What's all the stink about

A guide to sulfur gas emissions in Australian wetlands and disposal basins

By Greg Lawrence

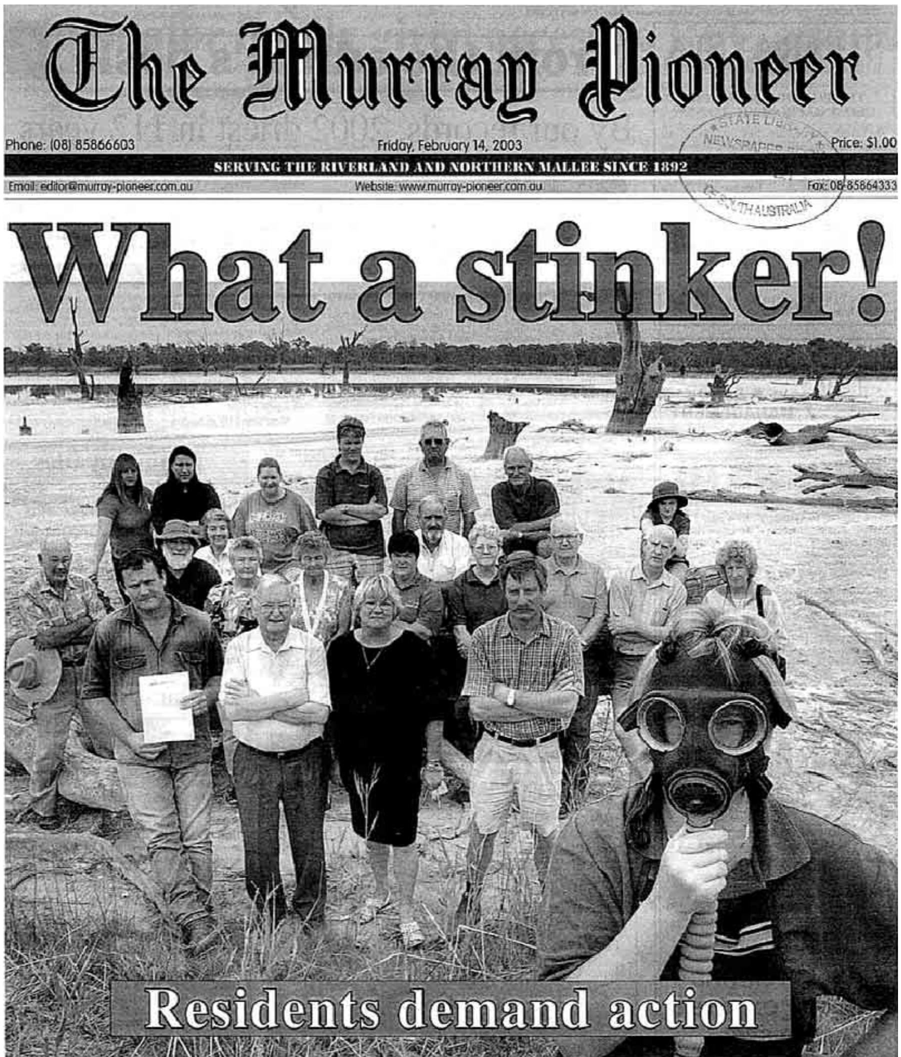
The drought and the ongoing salinisation of lower River Murray floodplains have resulted in an unforseen problem — stinking wetlands!

Providing a new insight into the mechanisms that create these foul odours is a recently published report from the Cooperative Centre for Landscape Environments and Mineral Exploration (CRC LEME) entitled *A Guide to Sulfur Gas Emissions from Wetlands and Disposal Basins: Implications for Salinity Management.*

The mechanisms responsible for foul odour generation from these wetlands are not yet fully understood but they are almost certainly associated with the cycling of sulfur, a common element found in many salts (such as gypsum).

During the past 75 years, land clearing, river regulation and the disposal of irrigation drainage waters have resulted in an increase in the storage of salts in Lower Murray floodplains and their associated wetlands. One of the components of these salts, sulfate, is biologically-reactive and can be converted into pyrite, organic sulfur, and other sulfur-containing compounds within wetlands. Wetland sediments rich in pyrite and organic sulfur are relatively stable when covered by water because they are shielded from the oxygen in the atmosphere. When wetlands dry out, which is happening during the current drought conditions, these sediments are exposed and may become an environmental hazard. The two main environmental risks associated with exposing sulfur-rich wetland sediments to the atmosphere are wetland acidification and the production of foul odours.

A number Riverland disposal basins (wetlands converted to store irrigation drainage) along the lower River Murray experienced a severe noxious smell event in the summer of 2003. These wetlands were faced with lower water levels at the time because of the drought and more efficient irrigation practices in the region. This particular event had an adverse impact on the local tourism industry and economy.



The Murray Pioneer

Phone: (08) 85866603 | Friday, February 14, 2003 | Price: $1.00

SERVING THE RIVERLAND AND NORTHERN MALLEE SINCE 1892

Email: editor@murray-pioneer.com.au | Website: www.murray-pioneer.com.au | Fax: 08 85864333

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

Finding answers

CRC LEME researcher, Sebastien Lamontagne (CSIRO Land and Water), said a study, forming the basis for the guide, was undertaken in response to requests to CRC researchers to explain in simple terms the cause of the noxious smells.

"Most of our research focused on reviewing overseas literature, as very little work on sulfur gas emissions from Australian wetlands has been done," Dr Lamontagne explained.

"Because of this, many of the mechanisms explained in the guide should be viewed as testable hypotheses that require further validation with field and laboratory results.

