Bachelor of Science (Honours) Project Booklet 2019

University of South Australia

Welcome to UniSA's Bachelor of Science (Hons.) 2019 Project Booklet

The University of South Australia, Australia's University of Enterprise, possesses a diverse range of researchers and research excellence in pure and applied science.
We welcome you to join us in our search for new scientific knowledge.

A Bachelor of Science (Honours) degree provides the perfect platform to develop your skills as a scientist and often gives you the opportunity to become highly experienced in your chosen field of research. This provides a pathway for further research as part of a PhD or Masters program and assists with gaining the skills and knowledge that many employers consider valuable for graduate employment.

The BSc(Honours) program at UniSA brings together a diversity of researchers and students from a broad range of undergraduate degrees at UniSA and elsewhere in Australia. This booklet provides an overview of some of the projects that are available to students planning to undertake their Honours degree in 2019. UniSA offers flexible entry timing for the Honours degree and students can commence at the start of the year or as mid-year entry.

Entry into the Honours degree requires a GPA of 5 (Credit average) for the relevant undergraduate degree. Applications for entry into the degree are made through SATAC (code provided below) but we also prefer if students contact their potential supervisor and the Program Director for the degree prior to application. The Program Director will guide you through the enrolment process and may also be able to put you in contact with other potential supervisors if your interests fall outside those projects included in this booklet.

The projects in this booklet are loosely grouped into discipline areas. If you are interested in undertaking one of the projects or would simply like more information on the projects we encourage you to contact the listed supervisor/s as they will be more than happy to discuss their research projects with you.

RESEARCH RATED ABOVE WORLD CLASS IN:
Environmental Science and Management, Physical Chemistry, Biochemistry and Cell Biology
*2015 Excellence in Research for Australia (ERA)

97% OF OUR ASSESSED RESEARCH RATED AT OR **ABOVE WORLD-CLASS**
*2015 Excellence in Research for Australia (ERA)

Program web page:
https://study.unisa.edu.au/degrees/science-honours

SATAC code: 4BH009*
*Please note that SATAC incorrectly lists a former specialisation for the Bachelor of Science (Honours) degree. Applications using this code will be considered for a general Bachelor of Science (Honours) degree

Project Areas

Biochemistry and Analytical Chemistry

Earth Science

Environmental Science - ecology, habitats and human interactions

Environmental and Agricultural Science - water, soils and chemistry

Environmental Health and Food Safety

Materials Science

A note from the Program Director

Welcome to our BSc (Honours) Project Booklet for 2019.
I'm Justin and am the Program Director for the BSc (Honours) program at UniSA. I'm based in the School of Natural and Built Environments but our Honours Supervisors are spread across a range of Schools, Research Institutes and Centres at the university. As all of these supervisors can tell you, the Honours year is easily the most rewarding of your undergraduate career and the friendships and professional networks you form during the year can often last a lifetime! If you have any questions about the degree or entry requirements then feel free to contact me and I can either answer your questions or provide you with the appropriate contact that can help. I can also let you know about scholarship options at UniSA.

We look forward to having you join our program.

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Biochemistry and Analytical Chemistry

Mass Spectrometry imaging of small molecule therapeutics

SUPERVISORS

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FIELDS of STUDY

Biochemistry, Analytical Chemistry, Proteomics, Metabolomics

RESEARCH PROJECT

Improvements in cancer treatments have been made by the onset of new drugs that are more specific and thus have less toxicity compared with established chemotherapy. Specifically, small molecules that inhibit Cyclin-dependent kinases (CDKs) have shown the greatest promise, particularly as CDKs play an important role in regulating cell cycle progression [1]. Specific small molecule CDK inhibitors, developed by Professor Shudong Wang, have shown great efficacy as a treatment for ovarian cancer (OC) [2] and combinations of inhibitors have shown promise as a tool to overcome treatment resistance [3]. In OC, a key component of resistance is the presence of 3 Dimensional Cancer Spheroids (3D CS) in the abdominal cavity [4]. The aim of this project is to utilise a newly developed 3D CS analysis platform capable of monitoring the ability of CDK inhibitors to kill 3D CS from OC cell lines as well as from OC patient samples in order to develop a personalised treatment for OC patients.

Practically, the student will continue development of a drug testing platform for OC using a 3D CS, coupled with state-of-the-art Mass Spectrometry Imaging (MSI). The student will be trained in cell culture and to prepare 3D CS for subsequent testing of CDK inhibitors. These samples will be evaluated using MSI methods for targeted monitoring of small molecule CDK inhibitors. Furthermore, the student will develop methods for screening of associated metabolites and measure proteome changes using the available MS instrumentation in the institute. The data obtained from these MS evaluation will be aligned with complementary techniques, including flow cytometry and immunohistochemistry.

The Mass Spectrometry and Proteomics Group in the Future Industries Institute (FII) at the University of South Australia, led by Prof Peter Hoffmann, is focusing on laboratory-based and industry-related research in the field of analytical and bioanalytical chemistry. The group successfully conducts research in the application of Mass Spectrometry for analysing biological molecules such as proteins, peptides, lipids, glycans and small molecules.

The applicant should have foreknowledge in chemistry, biochemistry and cell biology.

References:

[1] Robert Roskoski Jr. Pharmacological Research 107 (2016) 249–275. [2] Lam et al. Oncotarget, Vol. 5, No. 17 (2014) 7691-7704. [3] Hamilton et al., Cancer Treatment Reviews 45 (2016) 129–138. [4] Shield et al., Gynecologic Oncology, Vol. 113, Issue 1 (2009) 143-148

Milk longevity across species

SUPERVISORS

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FIELDS of STUDY

Biochemistry, Analytical Chemistry, Proteomics, Microbiology, lipidomics

RESEARCH PROJECT

For decades bovine milk has to be highly processed through methods such as pasteurization and homogenization and stored under cold conditions to prevent early milk spoilage. This treatments reduce the nutritional value of milk and require high investments in cooling systems. In order to discover alternative approaches for improving milk lifetime, the understanding of the mechanisms that are critical to maintain the stability of milk is crucial. Milk from different species vary in composition and their stability also varies tremendously. Characterising the differences in composition as well as the mechanisms for longevity and applying them to cow milk could improve the nutritional quality, the sensory characteristics and reduce the huge investments in cooling systems. The aim of the project is to examine the molecular, physical and microbiological differences between several milk species and thus, to draw conclusions about the exact mechanisms which prevent spoilage in milk.

Practically, the student will develop an analytical toolkit for attaining Mass Spectrometry profiles from several milk species at different stages of spoilage to analyse various aspects of milk spoilage across milk species. The student will be trained to develop Mass Spectrometry (MS) methods for profiling these analytes using the available MS instrumentation in the institute: Electro Spray Ionization (ESI), Quadrupole time-of-flight (Q-ToF) Mass Spectrometry and Matrix Assisted Laser Desorption/Ionization (MALDI)-Time-of-Flight (ToF)/(ToF) Mass Spectrometry. Also, the student will participate in collecting, interpreting results, including possible journal publications and will work closely with industry partners.

The Mass Spectrometry and Proteomics Group in the Future Industries Institute (FII) at the University of South Australia, led by Prof Peter Hoffmann, is focusing on laboratory-based and industry-related research in the field of analytical and bioanalytical chemistry. The group successfully conducts research in the application of Mass Spectrometry for analysing biological molecules such as proteins, peptides, lipids, glycans and small molecules such as pharmaceutical drugs, micro toxins or pesticides.

The applicant should have foreknowledge in chemistry, biochemistry and/or microbiology.

