CSIRO LAND and WATER News
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Land & Water Link

World-class Science Chief Appointed

"Australia is well placed to become a world leader in land and water science"

An eminent ecologist, freshwater and marine biologist, Dr Graham Harris, has been appointed as Chief of CSIRO Land and Water, the new Division formed from the amalgamation of the previous Division of Soils, Division of Water Resources, and the Centre for Environmental Mechanics.

Dr Harris has an international reputation for work in aquatic and terrestrial ecology, freshwater biology, pollution monitoring, biological oceanography, and remote sensing, publishing more than 100 papers and four books. He has also done leading work in fisheries dynamics and the effects of climate variability.

Opportunities

Dr Harris says "CSIRO Land and Water is one of the largest and scientifically best-qualified research agencies in the field of land and water science, and we will be tackling issues central to the future prosperity of Australia, its communities and industries — issues such as salinity, acid soils, erosion, loss of fertility, pollution, and declining water quality."

Dr Harris thinks that currently there are real opportunities for CSIRO to hasten the growth of Australia's burgeoning environmental export sector, providing knowledge and advice for over-

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seas customers struggling to cope with problems of pollution and degradation caused by rapid development.

"Urban water will be a key focus for the new CSIRO Land and Water, but we also have a major role to play in helping increase the productivity of agriculture and rural industries through a new national irrigation centre based at Griffith, NSW." he said.

Dr Harris was previously Head of CSIRO's Environmental Projects Office, supplying interdisciplinary scientific expertise in environmental monitoring throughout the Asia–Pacific region and has set up CSIRO programs in biological and chemical oceanography and remote sensing.

Dr Harris was leader of CSIRO's Port Phillip Bay Environmental Study, which has since prompted similar in-depth studies in Sydney and Indonesia. He was also the leader of CSIRO's Coastal Zone Program and involved in CSIRO's Blue-Green Algal Research Program, and has been an Adjunct Professor at the University of Canberra.

Dr Harris was born in the UK and graduated from Imperial College, London, in Botany. He joined CSIRO after a distinguished career as a biology professor in Canada.

Inland Rivers – Chemical Cocktail

The Prime Minister's Science and Engineering Council has been given an assessment of algal blooms and chemical contamination of Australia's inland waterways which has pointed to high human health risks and threats to the livelihoods of farmers.

The assessment was delivered by an independent working group of researchers, summoned to Canberra in the wake of concern for the health of the nation's water resources. The group included Dr Gary Jones and Dr Richard Davis of CSIRO Land and Water.

The group's analysis of the cocktail of chemicals entering surface and groundwater resources of the Murray-Darling Basin (MDB) and the Great Artesian Basin are of particular concern. National research of the issues is sparse, they warned.

"The topic of pesticide contamination of these waters – for human health, agriculture and the environment – requires urgent attention, as they are still poorly understood."

And while the nation's understanding has languished, the growth in pesticide sales, and use, has been exponential. In 1978 sales were estimated at $90 million. By 1993 this had risen to $757 million, with most sales to the agriculture sector.

Intensive cropping, which characterises the MDB, relies heavily on pesticides. There are 61 pesticides under 176 names for use in cotton alone. The group acknowledged the cotton industry's

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awareness of the problem and actions it is taking, but saw fit to emphasise that more thought must be given to the ramifications for human health of the issue generally. A wide range of crops – from horticulture, including fruits, to broadacre cereals like rice, use large amounts of pesticide.

