Careers grounded in soils














TERN acknowledges the traditional custodians of the lands upon which we study and work and pay respect to their elders past and present.

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Foreword



I am delighted to commend this important booklet to you with its rich collection of conversational stories about careers in soils or linked to soil knowledge.

The booklet features thirty-three people from Australia and further afield who share their passion for the importance of soils by discussing how they see soils as integral to the social, economic, cultural, political, and health aspects of sustainability.

In my position as National Soils Advocate, which I have held since August 2020, I work to raise awareness of the value of soils, of the economic and environmental benefits soils deliver. I advocate for action to be taken to conserve and improve soil health and management across Australia.

I meet many people across the country in my role as Advocate. Although certain groups involved with soil appreciate its importance, many others do not and, when compared with many other natural resource science and management fields, soil science is not recognised by many as providing a attractive career path.

However, when I open the pages of this book and feel the energy from reading the anecdotes, I am hopeful they will encourage students to pursue a career in soils.

Having chosen soils careers for whatever purpose, the people in this book are ready to offer advice to readers and others thinking of following their lead.

One excellent feature of all the stories is that they explain their educational and vocational trajectory from student to professional. They describe work experiences, which cover collectively an amazing array of organisations and specialisations. However, despite that breadth of experiences, there are also some common threads woven through the book.

One thread traces a theme of being open-minded. It is suggested that this allows those contemplating a career in soils to trust their instincts, examine choices and even take risks when opportunities such as travel arise.



IMAGE: TERN, AUSTRALIA

Another commonality to the stories is the importance of mentors – people who inspire and encourage others to think and be alert. There is obvious value in looking proactively for mentors.

Perhaps the most important theme is the sense of purpose – every one of the people featured in this booklet is absorbed by their subject. Recognising the fundamental importance of soil to life, how much there is yet to learn about soil attributes and what the individuals can contribute, has obviously enriched the lives of many of the interviewees.

Reflecting on these themes in the advice provided throughout the booklet, reinforces the sense of purpose and commitment I have as National Soils Advocate - as I promote the critical role soil plays in sustainable agricultural production and food security; the need to improve soil health to benefit the environment; and the role soils can play in climate mitigation and adaptation.

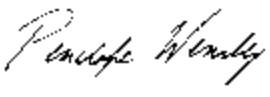
I am very pleased that TERN, Australia's Ecosystem Observatory, chose to produce this careers booklet as a constructive way to mark the launch of the 'TERN Australia Soil and Herbarium Collection' in Adelaide in late 2022.

TERN wanted a way to celebrate the achievements of people who have worked tirelessly to enable a better understanding of Australian soils. It also wanted to communicate how vital soils are as living ecosystems, supporting some of the richest biodiversity in the biosphere.

Based on the pages that follow, it is evident that Australia is producing some wonderful soil scientists. Just as obviously, this booklet is incomplete as a record of all the Australian soil scientists who have contributed to discovering what we know today about the properties of soil, and which is facilitating its effective and sustainable management.

Australia needs new generations of soil professionals to assure continued delivery of effective research, development and extension for the benefit of all Australians and the Australian environment.

I hope you enjoy this booklet and that it will encourage interest in careers grounded in soils.



The Hon. Penny Wensley AC
National Soils Advocate



Preface

IMAGE: LACHLAN PINK, TERN AUSTRALIA



IMAGE: TERN

Before I tell you about the purpose of this booklet, first let me explain why TERN decided to undertake the project.

TERN is Australia's terrestrial ecosystem monitoring observatory and soils are an essential component of ecosystems - regardless of land use.

TERN collects vegetation and soil samples for analysis; analyses information about the exchanges of gases, energy, and nutrients between soil, plants, animals and the atmosphere; develops decision-making digital products from landscape and soil data derived from satellites and other remote sensing instruments; and enables ecological forecasts.

The soil scientists in the TERN team have produced some world-leading tools and data that are helping us to better understand the resilience of ecosystems. It would be great if we could encourage a new generation of soil scientists to continue the work.

So, with those words and based on its title 'Careers grounded in soils', this booklet needs little explanation of purpose. The publication contains the results of 33 interviews with people who, in 2022, have jobs relevant to soils.

It is intended for use by secondary and tertiary students who are perhaps wondering what to study or which career might be satisfying - or maybe they have already chosen a soils-related career and are keen to learn something about others who they may meet as lecturers, co-workers or employers.

The booklet will also hopefully be a useful resource for those that assist students with such decisions, including teachers, careers counsellors, guidance officers, librarians, and parents.

While every page tells a unique story, the reader will nevertheless find out what type of training and education each person has undertaken, the catalyst that led them to choose their career path and how that panned out as they progressed over time. We also read about some of the best moments, greatest highlights and career-defining moment - as well as the little things that have contributed to making the career so fulfilling. And the best part of the stories is that they each contain reflections and advice to aspiring soil scientists.

When TERN decided it wanted to promote the importance of soils and how exciting it can be to have a career in soils via a booklet, we went to Soil Science Australia (the Australian Society of Soil Science Incorporated) for advice. This is the professional body that supports soil scientists and promotes the importance of soil as a finite resource. We thank everyone in the Society for their generous help in directing us to people to interview.

Dr Beryl Morris, Director, TERN Australia, December 2022



About Australian Soils

The general definition of soils is that they are layered mixtures of mineral and organic particles on the land surface, formed over very long time periods from the weathering of rocks, transport of sediments and interactions with living organisms.

Our soils are quite different to those in the Northern Hemisphere. They are very old, very weathered and infertile. This was not initially known by the first Europeans who settled in Australia and commenced agricultural practices familiar to them in other countries.

The initial soil degradation in some areas was catastrophic. It was time to learn new things and adapt to the previously unknown soil conditions of Australia's dry, flat continent. Driven largely by this necessity to solve its own unique problems, Australia is one of the world leaders in soil research.

Initially the focus of Australian soil research was on quite fundamental issues such as classifying soils and their attributes. Over time the emphasis has changed and is now more focused on applied research for specific agricultural and environmental problems.

For example, soils contain the Earth's largest pool of organic carbon (there are 20 tonnes in the top 10 cm of a typical Australian professional sports field). Yet decades or centuries of conventional farming in Australia have depleted and continue to deplete this resource.

With careful management and ongoing monitoring, farmers can use their soils to store carbon, resulting in numerous benefits to the farmer and the environment. Recarbonising soil results from adding biomass above and below ground.

The monitoring of soil carbon can be achieved through use of TERN's 'flux station network" in a more efficient, accurate and reliable way than traditional soil sampling - and is fairly low cost by comparison.

The TERN flux towers integrate data from a wide area (10-50 hectares), negating the problem of local soil variability. Instruments on the stations measure the real-time exchange of gases (especially carbon dioxide), water and energy between soil and air, in helping farmers undertake carbon-neutral agriculture.

In Australia, governments, industry and the community have invested significantly in the sustainable use and conservation of soil resources by adopting practices that restore function and avoid land degradation.

