Federation University | Centre for eResearch and Digital Innovation

CeRDI Annual Report 2021

Acknowledgement of Country

Federation University Australia acknowledges the Custodians of the lands and waters where our campuses are located and recognises their continuing responsibilities to care for country at these sites of teaching and learning. We pay our respects to Elders past and present and extend our respects to all Aboriginal and Torres Strait Islander First Nations peoples.

The Aboriginal Traditional Custodians of the lands and waters where our campuses, centres and field stations are located include:

BALLARAT | Wadawurrung

BERWICK | Boonwurrung

BRISBANE | Turrbal and Jagera

EUSTON STATION | Tatti Tatti

GIPPSLAND | Gunai Kurnai

NANYA STATION | Mutthi Mutthi and Barkindji

WIMMERA | Wotjobaluk, Jaadwa, Jadawadjali, Wergaia, Jupagulk

For further details about CeRDI's diverse portfolio of research please visit our website: **www.cerdi.edu.au**

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Foreword

Professor Chris Hutchison, Deputy Vice-Chancellor (Research and Innovation)

The global COVID-19 pandemic has presented many challenges. Daily life and work activities have been disrupted. Resilience, agility and creativity have provided a strong foundation from which to respond to the pervasive impacts of the pandemic and to pivot towards successful outcomes.

It is these qualities, upheld by the staff within the Centre for eResearch and Digital Innovation that has guided its successes over the last 18-months. Under strong and committed leadership, the Centre and its staff have advanced high-quality research while embracing new opportunities that are making a real-world difference at the individual, community, industry and national levels.

The Centre has a long history and a strong commitment to partnership. This has seen it establish trusted collaborations with research partners, industry groups and funding bodies. These partnerships represent enduring collaborations that have extended over many years and across multiple projects. The strength of these partnerships has enabled the Centre to thrive, particularly during times of challenge.

CeRDI's 'can do' attitude, its multidisciplinary research team of researchers and technology experts, and its commitment to sourcing new technology solutions and implementing eResearch, ensures that the outputs generated are practical, of value to users, and generate new insights that are valued by industry and academia. This has been integral to the work of CeRDI this year and is exemplified in the projects featured in this annual report. They reflect the growth and maturity of CeRDI in which it is fulfilling the strategic interests and research goals of Federation University.

Introduction

Associate Professor Helen Thompson, CeRDI Director

The Centre's annual report provides an opportunity to showcase and celebrate the many achievements of CeRDI. This year's report is no different, although the research and activities presented in this report hold greater significance for their achievement, given the challenges that we have all endured with the COVID-19 pandemic over the past two years.

This report demonstrates the growing reputation of CeRDI as a thriving research centre. This is exemplified by the breadth and depth of multi-disciplinary research comprising research and technology staff working collaboratively on projects across broad themes including agriculture, the natural environment, agriculture, health and wellbeing, hazards planning and resilience, heritage and culture, and regional development.

This year we've been particularly proud to foster collaboration with researchers in other Centres and Schools across the University. These partnerships, some of which are new and others have been long-established, are furthering the important connections we have throughout the broader University community.

We have continued to develop strong and enduring partnerships with industry by developing applications and conducting research to transform practice. This is evident across projects large and small, where our commitment to developing strong connections with project funders and partners ensures collective agreement and leading to valued project outcomes.

The success of our flagship projects has contributed to the steady flow of research income and funding successes to extend existing research projects and to launch new research projects. Our research growth from external research income, including Category 1 research income, is representative of these achievements.

Our research outputs are many and varied. While the development of journal publications by CeRDI staff has been strong, we've also seen a surge in outputs that are being showcased in non-traditional ways. Videos, documentaries and publications in research-based news sites represent a new approach and broader focus to the way the Centre is sharing information about research and extending its reach to a new audience.

A strong HDR cohort with candidates at different stages of their research journey are integral to our thriving research Centre. New PhD scholarships will ensure a new cohort of HDR candidates commence their research with CeRDI. Recent CeRDI alumni are providing an enduring legacy for current and prospective PhD candidates.

As we look forward to 2022 we anticipate expanding the research achievements we have built in this and previous years. We will continue to embrace new research opportunities while striving to meet and develop the expectations of our broader community including the University, our project partners and funders, and the communities and industries that our work in the Centre supports and benefits.

About CeRDI

Overview

The Centre for eResearch and Digital Innovation (CeRDI) at Federation University Australia is located within the Office of the Deputy Vice-Chancellor (Research and Innovation) and based at the Ballarat Technology Park, Mt Helen.

CeRDI focuses on multidisciplinary research and the application of eResearch and advanced technology systems to enable digital transformations and practice change, together with enhancements in effectiveness and productivity in industry, government and academia.

CeRDI's multidisciplinary research capabilities distinguish it from traditional research centres. This ensures that the research undertaken has impact across a broad discipline base and in each of the six research themes.

CeRDI has a long-established reputation for achieving successful outcomes and is committed to building capacity and engagement with its collaborators. This ensures the application and uptake of the technologies and research for the benefit of our partners, industry and the broader community.

The work of CeRDI has made significant advances in expanding engagement in spatial information systems, visualisation, knowledge management and data interoperability. CeRDI responds to, and anticipates, new technology directions and opportunities based on insights from research and partner engagement. These innovations generate beneficial outcomes and attract sustained research investment.

CeRDI's research approach is characterised by the following attributes:

- **Partner engagement** – listening skills and the ability to translate information from partners into research projects with outcomes that stakeholder's value. CeRDI has a reputation for consistency, reliability, timeliness, credibility and excellence.
- **Fostering long-term partnerships** – sustained beyond the period of initial grant funding (many partnerships have continued for more than 10 years) and undertaking practical and applied research that deliver on outcomes.
- **A multidisciplinary team** – comprised of researchers with specific discipline expertise, technical and support staff and HDR candidates drawn from within the research centre and elsewhere in Federation University. These are essential foundations for innovation, knowledge and technology transfer.
- **A diverse portfolio** – stretching across a range of disciplines, with a multiplicity of organisations contributing to overall financial sustainability.
- **Prioritising a high level of co-creation** – through close linkages and engagement with staff from partner organisations including researchers, government, industry and community. Catalyses knowledge mobilisation and ensures beneficial outcomes for partner organisations.
- **Continuous innovation** – data federation, knowledge management, web publishing, spatial mapping, data visualisation and decision support systems.
- **A leader in eResearch and digital innovation** – adding value to Federation University's areas of research strength.

CeRDI Team

CeRDI employs 31 staff with 21 staff in the research team, nine in the technical team and one administrator. CeRDI has six HDR (PhD) candidates.

eResearch

eResearch is the application of information technologies to support existing and new forms of research. At CeRDI, eResearch is characterised by the following features:

- **Applied** – research focused on developing solutions that meet specific real-world priorities for our research investors, stakeholders and communities.
- **Impactful** – research that creates novel and disruptive technologies that enhance industry, sector, and community practices; improve digital literacy among researchers and industry practitioners; and influences social change through implementing data and information democracies.
- **Multidisciplinary and cross-disciplinary** – contributes to a range of Field of Research (FoR) codes (information and computing sciences; physical geography and environmental geoscience; earth sciences; human movement and sport science and historical studies). Collaborates with researchers in Schools across Federation University.
- **Collegiate, collaborative and inclusive** – engages in collaborative design that results in co-developed solutions. Leads and participates in a range of research projects at the international, national and regional scale.

Research themes and activities

At CeRDI, eResearch and digital innovation has focussed on the development of interoperable spatial knowledge systems that meet the needs of our research investors across a range of diverse disciplines.

Most of these systems are collaboratively designed and developed to federate qualitative and quantitative data from disparate sources, both in the public and private sectors. The data federations are almost always provisioned as customised web-based portals that are used for data discovery, dynamic modelling and visualisation, decision support, and knowledge dissemination.

The demand for these bespoke knowledge systems has driven significant and growing investment in our research that has clustered around six core themes:

- **Natural Environment**, including land, water and biosphere, with research investment in catchment management, citizen science, community-based monitoring, protection and conservation of threatened species, implementing environmental sensor technologies, environmental modelling and decision support systems, and monitoring, evaluation, reporting and improvement (MERI).
- **Agriculture**, mostly focused on broad-acre farming, with research investment in precision agriculture, food agility, soil performance and health, on-farm data aggregation and visualisation (public-private data federations), farm decision support systems, on-farm sensors and Internet of Things (IoT) technologies, remote and proximal sensing technologies, cropping trials, grains trials research, and real-time soil moisture sensing and interpolation.
- **Hazard Planning and Resilience**, including emergency management planning and disaster recovery, with research investment in emergency services, community-based emergency management, fire, flood, landslides, coastal inundation and erosion, community engagement tools, community monitoring tools, strategic planning for emergencies and natural disasters, and planning and preparedness for climate change.
- **Health and Wellbeing**, including social justice and regional health challenges, with investment in spatial mapping of sports and recreational activities and services, diagnostic tools to assist with dementia referrals, collaboration and evaluation on health justice partnerships, interventions for youth alcohol consumption, family and domestic violence, and sport and leisure injury epidemiology.
- **Heritage and Culture**, including Historic Urban Landscapes (HUL) and Aboriginal land management, with investment in urban planning, social perceptions, landscape amenity, tourism, tools to support indigenous cultural assets management and mapping indigenous heroism, and digitising local history associated with World War One and World War Two.
- **Regional Development**, mainly focused on supporting regional communities in strategic planning, with investment in digital strategies and improving digital literacy, fostering smart cities, business accelerators, portals to support strategic and statutory planning in municipalities, and information portals to support regional communities.

CeRDI Technological Approach

CeRDI's Capability: Interoperability

The majority of CeRDI's eResearch is invested in the development of spatial data portals.

These portals address the increasing problems associated with the sheer range of information sources and volume of data that is now available (i.e., in the era of big data). In Australia, for example, information and data on agricultural soils is distributed via dozens of web-portals, web-based geographic information system (GIS) tools, password-protected portals, cloud storage, portable storage devices, hardcopy maps, theses, reports, newsletters, documents, videos and podcasts. Outside of the research community, however, this vast source of data is largely ignored, as few people have the time or the skills to consolidate available data.

To address these concerns, spatial data infrastructure (SDI) has been developed and deployed to federate data from disparate database sources into a single web portal, thereby making data more discoverable. Globally, the systems developed by Natural Resource Canada provided the initial exemplars that were developed using open geospatial standards and technologies. Other examples include the European Commission's INSPIRE network, the New Zealand SMART system, and those developed by the United States Geological Survey, the French Bureau de Recherche Géologiques et Minières (BRGM), Australia's CSIRO, and the Australian Bureau of Meteorology (BOM).