"What we do know is that pyrite and other sulfur compounds are becoming more common in Australian wetlands, particularly along the lower Murray. We also know that those wetlands with the highest concentrations of sulfur in their sediments tend to be the ones with odour problems, especially during the summer months."

The study's international literature review revealed that wetlands can emit a range of gases depending on a number of factors such as salinity, wetting-drying regimes, soil type and diurnal cycles. It revealed there were three main types of sulfur gases that can be emitted by wetlands: hydrogen sulfide (H_2S); volatile organic sulfide compounds (VOSC); and sulfur dioxide (SO_2) — see Figure 1.

These compounds are produced in different ways, and vary in odour characteristics and smell threshold. Some are detectable by humans at very low concentrations.

Gases such as H_2S and SO_2 can have adverse health effects when humans are exposed to them at significant concentrations. The SA Department of Water, Land and Biodiversity Conservation (DWLBC) is currently monitoring the ambient H_2S concentration at one of the most problematic sites (Loveday Disposal Basin). So far, while peaks in H_2S concentration occasionally occur near Loveday Basin, they have remained below recommended health guidelines. While maintaining H_2S concentrations at the recommended acceptable levels, DWLBC is actively investigating long-term odour control solutions for the site.

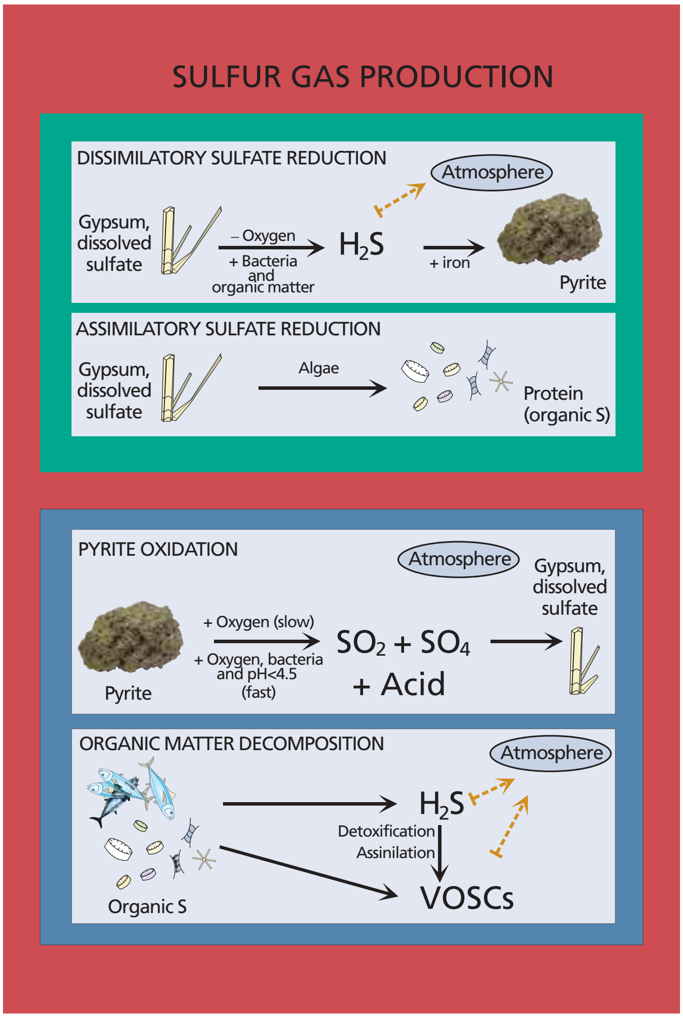


Figure 1. Sulfur gas production

Finding out what kind of sulfur emissions occur where and understanding the processes that lead to their formation is the first step in devising a strategy to reduce such emissions. However, since no studies have been carried out on the different kinds of sulfur gas emitted by inland Australian wetlands and their potential environmental controls, the review was unable to provide any scientifically-defensible management guidelines at present.

Before potential management strategies can be formulated, a list of critical knowledge needs to be acquired, including:

- Determining what inorganic and organic sulfur gases are emitted from wetlands;
- Understanding the environmental factors controlling emission rates for the most common foul-smelling gases. Based on the literature review these factors could include sediment texture, organic matter content, water content, pH, time of day, temperature and the presence or absence of a water cover;
- Determining the relative significance of dissimilatory sulfate reduction (i.e., the biological process leading to the production of pyrite) and organic matter decomposition as sources of H_2S during wetland-drying events.

What is to be done

"We need to tackle a number of challenges before these knowledge gaps can be filled in," says fellow CRC LEME researcher, Warren Hicks (CSIRO Land and Water).

"Instruments to measure inorganic sulfur gases such as H_2S and SO_2 are readily available. However, many of the larger, foul odour-generating VOSC molecules can not be easily measured because they are at such low concentrations, but still can be smelt by humans.

"It's even harder to accurately measure the emissions rates —which is how much gas is given off per unit area of sediment per unit time. These rates must be known to evaluate how far noxious gases will spread."

Overseas studies have used special chambers installed on wetland sediments to measure sulfur emission rates. For gases found at relatively high concentrations, the chambers can be directly coupled to measuring instruments in the field. For gases found at lower concentrations, the chambers are used to concentrate gases into special columns or other media for later analysis in the laboratory.

"We need to better understand sulfur-cycling in inland wetland environments to help Australian wetland managers come to terms with dealing with both salinity and a drying climate," Mr Hicks said.

Copies of CRC LEME Open File Report 208 *A Guide to Sulfur Gas Emissions from Wetland and Disposal Basins: Implications for Salinity Management* can be downloaded free as a PDF file from the CRC LEME website (www.crcleme.org.au).

■ **CONTACT**: Sebastien Lamontagne
E: sebastien.lamontagne@csiro.au