As an example, the 2021 National Soil Strategy and the 2021 Commonwealth Interim Action Plan for the National Soil Strategy are intended to encourage practices that continue toward improved productivity and profitability, as well as improved natural resource condition.



Establishing UV experiments at high altitude in Salar de Huasco, Chile

IMAGE: JHONATTAN PÉREZ

Vilma Pérez

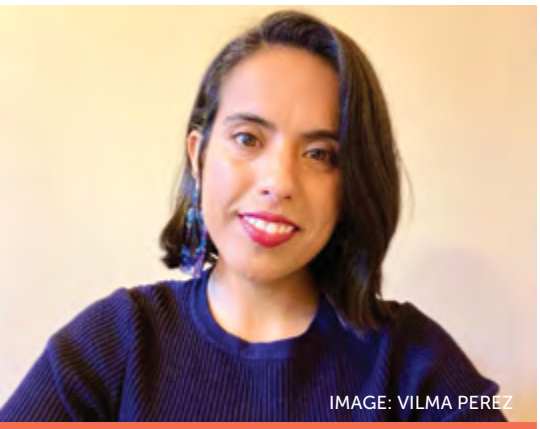


IMAGE: VILMA PEREZ

Hailing from Chile in South America, microbial ecologist Vilma Pérez has travelled the world pursuing her passion for soil science. Completing her PhD in Chile, Vilma studied the survival strategies of microbial communities in poly-extreme environments, such as the High Andean Plateau in South America, before moving to Scotland for an internship investigating proteomics.

"We used proteomics to look at how bacteria survive in the High Andean Plateau in Chile," Vilma said.

"Isolating bacteria and putting them through various stress scenarios would trigger different coping strategies; however, we noticed they used the same tools for each type of stressor, which was efficient, novel, and extremely interesting.

"I enjoyed working in the High Andes: it was the coolest thing ever because at 5,000 metres above sea level everything changes – colours, animals, everything.

"We also worked with indigenous communities there to integrate their knowledge into our research. Sitting, talking, and hearing their stories was a career highlight."

After seeing how interesting a tiny sample of soil could be, and how many species it could contain, Vilma's interest and passion was sparked – and it's not dulled since.

"At the beginning, it was overwhelming because you have so much information in just a few grams of soil, but trying to disentangle that information and build it into a whole story; I was captivated by that from day one," Vilma said.

"When I look at microbial communities I see thousands of completely different species, and millions of individual cells and I can't believe how they co-exist and make it work so efficiently.

"Yes, they are competing, but at the same time, they are working together to exist and survive. As humans we should take note of this – we could learn from soils."

After Chile and Scotland, Vilma bravely reached out to Dr Laura Weyrich from the Australian Centre for Ancient DNA. "I contacted her and said I was thinking of applying for an postdoctoral scholarship from Chile and would she like to have me in her lab? She said yes," Vilma said.

"The one thing I would say is, look for the researcher you'd like to work with and reach out to them because they may say yes; I've had really good experiences doing this."

Vilma now works with modern contemporary samples and ancient samples, investigating soils from the 2019 - 2020 mega-fires.

"I'm seeing how microbes respond to environmental conditions and fire through time. "We have a new era of mega-fires that we haven't really seen before so we want to know how environments have responded to fire in the past so we can better predict how they're going to react in the future.

"To do this, I'm using sedimentary ancient DNA and trying to put modern context into that ancient signal using soil samples from TERN."

Vilma's advice for the next generation of soil scientists is to have a lot of patience, especially when you're working with the biological part of soils.

"When I analyse a sample and get results, I already know what to expect, so I'm not overwhelmed when I see thousands of species; however, I've seen the expression a student gets when they see this and don't know where to start.

"It's complex but rewarding, so be patient, go slowly, don't try to explain all the data at the same time, and find a good mentor because nothing will replace having a good mentor.

"When I first started, I would have liked to have heard that it's okay to struggle; there's nothing wrong with that. Knowledge will get there and if not, collaborations. When you work in a team with chemists, microbiologists, ecologists, you have a better picture of what's happening.

"You don't need to explain everything on your own, find good collaborators."

James Quilty



IMAGE: ACIAR

James Quilty was embracing life as a software developer when a group of kids outside the Moroccan town of Marrakech inspired him to change tack, go back to university, and study soil science.

"I finished high school in the dot com bubble, and didn't know what I wanted to do, but I knew I wanted to see more of the world and make a positive difference," James said.

"I was in Morocco by myself, in this small town, when a group of kids ran down the street playing with plastic water bottles they had turned into water pistols.

"I realised that compared to back in Australia, these kids had almost nothing, but they were incredibly happy, and I thought, I'm not in the right job; I need to be in a job where I can make sure these children have food and resources throughout their life.

"You could see it was a desert area, they had very limited resources, but the way they were using their resources was amazing.

The question I asked myself was, can I do something that contributes to making this world a better place for everyone? I saw agriculture as key to that question, so I went back to university."

While studying agriculture, James fell in love with soil science, and carried on to complete a PhD in soils.

"My PhD led me to work with the New South Wales Department of Primary Industries, then over to the Philippines with the International Rice Research Institute, and to where I am now, back in Australia working at the Australian Centre for International Agricultural Research," James said.

"The best experiences have been talking to farmers from far-flung areas of the world, understanding their constraints, and then mutually addressing those issues within their means.

"Generally, we're working with farmers considered to be some of the poorest people in the world, but they are so generous with their knowledge and resources.

"For them, it's not a 1% increase in yield; it's getting their kids into education, access to food and health. That can be life changing.

"I've loved being able to bring some of Australia's best agricultural scientists over to countries in the Pacific, Southeast Asia, and South Asia, connecting those partnerships and getting these communities help; that's been rewarding."

James said if it was opportunity you were after, soil science was the perfect space.

"If you study soil science, the opportunities to work in agriculture are pretty limitless because soil is one of the foundational pieces. If you don't have good soil and access to water, you don't have agriculture," James said.

"When I look at the top researchers in the community in which we work, the number of soil scientists who are at the very peak of research for development is quite extraordinary.

"You don't just have to be a researcher either; you can go into agronomy, research management, the private sector – you can go almost anywhere with soil research."

While working overseas had created life-long memories for James, he said there was plenty of opportunity on home soil.

"Here in Australia, our soils are being impacted by temperature rises, droughts, floods and more. Good soil scientists who can improve crop resilience and help farming systems recover faster from stress through better management practices are desperately needed," James said.

"The opportunities in soil science are here in Australia, or all over the world, they can take you anywhere. I think it's really exciting to have those doors open to young, brave scientists willing to take on a big challenge."

Michael Crawford


IMAGE: SOIL CRC

Dr Michael Crawford has been working in soil science for 25 years, undertaking and managing soil science research programs that help farming and the environment. He is now the CEO of the Cooperative Research Centre for High Performance Soils or 'Soil CRC' for short.