CeRDI actively collaborates with these leading organisations by sharing open-source technologies and developing open standards. Seamless international information exchange of complex domain data, such as groundwater or soil data, relies on agreed formats, communication protocols and schemas for serving, querying and consuming data, along with agreed content (known as semantic interoperability).

CeRDI's Capability: Systems Architecture

The spatial data infrastructure (SDI) deployed by CeRDI was initially developed by CSIRO, and is known as the Spatial Information Services Stack (SISS).

At the core of the SISS is the open source spatial data engines Mapserver (www.mapserver.org) and Geoserver (geoserver.org), which are used for the geospatial processing and service delivery using Open Geospatial Consortium (www.opengeospatial.org) standards. Vector data are commonly stored within a MySQL or PostGIS database, and raster data are dynamically processed from their native format. To deliver complex web feature services (WFS), the Geoserver app-schema extension has been deployed. Geonetwork (geonetwork-opensource.org) is used as the public-facing metadata catalogue for the portals.

The general systems architecture and data flow from custodians to end users is illustrated in Figure 1.

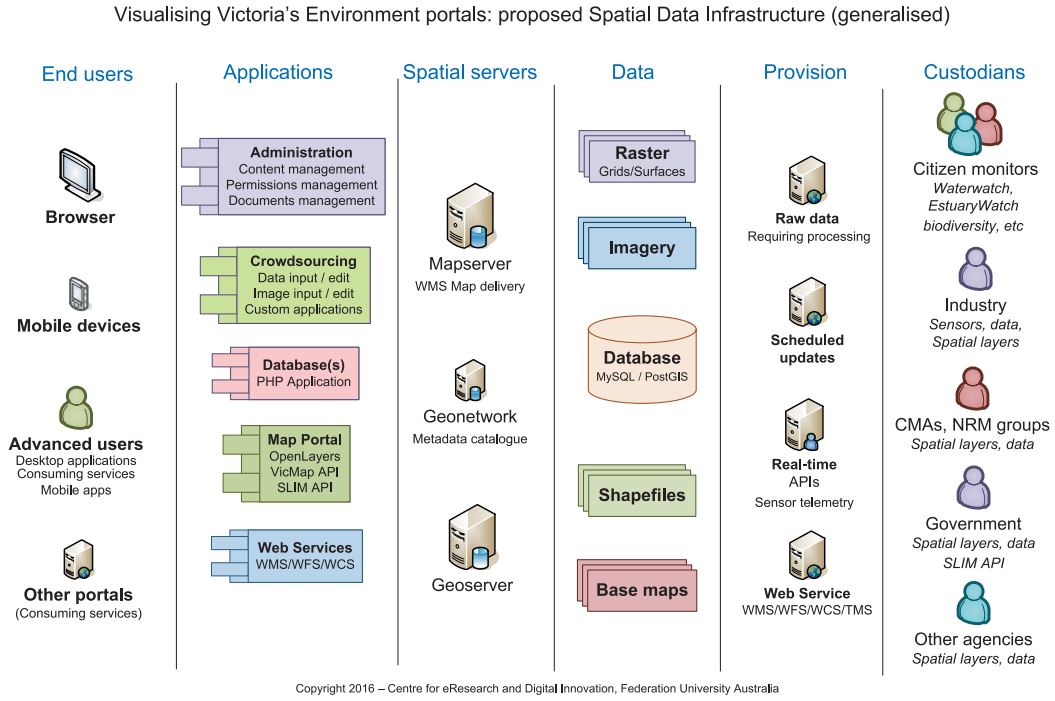


FIGURE 1. CERDI'S GENERAL SYSTEMS ARCHITECTURE AND DATA FLOW FROM CUSTODIANS TO END USERS (SOURCE: DAHLHAUS AND THOMPSON, 2016).

Key components of the system include:

- The data resides with the data managers (ensuring currency and validity).
- They are intuitive to use (similar to Google Maps).
- All forms of data are included (vector, raster, text and multimedia).
- Data downloads are allowed (subject to data custodian's consent).
- Spatial data links to original source (documents and images).
- Spatial data links to real time data (data loggers, webcams).
- They are capable of analysing the interoperable data on the fly.
- Interactive 3D visualisations can be created for user-selected scenes.
- Users can add, edit or update data (subject to quality assurance and quality control).
- The spatial data and models are credible to the user.

The key principles underlying all technical innovation and development at CeRDI include:

- ensuring end-user tools and applications are fast, intuitive and easy-to-use,
- making sure that applications work seamlessly across a variety of platforms, operating systems and browsers to the extent possible,
- use of open-source and standards compliant software and technologies, wherever possible,
- building upon existing collaborative software initiatives and contributing enhancements/ tools back to the community,
- ensuring the flexibility of the developed system to consume data from a variety of sources so as not to interfere with existing provider work practices, and
- use of software based in the cloud: no end-user requirement for software, updates, computation power or plug-ins.

The CeRDI technical team applies best practices for web development to ensure systems are responsive and accessible to the needs of users. Members of the CeRDI technical team have relevant qualifications and capabilities as well as extensive training and industry experience to ensure optimal project outputs. This enables delivery of scalable and customised applications to meet the unique requirements of various project partners.

CeRDI adopts an agile path for software and spatial knowledge systems development. Rapid prototypes of products are developed in conjunction with project partners, stakeholders and researchers to ensure that technical requirements are met at each stage of development.

CeRDI
Research Projects

AGRICULTURE

Cooperative Research Centre for High Performance Soils Projects

In 2021, CeRDI commenced leadership of three soil research projects funded by the Cooperative Research Centre for High Performance Soils (Soil CRC).

Soil CRC is a national centre that facilitates solutions for Australia's underperforming soils by bringing together scientists, industry representatives and farmers. The projects aim to assist Australian farmers to better manage their soil for more profitable and productive farming.

One million dollars was awarded to extend 'Visualising Australasia's Soils' (VAS). VAS is a successful, cloud-based federation of research data relating to soils (see below: Visualising Australia's Soils). Funding will expand VAS as an independent and enduring soil research data federation that is self-sustaining and meeting the needs of end users and providing value for research and education. The project is led by CeRDI Associate Professor Peter Dahlhaus.

The Soil CRC also awarded funding for a further two projects both of which are led by CeRDI Senior Research Fellow Dr Nathan Robinson. Matching soil performance indicators to farming systems involves conducting research with growers to explore and understand their information needs in relation to soil properties, soil health and soil performance. A coordinated and consistent approach to managing and enable soil data is a collaborative and comprehensive project focused on data management for secure, reliable storage, sharing, analysis and visualisation for soil-related data.

An additional $300,000 was also awarded to a two-year project: Knowledge-sharing for good soil stewardship. This project is led by Dr Hanabeth Luke and researchers at Southern Cross University researchers, and supported by CeRDI researchers Associate Professor Peter Dahlhaus, Associate Professor Helen Thompson, and Dr Alison Ollerenshaw. CeRDI will contribute to the online analytics to assess the use and impact of digital and online tools identified by researchers and grower groups and to enable and facilitate data sharing for the industry.

In commenting on these projects and the contribution they will make for the industry, Associate Professor Dahlhaus said: "This work is so important because soil data is currently kept in a million different places – it could be anywhere from a government website to old soil tests sitting in a shoebox. A lot of this data collected through satellite imagery, sensors on tractors and soil moisture probes in paddocks – the big challenge is getting it all together, which is our area of expertise."

CeRDI Director Associate Professor Helen Thompson was delighted with the latest funding news and for the opportunity to further expand CeRDI research and expertise in soils data by using technology to facilitate this: "This means we can deliver these kinds of projects that require bringing together huge volumes of data and which can have a significant impact on the profitability of Australia's farming industry. Because we have been working in this data space for a long time, we have the trust of everyone from farming groups to governments and other universities".

AGRICULTURE

Visualising Australasia's Soils

During 2021, CeRDI finalised the key milestones associated with Visualising Australasia's Soils (VAS) Stage 1.

The project involved the development of a cloud-based research data federation, commenced in late 2018 following the awarding of funding from the Co-operative Research Centre for High Performance Soils (Soil CRC). Project investment of $1.1M was awarded.

Project lead, Associate Professor Peter Dahlhaus and the CeRDI team have conducted extensive foundational work with 16 industry partners around data governance, to both understand, and demonstrate, the value of data sharing and data access and usage. Subsequently, stakeholder insights have been used to inform the development of the VAS web portal, which provides access to shared public and private soils research data and comprises broad functionality and features, including sophisticated spatial mapping.

The web portal represents a significant output associated with the VAS project, in which custodians retain data ownership and control how and what data is shared. The development of a governance and stewardship model for data custodians, which extends the earlier work linked to the Agricultural Research Federation (AgReFed), establishes the guidelines under which data can be shared and accessed.

The deliverables for this project highlight the range and breadth of work accomplished with many important milestones having been successfully achieved and substantial outputs for the project having been reported and documented, including:

1. Data Governance and Stewardship Guidelines. These have been reported as a discussion paper and are available to VAS project members and the Soil CRC website.
2. VAS data portal with spatial mapping: https://data.soilcrc.com.au
3. The completion of a social engagement report, Visualising Australia's Soils: Social Engagement & Collaboration Learnings prepared by CeRDI Research Fellow Dr Amie Sexton. The document is publicly available on the Soil CRC website.
4. A systems architecture report for VAS, containing the technology vocabularies.
5. A soils data inventory and summary. This comprises methods and scripts and assessment of VAS within the context of the FAIR (findable, accessible, interoperable, reusable) principles for data.
6. Data Federations in Agriculture, a short documentary film about interoperable data federation using VAS as a case study.

A final report on the project was completed in 2021. Preparations has since been made to share the insights from the project to industry and academic audiences.

During 2021, the Soil CRC has awarded funding to expand VAS into a second phase. This second staged expansion of VAS will enable the potential for VAS and data sharing to be fully realised.

PROJECT PARTNERS

Cooperative Research Centre for High Performance Soils
Birchip Cropping Group
Burdekin Productivity Services
Central West Farming Systems Inc.
Gillamii Centre
Herbert Cane Productivity Services Ltd
Holbrook Landcare Network
Liebe Group
North Central Catchment Management Authority
Nutrien (formerly Landmark)
Riverine Plains Inc.
Southern Farming Systems
University of Southern Queensland
University of Tasmania
Western Australia No Till Farmers Association
West Midlands Group
Wimmera Catchment Management Authority

Website:
https://data.soilcrc.com.au/map

AGRICULTURE

Online Farm Trials

Online Farm Trials (OFT) is a long-term, collaborative project involving CeRDI and the Grains Research and Development Corporation (GRDC).

