THE ROLE OF

AQUATIC PLANTS AND SEDIMENTS

IN

RADIUM

CYCLING

IN A TROPICAL WETLAND.

A thesis submitted to the School of Biological Sciences,
Macquarie University
for the degree of Master of Science (Honours)

by

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MACQUARIE UNIVERSITY

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The Academic Senate on 19 July 1988 resolved that the candidate had satisfied requirements for admission to the degree of MSc(Hons) This thesis represents a major part of the prescribed program of study.

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SUMMARY

The Magela floodplain, in the Northern Territory of Australia, drains two large uranium deposits: Ranger, where mining began in 1980, and Jabiluka, which is undeveloped. The floodplain is a seasonal freshwater lagoon in which dense stands of aquatic plants grow during the annual wet season and through much of the dry season. Radium (Ra) is a waste product from uranium mining that may enter the floodplain through leaching or seepage from the mine site or through accidental or controlled release of waste waters. No Ra pollution of Magela Creek has yet been detected but preliminary studies suggested that small amounts could be a significant health hazard to local Aborigines who drink creek water and eat a variety of aquatic foods including water buffalo that graze on the floodplain. If effluent Ra does enter the floodplain it may be flushed out to sea by subsequent floodwater or, more likely, be taken up onto vegetation or bed sediment. The vegetation may, in turn, remobilize Ra from the sediment into the water column. The purpose of the present work was to investigate the relative importance of these processes and to predict the potential for Ra transfer through the buffalo-human food-chain.

The study began with a survey of the natural Ra distribution in soil, plants and buffalo faeces on the floodplain in 1975-76 before mining began in 1980. This showed a natural accumulation of Ra at the beginning of the floodplain and from this it was predicted that effluent Ra may behave in a similar way and be held up in the floodplain rather than being flushed out to sea. Laboratory experiments were then carried out on the major plant species from the floodplain, the semi-aquatic grass *Pseudoraphis spinescens*, and the water lily *Nymphaea violacea* (the latter studied by my colleague J.R.Twining), to measure the rates of Ra exchange between the water column, the plants and the sediment.

A computer model was constructed from these data to simulate Ra transfer through the floodplain. The model consisted of water flow from a monsoonal rainfall pattern over a simplified catchment and through a rectangular floodplain divided into 12 square "plainettes" (3x3 km each). The water carried natural Ra from the catchment and as it flowed through each plainette it exchanged Ra with plants, detritus, suspended sediment, bed sediment and subsoil at rates determined from the experimental and field data. Hypotheses about the fate of Ra were tested by manipulating the state variables and introducing simulated effluent into the input water.

These experiments with the model identified direct Ra uptake from the water column onto plants and bed sediment as the major process in Ra transport through the system.

Approximately similar amounts of Ra were taken up by these two components and a small proportion remained in the water column. As a result, nearly all the effluent Ra was taken up in the first 10 kilometres (the floodplain is 36 kilometres long) as predicted from the field survey. There was negligible translocation of Ra within the plants (determined from the laboratory experiments) and Ra uptake onto suspended sediment was not significant because its mass was small compared with the masses of bed sediment and plants.

When effluent Ra was introduced into the model and traced through the buffalo-human food-chain, a fourfold increase in Ra concentration in water over the entire wet season led to an average 2-fold increase in the human dietary intake of Ra. Increases in bioturbation and effluent salinity strongly suppressed Ra transfer through the food-chain. Variations in plant species or biomass or variations in the adsorption capacity of the sediment had only a small effect. Variations in rainfall and suspended sediment load had negligible effect on the fate of Ra. These effluent simulation experiments predicted that the Ranger mine could dispose of a million cubic metres of Ra-contaminated waste water over a 10-day period in the early part of the wet season without significant impact on the local Aborigines or the environment.

STATEMENT

This thesis contains no material that has been submitted to any other university or institution for a higher degree. The information herein is the result of my own research except where acknowledgement of others is given.

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"Behold, BEHEMOTH ...
under the lotus plants he lies,
in the covert of the reeds
and in the marsh".
Job 40:15,21