Earth Science

Kimberichnus, Radulichnus or just Pascichnia

SUPERVISORS

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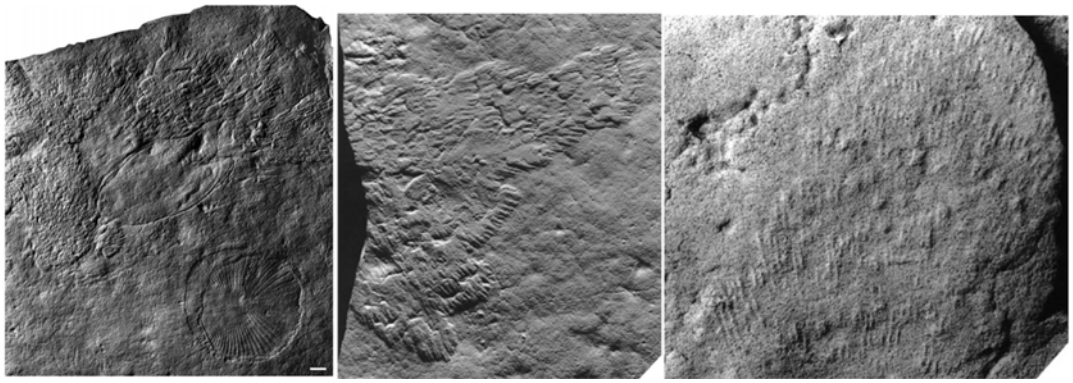
FIELD of STUDY

Ediacaran palaeontology

RESEARCH PROJECT

Kimberella quadrata is a key Ediacara biota body fossil as it is demonstrably associated with radiating "scratch-marks" that are interpreted radula feeding marks. Combined with the morphology of *Kimberella,* these trace fossils provide robust evidence that *Kimberella* was a bilaterian mollusc living ~ 555 million years ago (Fedonkin and Waggoner, 1997; Fedonkin et al., 2007; Gehling et al., 2014). *Kimberichnus terruzi* (Ivantsov, 2013) is the name given to the radular scratch marks that are directly related to *Kimberella* fossils and are commonly described as sets of paired scratches often associated with pellets of sand (Gehling et al., 2014). A review of the literature and new fossils discovered in South Australia suggest there may be two distinct sets of pascichnia (feeding trace fossils) that are incorporated into the *Kimberichnus terruzi* terminology. This project will use a combination of fieldwork in the Flinders Ranges and pre-existing material to undertake morphometric studies of trace fossils currently considered to be *Kimberichnus terruzi* to determine if they should be considered a single or multiple ichnotaxa. The primary field site for the study is a rare gem as it has only been investigated/visited 3 times in the last 50 years and seems anomalously rich in *Kimberichnus*. Despite being rich in *Kimberichnus* no specimens of *Kimberella* has ever been found at the site and the *kimberichnus* found to date appear to vary dramatically in their appearance.

This project offers the opportunity to work on world class fossil material from the South Australian Museum collections in conjunction with Museum researchers. This project will also involve data collection and fieldwork at relatively new fossil sites in the Flinders Ranges.



Kimberella (top left) and associated *Kimberichnus* scratch traces (Gehling et al. 2014)

Primary, Metamorphic or Alteration – a Fe story

SUPERVISORS

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FIELDS of STUDY

Mineralogy, petrography, geochemistry

RESEARCH PROJECT

The Gawler Craton in South Australia is host to a world-class iron oxide-copper-gold province exemplified by the Olympic Dam, Prominent Hill and Carrapateena deposits. These deposits are intimately associated with early magnetite alteration with a number of other deposits and prospects also hosted within early magnetite(-skarn) alteration. The role of the magnetite in localising subsequent metal deposition is unclear and it is also unclear in some prospects how much of the magnetite alteration is associated with the mineralising event or is present from metamorphism of pre-existing iron-rich sediments and/or unrelated alteration events. This project will investigate magnetite alteration compositions and isotopic characteristics in a range of prospects and deposits in the northern Gawler Craton. This will provide new insight into the mineralisation in this region and allow for comparison to the previously characterised "traditional" IOCG deposits from the southern Gawler Craton.

The project is associated with the Commonwealth-funded ARC Linkage project "Source to Spectrum" that has project partners minerals sector partners including the Geological Survey of South Australia, Minotaur Exploration, Fortescue Metals Group, Investigator Resources and Rex Minerals.

Environmental Science: Ecology, habitats and human interactions

Holistic assessment of agriculture and food systems in South Australia: An application of true cost accounting

SUPERVISORS

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FIELDS of STUDY

Environmental science and management, Ecosystem Services, Ecological Economics, Agriculture, Climate Change

RESEARCH PROJECT

True cost accounting is a method to capture all costs and benefits associated with the production, distribution and consumption of all goods and services in agriculture and food systems. The current accounting system only recognises costs associated with inputs, labour, capital costs, etc. It does not account for any depletion of natural resources, ecosystem services, greenhouse gas emissions, and associated environmental costs including damage to air, water and biodiversity, social inequities, loss of natural, social and human capital and any impacts on health. Absence of true costing results in perverse outcomes such as wrong economic policies that favours short term gains over long term sustainability and are detrimental to sustainable social, environmental and economic outcomes in agriculture and food systems. Therefore, there is need to fix the current economic systems at farm and national level by accounting for all costs and benefits so that it can support policies to rectify wrong practices and incentivise sustainable practices. Hence, true cost accounting (TCA) is required to understand the full costs and benefits of our agriculture and food systems. TCA can be used to value all positive and negative impacts. These may include human, social, natural and financial capital. There is increased interest in scientific and policy community to explore TCA in agriculture and food systems. This concept can be applied to diverse food systems in South Australia. A variety of Hons/Masters projects are available as below.

To examine all costs and benefits of food production systems by focusing on social, environment and public health costs in South Australia.

Full cost of the weekly food basket in South Australia.

Food culture and the environment: A spatial analysis of cultural ecosystem services in major food growing region of South Australia

The economic cost of climate change in South Australia

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FIELDS of STUDY

Environmental science and management, Ecosystem Services, Ecological Economics, Agriculture, Climate Change

RESEARCH PROJECT

Climate change has impacted the environment and also has economic consequences. Any effects of climate change such as damages to human health, property and economic activities impose a cost on society. There is need to understand these costs in order to develop an appropriate policy response. Therefore, a potential project can examine the current policy environment, various drivers, and evaluate economic costs to society based on recent climate projections by focusing on South Australia.

Accounting for blue carbon in South Australia

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FIELDS of STUDY

Environmental science and management, Ecosystem Services, Ecological Economics, Agriculture, Climate Change

RESEARCH PROJECT

Coastal ecosystems in South Australia such as saltmarshes, mangroves, seagrasses provide many essential ecosystem services including water purification, climate regulation, erosion control, habitat provision, recreation etc. There is a growing interest in blue carbon, which is associated with these coastal ecosystems. Blue carbon is the carbon sequestered and stored in the biomass and soils of vegetated coastal ecosystems, such as mangroves, tidal marshes and seagrasses. The coastal ecosystems especially the soil can store carbon for hundreds to thousands of years. They are extremely stable carbon sink over long-term. In accordance with the United Nations Framework Convention on Climate Change (UNFCCC), and the relevant decisions of the Conference of the Parties, Australia submit national greenhouse gas (GHG) inventories to the Climate Change secretariat. Australia is progressively implementing its reporting of coastal carbon (blue carbon) in its national greenhouse gas inventory (NGGI), and has prioritised coastal ecosystems due to their extent and importance in Australia. However, there is lack of information on the status, trends of potential blue carbon associated with coastal ecosystems. A project can examine the current status and trends of blue carbon in South Australia. By using carbon accounting methods, it can estimate the value of blue carbon to South Australian economy.

