Centre for Environmental Risk Assessment and Remediation
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 human activities. It is estimated that the nation spends over AU$2 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 and capacity, with more than 80 staff, students, and visiting domestic and international researchers based at purpose-built world-class laboratories at the Mawson Lakes campus of the University of South Australia.

CERAR develops novel, cost-effective and sustainable solutions to complex contamination problems by combining multidisciplinary expertise in fields such as biogeochemistry, contaminant chemistry, physics, microbiology, toxicology, environmental biotechnology, engineering, mathematical modelling, hydrogeology, resource recycling and nanotechnology. By focusing on Australian research priorities and industry opportunities, CERAR supports Australia’s economy and protects our health and natural resources.

With significant end user support, CERAR established the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) in 2005. CRC CARE performs world-leading research on, and develops technologies for, assessing, preventing and remediating contamination of soil, water and air. With its diverse mix of industry, university and government agency partners, CRC CARE focuses on best practice policy, better measurement, minimising uncertainty in risk assessment, and cleaning up contamination. CRC CARE also trains and educates students, consultants and end users in the field of environmental risk assessment and remediation.

Locating both organisations at Mawson Lakes has enhanced multidisciplinary interaction by fostering links between labs and research students. As CERAR develops its facilities through its strong relationship with the CRC CARE, it will continue to recruit world-class researchers and postgraduate students.

Professor Ravi Naidu

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

CRC CARE is Australia’s leading science-based partnership in assessing, preventing and remediating contamination of soil, water and air.

With a unique mix of industry, university and government agency partners, CRC CARE’s research program focuses on the challenges of best practice policy, better measurement, minimising uncertainty in risk assessment, and cleaning up.

CRC CARE is a multi-partner research organisation at the forefront of research and technology development for the assessment, remediation and prevention of soil, water and air contamination.

World class researchers from universities across Australia work with industry on global contamination issues, engaging with major end users such as the minerals and petroleum industries, environmental regulators, the Department of Defence, government organisations, SMEs and consultants.

In addition to its substantial research program, CRC CARE also plays a key role in training and educating students, consultants and end users in the field of environmental risk assessment and remediation.

CRC CARE was established in 2005 through the Australian Government’s Cooperative Research Centres (CRC) Program, which provides funding for research ventures to enable researchers to innovatively and effectively tackle large issues faced by end users.

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

To enhance Australia’s economic, environmental and social sustainability and boost its international competitiveness through high quality strategic and tactical research in key areas of natural resource regeneration.

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 research excellence effectively benefits Australia and the region through the implementation of practical and affordable solutions in collaboration with end users and our complementary education and training programs. We strive for quality and impact of our research.

CERAR Advisory Board

Dr Bruce Kelley
Chair – CERAR Advisory Board; Global Practice Leader – Environment, Rio Tinto

Mr Gavin Price
Head of Environment, BHP Billiton Iron Ore

Mr Terry Weston
Assistant Secretary Environment and Engineering, Department of Defence

Mr Stuart McConnell
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Prof Ravi Naidu
Director, CERAR; CEO, CRC CARE

Prof Megh Mallavarapu
Deputy Director: CERAR
University of South Australia

Mr Bruce Perkin
Senior Business Development Manager: IT, Engineering & the Environment, University of South Australia

The role of the Advisory Board is to monitor, review and provide advice on the strategic plans and activities of CERAR including the following:

- the development of appropriate goals and strategies for CERAR
- setting of financial goals and performance reviews
- identify business development opportunities
- identify opportunities for securing financial support for CERAR from the University, Government, industry and elsewhere
- promote CERAR and its activities
- cooperate with other organisations nationally and internationally to advance the goals of CERAR
- provide assistance and advice to the Director of CERAR, and
- provide advice and make recommendations to University Council regarding the governance of CERAR
Our focus

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 waste 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.

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, and it is essential that the dynamics of these chemicals in the environment are 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 occasionally soil treatment technologies including bioremediation. Practical remediation is often constrained by the costs associated with treatment technologies.

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
- Speciation and toxicity assessment
- Ecological and human health risk assessment
- Bioaccessibility/bioavailability assessment
- Innovative remediation methods for contaminated soil and ground water
- Risk communication
- Specialised analytical testing
- Specialised services including treatability studies for remediation
- Remediation treatability studies

CERAR seeks to provide commercially viable and cost effective solutions to environmental contamination that benefit industries, regulators, policy makers, consultants and academics within Australia and abroad.
Our research applied

From nano to field scale

Nanotechnology forms an integral part of CERAR’s research programs. Nano structural materials have developed 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.

CERAR’s involvement in nanotechnology covers a wide range of activities including the development of novel nano materials for remediation of contaminants including risk assessment in the environment.

The current paucity of information in regard to the fate and behaviour of manufactured nanomaterials in the environment is not only a threat to environmental health but also to the development of the nanotechnology sector. In fact, it is critical, in this initial phase of the development of nanotechnologies, that the public debate of these new technologies is based on a scientific understanding of the environmental fate of these new products and not on simple perception of potential risks.

