



University of
South Australia

Centre for Environmental Risk Assessment and Remediation

Experience. The Difference.





Welcome to the Centre for Environmental Risk Assessment and Remediation (CERAR)

Maintaining a healthy environment is central to Australia's health, safety and sustainable prosperity. These are at risk from widespread contamination of soil, air and water caused over the past century, by mining and minerals processing, agriculture, urban waste disposal and industrial activities. It is estimated that the nation spends over AU\$1 billion a year cleaning up contaminated land and water. At the same time, areas of potentially high-value urban land lie unused.

CERAR was established at the University of South Australia in December 2002 and Professor Ravi Naidu was appointed the inaugural Director. It has since grown in strength, capacity and infrastructure, with purpose-built world class laboratories, to more than 60 staff and PhD students. CERAR combines multidisciplinary expertise in fields such as biogeochemistry, contaminant chemistry, ecotoxicology, environmental biotechnology, hydrogeology, resource recycling and nanotechnology which are essential for solving the complex contamination problems of today and thereby protecting Australia's health and natural resources. CERAR's research focuses on Australian research priorities, industry opportunities and developing novel, cost-effective solutions based on sound scientific principles for contamination problems faced by industry and the nation.

Handwritten signature of Professor Ravi Naidu in black ink.

Professor Ravi Naidu
Director

Handwritten signature of Professor Megharaj Mallavarapu in black ink.

Professor Megharaj Mallavarapu
Associate Director

Due to the work of Professor Ravi Naidu and the CERAR team, CRC CARE was established and Professor Ravi Naidu appointed the Managing Director. Both organisations are co-located in the new multi million dollar purpose built facilities at the Mawson Lakes Campus of the University of South Australia.

This signature building boasts world-class facilities including a chemical storage facility and offers maximum flexibility for future growth and success.

Multi-disciplinary interaction is enhanced by creating the right links and connections between labs and research students.

The recruitment of world class researchers and top quality postgraduate students to the centre will be aided by the continual development of CERAR and its facilities and through its relationship with the CRC CARE.

For further information on CRC CARE go to www.crccare.com

Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE)

CRC CARE is a research and development organisation established under the Federal Government's CRC Program in 2005. The aim of this program is to bring together Australia's foremost expertise in science, industry and government in a partnership for the development, commercialisation and extension of advanced technologies and methods.

Assisting industry

Many industries now have a strong commitment to environmental management and recognise the emergence of environmental issues as a major corporate responsibility.

Industry is developing partnerships to address the legal, social and economic importance of effective environmental management.

Being at the cutting edge of environmental remediation research, CERAR has the expertise to assist industry in developing and implementing evaluation, remediation or management strategies for contamination issues.

Our Mission

Through fundamental and applied research in collaboration with industry end users and the community, CERAR aims to minimise risk to human and ecosystem health through rigorous risk assessment and the development of cost-effective and sustainable remediation technologies for air, soil and water contamination.



CERAR organic analysis instrumentation laboratory.

CERAR seek to provide commercially viable and cost-effective solutions to environmental contamination to realise benefits to industries, regulators, consultants and academics within Australia and abroad.



CERAR inorganic analysis instrumentation laboratory.

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Our focus

It is estimated that 10 million tonnes of toxic chemicals are released into the environment every year as a consequence of anthropogenic activities. New chemicals are constantly being produced. It is therefore essential that the behaviour of these chemicals in the environment is assessed in order to quantify the potential risk to human and environmental health.

The most common approach to remediation includes excavation and transport of soils to prescribed landfill sites, pumping and treating contaminated water and occasional soil treatment technologies including bioremediation. Practical remediation is often constrained by the costs associated with the treatment technologies.

CERAR's research focus is to deliver innovative solutions and technologies for the assessment, remediation and management of contaminated urban, industrial and mine sites in Australia and the Asia-Pacific region, and the sustainable management of wastes for beneficial use. To achieve this goal, CERAR brings together an interdisciplinary approach for solving real-world environmental problems. The delivery of these solutions is based on solid fundamental and end-user inspired applied research.

Our expertise

CERAR's strengths lie in the application of fundamental and applied research and the interdisciplinary expertise in biogeochemistry, contaminant chemistry, ecotoxicology, environmental biotechnology, hydrogeology, resource recycling and nanotechnology. These disciplines are essential in developing sustainable environmental solutions to real-world environmental problems.

To undertake environmentally focused research CERAR has established expertise in the following areas:

- Risk based land management
- Contaminant life cycle assessment
- Waste characterisation
- Ecological risk assessment
- Human health risk assessment
- Speciation and toxicity assessment
- Bioaccessibility/bioavailability assessment
- Innovative remediation methods for contaminated soil and ground water
- Specialised analytical testing
- Specialised services including treatability studies for remediation
- Risk communication.

