NUTRIENT INPUT IN CLEVELAND BAY

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INTRODUCTION:

Case studies of severe eutrophication problems throughout Australia (AEC Report No.19,1987) clearly implicate blue-green algae.Proliferation of these algae in water can cause nuisance odours, toxins in the water, fish kills(Putnam and Hain,1980),alterations to the planktonic community (Murphy et al.1976), and more recently mobilisation of toxic metal ions in inshore waters of the Great Barrier Reef Lagoon(GBRL)(Jones et al, 1982; Jones et al.1986;Jones,1986;Jones,1987a,b;Jones and Thomas,in press).Overseas the increased occurrence of phytoplanktonic blooms in Hong Kong has reached alarming proportions recently,such that the Environmental Protection Department is convinced that pollution is the cause,and legislation to improve water quality is underway.Extensive red tides of plankton in 'the Seto Inland Sea in Japan are attributed to' sewage input (Okaichi, 1987).

My interest in nutrient inputs in Cleveland Bay stems from my earlier PhD studies involving the effects of Trichodesmium blooms on toxic metal ions in the bay and my present, position with the Townsville City Council. blooms of this blue-green algae are so prolific in certain regions of the reef,and effect inshore waters for many months that in my view a potentially serious environmental threat exists from the interaction of these blooms and pollutant input (Jones, 1987b).This potential threat is inextricably linked with organic matter exuding from inshore Trichodesmium filaments.This organic matter binds the element iron extremely efficently(Jones and Thomas,1988a,b).The extent of. these blooms in the GBRL is slowly being reali'sed (Kuchler 'and Arnold,1986).Of thirty one retrospective Landsat images taken during November and December 1980-84 and 1972, thirteen had captured massive surface blooms.This represented a temporal occurrence of 41.93% of the total sample.Spatially each bloom(with one exception covered more than 5% of the 34,225 sq.km of 'area' sampled (171 lsq. km) . Four processes are highlighted,which in conjunction with Trichodesmium blooms could cause serious environmental damage to the reef (Jones, 1987b).These are;

(1) Input of sediment from the erosian of soil or sandmining.Such processes, in conjunction with Trichodesmium blooms are potentially capable of mobilising metal ions.

(2) The interaction of sewage and Trichodesmium bl'ooms will mobilise metal ions.

(3) The effects of dredging and Trichodesmium blooms is potentially capable of mobilising metal ions.

(4) The input of metal wastes into, the GBRL could havg far greater impact in those regions where Trichodesmium blooms occur.

Al though 1 i tt le work has been carried out on the charactrrisation of this mar i tie humus we are able to say;

(1) The bu 1 k of the mar i ne humus is produced f rom Irichodesmium inshore. The process seems to be predominantly an INSHORE PHENOMENON.

(2) The marine humics frorn Irichodesmium are more soluble than their terrestrial counterparts introduced into the sea in the monsoonal season,and persist in coastal waters at Townsville for many months(Jones et a1.1982).

(3) The marine humus exuding from the filaments exhibits high UV absorption and fluorescence,and chelates iron in seawater to levels of 5%,an 'enrichment factor of 45 million over seawater iron levels. It is bel ieved that this fact has considerable environmental siqnif icance in those regions of Australia where this algae accumulates,and in regions of Australia where this algae has accumulated in the past (McConchie, 1987).

(4) Althouqh this marine humus causes marked enrichment in the toxic metal ions cadmium,nickel,and lead,it also mobilises these toxic ions to more availible forms to marine life.This material is therefore capable of interfering with the natural scavenging process that removes metal ions in the sea.

(5) This marine humus is taken up by the branching coral Acropora formosa in the laboratory,prior to spawning.UnexposedA.formosa did not spawn.

Al thouqh what I have described affects trace and toxic metal ions I believe this process will also affect nutrients which are adsorbed to col loidal particles and suspended sediments.An interestinq paper, which illustrate5 how effective organic material can be i-n causing serious environmental problems especially eutrophication is the work of Murphy et al (. 1976). 'During an invest iqat ion in the Bay of Quinte,a eutrophic bay on the northern shore of Lake Ontario it was found that during 'blue-qreen algal blooms ofAnabaenaandScenedesmus other algae can be completely suppressed.These workers concluded that the ability of blue-green algae to suppress other algae can be determined by the availibility o f iron.Iron deprivation induced the production of hydroxamate chelators,which were the agents suppressing other algae.These authors concluded that the availibility of iron may be an important factor in determininq the stabi 1 i ty and composition of acquatic ecosystems.A diagram depicting how excess P increases the nitrogen budget of natural waters from the activities of blue-qreen algae is shown in Fig 1. This clearly demonstrates how important it is to control P ernrn i ss i ons to our envi ronmen t (Water Pollution Control Federation, 1983).

PHOSPHORUS INPUT:

In assessing man-made P inputs to Cleveland Bay it is important to realise that natural inputs also occur. Natural inputs include; mangroves; anoxic sediments, freshwater runoff, groundwater intrusions, *Trichodesmium* blooms, suspended sediments. Man-made inputs include sewage discharge, agricultural runoff, stowater runoff, animal husbandry (eg. acquaculture), tourist development. In my work in Cleveland Bay I will be concentrating on three areas. (1) Sewage, Discharge. (2) Freshwater Runoff. (3) *Trichodesmium* input and trying to asses5 the significance of each.