Adaptation to climate change and Goyder's line

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FIELDS of STUDY

Environmental science and management, Ecosystem Services, Ecological Economics, Agriculture, Climate Change

RESEARCH PROJECT

Goyder's line has been a unique feature of South Australian agricultural and land use history since 1865, when the land was surveyed by George Goyder, the then Surveyor-General of the colony. There are distinct changes in the landscape across the line, which are caused by climatic factors such as changes in precipitation and temperature. Changes in natural vegetation, land use patterns and types of crops grown on both sides of the Goyder line can be observed as we travel along the line. Observing these changes and identifying patterns of land use change in the region are essential to understand impacts of any change in climatic factors, impacts on natural resources and how rural community has adapted to these changes over the past 150 years. Future projections of climate change indicate that the Goyder line will shift south as the temperature rises and the rainfall decreases in the region. This has implications for the rural community in terms of social, economic and environmental impacts. The potential project can examine climate change impacts and contribute to develop adaptation strategies across Goyder line.

Spatio-temporal analysis of habitat for endangered bats

SUPERVISORS

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FIELDS of STUDY

Geospatial Science, GIS, Cartography, Environmental Science, Ecology

RESEARCH PROJECT

Background

The southern bent-wing bat (Miniopterus orianae bassanii) is a native endemic mammal found in southeast South Australia and western Victoria. The population is centred around the Naracoorte Bat Cave (Naracoorte National Park, a World Heritage Site), which is their key breeding site. Unfortunately, since the 1960s this species has declined dramatically, and bat scientists link this decline to loss of foraging swamp habitats in the region. This project will examine changes in land use, land cover, and habitat availability around the Naracoorte cave site since 1972 using freely available Landsat imagery data.

Objectives

Spatio temporal analysis and mapping of the loss and modification of bat habitats, with particular focus on swamps, for endangered bats over 40 years, and identify priority areas for bat habitat restoration.

Southern bent-wing bat (adelaidebatcare.com.au)

***Pre-requisites**:*
Basic skills in GIS and Remote Sensing

***Project collaborators would include** Department of Water, Environment and Natural Resources (DEWNR), Naracoorte Caves, the Drainage Board, and Nature Glenelg Trust (a non-government organisation).*

More information about the southern bent-wing bat:
http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=87645

Identifying new bike trails for Adelaide – a geospatial approach

SUPERVISORS

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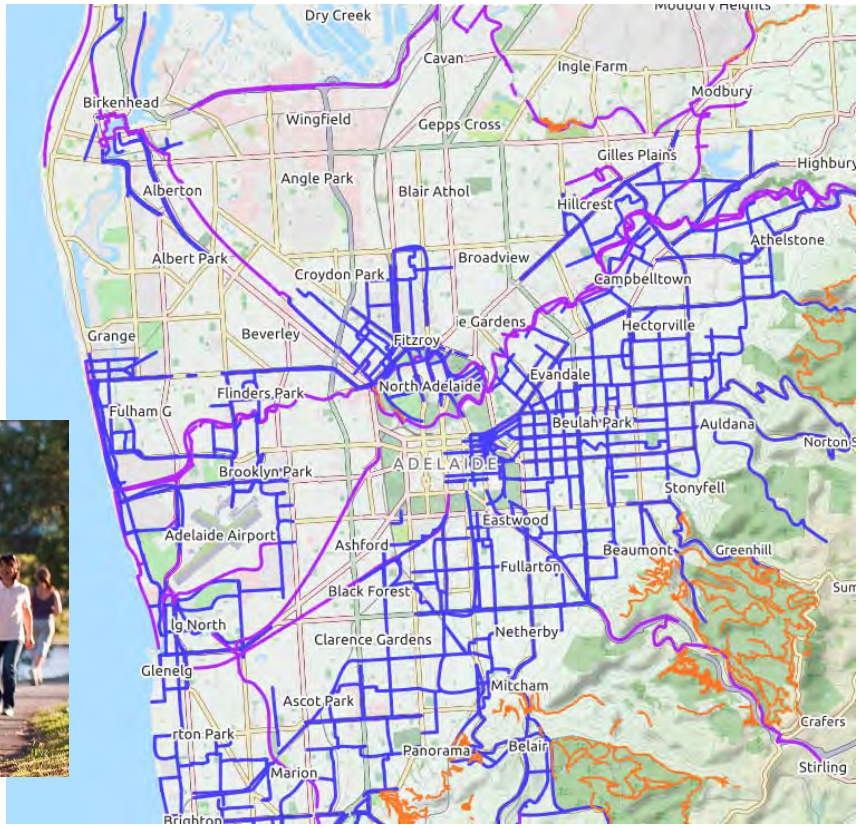
FIELDS of STUDY

Geospatial Science, GIS

RESEARCH PROJECT

With the constantly increasing traffic in Adelaide, there is a demand for eco-friendly urban mobility solutions to reduce congestions and improve air quality. Providing and promoting bicycle lanes and trails would be one potential answer.
This project focuses on applied GIS and Remote Sensing research to identify possible new bike lanes in Adelaide.
Various aspects, such as purpose specific design of bicycle lanes and trails will be considered. Moreover, project outcomes (results of geospatial bike trails) are planned to be published in a web map application.

***Pre-requisites**:*
Basic skills in GIS and Web Cartography



left: bike trails in Adelaide (src), right: opencyclemap.org

Remote Sensing based vegetation health monitoring along the Murray River

SUPERVISORS

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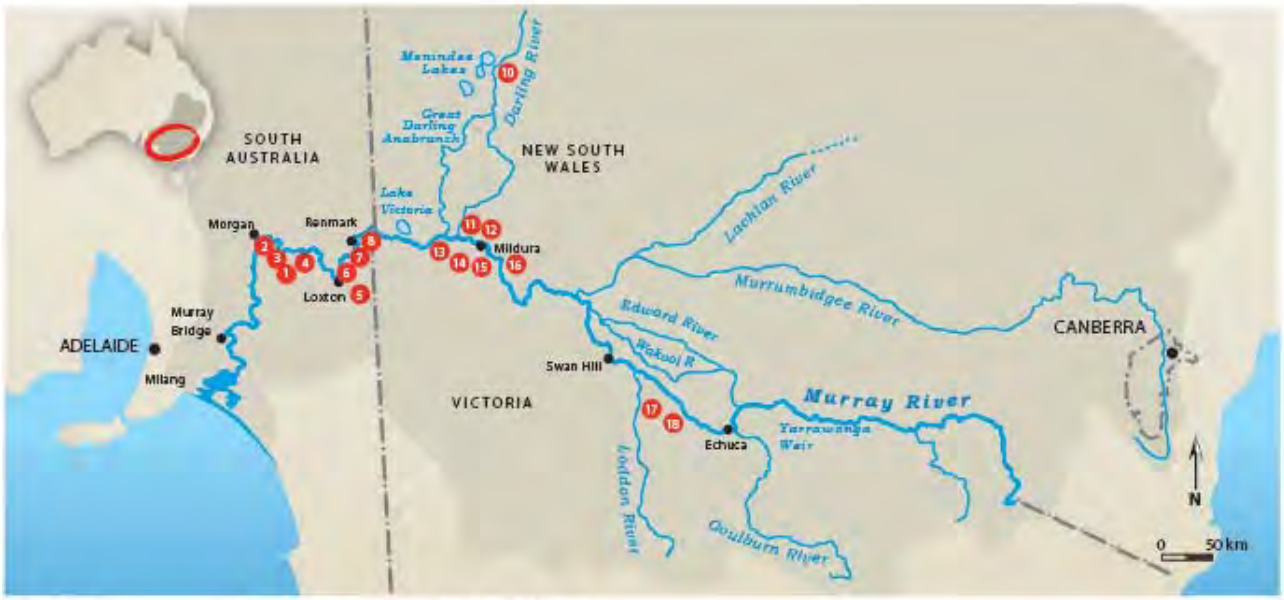
FIELDS of STUDY

Geospatial Science, GIS, Remote Sensing, Environmental Science

RESEARCH PROJECT

Salt interception schemes are large-scale groundwater pumping and drainage projects that intercept saline water flows and dispose of them, generally by evaporation. Since 1988, the New South Wales, Victoria and South Australia Governments, together with the Commonwealth Government, have funded the construction of salt interception works along the Murray River, that have resulted in a reduction of 80 EC units (a measure of salinity concentration) at Morgan, South Australia. As shown below, altogether 18 salt interception scheme exists.
This project aims to investigate changes in vegetation health at Murray river since 1988 using a variety of aerial and satellite imagery data.