Our strategies for a cleaner future

Historical contamination of the Australian environment presents unique challenges for industry, federal and state governments and the communities directly affected by contamination. Australia also produces a large volume of solid and liquid wastes.

Waste recycling generates business turnover of more than AU\$11.5 billion per year, with another AU\$44 billion per year of downstream benefits in manufacturing. CERAR scientists are involved in many aspects of research related to these environmental issues.

Assessment

Contaminated site assessment is fundamental in understanding the potential risk posed by environmental contaminants to ecological and human health.

Research at CERAR focuses on the development of assessment and monitoring tools for reducing the uncertainty associated with contaminant bioavailability and toxicity for ecological and human health exposure assessment.

To undertake this research, state of the art laboratories were developed at CERAR for the analysis of priority contaminants and emerging contaminants.

Remediation

The management of any contaminated site should be underpinned by the principles of Risk Based Land Management (RBLM). Therefore the corrective action taken at any specific site would be proportional to the risk posed by contamination and the final end use for the site. The aim of RBLM is to remediate or manage land so that it is fit for purpose. With this in mind, fundamental and applied research is used at CERAR to develop, evaluate and demonstrate innovative in situ and ex situ remediation and management techniques.

The research targets cost-effective technologies and risk-reducing management options for contaminated environments that are protective of human health and the environment.

Prevention

Through innovative research CERAR scientists are investigating how some contaminated soils, treated soils, municipal and industrial wastes may be safely reused on land to return maximum value without creating further contamination issues.

CERAR researchers are focused on answering some of the broad questions related to the reuse of solid and liquid wastes, in particular, investigating the innovative use of organic wastes in agriculture for their nutrient content (nitrogen, phosphorus and sulfur), reuse of mineral solid wastes as soil replacements (either as an artificial soil in urban settings, or as a soil replacement in industrial and mining situations), and the use of metallic manufacturing wastes for their micronutrient value (e.g. copper, zinc, manganese).





CERAR greenhouse for plant growth experiments.

Our research in practice

5 Living with contaminants

We all know the dangers of arsenic and mercury. But are the dangers of brominated flame retardants or polychlorinated biphenyls known or recognised? Every day people are exposed to a range of contaminants in the workplace and their homes and most of the time don't know that they are! How toxic are these contaminants? What is the impact of the contaminant in the environment? And how are we exposed to the contaminants? CERAR scientists are trying to answer the difficult questions related to contaminants, both known and unknown.

CERAR scientists undertake research that incorporates soil-plant-human transfer studies to assess the possible human exposure pathways for these contaminants. Understanding the potential impacts on the environment of many emerging contaminants is one of the core aspects of CERAR research. Utilising the latest analytical technologies, CERAR researchers investigate the impact and behavior of contaminants from the micro through to the macro scales.

Clean-up technologies

Bioremediation is gaining increased acceptance by the public as a green and alternate remediation technology to the costly conventional technologies such as 'dig and dump' or 'pump and treat'. However the challenges remain associated with bioremediation including understanding of complex microbial processes responsible for successful bioremediation, particularly for halogenated pollutants. CERAR is at the forefront of research unravelling several challenges related to increasing the understanding of complex microbial processes that enable the success of bioremediation technology for persistent organic pollutants. CERAR has successfully demonstrated natural attenuation based on intrinsic microbial activity as a preferred remediation technology for several hydrocarbon impacted soils and groundwater. CERAR is also involved in developing cost effective remediation technologies for halogenated solvents/persistent organic pollutant contaminated sites.

Waste to resource

According to the OECD (2002), Australia is one of the highest producers of waste in the world, generating waste at a rate of over 2 kg per person per day, the majority of which ends up in landfill. The management of municipal and industrial wastes has long been recognised as a key issue in environmental sustainability. CERAR focuses on tackling three needs of modern society in this area, and their consequent pressure on the environment:

- The need for environmentally sound and safe management, reuse and disposal of wastes;
- An increasing need for recycling nutrients in agriculture;
- The necessity to reduce the impact of soil degradation and contamination processes.

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Communication Education

The overall aim of this research is to explore, assess and test innovative approaches for the characterisation, reutilisation and management of solid wastes. This aim fits within the guiding principles of waste management strategies in Australia which are represented by the waste minimisation hierarchy – reduce, re-use and recycle.