SEWAGE DISCHARGE AND TREATMENT:

Treatment of Townsville and Thuringowa's waste water takes place at the Mt St John and Bohle sewage treament plants to the west of the city. At present only 25% of our total wastewater is treated at these plants. The remaining wastewater (75%) is discharged untreated into Cleveland Bay at Sandfly Creek.
The Bohle plant is quite small treating effluent from a population of about 1000 people and some industries in the area. Treatment of wastewater at Mt St John is by primary sedimentation, secondary treatment by biological filters, sedimentation, sludge digestion and finally effluent discharge. The effluent from the plant is discharged by gravity to a perrnanent channel cf the western boundary of the Town Common, which is connected directly to a tributary of the Bohle River. These plants have a licence to discharge effluent of a 20:30 quality (i.e. 20 BOD, 30 suspended solids). Overall 85-90% of the BOD and 90% of the suspended solids are removed. At Magnetic Island sewage treatment is by an extended aeration plant at Nelly Bay. In Thuringowa City sewage will soon be treated at Condon by an extended aeration plant and will process effluent from 10,000 people.

Historically raw sewage ha5 been discharged into Cleveland Bay since 1940, primarily at the mouth of the Ross Estuary. This outlet was closed in 1986. From December 1963 raw effluent started to be discharged from Sandfly Creek. In a few months the Cleveland Bay Purification Plant (CBPP) will be commissioned to treat raw sewage from the Western Suburb5 Scheme. This sewage scheme was constructed from the mid 1950's to the rnid 1970's, and services mainly residential suburbs. This effluent, will be, used, by Colinta Holdings Pty Ltd for irrigation and pasture improvement. Effluent from the Eastern Suburbs Scheme will not be treated for some years since more development is needed at the CBPP (McIntyre and Associates, 1987).

The overall treatment process at the CBPP is identified as the PASSAD Process. The process incorporates essentially two separate and independant treatment operations as follows.

PAS- Primary Activated Sludge, loaded with raw sewage in the high to very high biological loading range, to produce an effluent suitable for outfall discharge and a waste sludge requiring further treatment.

SAD-Secondary Anaerobic Digestion including pre-thickening and post dewatering, to stabilise the waste activated sludge from the PAS process, with final land disposal on site. At present treatment will only involve the provision of PAS facilities for flows from the Western Suburbs, and effluent quality will be 50/60 quality. When this plant is in operation the effluent characteristics will change with the volatile fatty acid fraction increasing.

Sewage Discharge:

The CBPP has the highest discharge(30 megalitres/day), followed by Mt St John(10.5) and a small discharge from the Bohle Plant (0.15). Total daily discharge of wastewater to Cleveland Bay is therefore in excess of 40.65 megalitres/day. In order to get some idea of the quantities of orthophosphate discharged into Cleveland Bay I have decided to take the period 1974-86, since this shows a high and low freshwater input cycle.

Freshwater Runoff

Total freshwater runoff for the Ross River catchment from 1974-86 totals 1,103,192 megalitres(QWRC), whilst sewage discharge for the same period was 178,047 megalitres. Sewage discharge was therefore 16% of freshwater discharge during this 12 year period. From 1981-86 however sewage discharge comprised all of the discharge to Cleveland Bay. This alternating cycle of wet/drought can obviously affect the marine coastal regions to varying degrees.

Orthophosphate Input

Although P discharge at Mt St John is high this discharge is buffered from the marine environment by the Bohle Estuary and the surrounding lagoons which harbour prolific bird life. In this discussion I will concentrate on inputs at Sandfly Creek since flows are substantially higher than the other plants, and no buffering takes place. Based on a concentration of 6 mg/l of orthophosphate in raw sewage at Sandfly Creek total input of dissolved orthophosphate for the twelve year period totals 788.4

metric tons. Approximately 110 metric tons of dissolved orthophosphate is as been delivered to Cleveland Bay from freshwater discharge. This is based on a freshwater concentration of 100 ug/l of dissolved orthophosphate. Man-made input of dissolved orthophosphate therefore exceeds natural inputs from freshwater discharge by a factor of well over 7 times, that of natural sources, since we have not considered inputs from diffuse sources, and the other two plants. Total P emissions: from wastewater are obviously much higher than these figures since, orthophosphate in wastewater is about 50% of the total P levels. Clearly with the commissioning of the CBPP P emissions will reduce to Cleveland Bay, and the overall quality of wastewater discharged into the bay will dramatically improve.

CORAL CORES AS GEOCHRONILOGICAL INDICATORS OF FRESHWATER RUNOFF AND POLLUTANT INPUT IN CLEVELAND BAY

In association with Dr Peter Isdale and Dr Kevan Boto(AIMS) I am workinq on the above project. This project is suported by the Australian Water Resources Advisory Council(AWRAC) and AIMS under the Partnership Programme of AWRAC. In addition to the valuable runoff data for the Ross Dam region the analysis of the chemical signatures laid down in the coral matrix should be of great value as indicators of past event5 in Cleveland Bay, especially events that relate to nutrient input. Core material from Geoffrey Bay is being processed at the moment for' P, but other poilutant element' analysis are planned. This core will provide records going back to 1814.

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ROLE AND IMPACT OF NUTRIENTS

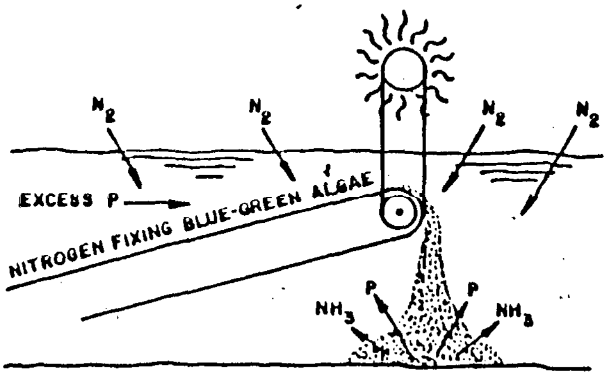

FIGURE 1. Diagram depicting how excess phosphorus increases nitrogen budget of natural waters and hastens eutrophication.