Human Health

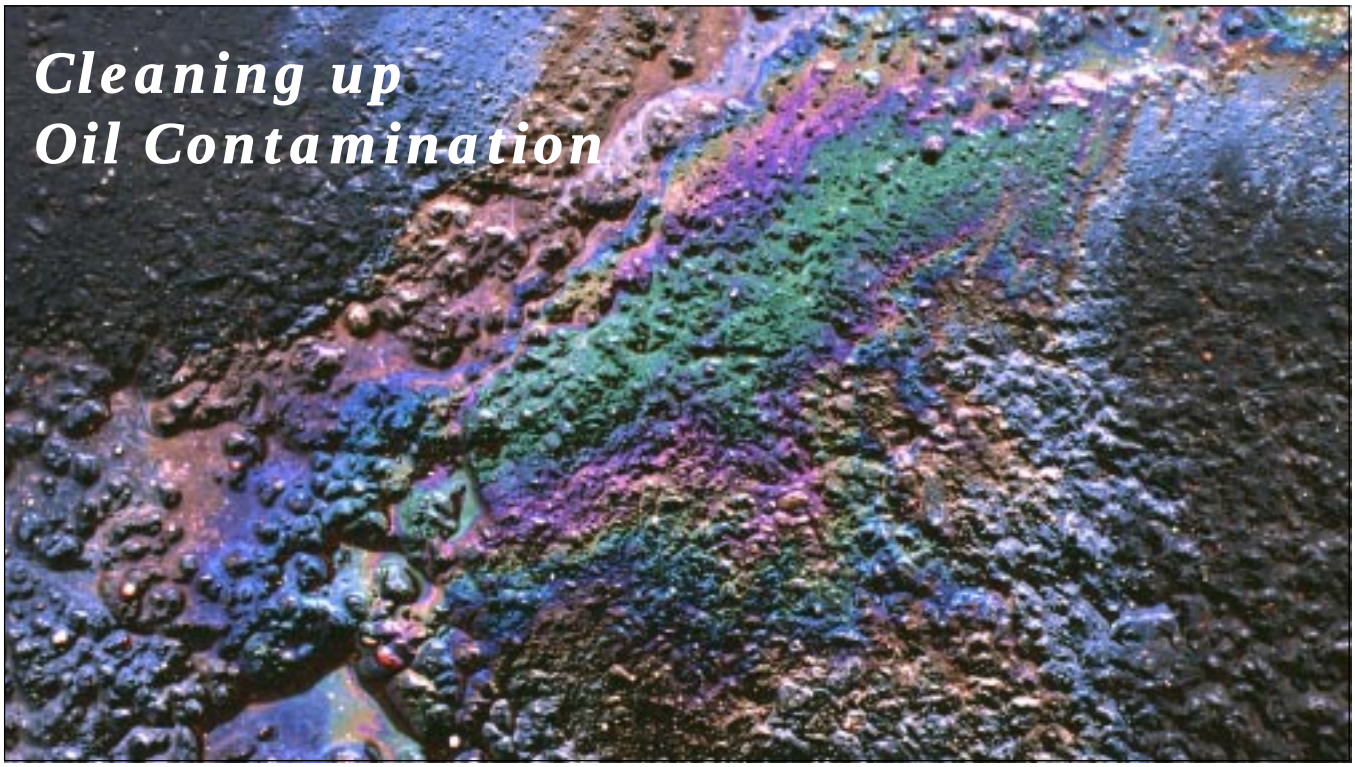
Studies in north-western NSW and the Murrumbidgee catchment have regularly detected residues of pesticides in surface waters used for town supply and domestic use, sometimes at levels exceeding current drinking water health guideline levels. AGSO recently found that 20 to 25 percent of groundwater samples within the MDB were positive for residues of pesticides (mainly triazines).

But while concentrations seldom exceeded 1 microgram per litre, which is well below current health guidelines, the group said "there is greater concern about the growth of intensive agriculture in the parts of NSW and Queensland that overlie or are close to the recharge areas of the Great Artesian Basin (GAB).

There is no easy solution for towns dependent on these waters for drinking supplies.
"While the technology exists for removing these residues from surface or underground town water supplies, it would be cost prohibitive to rural town communities and impossible for farming families."

A spokesperson for the group told the Prime Minister's Council that "an appropriate response would be to determine the extent of the contamination in the MDB; develop cheap and effective treatment procedures; and develop guidelines for the use of all highly mobile pesticides in areas overlying shallow groundwater." Similar recommendations were put for offsetting risks posed by veterinary chemicals.

To guard against the contamination of food grown under irrigation, the group said the Australian Market Basket Survey and the National Residue Survey, both of which regularly check for pesticide residues in meat and crop produce, must be adequately resourced to keep up with the expanding range of agricultural chemicals in use.