1. Waikerie
2. Waikerie 2L
3. Sunlands - Quakco
4. Woolpunda
5. Noora
6. Loxton
7. Bookpurnong
8. Murtho
9. Rufus River
10. Upper Darling
11. Curlwaa
12. Buronga
13. Mildura Merbien
14. Lake Hawthorn
15. Psyche Bend
16. Mallee Cliffs
17. Barr Creek
18. Pyramid Creek

Environmental effects of pollution near a coastal smelter

SUPERVISORS

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FIELDS of STUDY

(Marine) Environmental Science – Toxicology, Ecology & Geology

RESEARCH PROJECT

Port Pirie is located on the eastern shore of the Upper Spencer Gulf and hosts one of the world's largest lead and zinc smelters, in constant operation for more than 120 years. Although discharges and emissions have reduced from the plant in recent years, past studies found extremely elevated levels of metals including zinc, lead, arsenic, manganese and copper in the adjacent marine system. Smelter upgrades should keep reducing future inputs, but it is unclear exactly what the existing metal loads are or their dynamics i.e. how contaminants are interacting with ecological components of the marine ecosystem, how much (and where) metal is available biologically, and how much is sequestered into sediments and/or exported from the system. A range of potential projects are available for students to work within a larger project, working with Nyrstar, Flinders Ports & the EPA:

- Metal contamination in mangroves and saltmarsh

While we have quite a lot of data on metals in seagrass and other subtidal habitats surrounding Port Pirie, we have less information on metal contamination in intertidal areas such as mangroves and samphire (saltmarsh) areas. This project would measure contamination in these plants and surrounding sediments to determine how much metal is contained in these habitats and, potentially, how this affects the plants.

- Development of ecotoxicology tests for sediment elutriates

Sometime in the near(ish) future, the port at Port Pirie will need expanding, which will involve dredging of highly contaminated sediments. This project will build on work being done in our lab to develop ecotoxicology assays to assess the potential impacts of dredging/metal liberation. Most assays in our lab focus on reproduction and early development in marine invertebrates and a range of projects could further these. Bryozoans are also important (and sensitive) receptors in SA gulfs and a project could develop lab assays using adult colonies.

- Ecological effects of metals on seagrass

While there are some good measurements of the broader impacts of metals on subtidal systems from the 1980s, there is little contemporary information now that smelter emissions are reducing. Using video transects of seagrass and other subtidal habitats across the broader Port Pirie area, this project would test for current impacts by testing for correlations in habitat/seagrass health with (landscape scale) spatial patterns in metal contamination.

- Geostatistical estimates of metal contaminants/resources at Port Pirie

One of our goals for our work at Port Pirie is to create a map of contaminants that can be used to estimate the metal resources locked away in sediments and identify potential 'hot spots' for dredging. Using information on metal contamination from sediment cores collected across the bay surrounding Port Pirie, this project would use geostatistical analyses to create a spatial/block model of metal resources in marine areas that could be used to help plan future dredging or remediation activities.

A participatory Web Map App for the Walk the York trail

SUPERVISORS

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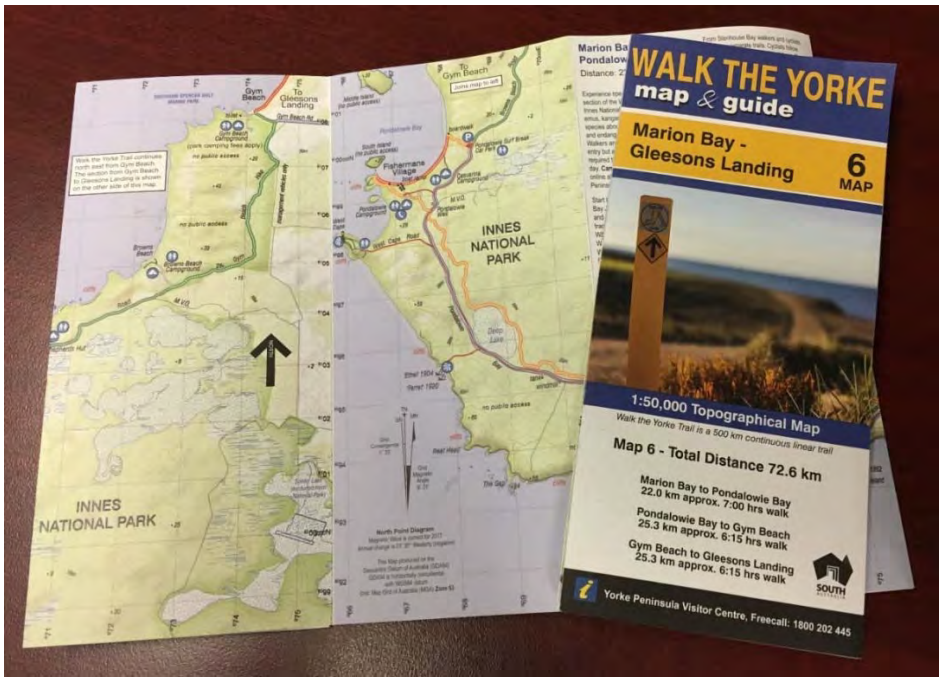
FIELDS of STUDY

Geospatial Science, GIS, Web Cartography

RESEARCH PROJECT

Preparing for a longer trail, no matter if walking, biking or horse-riding, requires good planning using a map. Today, the power of map lies in particular in interactive web maps. Web maps are excellent trail planning as well as on-site tools providing in-depth insight into location and trail-related information. Through user interactions (popups) and embedded multimedia, a user can explore and plan a route before visiting.
Furthermore, mobile-device friendly web map apps provide in-situ location-based information and help to adapt personnel planning and ad-hoc decision making.
This project aims to develop a trail web map for **Walk The Yorke** as well as a participatory web map tool to report map errors and constantly feed up-to-date information into the application.

Pre-requisites:
Basic skills in Web Cartography (GEOE3019 or equivalent)



Walk The Yorke printed map (foto-source)

Virtual Witchelina – 3D Geopark Web Map Application

SUPERVISORS

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FIELDS of STUDY

Geospatial Science, GIS, Web Cartography

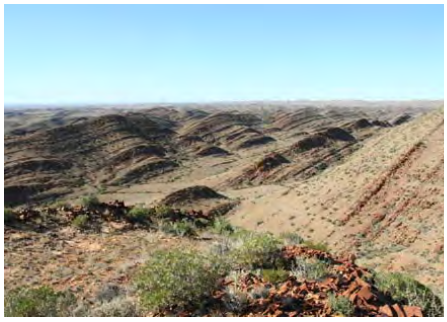
RESEARCH PROJECT

Witchelina is a magnificent outback expanse extending from Lake Torrens in the south to Marree in the north. Now managed for conservation by Nature Foundation SA, the former pastoral property spans three bioregions, Willouran, Mulgarie and Marree, and contains a number of fascinating geological attractions. A couple of geologists and others are working currently on a "Geopark" concept for Witchelina. A 3D Web Map Application – main goal of this project – is potentially an effective approach to boost tourism to this unique geological landscape.