The focus of the research is on both municipal and industrial wastes that have the potential to be safely utilised either in agriculture or for the amelioration of degraded land, therefore transforming wastes into resources. Ultimately this research is expected to reduce the impact of waste in the environment and to contribute to the ever increasing need of materials and nutrients of modern society.

Every community consultation procedure that involves contaminated land issues is unique, requiring specific response to different community needs. Effective communication means having communication plans in place to deal with these potentially difficult situations.

Consultation with an affected community during the pre-site remediation and planning process provides an early opportunity for local communities and stakeholders to raise issues and concerns.

CERAR in collaboration with its major industry partner, CRC Care, is actively involved in developing best practice principles and guidance on community consultation for the remediation process of contaminated land.

Educating collaborating industries, academia and the community is a major focus of CERAR. CERAR aims to foster a new group of postgraduates through an environmental Masters Program and research-focused PhD graduates in the area of environmental contamination, assessment and remediation. The Postgraduate Program addresses a shortage of trained technical experts and researchers in environmental contamination assessment and remediation.

Publication of CERAR's research is important to the scientific transfer process. Communicating its latest research to the scientific community, industry and public is a crucial part of the CERAR education process.

By global standards Australia is an extremely dry continent with severe limitation of fresh water resources. A current lack in available water is now the most limiting factor to economic growth within the horticultural sectors. Seth Laurenson is a postgraduate student within CERAR, investigating the long term effect of recycled waters on the fertility and health of vineyard soils and is working with grape growers in the McLaren Vale and Barossa Valley Grape Growing Regions. At the completion of Seth's research, he hopes to improve current understanding of the suitability of recycled waters of varying quality in vineyards. This work will ultimately help growers maximise benefits from waters of marginal quality without compromising soil health, both in the short and long term.



Seth Laurenson CERAR Phd student.



Arsenic toxicity, Bangladesh.

We don't just create knowledge, we apply it so that our research can be translated into new products and services that will be needed to meet the needs of tomorrow.

Our research applied – tackling the largest mass poisoning in the world

In the 1970's international agencies headed by UNICEF and the World Bank began to fund the installation of tubewells to access clean drinking water for the rural populations of Bangladesh and West Bengal, India. Little did the funding agencies know that 20 years later it would result in one of the largest poisoning epidemics in the world. Due to the presence of arsenic in the groundwaters, the scale of the problem is immense, with millions of people exposed everyday to arsenic contaminated water.

Researchers at CERAR have lead Commonwealth funded aid projects in assessing the extent of arsenic contamination in groundwater and

potential issues related to the use of groundwater in agriculture. Groundwater is used largely in the winter (dry) season to irrigate large areas of land used predominantly for rice production.

CERAR researchers have contributed to the discovery that a large percentage of daily intake of arsenic may be sourced to eating rice, which is the main staple food in Bangladesh and West Bengal.

Having identified the agricultural issues, CERAR researchers are working on potential future solutions. The answer will be complicated with no single solution applicable to all.

From nano to field scale

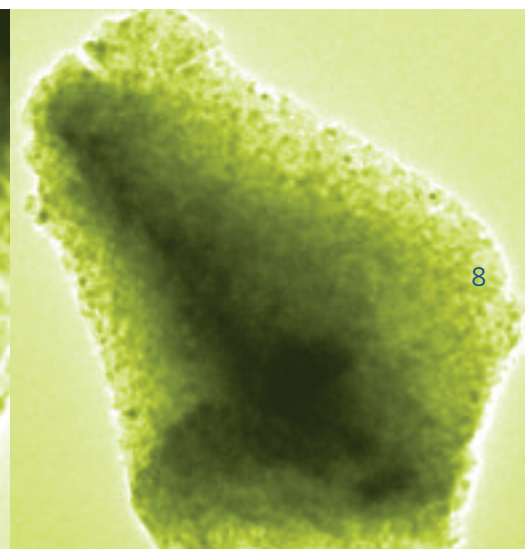
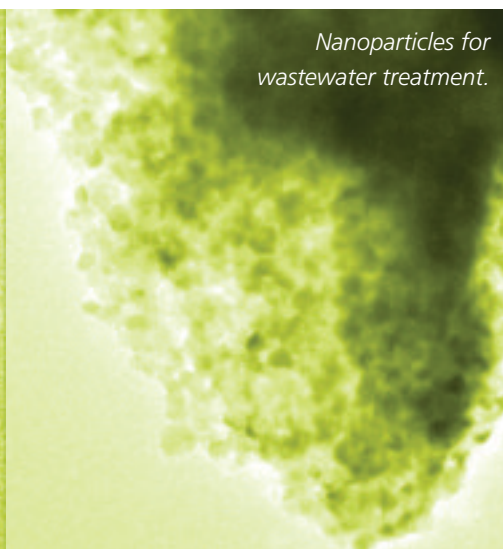
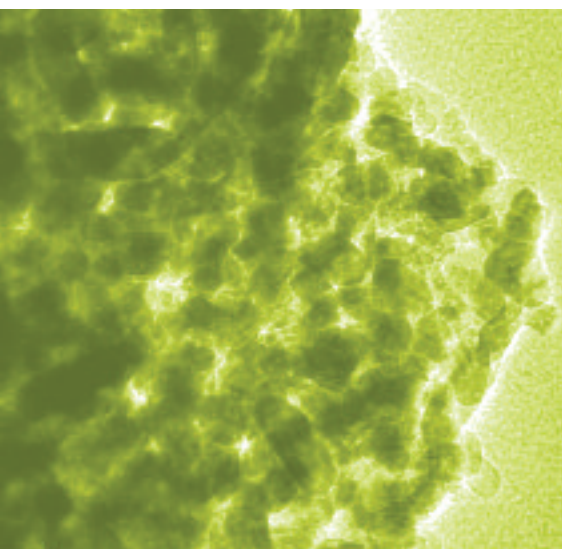
Nanotechnology forms an integral part of CERAR's research programs, especially in the areas of contaminant remediation in air and water, promoting a cleaner environment and delivering clean and cost-effective technologies.