OFT commenced in 2015 and involves the digital transformation of research data and information from Australia's grains industry. It offers advanced spatial mapping and filtering systems for accessing current and historical data. The farm trials data available on the portal have been supplied by stakeholders, including grower and farming systems groups, government researchers, universities and private industry across Australia. Currently there are over 15,000 trials available on the site. This provides access to a public repository of varied trials and data from multiple sources which can then be used to assist with on-farm decision-making.

The website is continually evolving, and new data are regularly uploaded to ensure increased breadth and currency of available data and information. An expert advisory group provides governance to OFT with the research and technology developments undertaken by CeRDI under the leadership of Senior Research Fellow Dr Nathan Robinson.

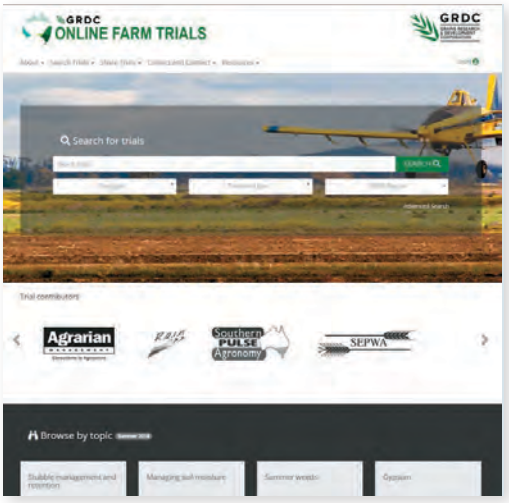
Recent OFT initiatives include the preparation of a podcast which was coordinated by GRDC and hosted by Hilary Sims. The podcast features GRDC's Dr John Rivers together CeRDI's Dr Nathan Robinson and Northern Grower Alliance representative Denielle Smith. The podcast provides an overview of OFT, describing its features, and the ease by which trial data can be accessed by growers and researchers alike. It describes the benefits of being an active data contributor to the portal.

In other OFT news, Dr Benedikt Fest was appointed as the CeRDI-OFT research coordinator. Ben oversees the management and provision of research activities for this and other CeRDI projects.

A third wave of impact research for OFT was conducted during 2021. Survey and interview data were collected to assess the impact of technology in supporting decision making and practice change. The research has been undertaken with OFT on two previous occasions to provide and extend the insights about how web portals, such as OFT, are being applied and used.

PROJECT PARTNERS

Grains Research and Development Corporation
Ag Excellence Alliance (South Australia)
Birchip Cropping Group
Grower Group Alliance
International Plant Nutrition Institute
Liebe Group
Nicon Rural Services
Northern Grower Alliance
Southern Farming Systems
Victorian Grower Group Alliance



Website: https://farmtrials.com.au

AGRICULTURE

Agriculture Research Federation

Federation University Australia and the Australian Research Data Commons (ARDC) commenced a new project to accelerate research innovation and enhance the Agricultural Research Federation (AgReFed) platform.

The AgReFed platform supports collaboration and innovative insights in agricultural research, development and policy by improving the discoverability of trusted, reusable and analysis-ready agricultural research data across Australia.

This is one of 16 new collaborative projects in the ARDC Platforms program which is aiming to facilitate and encourage radical changes in the way research is conducted, and dramatically increase the speed of research.

CeRDI is leading the new project to increase the platform's ability to adapt to the way agricultural researchers collect, describe, and disseminate their research findings. The project will address some of the current challenges facing agricultural researchers who perform data management and analysis on desktop computers. Many have limited access to platforms, workflows and analysis tools designed for agricultural research.

The changes envisioned for the project will allow researchers to better access trusted, reusable agricultural data. This will facilitate data reuse and cross-discipline collaborations for novel research insights and practical applications in policy, reporting and on-ground decision making.

CeRDI Director and AgReFed Council Chair, Associate Professor Helen Thompson, commented that the project and associated funding will enable AgReFed to accelerate its activities towards providing access to agricultural research data from across Australia. Helen also noted the important collaborations for the project stating "We are delighted that Federation University, Queensland Cyber Infrastructure Foundation (EcoCommons), Sydney Informatics Hubs (University of Sydney) and international partners will collaborate on the AgReFed platform technologies".

The project will be completed in 2023.

PROJECT PARTNERS

National Research Infrastructure Strategy
Australian Research Data Commons
The University of Sydney
Queensland Cyber Infrastructure Foundation
Grains Research and Development Corporation
Atlas of Living Australia
Australian Plant Phenomics Facility
CSIRO
Geoscience Australia
NSW Department of Primary Industries
TERN, The University of Queensland
The University of Adelaide
The University of Western Australia
University of New England
University of Southern Queensland
Western Australia Department of Primary Industries and Regional Development
Earlham Institute
EcoCommons, Griffith University
Food and Agriculture Organization of the United Nations
Griffith University
Macquarie University

Website: www.agrefed.org.au

AGRICULTURE

Kangaroo Grass, as a Crop and to Heal Country

The Dja Dja Wurrung Clans Aboriginal Corporation, trading as DJAARA, is successfully leading the agricultural project, Djandak Dja Kunditja (Country Healing its Home), to research and develop methods to grow the highly regarded Kangaroo grass (*Themeda triandra*) as a modern perennial broadacre cropping system.

DJAARA's business enterprise arm, Djandak, provides a vision for a sustainable future through its leadership of the project. The project will enable the establishment and revival of growing seed for landscape regeneration and as a modernised food crop from its traditional origins over thousands of years.

"The Djandak Dja Kunditja project will grow a large-scale agricultural crop, a crop that is a perineal and suitable to grow across Dja Dja Wurrung Country, especially in our drying climate. The project will enable Dja Dja Wurrung People to combine their Cultural Knowledge with modern agricultural technology to build an exciting Traditional Owner led and owned agricultural business" comments Djandak operations manager, Trent Gibson.

Djandak formed the project consortium with collaborations across research with La Trobe University (Bundoora), Federation University, Department of Environment Land Water and Planning, Agriculture Victoria, Regional Development Victoria, Goulbourn Murray Water, and the North Central Catchment Management Authority.

Substantial data collection will occur alongside the research experimentation and testing of kangaroo grass seed production by La Trobe University. Accurate and timely data capture is a key deliverable of the project to inform best practice, innovation, communication, and outreach.

CeRDI Research Associate Dr Megan Wong will manage CeRDI's involvement in the project. CeRDI will work closely with the Djandak appointed PhD candidate and agronomy and ecology researchers at La Trobe University to provide guidance and assistance around data technology solutions. The solutions will support trusted data storage and appropriate, fit-for-purpose, data access and reuse that supports Dja Dja Wurrung's aspirations in the agricultural sector.

How the technology solutions align with best practice data management principles (FAIR and CARE) will be investigated. The FAIR principles support the approach for making data more finable, accessible (as appropriate), interoperable (able to be transferred from machine to machine easily) and reusable. The CARE principles for Indigenous Data Governance were developed to complement the existing FAIR principles to encourage the open and other data movements to consider people and purpose in their advocacy and pursuits (Russo Carrol et al., 2018). The Nagoya protocol guidelines will be used to ensure the Intellectual Property developed remains with the project leader.

Djandak Operations Manager Trent Gibson is responsible for this Smartfarms project with Djandak, backed by the Federal Department of Agriculture, Water and Environment. It will receive $1.8 million to support the establishment, research, demonstration, and agronomy package for perennial broad acre cropping systems based on native Kangaroo grass.

This is a three-year project due for completion mid-2023.

PROJECT PARTNERS

Dja Dja Wurrung Clans Aboriginal Corporation

La Trobe University (Bundoora)

The Department of Energy, Environment and Climate Action

Agriculture Victoria

Regional Development Victoria

Goulbourn Murray Water

North Central Catchment Management Authority

Website:
www.cerdi.edu.au/KangarooGrass

REFERENCE

Russo Carrol, S., Hudson, M., Chapman, J., Figueroa-Rodríguez, O.L., Holbrook, J., Lovett, R., Materechera, S., Parsons, M., Raseroka, K., Rodriguez-Lonebear, D., Rowe, R., Sara, R., Walker, J., 2018. CARE Principles for Indigenous Data Governance, in: Indigenous Data Sovereignty Principles for the Governance of Indigenous Data Workshop. Gaborone, Botswana.

AGRICULTURE

Decision Wizard

The *Decision Wizard* is a new Food Agility Cooperative Research Centre project that will culminate in the development of a pilot web application to guide farmers to make informed decisions about their farm business operations.

The project is a collaborative partnership between CeRDI, Nicon Rural, Marcus Oldham College and Southern Farming Systems and is the first project associated with Food Agility's Better Data for Better Decisions research constellation program which is being led by Federation University.

The *Decision Wizard* project will become the vehicle that will inform, develop, and launch a desktop-based tool to support farmers' decision making. The decision-making component of the tool will initially comprise a set of five real-life decision scenarios, applicable to farmers in Victoria.

A decision matrix framework, informed by current data and proven decision sciences, will be developed to inform these critical on-farm decisions. The data collected using the matrix will guide, track and map the decision-making processes of farmers.

It is anticipated that the *Decision Wizard* will also be used for broader decision analysis and decision making. For the agriculture industry, and farmers, the project offers the opportunity to assist them with making optimal farming decisions. The tool will provide users with preferred options based upon a series of user-specified questions and answers, helping improve complex decision making by leveraging data to augment on-farm experience and knowledge.

The insights gained from this foundational project has the potential to support future programs by building on current knowledge around decision making which could be applied to machine learning applications within the context of farming productivity.

CeRDI's partnership with the project is being led by Senior Research Fellow Dr Birgita Hansen, as the *Better Data for Better Decisions* Constellation Leader with Food Agility.

Website:
foodagility.com/research/decision-wizard

PROJECT PARTNERS

Food Agility Cooperative Research Centre
Marcus Oldham College
Southern Farming Systems
Nicon Rural Services

Soil Carbon Data Report

AGRICULTURE

A research report documenting the outcomes of a review and analysis of existing soil carbon data for Australia was completed by CeRDI.

Commissioned by the Australian Government Department of Industry, Science, Energy and Resources (DISER) the research entailed an exploration of the quantity, quality, spatial extent, availability and suitability of existing soil carbon data. An assessment of the reusability of data for modelling to support the Emissions Reduction Fund (ERF) was also undertaken.