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 soils, films and coatings, nanoporous materials, inorganicorganic hybrids or nanocomposites and nanomaterials (molecular and bulk) characterisation techniques. Areas of current nanomaterial applications being studied include:

- environmental remediation and wastewater treatment;
- chemical and biological sensors for environmental applications;
- immobilisation and/or degradation of inorganic and organic contaminants using nanocatalysts grafted onto natural materials.

Natural resources for a cleaner environment

Extensive attention is being paid to the management and control of environmental pollution 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 and engineers 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 relatively inexpensive resources with large surface areas, 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 aluminosilicates with surfactants, and grafting of nano catalysts on natural materials and their use for immobilising and finally degrading a series of inorganic/organic contaminants.
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 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.

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 behaviour of contaminants from the micro through to the macro scales.

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.

The overall aim of this research is to explore, assess and test innovative approaches for the characterisation, reutilisation and management of solid waste. 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.
Community Engagement Projects

Community consultation projects involving contaminated land are unique and require specific responses to community needs. Consultation with affected communities 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.

Human Health Risk Assessment

Human Health Exposure Assessment is a critical component of both site assessment and the validation of remediation site efficacy. To address this critical component CERAR is undertaking both fundamental and applied research to determine exposure to organic and in-organic contaminants. The major exposure pathway for these contaminants is via incidental soil and dust ingestion with young children being the most sensitive receptor, due to their behaviour and hand to mouth activities.

Key research areas include:
- the development of simple, rapid, and inexpensive assays for predicting contaminant uptake
- validation of chemical assays against bio-availability gold standards, and
- testing soil amendments that minimise contaminant bio-availability.

“Our environmental challenges in Defence are many and varied, but none are more complex than the task of managing our large legacy of contaminated sites. CERAR is a key strategic partner in assisting us work through our contamination issues and continues to deliver innovative solutions and real outcomes for us.”

Terry Weston
Assistant Secretary, Environment and Engineering, Department of Defence.
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 waste. 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 – risk based approach
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 focus 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).

Climate change and carbon sequestration
Enhancing soil carbon storage not only helps to mitigate climate change but also improves soil quality contributing to food security and environmental remediation. CERAR researchers have initiated a number of projects examining the value of soil carbon storage in enhancing environmental remediation. Some of these projects include:

(i) Biochars and black carbon for remediation of contaminated soils which is aimed at utilizing advanced carbon sources to manage organic and inorganic contaminants in soils;

(ii) Organic amendments for soil carbon storage which is aimed at adding value to organic wastes thereby reducing the need for land filling these resources;

(iii) Carbon stabilisation in organic amendments which is aimed at exploring alternative technologies for carbon stabilisation in organic wastes;

(iv) Mine site revegetation to enhance biodiversity and carbon sequestration which is aimed at providing guidelines for revegetation as an economically viable land use for sustainable management of mine sites to enhance biodiversity and carbon sequestration; and

(v) Wastewater irrigation for carbon storage and biomass production which provides benefit to wastewater industries through trading carbon credits.
Eyes on the future

Educating collaborating industries, academia and the community is a major focus of CERAR. CERAR aims to foster a new group of postgraduates through 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.

Feet on the ground

Australia has quite a diversity of soils with vastly different properties in the case of organic matter, mineral, pH etc., influencing the extent of binding or potential risks of soil-borne contaminants. The acceptable levels of organic contaminant PAHs (polycyclic aromatic hydrocarbons) on land use are currently based on the total contaminant content, due to a lack of general information of chemical bioavailability among varied soil types.

Luchun Duan is a postgraduate student within CERAR, working on the long term effect of sequestration of PAHs in soils. The focus of her research is on the effects of different soil properties and ageing on Ph bioavailability. By the time Luchun competes her PhD, she hopes to improve the current understanding of bioavailability of contaminants in soil and of a risk-based approach for land management in practice.

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.
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 strong and productive relationships with:
- Agilent Technologies
- Australian Contaminated Land Consultants Association
- Australian Land and Groundwater Association
- BHP Billiton Iron Ore Division
- CRC for Contamination Assessment and Remediation of the Environment
- Department of Defence
- EPA Victoria
- GHD
- Mullen Partners, Germany
- Rio Tinto
- Soil and Groundwater Pty Ltd
- Verutek, USA

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:
- AECOM
- 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
- Ian Wark Research Institute
- Institute of Medical and Veterinary Science
- Kumoh National Institute of Technology
- Massey University
- New Zealand Institute for Plant and Food Research
- Purdue University
- Salisbury City Council
- SARDI
- Savannah River Ecology Laboratory
- Tamil Nadu Agricultural University
- University of Aberdeen
- University of Delaware
- University of Queensland
- University of Technology Sydney

“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 increasingly offers a one stop shop in the site remediation world. CERAR’s ability to provide world class science-based site remediation solutions is an essential component of effective mine closure. It is truly emerging as a global centre of excellence.”

Dr Bruce Kelley
Global Practice Leader – Environment, Rio Tinto