Michael began his career with a Bachelor of Agricultural Science with first-class Honours from The University of Melbourne.

"I initially started broadly in the agricultural science area, wanting to work as a scientist and contribute to society both nationally and globally, and work with other agricultural scientists to help to produce more food to feed the growing population of the world," Michael said.

"As I progressed through my course I focused more on soils. Livestock didn't have much interest for me. I was interested in the plants, crops, and pastures, but I also recognised that what really makes them grow is the soil, so my energy, focus and study were directed more towards the soil subjects."

After completing his degree, he took a year to travel, then started a job with the Victorian Government in the Department of Agriculture, working with farmers.

After three or four years of working he decided to pursue a PhD.

"If I was going to have a long-term career in this area, I thought it was important I took my qualifications further. I moved to Adelaide in the mid-1990s to undertake a PhD in Soil Science at the CRC for Soil and Land Management at The University of Adelaide.

"That really opened a whole range of horizons in terms of the opportunities and the people there; Adelaide was one of the global hotspots for soils capability research and that really set me on my way. Then I returned to the Victorian Department of Agriculture and continued to work as a research scientist but increasingly stepped up into research management and broader leadership roles within the department.

"In 2017, a CEO position came up with the new Soil CRC that was being established and I took the opportunity to apply for the role. What has been fantastic is that it has enabled me to take on a science leadership role, while also interacting with a whole range of stakeholders right across Australia.

"There have been a few sliding door moments and there have been times where I've seen a job advertised and thought 'that's a job I'd like to do in 5 years' time or when I've got a bit more experience', but then I've stopped and thought 'hang on, well why not now?' and to cut to the chase, I did put my hand up and got the job.

"Sometimes you're thrown in the deep end a bit or you're ahead of where you thought you might be in your career. If you make mistakes, you learn from them, but at the same time, you'll find that your colleagues and others will see a lot more in you than you might see in yourself.

"If you go into it with that perspective, that confidence, you don't have to be 100 percent correct all the time and so long as you have a rational, logical approach to what you're doing, people will understand that.

"The work is personally fulfilling because I feel that I'm helping to make a difference. I'm making one small contribution to a very big effort nationally and globally, around how we can sustainably improve our ability to feed the population, and at the same time help farmers make a profitable living. Helping others, contributing to a knowledge base of science, I'm doing something that is good for the planet, for people and the economy.

"In my current job as CEO of the Soil CRC, what I really find fulfilling is bringing partners together from different backgrounds from across the country, including researchers from different disciplines, and farmers and other research-users, and seeing the synergy that comes out of people looking at the same issue from different perspectives."

Michael's advice to aspiring soil scientists is to make sure your skills and knowledge are invaluable to others.

"Develop a real depth of expertise in a particular area so that you're one of the go-to people in your field. At the same time, have a breadth of knowledge, not just across technical or academic, but the industry context in which it happens or where it's important, be it agriculture, mining or engineering. As a soil scientist it helps to make your skills more resilient in the face of changing priorities."



Zeinab working with soils in the lab at the Institute for Molecular Bioscience, at The University of Queensland.

BOTH IMAGES: INSTITUTE FOR MOLECULAR BIOSCIENCE, UNIVERSITY OF QUEENSLAND.

Zeinab Khalil



Dr Zeinab Khalil is a Senior Research Officer in the Institute for Molecular Bioscience at The University of Queensland, and Co-Director of Soils for Science Program, the first national soils citizen science program.

Zeinab undertook a Master of Science in the School of Pharmacy in Cairo, Egypt, looking at the rapid detection of bacterial infections. This was followed by a PhD at The University of Queensland in the Institute for Molecular Biosciences, working with Professor Robert Capon.

Zeinab is recognised as an emerging leader in the identification and development of new medicines to treat diseases caused by pathogens. Her research has included developing highly efficient methods to discover useful new chemical and biological products in nature that are produced by microbes, including those found in soil. This has led to the identification of more than 15 new drugs targeting infectious diseases and attracted over $3 million in research funding.

"My dad is a surgeon and one day while I was waiting for him in the reception of the hospital, I saw an old man who was admitted to the hospital, and he looked very sick. A couple of days later, I asked my father about him, but he told me that this man had passed away because we could not find the proper antibiotic to treat the bacterial infection. I was very sad to hear that, and I decided to study medicines when I grow up, in particular antibiotics."

While Zeinab's research career started focused on treating pathogens that make humans sick, she has also diversified into studying other diseases such as crop and animal pathogens. Recently she discovered new natural product-inspired chemicals to treat fungal diseases on plant crops. The new agrochemical will help to support environmentally responsible and economically sustainable practices on farms, which in turn helps to enhance reliable food production.

"The best moment in my life is when we launched Soils for Science. Since the launch, Soils for Science has received 9,000 soil samples sent by the public and secured six partners - both of which are helping to find leads for new antibiotics and life-saving medicines. I was very much touched by the wonderful messages we received from the public when they appreciated our efforts and thanked us for this wonderful project.

"Antibiotic resistance is reaching a critical point around the world, and without the discovery and development of new, safe and effective antibiotics, the death toll could be staggering and the economic impact monumental. My work will keep Australians safe, so that infections in both humans and animals will remain treatable in the years to come.

"A library of approximately 100,000 Australian soil samples opens the gateway to tens of millions of microbial chemical defence molecules, only a small percentage of which are known to science. This resource will position Australian researchers to make exciting world-leading discoveries in basic and applied science, including new treatments for human and plant pathogens."

Zeinab says no career comes without challenges, but in science, overcoming those challenges will always be rewarding.

"Science is a wonderful career. There's definitely some ups and downs, but you will not find a career without any obstacles. In science, you will face an exciting world full of thrill, intellectual freedom, challenges to find new ideas and to solve problems and enormous happiness that comes with success."

Ben Macdonald



IMAGE: MACDONALD FAMILY

When Dr Ben Macdonald first entered the field of soil science, he had no idea it would send him everywhere from the wildlands of Vietnam to the shores of the Pacific Islands and beyond – helping boots-on-the-ground farmers and professionals alike.

Years later, Ben reflects on how soil science ticked all the boxes for his career.

"Much like understanding vegetation and why certain trees appear where they are, my driving factor was why certain soils evolved and understanding that evolutionary process," Ben said.

"Soil science struck the perfect mix between office and field work; I wanted a fundamental understanding of modelling, but also to be outside in the environment."

Currently leading research projects in Australian cotton production systems, Ben cut his teeth developing improved agricultural production systems nationally and internationally.

"I've been around the world with my career, looking at greenhouse gas emissions from agricultural production systems, measuring methane, nitrous oxide and carbon dioxide, and worked with small holder farmers in Vietnam, Tonga, Fiji, Kiribati, Tuvalu and Samoa to help improve agricultural practice," Ben said.

"The most rewarding part is talking to farmers about preliminary research findings on how to become more sustainable, then coming back the next day to see the recommendations already starting to be implemented – it's that feeling of, wow, I have already made an impact here.