The availability of soil carbon data is largely unknown, constrained by data holders in the private sector, and by research organisations and agencies where public data sharing is limited or non-existent. In this project, the CeRDI team led by Associate Professor Pete Dahlhaus with Web developer/programmer Dr Chris Bahlo and Manager Technical Projects Andrew MacLeod, sought to overcome these limitations by analysing a representative collection of available datasets using a recognised approach to ensure relevance and rigour could be achieved.

Through this research, 22 open data catalogues were identified, generating over 1,600 datasets many of which comprised different file formats and presentations. The catalogues were principally sourced from state government departments and agencies. The research team subsequently interrogated 14 datasets using tools developed by CSIRO and TERN Ecosystem infrastructure. The researchers also accessed nearly 800,000 soil observations from 17 datasets in the private sector, 89% of which were from one agribusiness and the others from farmer groups, catchment management authorities, Landcare groups, and academia. A representative overview of the data was captured through this approach, providing insights that support an overall understanding about the collection and reporting of soil carbon data in Australia.

The research reveals that soil data are useful for carbon modelling across landscape and as a space-time digital soil map. This is further strengthened where observations are closely located. The research highlights the disparate sources of available soil carbon data and the multiple methods for data capture which has been collected by multiple organisations and agencies. It was thus proposed that the introduction of a federated model for soil carbon data collection may assist to reduce these limitations, enabling the collection of rich, longer-term data for broader access and use.

The findings of this report will inform the DISER soil carbon collection program.

PROJECT PARTNERS

Australian Government – Department of Industry, Science, Energy and Resources

AGRICULTURE

Southern Farming Systems National Landcare Program

Southern Farming Systems (SFS) received funding from the Australian Government's National Landcare Program for the project Building the resilience and profitability of cropping and grazing farmers in the high rainfall zone of Southern Australia.

Commencing in 2018, this four-year project will increase the ability for farmers and agronomists to make better on-farm management decisions.

One of the key activities associated with the project is building resilient farm businesses and strengthening farm decisions. This involves combining the highly successful decision matrix process developed by Cam Nicholson, Nicon Rural Services, for the Decision Wizard tool with four key pieces of vital real-time information: soil water, pasture availability, commodity prices and climate data.

CeRDI has been working with SFS and partners on the design and development of the data and decision support platform. The new web-based dashboard compiles and summarises key climate, pasture, soil moisture and commodity price information. Connection to the required data services has been established with prototype web interfaces to support the four key decision components undergoing development, testing and refinement.

The interactive and customisable dashboard will provide on-demand access to information automatically summarised for a farm location. This includes:

- **Climate observation and forecast information:** Connected to CSIRO's Seasonal Forecast API and SILO climate data, it provides weather observations and seasonal forecasts for 300 locations within the project area.
- **Pasture biomas:** High-resolution satellite derived pasture biomass estimates for farms and individual paddocks at high frequency intervals.
- **Soil moisture:** A soil moisture and weather station web interface automatically summarises daily and historical plant available water levels and weather observation values.
- **Commodity Price Data:** Automated commodity price data updated through data services such as the Meat and Livestock Association's statistics database API.

For further information about the project visit:
www.cerdi.edu.au/NLPSmartFarming

PROJECT PARTNERS

Australian Government – National Landcare Program

Southern Farming Systems

McKillop Farm Management Group Inc

Agriculture Kangaroo Island

Department of Jobs, Precincts and Regions, Victorian Government

Agriculture Victoria

Precision Agriculture

Glenelg Hopkins Catchment Management Authority

Victorian Lime Producers Association

Australian Fertiliser Services Association

Data Federations in Agriculture

AGRICULTURE

In 2021, CeRDI commissioned a new documentary video: *Data Federations in Agriculture*. This is the latest in a series of short films produced for CeRDI which explore big data and data federation.

This documentary examines the application of technology for federating research data through the lens of agriculture, an industry of focus for data technology advances by CeRDI.

Data Federations in Agriculture outlines the opportunities available to Australia's agriculture industry by sharing research data and unlocking new production opportunities through data discoveries. CeRDI Associate Professor Peter Dahlhaus, together with Mr Paul Box, Social Architect at CSIRO Land and Water are featured in the documentary, which was directed and produced by Wind and Sky Productions. Peter provides the core commentary, outlining the concept behind data federation and the immense opportunities and challenges for the industry in sharing data. The Visualising Austrasia's Soils project provides the backdrop and project exemplar for exploring and discussing the concept of data federation within the film.

Data Federations in Agriculture highlights the possibilities for research data sharing. Generations of farmers have gathered knowledge on how to grow better crops. Technology can now be used to improve the agricultural know-how and profitability by unlocking the value from digital agriculture and data sharing. It is anticipated that the film will contribute to the current debate and discussion about data sharing and how this can be achieved through the strong collaboration and commitment of data providers.

This short film complements the Data Democracy films commissioned by CeRDI and launched in 2018. These films address the frequently asked questions about data democracy and big data and culminated in the production of an extended documentary about Data Democracy. Wind & Sky Productions have developed the films ensuring continuity and commitment and the production of high-quality documentary films for a varied public audience who may have limited data and industry expertise.

One of the Data Democracy films was featured at an international film festival at Silicon Valley, California in 2021.

PROJECT PARTNERS

Paul Box, CSIRO

Wind & Sky Productions

Website:
www.cerdi.edu.au/videos#featured

View: www.youtube.com/watch?v=hnA4trnXKsw

NATURAL ENVIRONMENT

Mine Rehabilitation Trial Data

The Mine Rehabilitation Trials Online (MRTO) project is a foundational project of the Cooperative Research Centre for Transformations in Mining Economies (CRC TiME), led by CeRDI Associate Professor Peter Dahlhaus and Research Associate Dr Patrick Bonney.

The project commenced in late 2020 and aims to provide access to mine rehabilitation knowledge and data for CRC TiME participants, and the broader mine rehabilitation industry. These systems would typically include data and information on rehabilitation trials and demonstrations, remediation practices, hazard management, landform management, water management, air quality management and stakeholder consultation, among other information.

The success of MRTO was dependent on the development of a social and technical architecture that enabled an accepted and trusted platform for data sharing. In addition, CRC TiME stakeholders and the broader mining industry needed to see value in the project. To address these issues, the project involved a social research component to explore and document use-cases that provide a value proposition for the establishment of a CRC TiME knowledge management system for mine rehabilitation trials. It also involves the development of a pilot data management portal to test the potential to federate data from disparate sources for the two case studies (Pilbara and Latrobe Valley) and work through the potential barriers and benefits with the project participants. Finally, Dr David Lemon, Principal Research Scientist at CSIRO, developed an architectural framework (covering social, information and technical elements) and guidelines for suitable data governance and stewardship.

The social research found that sharing knowledge, learnings and data across the mining sector could have many important benefits for the sector, including for transparency, knowledge discovery, efficiency and improved stakeholder relationships. However, data sharing was found to not be a widespread activity, and several obstacles will need to be overcome for the mining sector to realise the potential of harnessing collective information assets. These include various technical (i.e. data not collected, lack of metadata), motivational (i.e. no incentives), economic (i.e. potential economic damage), political (i.e. lack of trust, enabling guidelines), legal (i.e. ownership and IP issues) and ethical barriers (i.e. lack of reciprocity).

Federation University looks forward to exploring the next phase of MRTO and would like to acknowledge the support of the stakeholder advisory committee, which included industry and government stakeholders from across the country. We thank them for their participation.

PROJECT PARTNERS

Cooperative Research Centre for Transformations in Mining Economies

CSIRO

Fortescue Metals Group Ltd.

Rio Tinto Services Limited

Energy Australia

Rangelands NRM Co-ordinating Group

The Western Australian Biodiversity Science Institute

Department of Jobs, Precincts and Regions, Victorian Government

Department for Energy and Mining, South Australian Government

Department of Natural Resources, Mines and Energy, Queensland Government

For further information:
www.crctime.com.au

NATURAL ENVIRONMENT

Rating Curve and Water Balance Model Development: Winton Wetlands

In 2010, following the decommissioning of Lake Mokoan in north east Victoria, a program was initiated to restore the Winton Wetlands. This undertaking represents the largest restoration project in the southern hemisphere.

In support of program, CeRDI and Federation University School of Engineering, Information Technology and Physical Sciences collaborated to develop a digital terrain model (DEM) for the Winton Wetlands.

The project was commissioned by the Winton Wetlands Committee of Management and involved developing a rating curve, which looks at the relationships between water depth, volume and surface area, and a subsequent water balance model which tracks the balance between water flowing into the system and water flowing out.

The DEM model includes data available from a LiDAR survey when the wetlands were dry for the larger water bodies. The model contained approximately 190 million points in a GeoPackage. The LiDAR survey across the whole site was used to develop the model and establish a rating curve for the Wetlands. Open-source software, QGIS was used with two plugins, QSWAT+ (Soil & Water Assessment Tool) for flow and catchment delineation and Hypsometric Curves for the development of the Rating Curve.

Future development of the DEM, incorporating a full set of rating curves and an associated water balance model, is currently being considered. These advances would further enhance the DEM and aid future operations and support planning.

PROJECT PARTNERS

Winton Wetlands Committee of Management

Website: www.cerdi.edu.au/CeRDINewsletterWinter2021#6

Victorian Drought Resilience Adoption and Innovation Hub

HAZARD PLANNING AND RESILIENCE

During 2021, the Commonwealth Government announced funding for eight Drought Resilience Adoption and Innovation Hubs.

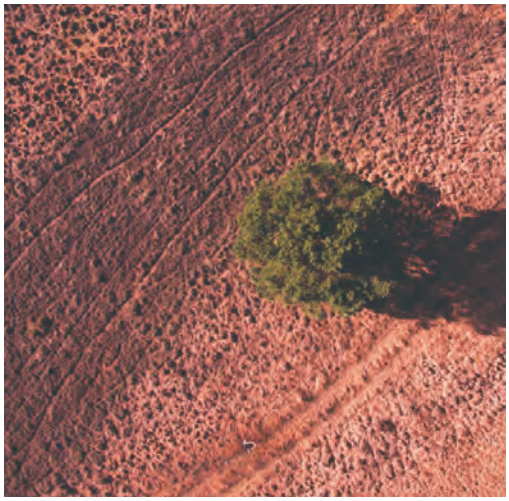
Each hub will provide networks for researchers, primary producers and community groups to work together to enhance drought resilient practices within their focus region and to become flagship precincts for agricultural innovation.

Federation University is a consortium partner on the Victorian Hub, led by the University of Melbourne, which will be supported by $8M funding over four years from the Commonwealth Government's Future Drought Fund (FDF). The vision for the hub is to see an innovative and profitable agricultural sector in Victoria. This means sustainable landscapes, and resourceful and adaptable regional communities. Through the hub, farm businesses will be better informed, more productive, and more profitable in the face of future droughts.