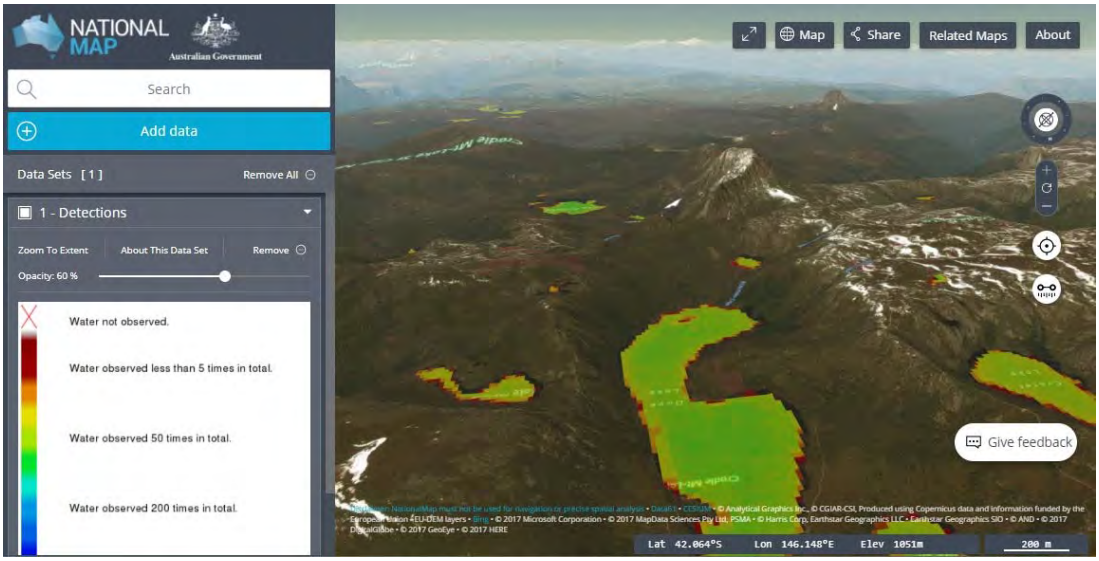
Main Objectives

- *Create a 3D Web Map Application - using Cesium and TerraJS Java Script - with interactive information about Witchelina Geopark, walking trails, car tours, embedded photos, videos, and other medias, etc.*
- *Explore possibilities and limitations of Cesium JS*
- *Investigate alternatives to Cesium JS*

***Pre-requisites**:*
Basic skills in Web Cartography (GEOE3019 or equivalent)



Witchelina geopark (image source)



Exemplary TerriaJS 3D Web mapping application: http://nationalmap.gov.au/

Biodiversity value and microclimate of karst dolines in South Australia

SUPERVISORS

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FIELD/S of STUDY

Climate change, Conservation, Ecology, Environmental Science

RESEARCH PROJECT

Refugia from climate change are vital for the persistence of biodiversity under climate change. Karst dolines are important for maintaining biodiversity, acting as refugia during times of environmental change by retaining unique climates not available in the surrounding landscape. As a result, many are hotspots of biodiversity that provide safe havens under environmental change.

In Europe, dolines are well-known refugia for biodiversity when environmental conditions change. Dolines are common in South Australia's extensive karst landscapes, but have not been studied with respect to biodiversity, microclimate or as potential microrefugia. This study will investigate the microclimate, plant diversity and conservation status of these unique habitats. You may focus on only one or all of these aspects. Some background in ecology or conservation biology would be advantageous.

Picture: Hungarian karst doline in early spring.

Ecology and microclimate of woodland edges in South Australia

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FIELD/S of STUDY

Climate change, Conservation, Ecology, Environmental Science

RESEARCH PROJECT

Forest cover is decreasing on a global scale. As a result, landscapes are increasingly fragmented, meaning that the total proportion of habitat close to the woodland edge bordering more disturbed vegetation types is increasing. Due to this increasing prevalence of edge habitats, it is important that we understand how environmental gradients (e.g., changes in temperature and humidity) from the edge to the interior of the woodland affect biodiversity.

In South Australia, woodlands are also highly fragmented, but little is known about the ecology of these edge habitats. This project will investigate how the microclimate, and the diversity and ecology of plants and animals, vary in the edge habitats using transects extending from the edge towards the centre of the woodland. You may focus on only one or all of these aspects. Some background in ecology or conservation biology would be advantageous.

Picture: The edge of a woodland in the Fleurieu Peninsula.

Trailing edge regeneration in *Agathis macrophylla* and *Degeneria vitiensis* in Fiji

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FIELD/S of STUDY

Climate change, Conservation, Ecology, Environmental Science

RESEARCH PROJECT

Modern climate change is producing range shifts of numerous species and communities. On mountains, many species are shifting upwards in response to warming temperatures, creating a leading edge (where populations are expanding at higher elevations) and a trailing edge (where populations are persisting at lower elevations). For plants, changes in distribution should manifest in improved regeneration and recruitment at the leading edge (higher elevation) and suppressed recruitment at the trailing edge (lower elevation).

Fiji is an island in the Southwest Pacific where we have an established transect from 750 – 1100 m elevation on Mount Batilamu. This study will investigate trends in regeneration at the trailing edge (and compare these with values at more suitable habitats) for two iconic Fijian tree species in Fiji, the Pacific kauri Agathis macrophylla *and the relict species* Degeneria vitiensis. *Travel funding for this project is restricted to Australian students and students of other nationalities would have to cover their own flight costs. Some background in ecology or conservation biology would be advantageous.*

Picture: View of Mount Batilamu, where the study site is located.

Environmental and Agricultural Science: Water, soils and chemistry

Minimising the impact of pesticides on soil health?

SUPERVISORS

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FIELD/S of STUDY

Soil Science, Agriculture, Environmental Science

RESEARCH PROJECT

Do you want to get your hands dirty?! The focus of this project is to better understand the effects of agricultural pesticides on soil microbial communities. Ultimately, the results from this project will help South Australian farmers to choose the best soil-pesticide combinations for maintaining healthy soil microbial communities in their soils.

In Australia, the application of pesticides plays an important role in high production agriculture. However, less than 5% of sprayed pesticides actually reach their target. Instead, most of the pesticide ends up in the soil where it can negatively affect soil microorganisms. This can be detrimental for farmers because they rely on healthy soil microbial communities for achieving agricultural sustainability and productivity.

This study, which is linked to a project funded by the South Australia Grain Industry Trust (SAGIT), will use a combination of laboratory experiments and field trials (carried out near Clare, SA) to better understand the links between pesticide choice and soil microbial functions and soil fertility. Some background in soil, soil chemistry or environmental chemistry would be advantageous.

Interactions of Engineered Nanomaterials with Cereal Crops – Agronomic game changer or environmental disaster?

SUPERVISORS

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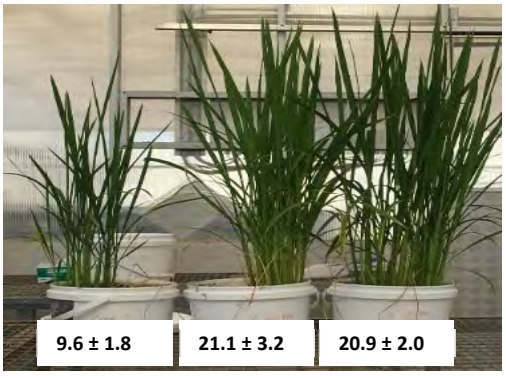
FIELD/S of STUDY

Environmental Science and Engineering: agriculture, *biogeochemistry,* fertilizers, *food security, nanomaterials,* plant nutrients, soils.