"I'll always remember sitting in a small hut in Vietnam with a generational farmer and seeing the excitement on his face because we were there to help, and we were equally as excited because it was a rare opportunity for us to absorb years of knowledge."

Ben is also the recipient of the CSIRO Julius Career Award, which allowed him to visit and collaborate with researchers from Stanford University and with the Karlsruhe Institute of Technology on greenhouse gas emissions.

"This allowed me to connect with researchers in the field, which was an exciting and awesome opportunity," Ben said.

"I didn't think I'd have these experiences when I first started and I didn't know where it would take me.

"To aspiring soil scientists, it's a great career which opens lots of opportunities you don't think exist.

"You'd be surprised where a career in soil can take you."



IMAGE: UTA STOCKMANN

After the late 2021 Hunga Tonga-Hunga Ha'apai volcanic eruption the Pacific Community, Ministry Agriculture Fisheries, Forestry and Food, Mordi, and CSIRO collaborated to collect and analyse soil samples from tsunami and ash affected sites across the Kingdom of Tonga. The data will enable the development of appropriate soil management and policy.

Yunru (Chloe) Lai



IMAGE: DR ANDO RADANIELSON

Chloe is a postdoctoral research fellow at the University of Southern Queensland and with the Soil CRC.

In year three of her Bachelor of Environmental Management degree, Chloe got an internship with the Queensland government researching strategic tillage in no-till farming systems. This first sparked her interest in soil science.

"Understanding the dynamics between the physical, chemical and biological aspects of soil helps you be more connected to the environment. I started to identify myself as a soil scientist, then became truly proud of that identity", said Chloe. "The internship supervisor, Dr Yash Dang, eventually became my PhD principal advisor".

"In my PhD, I looked at how sodicity affects wheat growth in northern Australia. However, the more important question is, once we identified the larger spatial and temporal patterns, how could we help farmers better manage soil and yield variability to improve productivity and profitability?

"Ultimately I want to develop tools that can help farmers make timely, data-driven agronomic decisions. With climate change and increased variability within a season, most decisions are actually made in the field, right? So you can't really have a complicated model sitting on the computer at home because the farmer needs to make decisions when they're in the paddock looking at the crop. How do we make it mobile and easy to use so that a farmer will make the best decision at those moments?

"Fundamental to this is the availability and usability of data. We live in a data-rich environment. However, do we have the data needed to answer our research questions? Is the data suitable and at the right resolution to address farmers' concerns?

"We need to strike a balance between advancing the science and making a real impact for the farmers, how do we make use of what's available and prioritise what truly matters?

"An idea that is central to me personally is that we reduce the time lag between when the science becomes available and its adoption. This is what my current projects with the Soil CRC aim to achieve", said Chloe, "Having meaningful collaborations with, and valuable input from our industry partners, we are well-positioned to create decision-support tools backed by science that make a real impact on farmers".

Though still early in her career, Chloe has several highlights.

"Just one year into my PhD I gave an oral presentation at my first ever conference in Queenstown, New Zealand. Presenting my research and getting feedback from the wider scientific community was certainly confidence boosting."

Chloe presented 7 times nationally and internationally during her PhD alone.

Another highlight is soil judging.

"I learn how soils formed in different countries and why it's so difficult to standardise the vocabularies we use to describe soils across the world. The factors are unique in each region. Since I'm a modeller, it's rare that I actually get to go into the field. Soil judging is a good opportunity to learn those skills and provides great networking environments.

"Through conferences, soil judging and the Soil CRC, I've met people who share my interests, ground me and are a personal inspiration. There will be frustrating moments, and if you have those people, they can keep pushing you forward. "

"Soil degradation is serious" she says, "At times, you may feel overwhelmed by the urgency and complexity of the problem. It helps to have critical thinkers around you, even if you are not researching the same thing – conceptualising the research problem is important. The social interactions, particularly early in your career are important."

Chloe felt extremely lucky to have excellent support and mentoring networks during her PhD at the University of Queensland and postdoc with the Soil CRC.

Luke Finn


IMAGE: TERN AUSTRALIA

Luke Finn is a soil scientist with TERN Australia at The University of Adelaide. He graduated in horticultural science at The University of Sydney and then completed his honours project – 'The influence of Loessic topsoil on wine grape composition and quality in the Orange Wine Region, NSW' – for which he received First Class Honours.

When Luke started his horticultural degree, he was interested in propagating native plants and had thought about wanting to own a nursery. However, his career path was about to take a sharp turn as inspiring university lecturers in soil science helped him kick-start his career.

"Second year into my horticultural degree we had a subject called soil science, and my classmates and I were all a little naïve asking ourselves 'What's all this about? Why do we need to learn about soil?'

My first ever soil science lecturer was Stephen Cattle a bubbly, passionate soil scientist who ended up turning me towards the dark side and became my Honours supervisor," Luke said.

"After graduation Stephen put me onto Stuart Macnish and Bob Reid in Brisbane who were looking for a soil scientist. I worked with these guys for a few years and am grateful that they took me under their wings. I've had an ongoing mentoring relationship with them for the past ten years. Without those two fellas, I don't think I would have the career that I have now."

Luke worked at a Brisbane engineering firm called MWH, looking at reusing wastewater coming from coal seam gas exploration to irrigate crops and increase pasture production for cattle. From there, he moved into the Queensland government and was at the Department of Environment and Science as a Land Resource Officer, travelling around Queensland assessing soil erodibility in some of the Great Barrier Reef catchments. Since 2010, Luke has been the soil scientist for the TERN Ecosystem Surveillance team, which sees him spending lots of time in the field.

"To do what I do in my career, you need to engage in as much field related activity as you can to build up your understanding and knowledge," Luke said.

Luke thinks of his job as just one big adventure most of the time and says he gets to visit places that most people can't access.

"I have caught a helicopter into Staaten River National Park in North Queensland, and that's a national park without any roads, so being able to jump on a helicopter and go to work has been very special. I am paid to go camping across Australia for two weeks at a time with my work colleagues, who are now all close friends. I love it," Luke said.

Luke believes his drive to continue learning about soil comes from always asking questions, and the training he received from his mentors.

"For me having this big picture idea of the landscapes that we're living in is what drives me to continue learning and always asking 'why am I seeing what I'm seeing in front of me?' and 'how do I explain what I'm seeing?', and that's something that's come from my mentors and the training they've given me," Luke said.

"If you're wanting to be a field person like me, just get out as much as possible when there are field days being run, workshops, conferences, get a job or volunteer with organisations that do those things – and maintaining a network of contacts is important as well."



Inspecting and resampling a soil pit at UNSW's Fowlers Gap Arid Zone Research Station

IMAGE: AUGIE FACELLI

Aaditi Dang



IMAGE: MEAT BUSINESS WOMEN

When environmental engineer and PhD graduate Dr Aaditi Dang first looked at university, it made sense to turn her love of maths into a career in engineering, but she decided to take it one step further.