The hub is being established as a consortia of research providers and research users, with a regional focus. This network of stakeholders will work together to plan and undertake co-designed and demand driven drought resilience research, assisting Australian farmers and communities to prepare for, and become more resilient to the impact of drought. Stakeholders include primary producers, grower groups, industry, researchers, entrepreneurs, education institutions and governments.

Hubs will translate pre-existing research, knowledge and innovation around drought resilience, and support their effective uptake through the extension, adoption, testing and expansion of new solutions and commercialisation. The hubs will provide a vehicle for influencing and informing future research investment.

Associate Professor Helen Thompson is representing Federation University through her involvement on the governance group and as the Hub Lead for Digital Platform Innovations. Federation University, through CeRDI, will oversee the delivery of digital solutions for the implementation of innovation within nodes and across the Victorian Hub.



PROJECT PARTNERS

Australian Government – Department of Agriculture, Water and the Environment

Agriculture Victoria

Birchip Cropping Group

Deakin University

Food and Fibre Gippsland Inc

La Trobe University

Riverine Plains Inc

Southern Farming Systems

Mallee Regional Innovation Centre

Website: www.agriculture.gov.au/ag-farm-food/drought/future-drought-fund/research-adoption-program/adoption-innovation-hubs/victoria-hub

HEALTH AND WELLBEING

Green Scripts

Federation University, through CeRDI, is providing the technical support for the development of the online resources to support *Green Scripts* and the Dementia Sensory and Forest Trail at Ballarat's Woowookarung National Park.

Funding for the online resource is from the Bigger Hearts Dementia Alliance who have been awarded a Dementia Friendly Community grant. The project is being coordinated by Caroline Gibson, Ballarat Health Services. CeRDI will develop online resources that will support and highlight the health experiences and benefits for people with dementia and their carers to use the new park.

Routine social prescribing is encouraged by the Royal Australian College of General Practitioners for primary health practitioners. It provides alternative methods for improving the health outcomes of patients through the prescribing of social and community activities. Green Scripts is a dementia-friendly social prescribing project aimed at linking people with dementia and their carers with dementia-inclusive community activities.

The Woowookarung Park is being developing as a dementia sensory forest trail. The proposed online resources will complement the park's information, proving dementia specific insights about the trail for carers and their families and highlighting the potential sensory experience along the park walk. Additional information will be also be included for health professionals with information and research about green scripting.

PROJECT PARTNERS

Bigger Hearts Dementia Alliance

Caroline Gibson, Ballarat Health Services

Website: www.greenscripts.org.au

Virtual Honour Roll Project

HERITAGE AND CULTURE

CeRDI completed a project with the Ballarat Returned and Services League (RSL) to establish a virtual Honour Roll to record the men and women from Ballarat and surrounding districts that enlisted during World War Two.

Funded by the Department of Veterans' Affairs through the Commemorative Grants program, this project will ensure public access to information about residents who served during World War Two.

CeRDI developed the web platform to host the honour board data which is embedded within the existing Ballarat RSL website. Key functionality for the website includes an information display, with search functions (name, location, unit, date), and the facility for user contributions (text, images).

Until now, the names of Ballarat residents who served in World War Two were available only as a hard copy. The development of a virtual honour roll allows family members of the service personnel and other members of the public to access details about those that served, including the service number, name, rank and branch of service, and enlistment dates. Additional features planned for the website will enable the placing of a virtual poppy against names on the Honour Roll.

This project contributes new insights about the significant contribution that this region's men and women made during World War Two. The project involved close liaison with Ballarat RSL. Data for the Honour Roll was sourced from the Shrine of Remembrance and the Department of Veterans' Affairs.

PROJECT PARTNERS

Australian Government – Department of Veterans' Affairs

Ballarat RSL

Website: https://ballaratrsl.cerdi.edu.au

HERITAGE AND CULTURE

Lucas Girls Avenue of Honour: Audio Tour

During 2021, a series of audio tours focusing on the men and women from Ballarat and surrounding districts who served during World War One was launched.

The eight audio tours, which are available via the Avenue of Honour website, commemorate the substantial involvement of the employees (the Lucas Girls) from E. Lucas & Co textile company, who planted many of the trees along Ballarat's Avenue of Honour.

Dr David Waldron, local historian and Senior Lecturer in History at Federation University School of Arts successfully led this project. David conducted extensive research to inform each of the stories he wrote and that have since been narrated for the audio tour. CeRDI worked with David on this project providing the technical support for the inclusion of the stories on the website.

Each of the eight stories represents an important 'episode' in the history and lives of people from Ballarat who served during World War One. Combined they provide a unified collection of experiences that reflect the challenges and the strength of character exhibited by local men and women and their families during the Great War. The stories include a commemoration of the Garden of the Grieving Mother, diary excerpts from the experiences of being on the front-line, Ballarat's Chinese ANZACS, Ballarat's young people who enlisted in the war, prisoners of war, nurses at the war, and the Lucas Girls involvement in the Avenue of Honour.

The Lucas Girls audio tour is an important record of the Avenue's construction. It highlights the integral role that Mrs Tilly Thompson, Director of the E. Lucas & Co textile company, and the company's employees (the Lucas Girls) in fundraising and organising the tree plantings along the Avenue of Honour. The Avenue was officially opened in 1920 following three years of extensive tree plantings. It was the first of its kind in Australia and, at 22km in length and comprising nearly 4,000 trees, it is one of the longest Avenues in the Southern Hemisphere.

In commenting on the project, Dr Waldron said: "In an era when stories of war are often deeply partisan and politicised, I found it quite profound to get back to our common humanity. These were ordinary people from diverse backgrounds who found themselves in extraordinary and often horrific experiences. There is the tragic experience of those left at home, who often knew very little, just fragments, of what was facing their loved ones overseas. I feel quite privileged to be part of that experience."

Funding for this project was received from the Veteran's Branch, Department of Families, Fairness and Housing through the Victoria Remembers Minor Grant Program. Additional support was also received from Federation University and the Ballarat Mechanics Institute with input and support from members of both the Ballarat Arch of Victory/Avenue of Honour Committee and the Lucas Past Employees Association.

PROJECT PARTNERS

Veteran's Branch, Department of Families, Fairness and Housing

Ballarat Mechanics Institute

Ballarat Arch of Victory/Avenue of Honour Committee

Lucas Past Employees Association

The Avenue Audio Tour can be accessed at: https://honouringouranzacs.com.au

Aboriginal Heroes of Fire, Flood and Food Project

A new project has commenced at Federation University to document the stories of Aboriginal heroes in shaping Victoria's history between 1800 and 1930. It is believed that hundreds of colonists in 19th century Victoria were rescued from bushfires, flooded rivers or from being lost in the bush by Aboriginal people.

The project 'Aboriginal Heroes of Fire, Flood and Food' will use film and digital mapping to chronicle acts of heroism in relation to fire, flood and the search for food. The project leaders are Associate Professor in Aboriginal History Fred Cahir and Lecturer, History and Sociology Dr Dan Tout from Federation University School of Arts.

CeRDI researchers and technical staff are collaborating on the project to bring together stories in an accessible format using digital maps. Through this project, the researchers will consult and collaborate with Indigenous and non-Indigenous communities, historians and historical societies to create the first comprehensive map to highlight Aboriginal acts of heroism.

Already the project has uncovered over 100 reports of Aboriginal people saving non-Aboriginal people from bushfire, drowning and the tracking of lost people and their livestock in the period 1800 – 1930. Examples of Aboriginal rescue efforts include Aboriginal people saving the lives and homes of people in Rutherglen in Victoria's north-east, by warning them about large and devastating bush fires engulfing the region during the 1870s.

In Gippsland's Orbost district, an Aboriginal man rescued a sick colonist during floods. He made a canoe out of a sheet of bark, placed the sick man in it and swam through the turbulent waters by towing the canoe and the man to safety.

Documentary film-makers Wind and Sky Productions will produce a documentary film for the project and a book will also be written.

The outputs from the research, which have multiple uses, will be broadly available. They will be used for curriculum development in schools, and to promote cultural heritage tourism. The resources will also be available publicly to engender broader community knowledge about Victoria's shared history and acts of heroism.

In commenting on the project, Associate Professor Cahir identified the important and unique cultural perspectives that will be explored and shared: "The significant contribution of Aboriginal people to Victoria's history isn't well known within the broader Victorian community and we are confident this project will change that." The project will expand the current limited narratives that have prevailed through a history which have been largely retold from a colonial-settler perspective. According to Associate Professor Cahir the project will "assist in rewriting the dominant narratives and understandings of Australian history, revealing and celebrating a shared history that reflects stories that are culturally sensitive and important."

PROJECT PARTNERS

The project has been funded by the Telematics Trust

Image: Strutt, William (1864). *Black Thursday, February 6th. 1851*. State Library of Victoria. (Detail)

Website: www.aboriginalheroesmatter.org.au

Staff profiles

Research

Associate Professor Helen Thompson,
Director

Doctorate of Business Administration, Bachelor of Commerce (Accounting) with Distinction

Helen has led the Centre since 2002 and is responsible for the achievement of all CeRDI organisational objectives in respect of research, project management, partner projects, business development and financial management. Under Helen's leadership, CeRDI has become one of the University's most successful research centres, establishing a reputation for excellence at the regional, national and international level. Helen has organisation-wide leadership for eResearch. She is engaged in research into the use of ICT and is involved in a range of activities which contribute to the economic and social development of regional and rural Victoria.

Associate Professor Peter Dahlhaus,
Senior Research Fellow

PhD, Master of Applied Science, Bachelor of Applied Science

Peter joined CeRDI in 2012 as an experienced researcher and geologist. He has a comprehensive knowledge of the geology, geomorphology and hydrogeology of south west Victoria, where he has been influential in applying his scientific knowledge to direct policy on salinity and soil health management as an author of catchment action plans and strategies, and municipal planning overlays. Together with colleagues at CeRDI, Peter's current research focuses on spatial data interoperability and visualisation to ensure that natural resource management data, information and knowledge is globally available to researchers, government agencies, municipalities and the public. Peter is the lead researcher on numerous projects, including the Visualising Australasia's Soils.

Dr Francisco Ascui, Professor Environmental Accounting

PhD, MBA, MSc

Francisco is an internationally recognised expert in environmental accounting, finance and risk management. He has a PhD in carbon accounting, an MBA and an MSc in Environmental Change and Management. He worked for ten years in international energy and carbon markets before moving into academia. Francisco is supporting CeRDI's involvement with the Food Agility CRC.

