

The coastal pollution halo

Author:

Dr Rob Fearon, Coastal CRC, Indooroopilly Queensland

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There is a faint and usually invisible halo encircling Australia. It is formed by sediments, organic matter and nutrients that colour our otherwise clear coastal waters. An amount of sediment and nutrients naturally washes into coastal waters every time it rains and the coastal halo is always stronger near the mouths of estuaries. When catchments are modified for urban or agricultural use, the volume of nutrients and sediments flowing to the coast usually increases. The difference between the background and the increased volumes resulting from human activity represents land-based pollution, one of the main threats to the coastal environment.

When this pollution combines with that from shipping and from deposition from the atmosphere, it can damage habitats and communities of animals and plants. Because this process occurs over long periods, some effects can be detected only through sensitive measurement. However, on occasion, parts of the coastal halo increase in intensity and the halo becomes visible to the naked eye.

The Australian halo

The presence of a halo can be illustrated by the distinct pattern in water quality across Moreton Bay. Waters in the west, close to human activities, contain sediments and nutrients but these pollutants decrease in concentration from west to east across the bay (Dennison and Abal 1999). This halo is often visible from the air, and sensitive measurements from satellite sensors show clearly how the pollutants hug the coast (Figure 1).

Visible areas of the Australian halo are often brown because sediments suspended in the water are the most obvious (Figure 2). However, population booms of microscopic marine organisms (plankton) may colour

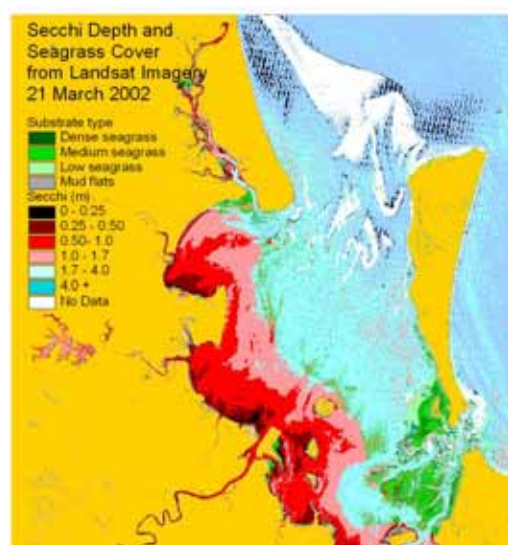


Figure 1. Satellite (Landsat) derived image showing waters with more sediments in dark red, grading to light red and blue representing clean water. (Source Phinn and Dekker 2004).

the halo green or red as they multiply rapidly in response to increased nutrients. Even when not visible to the naked eye, these organisms can be detected by sensitive handheld, airborne and satellite-based instruments.

While Australia's coastal halo is a natural phenomenon, increasing human pressures are creating a 'pollution halo', with associated negative environmental impacts. One example is when severely polluted waters produce eutrophication (Nixon 1995) which can cause the production of 'dead zones' (see Box 1).



Figure 2: Satellite (MODIS) image of northern Tasmania showing sediment plumes forming a pollution halo in September 2005 (Source: CSIRO Marine and Atmospheric Research).

Coastal dead zones in Australia

Only a few coastal 'dead zones' have been reported in Australian estuaries (see e.g. Turner et al 2004). Even the two Australian incidences commonly cited in international reports (e.g. UNEP 2003) are not coastal 'dead zones' as defined in Box 1. One is a small freshwater lagoon that acts as a holding pond for a local sewage treatment plant (Donnelly et al 1999). The second reports low oxygen in an estuary where "enrichment and pollution effects are minimal"

Box 1: Dead zones

When excess nutrients flow into water bodies they fertilise microscopic organisms called plankton. The plankton eventually die and their remains sink and provide food for bottom-dwelling bacteria. In extreme cases, the resulting bacterial population explosions consume most (hypoxia) or all (anoxia) of the available oxygen causing animals, and the bacteria themselves to 'suffocate' and creating a dead zone (Joyce 2000).