"I always loved maths, and people suggested engineering, but I always wanted to help in some way," Aaditi said.

"I stumbled upon environmental engineering when looking into degrees and realised this was the perfect way to connect with the world around me."

Jumping into the degree with vigour, Aaditi completed her bachelor's and went straight into her PhD, which she said was both rewarding and crazy.

"I had always dreamed of doing a PhD when growing up, so when I was offered the chance, I thought why not, and I took the chance" Aaditi said.

"What a mad, harrowing experience it was but I finished and even won the CG Stephens Award, which is given to the best PhD thesis in soil science by Soil Science Australia – that became a highlight and made me realise how worthwhile the experience was.

"As great as it was, it was in this process that I discovered I didn't want to continue in research right away."

Like many proud parents, Aaditi's mother kept an eagle eye on job opportunities, which started the journey down this diverse career path.

"In the job application process, my mum saw a presentation by Oakey Beef Exports at a careers day that said they wanted engineers," Aaditi said.

"When she mentioned it to me I thought it was unusual, but I went for it and ended up spending four years at Oakey, learning so much about myself and working in environmental management.

"It was here that I discovered how passionate I was about environmental management, especially in agriculture. Agriculture is such a big part of our lives, yet there is so much we don't understand about how much external effort is required.

"In 2022, I applied for a full-time position at AAM Investment Group and I have gone from the environmental management of one site to looking after quite a few different assets. "I am learning so much every day and connecting agribusiness with environmental goals has been really rewarding."

Aaditi said that while she doesn't work directly in research anymore, she still sees research in action.

"Agriculture is crucial to the livelihoods of many in Australia, but I found that the environment has become a hidden aspect in the worlds of so many people," Aaditi said.

"Because of the job I'm in now, I get to look at research for projects that may provide a benefit to the agricultural asset, see that research implemented, and then see the results from that research. I make sure that while businesses and farms take care of production, they work in a sustainable manner because healthy soils equals more productive agriculture."

When it came to advice for next-generation soil scientists, Aaditi said it was important to keep an open mind about your career.

"The amazing thing about soils is that it can open such a huge network of careers for you," Aaditi said. "It's not just research and consulting anymore; it can take you to mining, agriculture, and industry. Soils will always be relevant."



IMAGE: YINGCAN ZHU

Getting down and dirty at the World Science Festival, Toowoomba

Robyn Doyle


IMAGE: WENDY ROWE

Robyn Doyle's journey began when she took a year off after high school to work on a farm and complete a rural traineeship. She then studied a Bachelor of Agricultural Science at the University of Tasmania and went on to have jobs in forestry – surveying plantations for pests, diseases, soil, site problems – and in government as a plant pathologist.

After a few years in administration while having children, Robyn spent ten years working for a soil scientist in a small private company looking at soil for construction and on-site wastewater application, before starting her own business in 2018.

"I studied agricultural science because I wanted a job that took me outdoors. My soils lecturer was so enthusiastic about landscapes and how they formed that he took us on fantastic field trips, and we spent a lot of time mapping soils," Robyn said.

"My first job out of university was conducting surveys through forestry plantations across Tasmania. I was there for four years but did not really enjoy the job.

"I then worked as a plant pathologist studying soil-borne fungi, bacteria and nematodes and looking specifically at club root in brassicas and diseases in Pyrethrum. My career then took a sideways turn for many years as I put my children first.

"Working for a small business, I noted a lack of people with soil knowledge designing onsite wastewater systems, so I worked hard to attain a Building Services Provider (hydraulic) licence. They are hard to get because you need to work for someone who will provide on-the-job training for at least two years. Because I struggled to learn and find answers to problems when designing wastewater systems, I started a monthly networking event, 'Dirt Drinks' in the hope that we would share knowledge.

This event has become very successful and is now registered as a Continuing Professional Development event.

"In 2001, I worked on an archaeological dig in Northern Greece, and I found it fascinating, learning the area's history and why there might have been so much soil erosion.

"Starting my own soil testing business (Doyle Soil Consulting) has been highly challenging but extremely rewarding. I worked 7 days a week for the first 2-3 years but now I have found great people to work with me. I love the flexibility and diversity of my role, a good mixture of field work, reporting, and communicating with clients, plumbers and regulators."

Robyn loves teaming up with people to solve real problems. Her job is now flexible, so she can often be away, working remotely. She hopes the next generation of soil scientists will continue to work hard, grow and be curious about everything.

"Ask questions, be curious, and consider running your own consulting business. Don't be afraid to make mistakes, just own up, fix it and move on. That's how we learn and grow. Great communication is essential. People understand if you are busy, as long as you let them know they aren't forgotten. Take the time to collect as much data as you can, as you never know when it might come in handy. And travel, travel, travel. Any chance you get!"


IMAGE: RICHARD DOYLE

Digging a soil pit in deep sand at Blackmans Bay, Tasmania

Ruby Hume



IMAGE: LACHLAN PINK

We've heard of the world wide web, but for The University of Adelaide PhD student Ruby Hume, it was a radio interview about the 'wood wide web', the communication method used by plants through soil, that launched her into a diverse and satisfying career as a soil scientist.

"Until then, I hadn't thought about this whole other world underground and that was the first thing that made me think about soils as this really interesting concept," Ruby said.

"The more I learnt, the more I was struck by how incredible and complex the systems were, and I became fascinated. What really grabbed me was the combination of biology, chemistry and physics all rolled into one."

Working with TERN soil samples, Ruby soon met a diverse crew of people who helped launch her into her PhD.

"Working with the soil samples was a really good opportunity because it led me to work with TERN for my honours, processing soils in one of their labs, getting hands on experience, then from that applying for a PhD in agriculture, which I was successful with," Ruby said.

"It's so interesting, there's so much learning and I've been humbled to meet and learn from people who hold a stake in soil – such as scientists, farmers, land holders, students, and other researchers."

Ruby said being introduced to the world of soils was like opening a flood gate.

"It's mind-blowing how many options there are; it's like I had my eyes opened and it was endless," Ruby said.

"There's research being done at The University of Adelaide in soil microbiology and the amount of life in soils, so it's fascinating to see how rich in diversity it is."

Now approaching the end of her PhD, Ruby said her focus is on the world of agriculture and food security.

"The issue of food security and how we're going to feed our populations is so important and relevant to everyone because we won't exist if we don't get on top of soil health, security and sustainable practices going into the future; that's what really drives me forward in my career," Ruby said.

"While many of us are fortunate to live without considering where food comes from, I think understanding the importance of that will make the whole world a better place, so it's exciting to be part of that.

"The best piece of advice I have for aspiring soil scientists is to have a chat to people in the field and say yes to opportunities because it gives your path a chance to unfold in ways you never thought it would."