Dr Nathan Robinson, Senior Research Fellow, Soil Science

PhD, Bachelor of Applied Science (Honours), Graduate Diploma (GIS and remote sensing)

Nathan joined CERDI in 2017 after working in soil and landscape analysis for the Victorian government for 18 years. Nathan has been a lead researcher in the use of proximal sensors and rapid sensing techniques in the assessment of soil properties and links to crop yield. Nathan completed his PhD at Federation University in 2016 and his role in CeRDI is closely linked to his PhD and Soil Science where he is conducting research on advancements to spatial analysis to better understand the links between soil and the agricultural production systems.

Dr Birgita Hansen, Senior Research Fellow, Food Agility Constellation Leader

PhD, Bachelor of Science (Evolutionary Ecology)

Birgita is leading the Food Agility CRC Better Data for Better Decisions research constellation, which aims to build a research program around improving the translation of data into knowledge that improves farm outcomes. She has extensive experience in ecology, environmental management and citizen science, with a strong focus on understanding the ecological response of birds to modification of their habitat. This has included studies of woodland birds in agricultural landscapes, and shorebird conservation, management and monitoring at local and continental scales.

Dr Alison Ollerenshaw, Research Fellow

PhD, Master of Applied Science, Graduate Diploma of Applied Science (Professional Psychology), Bachelor of Arts, Diploma Project Management

Alison joined CeRDI in 2012 providing research support across a range of Centre projects and activities. She has experience in research and project management, impact evaluation, and in the application of mixed methods research. In 2016, Alison returned to full-time study and completed her PhD in CeRDI examining the relationship between business incubator services and tenants' positive psychological constructs. Alison works in CeRDI on various projects and is coordinating the impact research.

Robert Milne, Research Associate (Environmental Science)

Bachelor of Applied Science (Environmental Management)

Rob joined CeRDI in 2013 bringing specialist skills in geographic information systems and data management. Rob has extensive project management and stakeholder engagement experience gained during his extensive career with Federation Uniiversity and as partner in the family farming business.

Bruce Simons, Research Associate

Bachelor of Science

Bruce has worked as a geophysicist in private industry and the Northern Territory and Victorian geological surveys. While at the Geological Survey of Victoria and, since 2012, at CSIRO, Bruce has designed information management systems and part of international and national collaborative research projects into data exchange mechanisms and interoperability. Bruce joined CeRDI in 2017 with the aim of making natural resource management data, information and knowledge globally available to researchers, government agencies, municipalities and the public, while minimising the overheads to data providers.

Dr Megan Wong, Research Associate

PhD, Graduate Diploma of Education, Bachelor of Science

Megan joined CeRDI in 2017 and brings a broad range of experience gained across 15 years in the Science, Environment and Education sectors. Megan completed her PhD in 2014 at Monash University investigating the association of soil biology with vegetation and land use change across the Riverine Plains of Victoria. Megan has worked extensively on the AgReFed project.

Dr Angela Neyland, Research Officer

PhD, Bachelor of Arts (Honours), Bachelor of Science

Angela commenced at CeRDI in 2017 after graduating with a PhD from the Australian National University. Angela has a diverse research background encompassing both earth sciences and social sciences with a BSc/BA with honours in geology and archaeology from the University of Queensland. Angela's unique range of experiences and skills are being applied in CeRDI across various projects relating to natural resource management, digital agriculture and cultural heritage.

Jennifer Corbett, Research Coordinator

Bachelor of Management (Honours) (Marketing)

Jennifer joined CeRDI in 2009. She provides research coordination and support to a range of projects including regional ICT studies and projects in the agriculture sector.

Kate Light, Research Officer

Master of Agriculture

Kate is a specialist in breeding canola with disease (blackleg) resistance. In CeRDI, Kate is a key member of the Online Farm Trials team, contributing her agriculture knowledge and expertise to this project.

Dr Joel Epstein, Research Associate (part-time)

PhD

Joel has been working with CeRDI since 2015, providing support to the SLT and Director on a range of activities including strategic planning. Joel has a PhD in Chemical Physics and over thirty years' experience in strategic planning. Prior to CeRDI, Joel worked at Kodak and the University of Ballarat.

Rick Pope, Research Associate

Graduate Diploma in Land Rehabilitation

Rick commenced working for CeRDI in 2015 and has extensive expertise in geographic information systems (GIS) and global positioning systems (GPS). Rick has a close working relationship with local government, the spatial industry as well as Landcare networks in Victoria, Queensland and Western Australia. In CeRDI, Rick has been involved with many projects, including the recent rating curve and water balance model for the Winton Wetlands.

Dr Chris Bahlo, Research Associate

PhD, Bachelor of Information Technology (Honours), Bachelor of Information Technology (Professional Practice), Bachelor of Business, Diploma of Agricultural Science

Chris worked in information technology and agriculture roles and has business experience. She recently completed her PhD in CeRDI, researching data interoperability in precision agriculture. In 2021 Chris joined the CeRDI technical team and has supported the server migration project and is working on the AgReFed project.

Dr Patrick Bonney, Research Associate

PhD, Master of Science (Zoology), Bachelor of Science

Pat commenced his PhD with CeRDI in 2016 as part of the Regional University Networks Water Futures Fund. His research is examining citizen science and public policy and involves working closely with the Corangamite Catchment Management Authority to measure and explore the issues and opportunities of the Waterwatch Victoria and EstuaryWatch Victoria programs. Patrick works as a researcher at CeRDI and liaises with volunteers, environmental groups and government and non-government agencies involved with Citizen Science and Natural Resource Management. Pat has been conducting research to support the Mine Rehabilitation Trials Online project.

Jude Channon, Research Officer

Master of Education, Bachelor of Arts,

Jude worked as a research officer with CeRDI in 2017 and in 2019 returned to CeRDI after taking time out to implement a large-scale healthcare project across regional Victoria. Jude provides extensive support and is a key member of the Online Farm Trials team.

Dr Judi Walters, Research Associate

PhD (Forest Ecology), Master of Science, Bachelor of Forest Science (Honours), Diploma of Arts (Professional Writing and Editing)

Judi commenced at CeRDI in 2015 having worked extensively within the field of scientific research, publishing and editing from within a range of organisations and universities spanning fields such as forest ecology, bushfire research and contaminated lands auditing. Judi is part of the Online Farm Trials team.

Dr Benedikt Fest, Research Coordinator

PhD, Master of Science, Bachelor of Science

Ben was appointed CeRDI research coordinator in 2021. Ben has over 10-years research experience working in the field of ecosystem ecology having completed a PhD at the University of Melbourne investigating the processes controlling soil methane exchange in Australian forest ecosystems. Ben utilises his research skills and discipline knowledge to conduct research management and associated activities in CeRDI projects, including Online Farms Trials.

Dr Carolyn Staines, Research Officer

PhD, BSc (Hons)(Experimental Psychology)

Carolyn has more than 20 years' experience in public health research. Carolyn completed her PhD in injury epidemiology at Monash University in 2013 and has contributed to a broad range of research projects in diverse fields including nursing practice, sports injuries, cancer epidemiology and drowning prevention. Carolyn joined CeRDI in 2021, bringing a broad set of quantitative and qualitative research skills to her work in the Centre.

Peter Weir, Research Associate

Bachelor of Information Technology (First Class Honours), Bachelor of Information Technology (Software Development)

Peter commenced PhD at CeRDI in 2020 after many years in irrigated horticulture in the Riverland, South Australia, both as a farmer and a software developer. The aim of his research is to develop a conceptual model, using existing spatio-temporal data as the basis for predictions of within-paddock variability in plant-available water. Peter receives an Australian Government Research Training Program fee-offset scholarship through Federation University Australia and a scholarship from the Cooperative Research Centre for High Performance Soils whose activities are funded by the Australian Government's Cooperative Research Centre Program.

Technical

Andrew Macleod, Manager Technical Projects

Honours Applied Science (Information Technology), Bachelor of Computing

Andrew has extensive experience in project planning and the implementation of major information technology projects. He provides technical leadership for all Centre activities. Andrew has been instrumental in developing the technology innovations, data interoperability and knowledge management approaches demonstrated through CeRDI spatial initiatives. Andrew commenced his PhD in CeRDI in 2021.

Paul Feely, Senior Systems Analyst Programmer

Bachelor of Computing (Honours)/Bachelor of Commerce

Paul joined CeRDI in 2003. He specialises in PHP and MySQL development and has been the lead programmer on major projects including Sport and Recreation Spatial and Online Farm Trials.

Scott Limmer, Senior Technical Lead

Bachelor of Information Technology

Scott joined CeRDI in 2008 providing assistance with expanding programming and web development activities. He has introduced new multimedia and web2 technology skills to the team and has been the technical lead on various decision support and IoT projects, including the current server migration project.

Richard Archer, Systems Analyst Programmer

Richard studied Computer Science at The University of Melbourne and Federation University Australia and has extensive applied expertise and has experience with stakeholder engagement, requirements gathering, project management, programming, and server administration. Richard is working on the AgReFed project and other core projects across the Centre.

Heath Gillett, Senior Programmer

Bachelor of Computing

Heath joined CeRDI during 2009. He has extensive experience in design, programming, implementation and support of various IT systems. Heath has been a lead developer on key projects in CeRDI including Visualising Australasia's Soils, Precision Agriculture and the Victorian Fire Risk Register.

Rahul Sinha, Web Developer/Programmer

Masters of Information Technology, Bachelor of Engineering in electronics

Rahul joined the CeRDI team as a Web Developer in 2021. Prior to joining CeRDI, Rahul worked as a software developer for a US based software company. Rahul has developed software applications in domains like Retail, Automobile, and Education. He has experience with various front, back-end technologies, and their trade-offs. Rahul completed a master's in information and technology at Swinburne University in 2020 from Melbourne.

Craig Briody, Web Developer

Bachelor of Computing

Craig specialises in the development and implementation of web-based projects as well as having significant experience in the development and delivery of comprehensive client training programs.

Sudeera Abeywickrema, Web Developer

Bachelor of Information Technology

Sudeera joined CeRDI in 2013 and contributes to the implementation of a range of web-based applications and systems and the integration of emerging technologies to enhance CeRDI outcomes.

Dan Ferguson, Technical Assistant

Bachelor of Computer Science (Professional)

Dan joined CeRDI in 2019 and provides technical assistance across a range of projects.

Project and Administration Support

Kathy Gamble, Administrative support officer

Graduate Diploma of Education, Diploma of Fine Art

Kathy joined CeRDI in January 2013 after five years with the Federation Business School. Kathy provides administrative assistance and support for the CeRDI team. Kathy is also the personal assistant to the Centre Director.