Some areas have naturally low concentrations of oxygen, such as the oxygen minimum zones in some seas where exotic life has adapted to tolerate these conditions (Childress and Seibel 1998). In contrast, 'dead zones' are caused by human impacts and local organisms don't have time to adjust and either move away, or die. The zone is devoid of the organisms that would usually be expected to live there.

The most well known dead zones occur in the Gulf of Mexico, the Baltic Sea and the Black Sea but nearly 150 have been reported around the world (UNEP 2004). There is concern that such areas are increasing in number in estuaries and coastal waters world-wide, including in Australia (Boesch 2002; Rabalais et al 2002, Diaz et al 2003).

(Rainer and Fitzhardinge, 1981, 227).

This comparatively small number is odd given that despite a relatively small and highly dispersed population, our landuse activities and their potential impacts on estuaries are not dissimilar to other countries with many dead zones. An important mitigating factor is the degree of dilution and mixing in many of our estuaries.

Stratification – the horizontal separation of a water body into an oxygenated upper layer and a potentially low-oxygen lower layer, is a prerequisite for the formation of dead zones (Diaz et al 2003). Stratification is caused by salt or temperature differences in two bodies of mixing water and is not common in well-mixed estuaries and Bays.

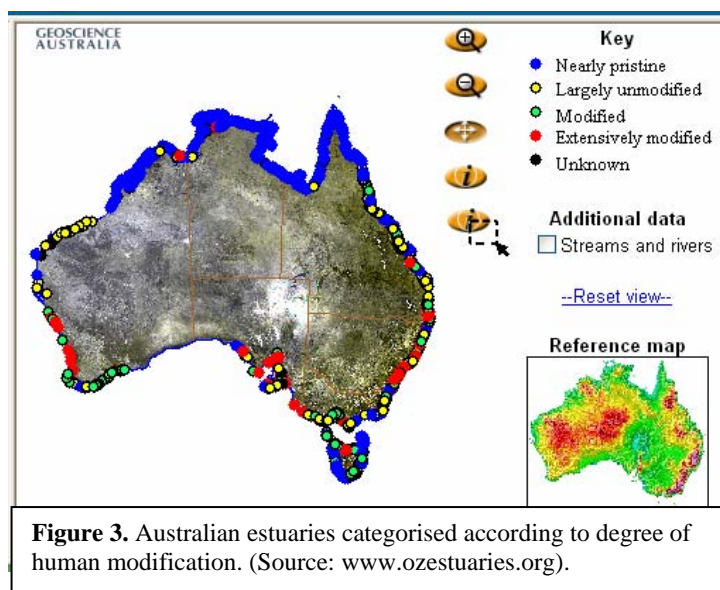


Figure 3. Australian estuaries categorised according to degree of human modification. (Source: www.ozestuaries.org).

The most common types of estuary in Australia are tide-dominated (see www.ozestuaries.org) meaning that they are well flushed by tides. For example, the majority of the estuaries in the north of Australia, many of which are also pristine or largely unmodified (Figure 3), are well mixed. In fact this is true even of the estuaries in the Great Barrier Reef catchment which have high concentrations of nutrients and sediments (Brodie, 2000; Haynes et al 2000; Reef Protection Steering Committee, 2003)

and the highly-modified estuaries near urban centres. Because of this tidal flushing, stratification is rare and dead zones are unlikely.

In contrast, many estuaries in the south of Australia, are wave- or river-dominated and at times experience little tidal flushing and may even be intermittently closed to the sea. Many are highly modified (Figure 3) being subject to both urban and rural pressures. However, estuaries in the south east of Australia are usually shallow (less than 2 m deep) and at this depth, stratification is rare because the water is mixed by wind action. Although stratification and low oxygen is reported for some estuaries, dead zones are rare despite high inputs of pollution.

Similarly, the south of Australia and Tasmania has a number of highly-modified estuaries, but there are few incidences of stratification and thus few dead zones. In the south west, most estuaries are poorly mixed and increasing urban and agricultural pressures and concomitant nutrient and sediment loads have caused increasing algal blooms in a number of estuaries. Stratification is present in some estuaries and there is potential for increasing occurrence of dead zones.