RESEARCH PROJECT

By the end of the 21st century, in excess of 9.5 billion people will inhabit the planet. This will result in increased demand for food, and a reduction in the area and resources available for food production. While many studies have advocated engineered nanomaterials (ENMs) as a game changing, novel means of improving agricultural productivity, many other studies have equally advocated ENMs as agents for environmental disaster due to significant physical and chemical interactions with both inorganic and organic species in aquatic and soil environments. Thus since the long-term effect of the efflux of such ENMs is uncertain, this project seeks to definitively assess whether the presence of ENMs in agricultural soils significantly alters soil nutrient and contaminant cycles and ascertain what effect this is likely to have on agricultural crop productivity and environmental health. Unravelling the complex interactions between ENMs, soils and cereal crops will provide fundamental new knowledge of the mechanisms involved; so as to protect Australian food quality and potentially combat food insecurity globally.

Figure 1. Differences in plant biomass of rice cv. Sherpa at harvest when grown with Nirtogen (N) alone (left), N + CeO_2 (middle) and N + TiO_2 (right). ENM added at 50 mg kg^{-1}.



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Transforming Agricultural Wastes: Biogenic synthesis of nanocomposites for wastewater treatment.

SUPERVISORS

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FIELDS of STUDY

Environmental Science and Engineering: environmental rehabilitation, green synthesis, materials science, nanomaterials, nanotechnology, plant extracts, recycling, waste reuse, water treatment.

RESEARCH PROJECT

The two most important global issues today are the sustainable provision of clean water and nutritious food. However, driven by an ever increasing world population and industrialisation water pollution is increasing; particularly in Australia where water resources are already severely stretched. Methodologies that allow wastewater to be reused are therefore of significant national benefit allowing pristine waters to be allocated for alternative uses. In addition coincident with the demand for increased food supply, agricultural waste; which is already a significant issue will only increase in the future. This project simultaneously provides a novel solution to both of these problems by developing advanced biogenic engineered nanomaterials (ENMs) from agricultural waste biomass for wastewater treatment.

While engineered nanomaterials (ENMs) are an emerging class of potential adsorbents their manufacture often involves toxic chemicals. Recently green synthesis of ENMs using simple plant extracts was proposed to be safer. In this project metal oxide nanomaterials will be prepared via a green synthetic route and characterised for removal efficiency for one or more common pollutants (i.e. arsenate, azo dyes cadmium, DDT,).nitrate, phosphate). The project further embraces the latest advances in green techniques ENM fabrication by not only using agricultural waste plant extracts to facilitate ENM reduction and capping but also uses the modified residual plant waste biomass simultaneously as a ENM biosupport thus obtaining better water treatment efficiencies.

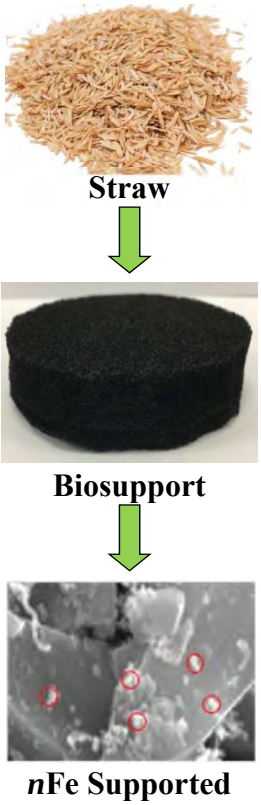

Figure 1. The figure on the right hand side represents the overall process from raw waste (straw) to biosupport and finally to a biogenic ENM (*n*Fe) decorated nanocomposite.

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Polymer sponges for enhanced water retention in soils

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FIELDS of STUDY

Environmental Science and Engineering: agriculture, materials science, polymer chemistry, soil science.

RESEARCH PROJECT

Australia is one of the driest countries in the world with only limited annual rainfall. This precious resource could be more effective utilized if a method could be found to retain water in the root zone of plants for longer periods. Hydrophilic polymers (hydrogels) are a class of organic compounds that have enhanced water retention properties. In this project a range of hydrogels will be combined with agricultural soils from arid regions of Southern Australia and the effect on water retention, fertilizer retention and metal leachability examined. The incorporation of polymer materials into the soil matrix may also increase the structural stability of fragile soils and reduce soil erosion.

Figure 1. Photograph demonstrating the significant cacpity og f hydrogels to swell and adsorb water (from http://andysteeluk.blogspot.com/2015/06/polymer-gel-invaluable-drought.html#!/2015/06/polymer-gel-invaluable-drought.html).

RELATED ARTICLES

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Low toxicity carbon quantum dots for enhanced photosynthesis in globally important food crops.

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FIELDS of STUDY

Environmental Science and Engineering: agronomy, *agriculture,* biogeochemistry, environmental science and materials science, *nanomaterials,* nanotechnology.

RESEARCH PROJECT

It is estimated that by 2050 the world's population will exceed 9 billion people with the consequential global increase in the demand for food currently beyond the means of current food production levels to deliver. To avoid this impending global food crisis food production needs to at least double but without compromising nutritional quality or increasing environmental degradation. Thus, inspired by recent advances in nanotechnology, this project addresses the approaching food crisis by developing new avenues for increased global food production via augmented photosynthesis.

Plants harvest sunlight via photosynthesis and convert it to electrochemical energy to drive important biochemical processes. However, surprising photosynthesis is a rather inefficient process, harvesting only a fraction of the available light energy. However, due to their unique photoluminescence properties quantum dots (QDs) have often been proposed as suitable materials to artificially augment photosynthesis. However, traditionally quantum dots have been composed of heavy metals making them unsuitable for agricultural applications because of their high biological toxicity. In this project a range of nontoxic carbon-based nanomaterials suitable for enhancing photosynthesis in rice and/or green algae will synthesized and their photosynthetic potential evaluated. The project thus has the potential to increase crop yield via enhanced photosynthesis and thus directly affect the lives of millions of people in developing countries where agricultural operates on modest margins.

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Phytoremediation of metal contaminated soils using Australian native vegetation

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FIELDS of STUDY

Environmental Science and Engineering: mine site rehabilitation, phytoremediation,

RESEARCH PROJECT

Phytoremediation encompasses a range of different techniques, including, phytoextraction, phytostabilization and rhizoremediation, all of which utilize vegetation to achieve *in situ* remediation of contaminated land. Phytoremediation technology is based on the capacity of the plants to remove, immobilise or render harmless metal soil contaminants. Phytoremediation techniques are attractive because they are publicly perceived as being a "green and clean" compared to traditional remediation technologies such as soil washing and excavation and is one of the few remediation technologies that aesthetically improve the landscape during remediation. Their main disadvantage is that although relatively inexpensive they do not offer a quick fix solution to contaminant problems as remediation below a specified level may require several years of repeated cropping to obtain clean up goals.

At present commercial viability of phytoextraction technologies are limited by the ability of the plants to hyperaccumulate metal(loids) to harvestable portions. The majority of hyperaccumulator species identified to date are also specific to Europe or the USA and there is no known species of Australian native vegetation known to hyperaccumulate metal(loids). In particular the harsh Australian climate typically requires plants that are hardy, salt resistant and utilize limited irrigation. Identification of indigenous hyperaccumulators will also circumvent the problems associated with importing and widely cropping an introduced species for use in Australia and will therefore speed the path to adoption.

The aims of this project are therefore to 1) identify and assess native (indigenous) plant species growing in contaminated areas for their potential to hyperaccumulate metal(loid)s, and 2) critically evaluate these species for their potential application as part of a commercial phytoremediation technology.