Higher Degrees by Research Candidates

Basharat Ali, PhD candidate

PHD TITLE: Investigating the roles of data, digital agriculture and resilience in agricultural performance.
SCHOOL: Engineering, IT and Physical Sciences
SUPERVISORS: Associate Professor Peter Dahlhaus, Associate Professor Helen Thompson, Dr Nathan Robinson

Elissa Ashton-Smith, PhD candidate

PHD TITLE: The conservation and management of sandy beach ecosystems: Exploring the divergence between policy, science and socio-cultural expectations for stewardship and use.
SCHOOL: Science, Psychology and Sport
SUPERVISORS: Dr Jessica Reeves, Associate Professor Fred Cahir, Dr Birgita Hansen

Rekha Attanayake, PhD candidate

PHD TITLE: Developing new methods to help farmers make decisions on lime use and lime requirement.
SCHOOL: Engineering, IT and Physical Sciences
SUPERVISORS: Associate Professor Peter Dahlhaus, Dr Nathan Robinson, Lisa Miller

Rob Clark, PhD candidate

PHD TITLE: Predicting crop yield within the growing season at sub-paddock scale: a big data approach.
SCHOOL: Engineering, IT and Physical Sciences
SUPERVISORS: Associate Professor Peter Dahlhaus, Dr Nathan Robinson, Dr Elizabeth Morse-McNabb

Andrew Macleod, PhD candidate

PHD TITLE: Advancing syntactic and semantic interoperability for data in the agricultural and food industries
SCHOOL: Engineering, IT and Physical Sciences
SUPERVISORS: Associate Professor Peter Dahlhaus, Dr Nathan Robinson, Dr Birgita Hansen, Dr Simon Cox
INDUSTRY SUPERVISOR: Cam Nicholson

Peter Weir, PhD candidate

PHD TITLE: In-Paddock variability of plant available water
SCHOOL: Engineering, IT and Physical Sciences
SUPERVISORS: Associate Professor Peter Dahlhaus, Dr Nathan Robinson, Associate Professor Peter Vamplew

Higher Degrees by Research Alumni

Dr Patrick Bonney

THESIS TITLE

Citizen science: Knowledge, networks and the boundaries of participation

SUPERVISORS | Dr Angela Murphy, Dr Birgita Hansen, Dr Claudia Baldwin

SCHOOL | Science, Psychology and Sport

ABSTRACT

The water-related challenges facing humanity are complex and urgent. Although solutions are not always clear, involving the public in the processes of knowledge production and policy development is widely recognised as a critical part of this larger effort.

Such public engagement is increasingly achieved through “citizen science”—a practice that involves non-professionals in scientific research and monitoring. Research literature has recognised that, while citizen science is both important and necessary to strengthen environmental policy, its acceptance and successful implementation is a difficult challenge.

Overcoming this challenge depends on the ability of volunteers, coordinators, scientists and decision-makers to work together to convert the potential of citizen science into practice. However, little is known about the collaborative relationships or the broader social contexts that shape and define the practice.

To address these shortfalls, this thesis advanced a conceptual framework for the relational analysis of citizen science that illustrates social networks and the boundaries between expert and community-based knowledge as critical sites of investigation.

Its findings shed light on the contributions of citizen science to key waterway governance objectives, including the social, political and cultural factors that influence its acceptance and uptake in governance contexts.

Dr Christiane Bahlo

THESIS TITLE

Open data and interoperability standards: opportunities for animal welfare in extensive livestock systems

SUPERVISORS | Associate Professor Peter Dahlhaus, Associate Professor Helen Thompson

SCHOOL | Engineering, IT and Physical Sciences

ABSTRACT

Extensive livestock farming constitutes a sizeable portion of agriculture and contributes to feeding a growing human population. The livestock industry is adopting technologies under the banner of Precision Livestock Farming (PLF) to help meet higher production and efficiency targets as well as help to manage the multiple challenges impacting the industry, such as climate change, environmental concerns, globalisation of markets, increasing rules of governance and societal scrutiny especially in relation to animal welfare.

PLF is particularly dependent on the acquisition and management of data and metadata and on the interoperability standards that allow data discovery and federation. A review of interoperability standards and PLF adoption in extensive livestock farming systems identified a lack of domain specific standards and raised questions related to the amount and quality of public data which has potential to inform livestock farming. A systematic review of public datasets, which included an assessment based on the FAIR principles (data must be findable, accessible, interoperable and reusable) was developed.

Custom software scripts were used to conduct a dataset search to determine the quantity and quality of domain specific datasets yielded 419 unique datasets directly related to extensive livestock farming. A FAIR assessment of these datasets using a set of general metrics showed a moderate level of compliance and suggest that domain specific FAIR metrics may need to be developed.

A case study was designed to explore the potential of public datasets in informing decision support in relation to livestock welfare, using the scripts previously developed. Welfare elements were extracted from Australian welfare standards to guide a dataset search.

It was found that with few exceptions, these elements could be supported with public data. The development of a geospatial animal welfare portal including these datasets explored and confirmed the potential for using public data to enhance livestock welfare.

Research Outputs

Research Publications

Bahlo, C., & **Dahlhaus**, P. (2021). Livestock data – Is it there and is it FAIR? A systematic review of livestock farming datasets in Australia. *Computers and Electronics in Agriculture*, 188, 106365. doi.org/10.1016/j.compag.2021.106365

Clemens, R., Rogers, D., Minton, C., Rogers, K., **Hansen**, B., Choi, C., & Fuller, R. (2021). Favourable inland wetland conditions increase apparent survival of migratory shorebirds in Australia. *Emu – Austral Ornithology*, 1-12. doi.org/10.1080/01584197.2021.1901596

Hansen, B., Szabo, J., Fuller, R., Clemens, R., Rogers, D., & Milton, D. (2021). Insights from long-term shorebird monitoring for tracking change in ecological character of Australasian Ramsar sites. *Biological Conservation*, 260, 109189. doi.org/10.1016/j.biocon.2021.109189

Joseph, L. Burbidge, A.H., Delhey, K., **Hansen**, B.D., Kleindorfer, S., Maurer, G. (2021) Emu's First 120 Years: landmark papers of change in austral ornithology. *Emu Austral Ornithology.* Special Issue Online 121, 284-291. https://doi.org/10.1080/01584197.2021.1993529

Muir, A., Heyes, S., Morgan, J., Hoebee, S., Enright, N., Whelan, R., Geschke, A., Bennett, A., Walsh, S., Weatherly, W., & **Milne**, R. (2021). Conservation challenges for Victorian Banksias: Workshop May 2020. Ecological Management & Restoration. https://doi.org/10.1111/emr.12448

Ollerenshaw, A., **Corbett**, J., & **Thompson**, H. (2021). Increasing the Digital Literacy Skills of Regional SMEs through High-Speed Broadband Access. *Small Enterprise Research*. https://doi.org/10.1080/13215906.2021.1919913

Searle, R., McBratney, A., Grundy, M., Kidd, D., Malone, B., Arrouays, D., Stockmans, U., Zund, P., Wilson, P., Wilford, J., VanGool, D., Triantafilis, J., Thomas, M., Stower, L., Slater, B., **Robinson**, N., Ringrose-Voase, A., Padarian, J., Payne, J., Orton, T., Odgers, N., O'Brien, L., Minasny, B., McLean Bennett, J., Liddicoat, C., Jones, E., Holmes, K., Harms, B., Gray, J., Bui, E., & Andrews, K., (2021). Digital soil mapping and assessment for Australia and beyond: A propitious future. *Geoderma Regional*, 24, e00359. https://doi.org/10.1016/j.geodrs.2021.e00359

Shackelford, N., Paterno, G.B., Winkler, D.E. **Wong**, M. et al. (2021). Drivers of seedling establishment success in dryland restoration efforts. *Nature Ecology and Evolution*. https://doi.org/10.1038/s41559-021-01510-3

Walters, J., **Light**, K., & **Robinson**, N. (2021). Using agricultural metadata: a novel investigation of trends in sowing date in on-farm research trials using the Online Farm Trials database. *F1000Research*, 9:1305 https://doi.org/10.12688/f1000research.26903.2

Other outputs

Short film: Data Federations in Agriculture

Commissioned by CeRDI this documentary examines the application of technology for federating research data through the lens of agriculture, an industry of focus for data technology advances by CeRDI. The film was produced by Wind and Sky Productions.

The Conversation

Hansen, B. (2021, August 30). This bird's stamina is remarkable: It flies non-stop for 5 days from Japan to Australia, but now it's habitat is under threat. *The Conversation*. https://theconversation.com/this-birds-stamina-is-remarkable-it-flies-non-stop-for-5-days-from-japan-to-australia-but-now-its-habitat-is-under-threat-165964

Panellist

Associate Professor Peter Dahlhaus was an expert panellist for the Soil Data and National Soil Strategy Panel Discussion, facilitated by the Soil Cooperative Research Centre. 17 August 2021. The webinar is available at: https://soilcrc.com.au/webinars/

Public repository of source codes

Software scripts for querying data catalogues and running FAIR assessments were published in association with Chris Bahlo's PhD research.
The public repository containing the source code for the scripts is available at doi.org/10.5281/zenodo.4057868

HDR-Food Agility YouTube videos

Facilitated by the Food Agility Cooperative Research Centre, three CeRDI HDR candidates showcased their PhD research in short YouTube videos:

- **Basharat Ali.** Investigating the roles of data, digital agriculture and resilience in agricultural performance.
  www.youtube.com/watch?v=dnu6UpusI68
- **Rekha Attanayake.** Developing new methods to help farmers make decisions on lime use and lime requirement.
  www.youtube.com/watch?v=j9Gz7WUkqkY
- **Rob Clark.** Predicting crop yield within the growing season at sub-paddock scale: A bid data approach
  www.youtube.com/watch?v=67hdUURlovU

Research Income

Research income for the Centre between 2017 and 2021 is presented in the following figures. Figure 2. shows a steady increase in overall income for the Centre since 2019, peaking in 2021.

Income allocation by research theme is presented in Figure 3. The figure highlights that income generation from agriculture research has grown across the reporting period and represents the single most successful funding stream for the Centre over multiple years.