In-field infrared scanning of cores enables in-situ collection of soil property data



Sampling at Acid Soils SA trial site established to test amendments and management approaches to treat soil acidity

IMAGES: BONNIE ARMOUR, RURAL SOLUTIONS PIRSA

Kylie Bradley



IMAGE: PHOTO STUDIO WEST END, QLD

Kylie Bradley's career has been anything but linear. She exited both her honours, then her PhD at a time when soil science wasn't the thriving arena it is today and faced many challenges that future soil scientists may encounter, coming out the other side with brilliant advice.

The first in her family to become a scientist, Kylie's career really progressed when she called an old contact at ExxonMobil, after a hiatus overseas, to ask them to be a referee for a consulting position – they refused, asking her to join them instead in a role focused on contaminated land management.

ExxonMobil was flexible with both location and working conditions, so contemplating an interstate move and being pregnant with her first child, Kylie said the decision to take the job was an easy one. Kylie stayed with Exxon for eight years, grateful for the client-side experience she gained, before spending more time overseas and then returning to private consulting.

Kylie's career has had many highlights.

"A few years ago, we won a project for a mine site after it had a significant underground fire. I had not worked on a mine site or with coal before, but I managed this massive year-long project on contaminated land. The speed at which they needed responses was critical to keep them operating, so it was a real challenge but rewarding."

Kylie's love for the job ultimately led to promotion to Principal– while tackling imposter syndrome, something many women (and men) suffer that deters them from backing themselves and progressing their careers.

"For a couple of years, my boss had asked me to take a promotion to Principal; however, in my head, a Principal in contaminated land practice was a little bit like a professor at University – they are the experts in their technical field and I'm a generalist, so I pushed back," Kylie said.

"Eventually my boss said, 'there is room for a Principal to have different roles and not all of them technical', and that changed everything. I was the first internal promotion to Principal within the company and the first female promotion to Principal, so a lot of good came out of it."

"One of the things I said was he probably didn't suffer from imposter syndrome but to my surprise he said he did, and this was his reality too."

Kylie said she still deals with imposter syndrome in her career but says there is room for many different styles.

"The question I ask myself is always, 'are you giving it the best you possibly can?" Kylie said.

Working closely with graduates in her team leader role, Kylie had some wisdom to impart to those still studying, or recently graduated.

"If you meet someone who is more senior, ask to connect and stay in touch with them; I personally do a lot of this with young professional groups," Kylie said.

"Be prepared to tell us how your qualifications can be applied on the job, or if you have no on-the-job application, what you need to translate qualifications to something commercial.

"When talking to a professional, find out about them, their company and industry, so they don't think you're there just because you had the opportunity.

"If you have clear intentions about this being the right career for you, then bring a good attitude, lean in and be prepared to learn your craft."

"Aspiring soil scientists need to know that academia and government aren't the only places to get a job – there's private industry, commercial, contaminated land management and more," Kylie said.

"There's so much out there; it's a great career to explore."

David Coventry AO



IMAGE: MARGARET COVENTRY

David Coventry is an Adjunct Professor and retired academic whose deep interest in agriculture took him to places he'd never imagined as a student at university.

David graduated in Agricultural Science from The University of Melbourne in 1970 and followed this with a masters and diploma of education. He then moved west to take on a PhD at The University of Western Australia.

"It was a love of agriculture and wide, open spaces, plus an interest in biological sciences that brought me to this career path", said David.

While David values a holistic approach to the sciences, he started his career in biochemical aspects within defined parts of the plant system. From there his work expanded to tillage systems, soil acidity, rhizobial ecology and resource efficiency.

In pondering his career highlights, David offers the insight that "without exception, the best moments have been when I had the opportunity to make contact and interact with farmers and farming communities.

"For example, in the mid-1980s while working with the Department of Agriculture in Victoria, I was involved in developing a very successful system-based model for farmer participation, where we were taking applied technology (in this case tillage systems) and adapting it to specific farm situations."

With his active involvement, the approach was applied more broadly in Australia and also overseas in Tibet (China), Iraq and Syria. In India it was applied to enhance rapid large-scale adoption of zero tillage by small and medium scale wheat farmers.

"It was fascinating and enriching to meet with very eager and switched-on farmers in all of these countries", said David.

Many research questions have underpinned David's work. "One that particularly intrigued me is 'what are the soil processes that are involved, or change, that are part of facilitating or driving successful zero tillage and sustainable systems', said David.

"And we know this thing called sustainable agriculture works with different soil types, in different climatic zones and systems, and different farm sizes or levels of capitalisation.

"Is it the same 'driver' across all systems? Importantly you now see that my skill base is not only plant based but has a very strong 'soils' emphasis," said David.

One of the most important formative experiences for David was the opportunity to spend more than two years living and working in India early in his career when he took an appointment as an agronomist at the Indo-Australian Sheep Breeding Farm in Haryana – transplanting himself and his young family to the edge of the Indian desert. At the time, the state of Haryana was undergoing much change in its agriculture as part of the green revolution.

According to David "this did much to shape my career. There I learnt about the great diversity of farming systems and the importance of understanding all of the many components that make a farming system."

Reflecting back on his career, David says "a highlight, which has given me much satisfaction, is that there has been a tangible and recognisable change and benefit to the agricultural industries that I have worked with."

David's advice to young, aspiring scientists is "always seek to work at a level a little higher than where you think your skill set is now. You will be surprised how quickly and naturally you meet your emerging career challenges."

Mike McLaughlin



IMAGE:LIELLIE MCLAUGHLIN

Mike McLaughlin is a Professor in the School of Agriculture, Food & Wine, and Director of the Fertiliser Technology Research Centre at The University of Adelaide.

Mike grew up in a small town in Northern Ireland - not on a farm, but his friends were farmers, and he helped them around their farms. His farming friends, together with inspiring undergraduate lecturers, sparked his love of soil science.

He completed his undergraduate training in science at The University of Ulster, Northern Ireland before completing a master's degree in soil science at the University of Reading in England in 1979.

Mike then left for South Africa for a few years to conduct research for the Soils and Irrigation Research Institute. He realised if he was going to work in research, he needed a PhD, so Mike undertook a PhD at the University of Adelaide in 1983. He went on to multiple roles with CSIRO in Canberra and Adelaide and worked in the fertilizer industry as a Technical Manager.

"I published my first paper in 1982. It was a review paper from my Masters, using dyes to trace water movement through soils. That was my first foray into the publication world, and when that was accepted, it was a big moment.

"You're always curious when you get some data that doesn't make sense. I love outliers, because outliers usually mean there's something happening that you don't know about already (or you've messed up!), and the excitement of designing experiments to follow that up is great. Fundamental knowledge is important, but the other question I always ask myself is, 'is someone going to use this?' That's why I always like to keep an applied aspect to my research, knowing that knowledge is useful and thinking about what we can improve with that knowledge."

Mike has received many accolades and has been a part of many groups helping to improve soil science research. He now says seeing his research being used in the real world is the most fulfilling.

"In 1998 an overseas mentor recommended I join an advisory panel to the international metals industry called 'the Eco-toxicity Technical Advisory Panel'," Mike said.