Conclusion

Dead zones are not common in Australia and are unlikely to increase in all but a few of our coastal waterways. However, the Australian pollution halo is increasing due to increasing urban impacts and effects of agriculture.

These seemingly incongruous conclusions arise because the lack of dead zones results more from the nature of our coast than from any lack of urban or rural pressure. Indeed, although much of the Australian coast is subject to significantly better management practices than even in the 1970's and 1980's, improvements are not keeping pace with pressures. Without increased emphasis on coastal management it is likely that we will become more aware of the coastal pollution halo and of dead zones before the next national SoE report.

References

Boesch DF 2002, Challenges and Opportunities for Science in Reducing Nutrient Over-enrichment of Coastal Ecosystems. *Estuaries* Vol. 25, No. 4b, 886-900, August 2002.

Brodie JE 2000, Keeping the wolf from the door: Managing land-based threats to the Great Barrier Reef, *International Coral Reef Symposium, Bali Indonesia, 2000*.

Childress JJ and Seibel BA 1998, Life at stable oxygen levels: adaptations of animals to oceanic oxygen minimum layers. *Journal of Experimental Biology* 201:1223-1232.

Dennison WC and Abal EG 1999, Moreton Bay Study: A Scientific Basis for the Healthy Waterways Campaign. Brisbane, Queensland, Moreton Bay Catchment Water Quality Management Strategy Team, Brisbane.

Donnelly TH, Ford PW, McGregor D and Allen D 1999, Anthropogenic changes to a billabong in New South Wales. 1. Lagoon evolution and phosphorus dynamics. *Marine and Freshwater Research* 50:689-698.

Diaz RJ, Nestlerode J and Diaz ML 2003, "A Global Perspective on the Effects of Eutrophication and Hypoxia on Aquatic Biota," in Rupp GL and White MD (eds.), *Proceedings of the 7th Annual Symposium on Fish Physiology, Toxicology and Water Quality*, Estonia, 12-15 May 2003.

Haynes D and Michael-Wagner K 2000, Water quality and the Great Barrier Reef World Heritage Area: Past Perspectives, current issues and new research directions. *Marine Pollution Bulletin* Vol 428.

Joyce S 2000, The Dead Zones: Oxygen Starved Coastal Waters. *Environmental Health Perspectives* 108(3): 120-125, March 2000, National Institute of Environmental Health Sciences, <<http://www.ehponline.org/docs/2000/108-3/iti.html>>, accessed August 2006.

Nixon SW 1995, Coastal marine eutrophication: a definition, social causes, and future concerns. *Ophelia* 41:199-219.

Phinn S and Dekker A 2004, An integrated remote sensing approach for adaptive management of complex coastal waters. The Moreton Bay Case Study. Moreton Bay Remote Sensing Tasks (MR2). Final Report – October 2004, CRC for Coastal Zone, Estuary and Waterway Management.

Rainer SF and Fitzhardinge RC 1981, Benthic communities in an estuary with periodic deoxygenation. *Australian Journal of Marine and Freshwater Research*, 32:227-244.

Rabalais NN, Turner RE and Scavia D 2002, “Beyond Science Into Policy: Gulf of Mexico Hypoxia and the Mississippi River,” *BioScience*, 52:2

Reef Protection Steering Committee 2003, Reef Water Quality Protection Plan for Catchments adjacent to the Great Barrier Reef World Heritage Area, *Marine and Water Division Environment Australia and Environment and Resource Policy Department of Premiers and Cabinet Queensland Government, Brisbane and Canberra.*

Turner L., Tracey D, Tilden J and Dennison WC 2004, Where river meets sea: Exploring Australia's Estuaries, Queensland, Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management, Brisbane.

UNEP [United Nations Environment Programme] 2004, *Global Environment Outlook Year Book 2003*, United Nations Environment Programme, Nairobi.