CeRDI Income 2017–2021

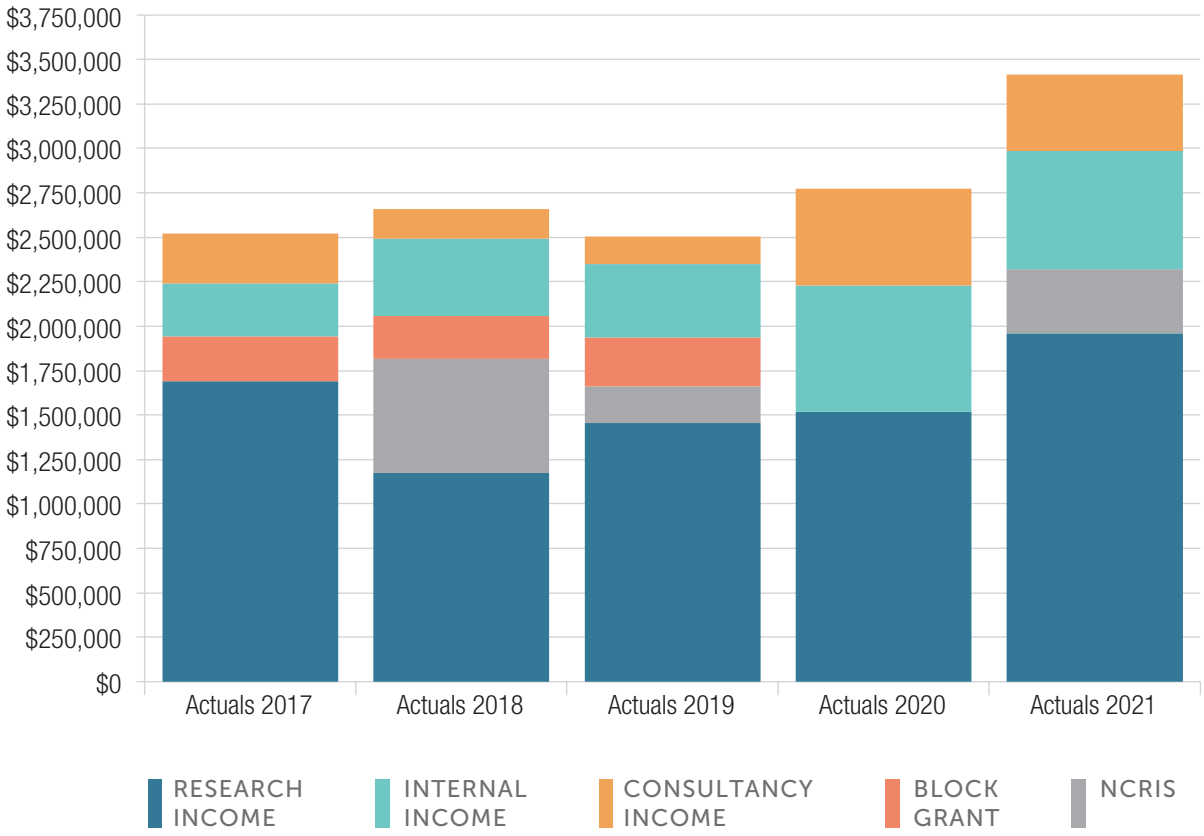


FIGURE 2. CeRDI INCOME BY SOURCE BETWEEN 2017 AND 2021.

Note: The NCRIS (National Collaborative Research Infrastructure Strategy) funds the Australian Research Data Commons AgReFed project.

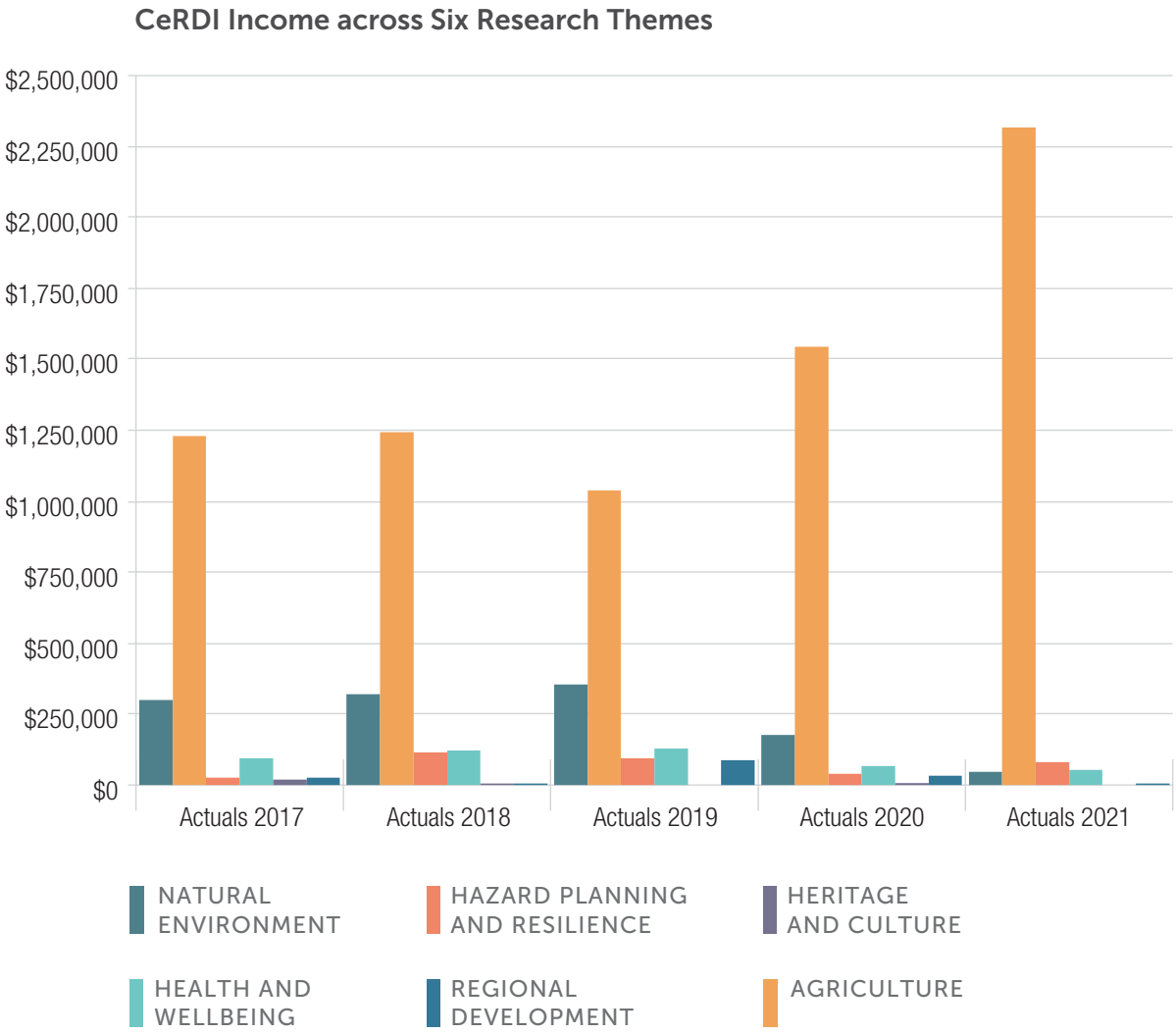


FIGURE 3.
CeRDI INCOME FROM 2017 TO 2021 ACROSS EACH OF THE SIX RESEARCH THEMES.

Research Partnerships and Collaborations

Ag Excellence Alliance (South Australia)

Agriculture Kangaroo Island

Agriculture Victoria

Atlas of Living Australia

Australian Fertiliser Services Association

Australian Government – Department of Agriculture, Water and the Environment

Australian Government – Department of Industry, Science, Energy and Resources

Australian Government – Department of Veteran's Affairs

Australian Government – National Landcare Program

Australian Plant Phenomics Facility

Australian Research Data Commons

Ballarat Arch of Victory/Avenue of Honour Committee

Ballarat Health Services

Ballarat Mechanics Institute

Ballarat RSL

Barwon Coast Committee of Management

Bigger Hearts Dementia Alliance

Birchip Cropping Group

Brimbank City Council

Burdekin Productivity Services

Capital Woodlands and Wetlands Conservation Association Inc

Central West Farming Systems Inc.

City of Ballarat

City of Greater Geelong

Commerce Ballarat

Cooperative Research Centre for High Performance Soils

Cooperative Research Centre for Transformations in Mining Economies

Corangamite Catchment Management Authority

Country Fire Authority

CSIRO

Deakin University

Department of Agriculture, Water and the Environment

Department for Energy and Mining, South Australian Government

Department of Environment, Land, Water and Planning | Arthur Rylah Institute for Environmental Research

Department of Industry, Science, Energy and Resources

Department of Jobs, Precincts and Regions, Victorian Government

Department of Natural Resources, Mines and Energy, Queensland Government

Department of Premier and Cabinet

Earlham Institute

EcoCommons, Griffith University

Energy Australia

Food Agility Cooperative Research Centre

Food and Agriculture Organization of the United Nations

Food and Fibre Gippsland Inc

Fortescue Metals Group Ltd

Geoscience Australia

Gillamii Centre

Glenelg Hopkins Catchment Management Authority

Grains Research and Development Corporation

Griffith University

Grower Group Alliance

Gunaikurnai Traditional Owner Land Management Board

Herbert Cane Productivity Services Ltd

Holbrook Landcare Network

International Plant Nutrition Institute

La Trobe University

Legal Services Commission of South Australia

Liebe Group

Lucas Past Employees Association

MacKillop Farm Management Group

Macquarie University

Mallee Regional Innovation Centre

Mallee Sustainable Farming

Marcus Oldham College

Mnaaki Whenua Landcare Research, New Zealand

National Research Infrastructure Strategy

Nicon Rural Services

North Central Catchment Management Authority

Northern Grower Alliance

NSW Department of Primary Industries

Nutrien (formerly Landmark)

Perennial Pasture Systems

Precision Agriculture

Queensland Cyber Infrastructure Foundation

Rangelands NRM Co-ordinating Group

Regional Universities Network

Rio Tinto Services Limited

Riverine Plains Inc

Southern Farming Systems

Southern Rural Water

Telematics Trust

TERN, The University of Queensland

The University of Adelaide

The University of Sydney

The University of Western Australia

The Western Australian Biodiversity Science Institute

University of New England

University of Southern Queensland

University of Tasmania

Veteran's Branch, Department of Families, Fairness and Housing, Victorian Government

Victorian Grower Group Alliance

Victorian Lime Producers Association

Victoria State Emergency Services

Western Australia Department of Primary Industries and Regional Development

Western Australia No Till Farmers Association

West Midlands Group

Wimmera Catchment Management Authority

Wind & Sky Productions

Winton Wetlands Committee of Management

Women's Health Grampians

Yarra Riverkeeper Association

Zoos Victoria

Contact CeRDI

For further details about CeRDI's diverse portfolio of research please visit our website: **www.cerdi.edu.au**

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