"Six scientists from around the world advise the industry on new science and regulation. It really changed my career outlook because I was mixing with many different organisations, disciplines and mining companies who are in the know, and I'd team up with them, which really helped my research for more than a decade. It was fantastic.

"Now I love research and supervising postgraduate students, and get excited as they go on to do good things and become consultants, regulators, technical managers, lecturers and professors. It's great to see that knowledge being passed down to the next generation.

"I also love being able to put ideas into action, seeing my research picked up by an environmental agency, by an international metals industry or by a fertilizer company and seeing it get used practically. While publishing papers is good, things that have real world impact are much more fulfilling I think, than seeing the next paper published. Except your first – your first one is a big milestone."

Mike hopes the next generation of soil scientists will continue to be diligent, remain enthusiastic and motivated, and always hunt for great opportunities.

"Work hard! Especially when you first start a job. Enthusiasm and motivation will outshine knowledge by far, I think. Knowledge can be gained over time. Always look for a new opportunity, don't necessarily sit in one job for 50 years, there's great ways that soil science knowledge can be used in different industries these days."

Uta Stockmann



IMAGE: NATHAN DYER

Dr Uta Stockmann is a great example of how good mentors and industry connections can positively shape careers.

Finishing (the equivalent of) her master's degree in Germany, with a major in soil science and remote sensing, Uta credits the enthusiasm and innovation of her mentor and supervisor, Prof Thomas Scholten with boosting her into the field she is in today.

"My degree was really diverse, but I ended up with a major in soil science and remote sensing because Prof Scholten joined the team," Uta said. "Prof Scholten and his team were among the first in Germany at the time, to apply pedometric techniques to soil assessment, which was exciting.

"He also helped with the direction of my master's thesis, which I did in a European-funded biodiversity project that investigated how land-use change impacts soil carbon stocks.

After completing her masters, Uta's networks came in handy. Whilst in Australia for work and holiday, Uta was given contact details for The University of Sydney's Prof Alex McBratney, who was in search of someone to help with a project assessing soil conditions in a private irrigation district in the Hunter Valley.

Alex then asked Uta to conduct a PhD with him and encouraged her to apply for a scholarship for international students, with Uta taking the chance. "The project involved quantifying soil formation using sophisticated laboratory techniques," Uta said. "My thesis ended up winning the CG Stephens PhD Award from Soil Science Australia, which was a great achievement."

"I had used highly laborious methods in the past but I wanted to investigate more rapid, efficient and effective measures; that's when I ventured into proximal soil sensing, point based sensors, and digital soil mapping and assessments."

"I was lucky to present my research work at international and domestic conferences on soil science; which helped me to create different career opportunities," Uta said.

Prof McBratney also appreciates the power of connection, urging students to branch out.

"He encouraged me to join Soil Science Australia, which gave me lots of opportunities in travel scholarships, awards, and even positions – as I became the branch president of Soil Science Australia for New South Wales."

Uta's career came full circle when she was offered a role as a researcher and lecturer at The University of Sydney, allowing her to encourage students in the same way her previous mentors had.

"Interacting with students and influencing the curriculum was exciting, and I enjoyed it very much," Uta said.

"I've run into students from my soil science courses who have become soil scientists, which makes me happy because I know I've had a positive impact."

Uta now works with CSIRO Agriculture and Food and has had the opportunity to apply her skills in pedometric and proximal soil sensing to real-world challenges, and extend the science even further.

With years of knowledge now under her belt, Uta's advice for the next generation is to always go for opportunities. "A change can be daunting but see it as an opportunity, always, and seek the positive in your experiences," Uta said.

"Don't think you can't apply for something because you won't qualify; it doesn't hurt to try.



IMAGE: SEONAID PHILIP

Photo opportunity during a soil survey of the Roper river catchment in the Northern Territory

Silvana Santomartino



IMAGE: TYLER ALBERTI

Surrounded by her parents' inner-city vegetable patch, Dr Silvana Santomartino grew up with a strong appreciation for the importance of soils. Now, Silvana runs her own consultancy firm helping others to appreciate soils and soil management.

"My parents were from small Italian villages; dad was a shepherd and mum worked the farm, so when they migrated to Australia, they created the largest suburban vegetable patch you've ever seen," Silvana said. "I learned a lot about soil health and sustainability from my parents and had a really great geography teacher in high school, so I knew I wanted a career in natural sciences from a young age."

Silvana studied soil science at university, completing her honours and PhD in soils and geochemistry.

"There was a mining boom when I completed my PhD, so I literally submitted my PhD thesis and was on a plane to work in mine site geochemistry the next day."

Silvana ventured from mines to urban development projects, then to Golder Associates to gain mentorship in the soil science space. Then, together with her mentor, Silvana took the daring step of starting her own consulting firm – PSK Environmental.

"We provide soil science consulting services to the resource, civil, industrial, and government sectors in the fields of acid sulfate soils, contaminated land, and agricultural land," Silvana said.

"We proudly employ locally with an emphasis on diversity and inclusivity and have a wide range of people here, which makes us unique.

"It's a challenge to run a business; you need a wide set of skills to enable you to win the work. You have to be able to complete the technical aspects of the project, manage and inspire a team, ensure timely project delivery, maintain excellent quality of work that aligns with our standards, and track budgets."

Every day is a new, exciting challenge for Silvana.

"I've worked on hundreds of projects and every day there is a new question posed by my client, so that's what drives me. I get to bring together all my soil science and chemistry knowledge to find a solution for that client so they can manage their project."

Silvana said she was proud of how far PSK Environmental had come. "This year we were one of six consultancies appointed to the Brisbane City Council Panel for Infrastructure and Design Consultancy Services. It was an exciting win for us, and you feel really proud if you have something like that happen as a small business."

Silvana works closely with students through her firm and in her role as an adjunct industry fellow at Griffith University and said she gave students experience-driven advice.

"I receive roughly 150 resumes for graduate positions, although not many will be from soil science students. One thing I value is a graduate who has completed honours or a research project because it means they've had time to think about the science and really consolidate what they've learnt in their undergraduate years," Silvana said.

"I recognise not everyone can, but if you're able to do honours or PhD, it's a great opportunity to prepare yourself for the wider world.

"When you graduate there are multiple career pathways, so if you venture into one and it doesn't work, don't give up. Soil scientists have such an important role, and the world needs them. Soil science is only going to become more and more important as we look for ways to meet demands for food and solve environmental issues."



IMAGE: JACINTA SAAD

Soil sampling for a bridge project in Brisbane

IMAGE: ANNE SCHNEIDER

Investigating the management of drilling muds in Chinchilla, Queensland



Emily Leyden


IMAGE: MARINA BIRC

Dr Emily Leyden is a Research Fellow at The University of Adelaide. Emily holds a PhD in Science from The University of Adelaide and specialises in soil biogeochemistry in coastal soils. Emily says she has always been interested in environmental science, environmental systems, and nature in general.