Cleaning up Oil Contamination

In Western Australia, CSIRO Land and Water's Centre for Groundwater Studies' project team, led by Greg Davis and Colin Johnston, in conjunction with BP Australia, is attacking the potential problem of hydrocarbon contamination of underground water and soil environments on several fronts, and with exciting results which have international applications. Both *in-situ* (underground) and *ex-situ* (above ground) treatment techniques are being applied and tested.

Air Sparging

Petroleum products such as diesel or gasoline can leak or spill, posing both environmental hazards and human health problems. Cleaning up contaminated sites such as disused petrol stations or sites of spills of other chemicals can be very expensive, particularly because the contamination is below ground - difficult to access and monitor.

If a clean-up can be done without excavations, the costs are greatly reduced, not the least because infrastructure such as power lines, water mains, telecommunications cabling etc., do not have to be disturbed.

At BP's Kwinana refinery, south of Perth, trials are proceeding using 'air sparging' – the pumping of air into contaminated groundwater to effect physical stripping or 'volatilisation' of the volatile components of gasoline, such as benzene and toluene. The stripped compounds move out of the water phase and into an air phase by which they can readily escape into the atmosphere. The air sparging also stimulates bacterial breakdown of the petrol compounds – this is referred to as bioremediation.

Contamination standards are very strict. This is not surprising given for instance that benzene is carcinogenic – a concentrate in water of one part per billion is deemed to be unsafe. Concentrations at contaminated sites can be many thousands of times higher.

The air sparging process is very straight forward - bore holes are sunk beneath the water table and compressors at the surface pump air in. An extensive array of monitoring boreholes and *in-situ* probes have been installed at Kwinana to monitor the sparging process.

According to project leader Colin Johnston there is a "double whammy" effect from the air sparging. "Not only do we get volatilisation but we also provide the essential oxygen required for microbial action which also breaks down the volatile compounds."

The results from the two trials so far have been striking. "Over a period of a few days we've been able to remove most of the contamination – in some places getting benzene concentrations down from 20,000 parts per billion to less than five parts per billion," he said.

Johnston says the system has wide applications – not just for cleaning up small local spills or leakage at service stations, but also for remedial work with large aquifers if ever they were contaminated. "The air sparging process is technically feasible for remediating deep aquifers as well."

Johnston was in New Orleans in April delivering a paper to an international bioremediation conference. Interest, world-wide, is very high in research of hydrocarbon contamination of groundwater. No more so than in the USA where the escape of volatile gases to the atmosphere, even vapours resulting from air sparging, is prohibited.

This point has spurred Johnston and his colleagues to vigorously pursue the second part of the "double whammy" – the injected oxygen's encouragement of *in-situ* microbial growth which in turn transforms the volatiles to harmless compounds.

"To date, microbial degradation seems to play the lesser part, but we're working on increasing that," he said.

Bio-piles

Also in conjunction with BP, CSIRO Land and Water is exploring the microbial treatment of piles of contaminated soil (bio-piles) which commonly result from excavation of contaminated sites such as service stations or fuel storage depots. There is a move, internationally, to rationalise petroleum retail activities which have often resulted in excavation of contaminated soil.

At the Kwinana refinery, BP has engineered several trial bio-piles – pervious pads are laid down containing a network of perforated pipes, and contaminated soil is placed over the lot.

Using a vacuum effect, air is drawn through the pile, again for the purpose of encouraging microbial growth and ultimately breaking down the hydrocarbon compounds. The piles are also fertilised and kept moist to maximise microbial activity.

Davis's team is assessing the efficiency of the process by monitoring degradation rates, adequacy of various fertiliser regimes, and the efficiency of the aeration system.

Indications are that decontamination of typical hydrocarbon contamination can be achieved in less than a year using bio-piles.

Pass the Salt .... Please!

National Heritage Trust Funds for corrective work in the Murray-Darling Basin will need to be well-targeted to seriously affect stream salinity in the Murray-Darling system.

A report recently completed for the Murray-Darling Basin Commission - Salt Trends, shows that trends in stream salinity are worse than previously expected and that certain "hotspots" contribute most to the trends. The hotspot finding will challenge conventional social and political thinking which often leads to funds being spread across all electorates and catchments rather than concentrating efforts where they would do most good.