Nano structural materials have opened up new avenues in various scientific fields and provide novel opportunities in environmental science. Nanotechnology has potential applications in many sectors of the world economy, including transportation, consumer products, health care, energy and agriculture. In addition, nanotechnology presents new opportunities to improve how contaminants in the environment are measured, monitored, managed and minimised.

Nanotechnology is prospective in creating new and better products which can be scaled up for mass production. Having a specialty in several ongoing nanotechnology activities, CERAR's key research areas and applications include: nanoparticles, colloids and sols, films and coatings, nanoporous materials, inorganic-organic hybrids or nanocomposites and nanomaterials (molecular and bulk) characterisation techniques.

Areas of current nanomaterial applications being studied include:

- catalysis, gas/liquid separation and membrane reactors;
 - chemical and biological sensors for environmental applications;
 - immobilisation and/or degradation of inorganic and organic contaminants using nanocatalysts grafted onto natural materials.
- environmental remediation and wastewater treatment;
 - chemical and petrochemical technologies;



Natural resources for a cleaner environment

Extensive attention is being paid to the management of environmental pollution and its control due to hazardous materials, such as organics, heavy metals and metalloids.

Decontamination of contaminants in the soil and water around industrial plants has been a challenge for a long time. At CERAR, scientists undertake research on novel modifications of natural clay-sized materials with highly efficient and cost-effective

technologies for remediation of environmental contaminants in soil, water and air.

Natural materials such as clays are a relatively inexpensive resource with a large surface area, strong ion exchange properties and proven long-term stability in the environment and these properties make these materials attractive candidates for remediation purposes.

CERAR researchers are targeting industry soil and waste water contamination issues through fundamental and applied research. Research focuses on the modification of clay-sized alumino-silicates with surfactants, and grafting of nano catalysts on natural materials and their use for immobilising and finally degrading a series of inorganic/organic contaminants.



Community education, Bangladesh.



Building through collaboration

CERAR maintains strong collaborative links with national and international research organisations at the forefront of advanced analytical method development for contaminant analysis, speciation, bioavailability assessment and toxicological studies. This research is also undertaken in collaboration with industry partners and environmental regulators.

CERAR has a strong and productive relationship with:

- BHP Billiton Iron Ore Division
- CRC for Contamination Assessment and Remediation of the Environment
- Department of Defence
- EPA Victoria
- Rio Tinto
- AusAid
- Australian Centre for International Agricultural Research
- Bharathiar University
- Chinese Academy of Sciences
- Cranfield University
- Curtin University of Technology
- Dhaka University
- Flinders University
- Hong Kong Baptist University
- Institute of Medical and Veterinary Science
- Kumoh National Institute of Technology
- Massey University
- New Zealand Institute for Plant and Food Research
- Pelorus
- Purdue University
- Savannah River Ecology Laboratory
- Salisbury City Council
- SARDI
- Tamil Nadu Agricultural University
- Ian Wark Research Institute
- University of Aberdeen
- University of Delaware
- University of Queensland
- University of Technology Sydney
- Verutek

Importantly CERAR maintains relationships with some of the leading researchers in Australia and internationally who provide new research opportunities and the ability to increase research knowledge. These groups include:



“The Department of Defence is committed in becoming a leader of sustainable environmental management and our strategic partnership with the CERAR is pivotal in achieving this.”