RELATED ARTICLES

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Environmental Health and Food Safety

Efficacy assessment of electrolysed oxidising water in reducing microbial contamination of minimally-processed foods

SUPERVISORS

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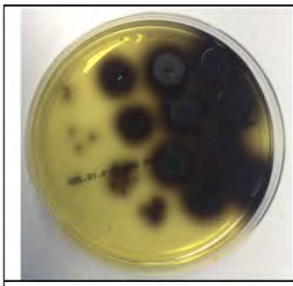
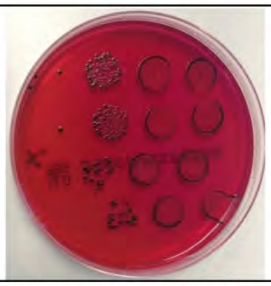
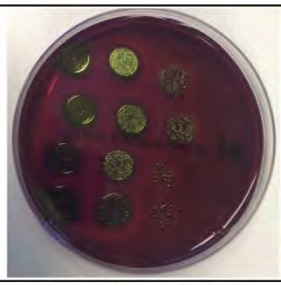
FIELDS of STUDY

Environmental Science, Food Safety, Microbiology

RESEARCH PROJECT

Foodborne diseases are a widespread and a growing public health and economic concern worldwide. Development of safe, effective, inexpensive, easy to deploy and environmentally-friendly solutions towards reducing or eradicating microbial spoilage and foodborne pathogens is paramount. In this project, we will carry out a comprehensive evaluation of the efficacy of a pH-neutral electrolysed oxidising (EO) water technology in improving the overall quality and value of minimally-processed foods such as lettuce, spinach, broccoli, tomato and capsicum. We will compare efficacy of different doses and dosage regimes of EO water with those of sodium hypochlorite (through irrigation) in reducing/eliminating artificial microbial contamination of these foods using culture and culture-independent (PCR)-based methods as well as shelf-life assessments. These activities should translate into health and economic benefit through reduction and/or elimination of food spoilage bacteria. It will also fortify engagement with industry and other stakeholders leading to translation of research outcomes into community benefit.

			
Listeria innocua 6a (ATCC 33090) on *Listeria* Selective Agar (Oxford)	*Salmonella enterica* serovar Enteritidis 11RX on Xylose Lysine Deoxycholate agar	*Escherichia coli* (ATCC 25922) on Eosin Methylene Blue agar	Red cos lettuce growing at Mawson Lakes Campus Greenhouse

Unravelling the mechanism of action of various disinfection processes used in the agri-food industry

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FIELDS of STUDY

Molecular Biology, Environmental Science, Food Safety, Microbiology

RESEARCH PROJECT

Global efforts are currently geared towards the use of safe, effective, inexpensive, easy to deploy and environmentally-friendly sanitisers that are compatible with the food industry. In the last few years, we have been investigating the efficacy of one such sanitiser, a pH-neutral electrolysed oxidising water (EO) in reducing or eliminating the microbial contaminants of minimally-processed foods (e.g. lettuce, spinach, broccoli, tomato). In this project, we will perform a detailed analysis of the mechanism of action and chemical composition (HOCl, OCl^-, Cl_2) of the various EO water delivery (liquid, fog, ice, gel, booster) systems and examine if any of these can eliminate biofilms and/or prevent the viable but non culturable microbial state. Molecular biology methods will include quantitative culture, DNA and RNA analyses by qualitative and quantitative PCR, digital droplet PCR, metabolic activity measurements (using biosensors) and next-generation sequencing (16S metagenomics). The results will provide recommendations for technology adoption by Industry.

The Molecular Biology Suite at FII, Mawson Lakes Campus

Red and green cos lettuce growing at Mawson Lakes Campus Greenhouse

Assessment of indoor exposure to environmental contaminants – the use of passive samplers for organic exposure analysis

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FIELDS of STUDY

Environmental Science, Exposure Assessment, Human Health Risk Assessment

RESEARCH PROJECT

Many people spend a large part of their lives indoors, and as such, the quality of the indoor environment is important. As part of everyday life, people are exposed to a wide variety of organic compounds (e.g. flame retardants, plasticizers, semi-volatile compounds) in everyday consumer products. Many of these compounds may exhibit adverse health effects at elevated doses or following chronic low-dose exposure. This project aims to assess the potential of passive samplers (for household, office or personal use) to measure the abundance of semi-volatile compounds as a means of estimating human exposure. An interest in environmental contaminants and some background in chemistry would be advantageous for this project.

Assessment of remediation strategy efficacy for Port Pirie lead-contaminated soil

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FIELDS of STUDY

Environmental Science, Exposure Assessment, Human Health Risk Assessment, Remediation

RESEARCH PROJECT

Port Pirie is one of several environments in Australia which has been impacted through lead mining/smelting activities. Elevated concentrations of lead have been detected in the peri-urban environment in addition to elevated blood Pb levels in Port Pirie's children. Lead exposure is a significant global concern due to its negative impact on neurological and cognitive development in children. As a consequence, risk management/remediation strategies are required in order to minimize the impact of lead exposure on childhood health. This project aims to assess the efficacy of remediation strategies for reducing exposure to lead-contaminated soil and dust. Research will focus on immobilisation strategies that can promote the formation of lead species (e.g. pyromorphites and tertiary lead phosphates), which exhibit low solubility in the acidic conditions of the stomach, thereby limiting availability for absorption in the small intestines. In vitro techniques will be utilized to assess treatment efficacy. Data will be used as input parameters into the Integrated Exposure Uptake Biokinetic Model (IEUBK) to determine the potential impact of immobilization strategies on reductions in childhood blood lead levels.

Assessment of biological and chemical treatment technologies for the remediation of persistent organic pollutants in contaminated soils

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FIELD/S of STUDY

Environmental Science, Environmental Microbiology, Chemistry, Soil Science

RESEARCH PROJECT

Over the past 150 years, urban development and industrial activities have generated large quantities of hazardous wastes containing persistent organic pollutants (POPs) that have resulted in environmental contamination issues. POPs are chemical substances that persist in the environment, bioaccumulate through the food chain and pose a risk of causing adverse effects to human health and the environment. POPs have been linked to adverse health effects including cancer, damage to the nervous system, reproductive disorders and disruption of the immune system. Concern regarding the presence of POPs in the environment lead to the adoption of an international treaty in 2001 (the Stockholm Convention on POPs) aimed at restricting and ultimately eliminating the release of POPs to the environment. Remediation of contaminated land has become an increasing priority due to the potential risk to human health from exposure to these contaminants. While a variety of treatment strategies (e.g. bioremediation, chemical oxidation, thermal destruction etc.) have been development for the remediation of POP-contaminated soil in order to minimize human and ecological impacts, their effectiveness may vary depending on physical, chemical, biological and economic factors. The aim of this research project is to assess biological, chemical and combined biological-chemical treatment technologies in order to develop effective POP remediation strategies that are both economical and sustainable.

Assessing potential exposure to rare earth elements in household dust via ingestion and inhalation exposure pathway

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FIELD/S of STUDY

Environmental Science, Chemistry, Soil Science, Exposure Assessment, Human Health Risk Assessment

RESEARCH PROJECT

As the commercial importance and prevalence of rare earth elements (REE; e.g. cerium, lanthanum, neodymium, praseodymium) in consumer products grows, information about REE concentrations in the indoor environment has become increasingly relevant. Household dust acts as a sink for a wide variety of compounds from consumer products, building materials and outdoor sources and is a useful medium for assessing residential exposure. Rare earth elements are transition metals with the most commonly recognised health effects of exposure related to the generation of reactive oxygen species, analogous to well-established redox mechanisms associated with other transition metals. Despite a significant increase in the use of REE in consumer products, limited information is available regarding human exposure to these technology critical elements. This study aims to investigate the prevalence of REE in household dust and potential human exposure via incidental ingestion and inhalation exposure pathways.

Are biodegradable plastic bags an environmental risk?

SUPERVISORS

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FIELDS of STUDY

Environmental Science and Engineering: biodegradation, composting, environmental risk assessment, heavy metals.