The Salt Trends report is part of a wider project funded through the Natural Resources Management Strategy Program of the MDBC which was initiated in June 1994 with contributions from CSIRO Land and Water, NSW Department of Land and Water Conservation, Sinclair Knight Merz Pty Ltd and the Australian Geological Survey Organisation. The study examined records for the Basin's 9 sub-catchments going back as far as 40 years in some instances.

It is the first time that the trend in both saltload and salt concentration of streams across the whole Murray-Darling Drainage Division has been determined.

CSIRO Land and Water's Dr Glen Walker was a major player in the study. "The key interstate agreement for controlling salinity in the Murray River (the Murray-Darling Basin Salinity and Drainage Strategy) has underestimated the contributions from the dryland parts of the catchments. This has resulted in some actions in these parts of the Murray-Darling Basin not being sufficiently encouraged," he said.

The Salt Trends report suggests that irrigation areas may inadvertently be storage areas for salt. "There is a substantial redistribution of salt being carried out through the diversion of water (and hence salt) for irrigation purposes. This regional imbalance may be producing a time bomb of salt, but equally may be providing a mechanism to retain more salt in storage while salt is released from other regions due to the changes in groundwater levels," the report says.

Southern parts of the catchment have a more serious problem. While the northern Darling Drainage Basin is in "approximate salt balance," the southern Murray Drainage Basin "has an output to input ratio of about three."

At Morgan in South Australia the saltload attributed to the Darling Drainage Basin was about 25% of the total. The remainder is due to the Riverine Plains (25%) and Victorian Mallee (50%).

The quantities of salt involved are significant. For example, the report says the Victorian Riverine Plains is estimated to have an increasing saltload of 71 tonne day $^{-1}$, equivalent to an annual increasing trend of 5% on the median saltload for the tributaries to the River Murray, upstream of Swan Hill.

The report cautions against any smugness or complacency in the northern areas along the Darling,

where the explosion of "destabilising impacts of agricultural development" could take as long 150 years to occur, compared to a lag time of about 80 years in the south.

"The urgency for management options to be put in place may be critical in the southern half of the MDB, but the possibility of prevention, or at least slowing the advent of the inevitable in the northern half, is a worthy objective."

The Salt Trend findings will surprise those observers who have been comforted by a couple of dry decades and the spate of initiatives for combating salting across the catchment. "The saltload trend since the mid 1970s is variable but appears to be rising despite the generally below average rainfall during this period," the report says.

When the Murray-Darling Basin Commission's Salinity and Drainage Strategy was prepared in 1987 it was estimated that saltloads from dryland areas would eventually cause a rise of between 30 and 50 EC units in salinity at Morgan.

The Salt trends study proposes this estimate should be "significantly upgraded". The report concurs with forecasts from some researchers that dryland salinisation within the Murray-Darling Drainage Division could rise from 2,000 square kilometres to 10,000 square kilometres by the year 2000.

"The saltload trend since the mid 1970s is variable but appears to be rising"

Update – Salt Disposal Basin Research

CSIRO Land and Water has secured funding of $1.2 million for extending its groundbreaking research of salt disposal basins to their use on farms.

The funding comprises a $760,000 grant from the Murray-Darling Basin Commission with additional funds from the CRC for Catchment Hydrology and Goulburn-Murray Water.

CSIRO Land and Water project leader, Dr Kumar Narayan, says the on-farm project has already begun, concentrating on the riverine plains of NSW and Victoria. It is continuing the themes of identifying better sites and management methods, thereby increasing the overall effectiveness of disposal basins.

Already throughout the Murray-Darling Basin over 190 basins receive more than one million tonnes of salt each year from irrigation effluent and pumped saline groundwater.

The new research will focus on on-farm basins in the Murrumbidgee Irrigation Area (MIA) and the Shepparton Irrigation Region. Stage one involves extensive field work – the collection of data on hydrochemical status, land use, soil types, hydrogeology, root zone salinity, basin leakage and the origin of salts in drainage water.

The second stage will involve the development of a computer model linking recharge and subsurface drainage on farms with salt and water movement in and around disposal basins.

"Local people will benefit because planners will get both economic and scientific guidelines for the siting, design and management of the basins. The results will provide the basis for a long-term strategy for community-based management of salt and water in irrigation areas," Dr Narayan said.

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