Terry Weston

Assistant Secretary,
Estate Policy and Environment,
Department of Defence.

“The knowledge and expertise held by the CERAR has directly shaped the bioavailability and bioaccessibility support services we provide to our consultants.”

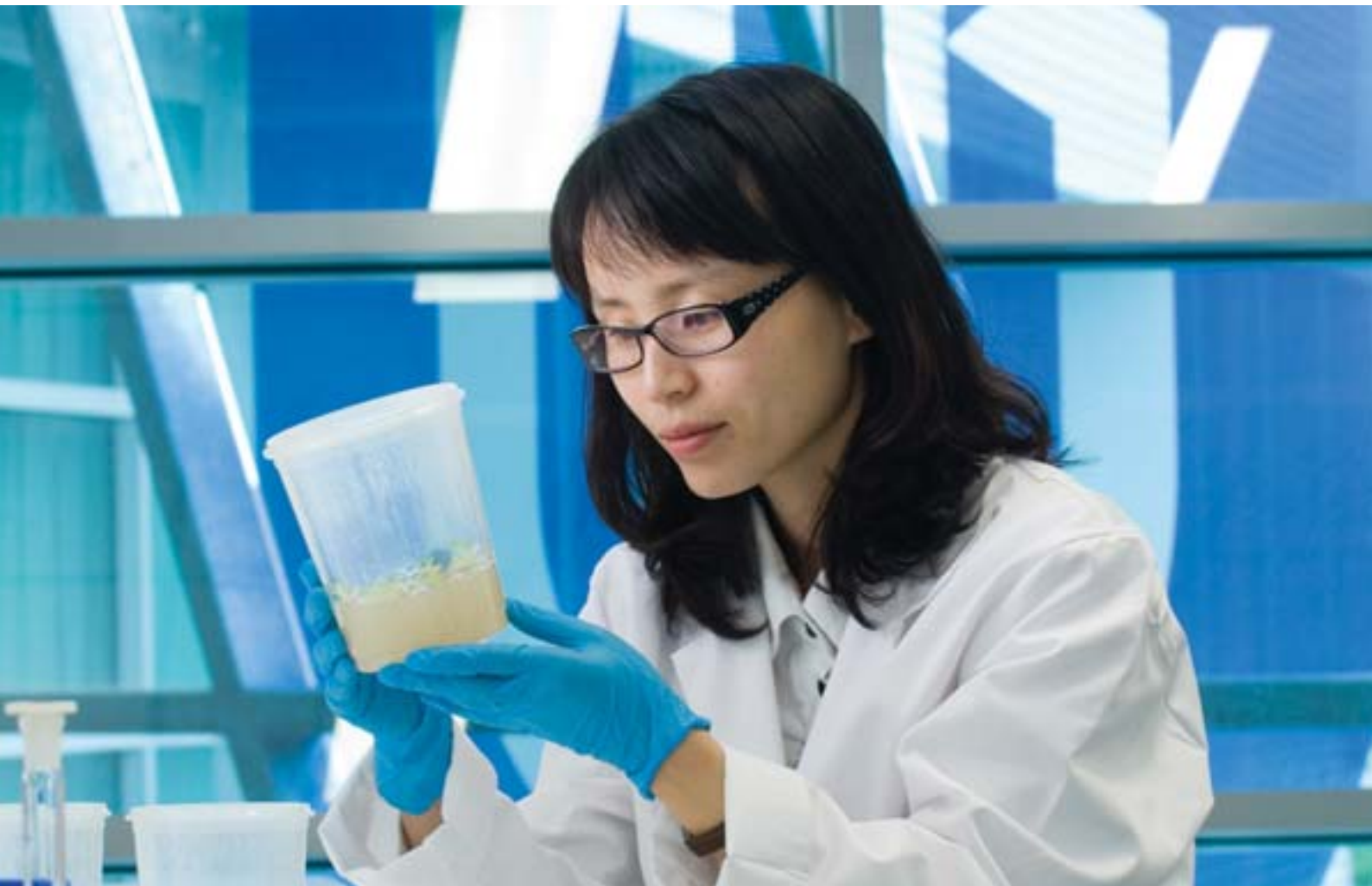
Ross McFarland

Senior Principal, AECOM
Environment and National Chair,
Australian Contaminated Land
Consultants' Association, Inc
(ACLCA).

“CERAR has been instrumental in bringing world class scientists and industry together to address issues related to site remediation. Our relationship with CERAR helps underpin our objective for environmental leadership.”

Dr Bruce Kelley

Global Practice Leader -
environment, Rio Tinto



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