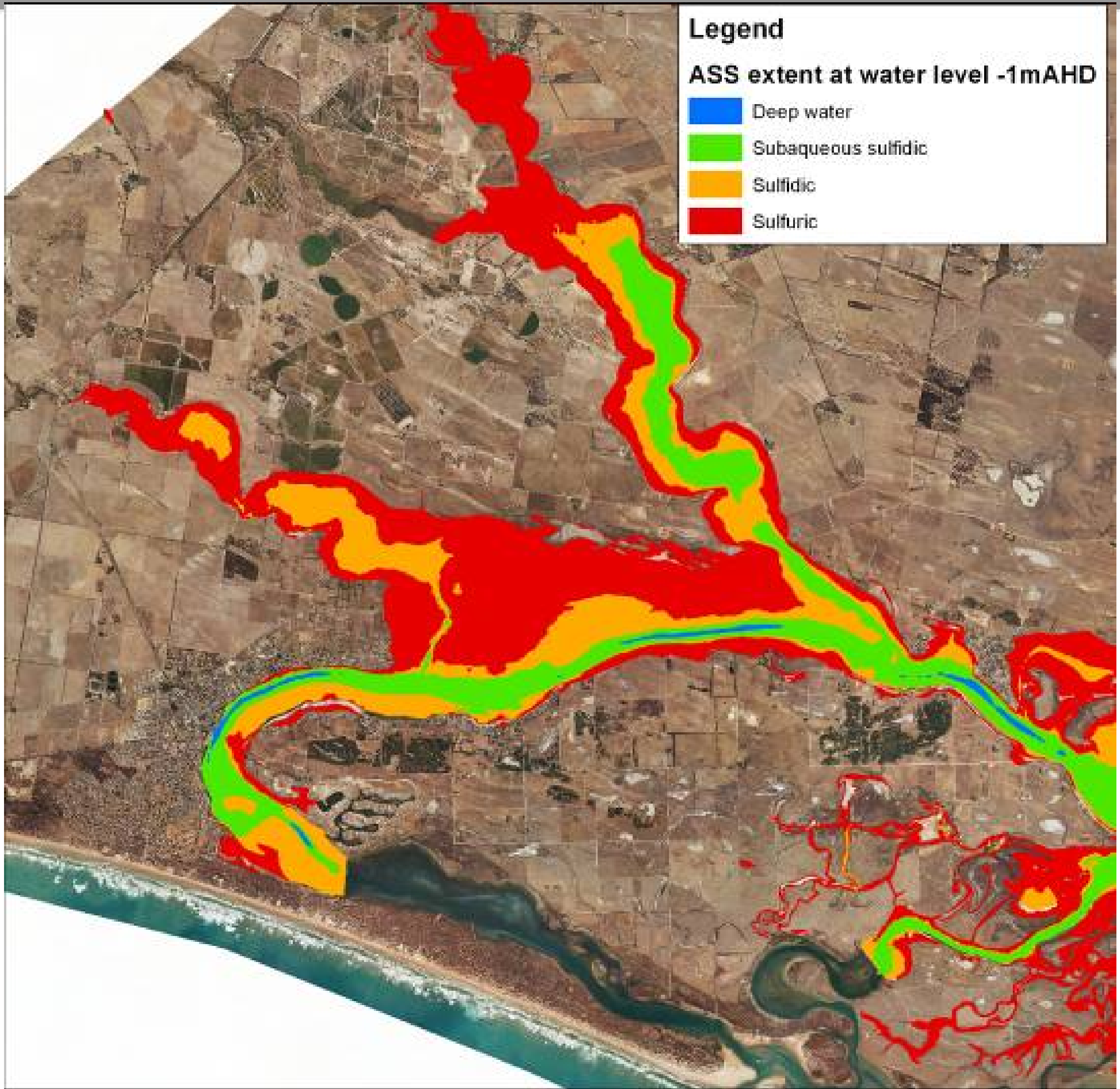
Map showing "current" distribution of ASS in Currency Creek, Finniss River, and Black Swamp



Summary of Lower Lakes outcomes

- **Currently** ~2,000 ha of **sulfuric material** is verified in Lower Lakes
- This equates to ~480,000 tonnes of H_2SO_4 already formed
- A further drop of 1m in lake water level will result in ~33,000 ha of sulfuric material equating to ~8,000,000 tonnes of H_2SO_4
- **Monitoring of ASS is continuing (50 plus sites)**

Recent publications: lower lakes region

Fitzpatrick, RW, P. Shand, M. Thomas, R.H. Merry, M.D. Raven, S.L Simpson (2008) Acid sulfate soils in subaqueous, waterlogged and drained soil environments of nine wetlands below Blanchetown (Lock 1), South Australia: properties, genesis, risks and management. Prepared for South Australian Murray-Darling Basin Natural Resources Management Board. CSIRO Land and Water Science Report 42/08. CSIRO, Adelaide, 122. pp.
http://www.clw.csiro.au/publications/science/2008/sr42-08.pdf

Fitzpatrick, RW, P. Shand, S Marvanek, R.H. Merry, M. Thomas, S.L Simpson, M.D. Raven and S. McClure (2008) Acid sulfate soils in subaqueous, waterlogged and drained soil environments in Lake Albert, Lake Alexandrina and River Murray below Blanchetown (Lock 1): properties, distribution, genesis, risks and management. Prepared for Department of Environment and Heritage, SA. CSIRO Land and Water Science Report 46/08. CSIRO, Adelaide, 167. pp.
http://www.clw.csiro.au/publications/science/2008/sr46-08.pdf

Thank you

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PhD students
NatCASS committee members
Agencies + Clients (SA DEH, MDBA, SA MDB NRMB, EPA, DEWHA)

CSIRO Land and Water
Rob Fitzpatrick
Phone +61-8-8303 8511
Email Rob.Fitzpatrick@csiro.au
Web www.clw.csiro.au

www.csiro.au

Thank You

What are acid sulfate soils?

What happens when pyrite in soils or sediments are disturbed or exposed?

$$FeS_2 + {}^{15}/_{4}O_2 + {}^{7}/_{2}H_2O \rightarrow Fe(OH)_3 + 2SO_4^{2-} + 4H^+$$

pyrite + oxygen + water → iron (aq) + sulfuric acid (aq)

Release and export of:

- Acid
- Iron
- Aluminium
- Other metals and heavy metals
- Consumption of oxygen
- Generation of monosulfidic black ooze