RESEARCH PROJECT

Biodegradable plastic bags are becoming increasingly attractive in Australia because of an associated "green" image. However, residual metals present in many biodegradable plastic bags may potentially pose a long-term threat to the environment. This project aims to provide baseline information on the type and potential for environmental harm from existing biodegradable plastic bags currently used in Australia and will assess the toxicological effect on the environment associated with the adoption of biodegradable plastics shopping bags when disposed to landfill or following composting.

RELATED ARTICLES

1. EN 13432 (2000) Requirements for packaging recoverable through composting and biodegradation - Test scheme and evaluation criteria for the final acceptance of packaging; English version of DIN EN 13432 (FOREIGN STANDARD).
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Development of cost-efficient adsorbents for wastewater treatment

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FIELDS of STUDY

Environmental Science and Engineering: adsorbents, azo dyes, biochar, environmental remediation, heavy metal, materials science, nanomaterials and nanotechnology, recycling, surface modification, textile effluent, water treatment.

RESEARCH PROJECT

Worldwide, the excessive consumption of water, compounded with a general deterioration in the quality of both surface and ground waters due to anthropogenic activities, is a major threat to water security and ecosystem health. In particular, industrial pollution of water continues to be of major issue; especially in developing countries where limited water resources are already stretched to breaking point and governments lack the resources to implement full wastewater treatment. Thus in many of these developing countries access to clean drinking water is not always guaranteed due to the high costs associated with water treatment. Thus access to cheap but efficient adsorbents for water purification is essential and consequently there is a need to develop cost effective and efficient adsorbents for a variety of inorganic, metallic and organic pollutants.

This project adopts a multi-faceted approach which considers water contaminant issues on a case-by-case basis and recognizes that there is no wonder adsorbent that would suit every potential contaminant situation. Thus contaminant issues that may potentially be considered include 1) the removal of azo dyes, which are common to the waste streams of textile and tanning industries, 2) the treatment of As contaminated drinking water in Bangladesh, 3) reducing excessive nitrate or phosphate pesticide levels in farm effluents, or more simply, 4) excessive heavy metal efflux from ongoing industrial processes. In all cases the project attempts to develop a tailored cost–effective treatment technology suited to the specific contaminant issue and prevailing environmental conditions.

RELATED ARTICLES

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Distribution and severity of Arsenic in Australian rice

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FIELDS of STUDY

Environmental Science and Engineering: arsenic, environmental risk assessment, food security, speciation, rice

RESEARCH PROJECT

Arsenic (As) is a colourless and odourless poison where long-term sub-lethal exposure is associated with increased human health risk and the development of various cancers. In many South East Asian countries and the USA rice is often found to contain elevated levels of As. In Asia these elevated levels are commonly associated with irrigation of rice with As contaminated groundwater, while in the USA such levels are more commonly associated with the ubiquitous use of As based pesticides. In Australia very little is known about the source or extent of As content of rice. In this project the distribution and severity of As in rice commercially available in Australian markets and/or grown in Australia will be determined and the risk of human health effects quantified.

RELATED ARTICLES

1. Nasreen Islam Khan, Gary Owens, David Bruce and Ravi Naidu (2009) Human Arsenic Exposure and Risk Assessment at the Landscape Level: A Review, *Environmental Geochemistry and Health*, 31 (Suppl. 1), 143-166.
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Distribution and speciation of metals in traditional medicinal plants

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FIELD/S of STUDY

Environmental Science and Engineering: analytical chemistry, biogeochemistry, heavy metals, human health risk assessment, medicinal plants, phytoavailability, plant uptake.

RESEARCH PROJECT

In many countries worldwide, traditional medicine using locally grown plants continues to be a common practice. However, there is a growing concern that this practice can potentially lead to detrimental health effects related to heavy metal toxicity when medicinal plants are consumed which accumulate high levels of heavy metals. The aim of this project is to determine the magnitude and severity of heavy metal contamination in medicinal plants and to understand the soil-to-plant transfer patterns of these heavy metals for a number of common medicinal plants. This study could be applied to medicinal plants from India or traditional Chinese medicines, or indeed any cultural background that has a tradition of medicinal plant use.

Figure 1. Two masters students examinine the growth of *Perilla frutescens*, a member of the mint family, which is widely cropped and used throughout South East Asia in both cooking and as a traditional medicinal herb. Of potential concern is that the exact same plant species is also identified as an efficient hyperaccumulator of the toxic heavy metal Cadmium (Cd). Thus there is concern that Perilla cropped on contaminated soils may accumulate metals in its edible parts and thus pose a potential threat to human health.

RELATED ARTICLES

1. Preeti Tripathi, Sanjay Dwivedi, Aradhana Mishra, Amit Kumar, Richa Dave, Sudhakar Srivastava, Mridul Kumar Shukla, Pankaj Kumar Srivastava, Debasis Chakrabarty, Prabodh Kumar Trivedi, Rudra Deo Tripathi (2012) Arsenic accumulation in native plants of West Bengal, India: prospects for phytoremediation but concerns with the use of medicinal plants, Environ Monit Assess, 184, 2617–2631.
2. P. Dzomba, T. Chayamiti and E. Togarepi (2012) Heavy Metal Content of Selected Raw Medicinal Plant Materials: Implication for Patient Health, Bulletin of Environment, Pharmacology and Life Sciences, 1(10), 28-33.
3. Mohammad Rahimi, Reza Farhadi and Mojib Salehi balashahri (2012) Effects of heavy metals on the medicinal plant, International Journal of Agronomy and Plant Production, 3(4), 154-158.

Materials Science

Frequency Selective Surfaces

SUPERVISORS

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FIELDS of STUDY

Materials Science, Automotive, Coatings

RESEARCH PROJECT

The student will be conducting exploratory work, in collaboration with SMR automotive, on the development of new decorative coatings that are transparent to radar waves for application in the automotive industry. These coatings are also known as "Electromagnetic Transparent Coatings" or EMTCs.

During this project, the student will first identify, through reading and basic modelling, various materials exhibiting the desired optical (high reflectivity) and electrical (low conductivity) properties. Second, he/she will prepare thin films and/or alloyed films of the selected materials using physical vapour deposition chambers, such as magnetron sputtering and e-beam evaporation. He/she will characterize their optical appearance (spectrophotometer, UV-vis) and electric conductivity (4 point probe) to assess their suitability for decorative radar transparent applications). Investigations around the deposition process (physical vapour deposition, such as magnetron sputtering) will involve the learning of the critical deposition parameters (such as pressure, power, deposition rate, dopant content) to enhance the performances or effects of the coatings. A final step will consist in incorporating the radar transparent layer into a robust "stack" and test its durability when submitted to harsh environments (UV, corrosion, abrasion resistance tests).

Hard Wear-Resistant Coatings

SUPERVISORS

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FIELDS of STUDY

Materials Science, Coatings

RESEARCH PROJECT

The cost of abrasion wear has been estimated as ranging from 1 to 4% of the gross national product of an industrialised nation. Wear associated productivity loss in the mining and agricultural industry's is a major cost for operators, wear is accelerated when in harsh environments (corrosive). This can occur in almost every aspect of the operations, anywhere where metal has to contact and work against ground (wet soil and rock). Research into methods to reduce wear and extend the life of components is crucial for the ongoing competitiveness of Australia's industry.

Specifically, this project is interested in assessing coating strategies to minimise wear. Two techniques under study are Laser Cladding and Thermal Spray. Thermal or laser cladding is a deposition process in which powdered components are delivered continuously to a substrate with a high density energy input to transform the powder to a continuous coating. Thick coatings and complex 3D shapes can be coated, even the internal diameter of cylinders can be clad. The powder composition is variable and consists of a hard phase in a binder phase. These coatings are produced by our industrial partner LaserBond.

Evaluation of these coating for erosion, corrosion, abrasion and impact must be carried out and linked with in-field performance. This information will be used to improve the coating and justify its use to end users, such as Boart longyear (mining) or the Sugar Research Assoc. (agriculture).

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