"I worked on a project during the Millennium Drought that was to do with acid sulfate soils, and through that pathway I developed an interest in the complexity of soils and the different processes in soils. Soils encompass all parts of science which I love.

"I did a very broad undergraduate degree, and then I did my honours in lake sediment paleolimnology.

I then worked at the Environment Protection Authority for five years, where I worked closely with, and developed an interest in, what's happening below our feet.

After a career break, I decided I would like to specialise in soils, and so began a PhD in soil science at The University of Adelaide.

"I love the diversity of lab work, office work and field work in soil science. Going to different locations and being in different landscapes and geomorphology is one of the best parts of soil science. I have really enjoyed looking at how the hydrology, climate, and the geology work together to have that soil in that particular place.

"I think probably the amount of field work which I did in my first job really defined for me that going out and observing the environment was the type of job for me. It's very difficult to look at soils from an office perspective. You really have to get out there, be in the environment, and observe them in place. In terms of looking at soils outside the environment sphere and more within the agriculture sphere, going to the National Soil judging competition in 2019 was really a defining moment in terms of understanding the complexity of classification and why classification of soils is so important for our understanding of soil constraints, how we make the most of them, what issues there are, and how we can protect soils.

"The thing with soil is there are always questions that need to be answered. One question always leads to another.

It's a bit like a 3D detective puzzle. So much is still unknown in soils – really we have just scratched the surface. Even just over the last 10 years, what we know about things like soil biology has changed immeasurably in such a short amount of time. So, it's quite an exciting field to be in. We know a lot about the above-ground processes, because we can see it, whereas below-ground is more difficult to observe and measure. We have to make a lot of predictions and there are a lot of questions that come from that, so there's always something new and interesting in soils.

Emily says if you want to work in soil science, take as many hands-on learning opportunities as you can.

"Make use of any practical opportunity you have. I think that's key. If you want to work in soil science, you must acknowledge that you have to be in the environment, you have to see the soils in place.

If you want to be a good soil scientist, put yourself forward for any opportunity that allows you to learn from other soil scientists around you, go to different environments, and continually build your skill set.


IMAGE: LUKE MOSLEY

Looking for soil organic carbon in the saltmarsh trial site, St Kilda, South Australia

Brendan Malone



IMAGE: BRENDAN MALONE

There's no such thing as six degrees of separation in the world of soil science, which is something that CSIRO's Dr Brendan Malone says is one of the best – and most rewarding – parts of his career.

Starting an agricultural degree in his mid-20s, Brendan said he was thankful to divert his career from an urban tree amenity business to soil science.

"I grew up in the country with a hobby farm, orchard, and veggie garden, so I always had a strong affinity with agriculture, but I never thought I'd make a career out of it," Brendan said.

"The University of Sydney Bachelor of Agricultural Science degree was awesome; it really stretched me intellectually. Not only that, but soil science training at Sydney Uni is world-class because there are so many great experts there, so I learned a lot."

Moving from a bachelor's to a PhD, Brendan focused on the budding, innovative area of digital soil mapping.

"It was the ideal choice because it mixed my passion for soil science with my love of geography, mapping, and digging deep into statistical methods and maths," Brendan said.

"Digital soil mapping received massive intellectual interest around the time I started my PhD due to a global fervour to develop comprehensive soil maps of the world. This fitted squarely with my project as there needed to be ways and methods developed to realise this audacious goal.

"It was this international flavour of the project, together with the goal of working on something really special, that made my PhD experience such a wonderful one. Looking back, it is fantastic to see now that digital soil mapping is used as an operational tool right throughout the world."

Brendan said it was, and still is, an exciting time for soil science.

"With digital soil mapping, we're taking existing approaches and leveraging technology, like remote sensing information and statistical data science methods, to provide useful information about the condition and status of soils so people can understand and manage soils better," Brendan said.

"It's also so fulfilling because no one is doing this alone – there's a national and international community who have the same mindset, so to be in that community and collaborate with people all around the globe and in Australia, that's one of my favourite aspects of soil science."

Brendan said there are a variety of paths soil scientists can take, but the key takeaways stay the same. "Keep an open mind, be prepared to really stretch yourself and take as many opportunities as you can."

"In undergrad and postgrad, opportunities you may not expect will be presented to you and the best thing you can do is take risks, because even if it falls apart there's always a positive to come out of it, such as a new idea or way of thinking.

"I did research because it offered a lot of freedom and I wasn't constrained to one area or task-orientated work, but there are lots of careers out there: it's not just research and academia.

"This career offers a range of opportunities, and it's the succession of all your experiences that will help you choose where you want to be."



IMAGE: UTA STOCKMANN

Soil sampling at CSIRO Boorowa Farm in south-eastern NSW

Gerry Turpin



IMAGE: GERRY TURPIN

Gerry Turpin is a Mbabaram man from north Queensland. Initially employed at the Queensland Herbarium as a Scientific Assistant, a scholarship awarded by the Queensland Government later saw Gerry majoring in botany at the University of Queensland (UQ).

With his degree, and career suggestions from Professor Susanne Schmidt at UQ, Gerry turned his focus to ethnobotany, paving the way for his current role, managing the Cairns-based Tropical Indigenous Ethnobotany Centre at the Australian Tropical Herbarium. The latter is run in partnership with James Cook University, Queensland Department of Environment and Science and CSIRO.

When asked about the link between soils and ethnobotany, Gerry highlighted that everything in the environment is 'kind of connected'. For example, a project Gerry undertook with the Queensland Herbarium on regional ecosystem mapping used soil mapping alongside field surveys, analysis of aerial photographs and satellite imagery, and assessment of other data such as geology and historical survey plans.

Gerry said, "recognition of connections between soils, landscapes and vegetation communities is part of Indigenous knowledge." A community would know, for example, that a trip to, say, Sandy Ridge country, meant going to the place where medicinal plants grow. Or that frequent cultural burning would not be advisable on *Debil-Debil* country because the underlying stony ironstone dictates that revegetation will occur slowly.

As an Indigenous ethnobotanist, Gerry loves being on country with clans or family groups where he is always learning something different from each community. Gerry has a strong cultural commitment to facilitating effective partnerships that support Indigenous communities to protect, manage and maintain their cultural knowledge on the use of plants.

Indeed, Gerry believes Australia needs to ratify the *Nagoya Protocol on Access and Benefit Sharing* to ensure Australia complies internationally with putting benefit sharing in place for protection of Indigenous knowledge.

A memorable part of his career was being part of the Indigenous round table discussions with the Queensland Government that eventually led to the '*Biodiscovery and Other Legislation Amendment Act 2020*' in September 2020 – Queensland was the first jurisdiction in Australia to introduce best practice biodiscovery legislation ('*Biodiscovery Act 2004*') for those undertaking biodiscovery activities.

Another highlight of Gerry's career was when he was recognised by the community in 2013, taking out the first ever science award at the '*National Indigenous Deadly Awards*' for Best Scientist or Science Project of the Year category. Commonly known as *The Deadlys*, the awards have been a celebration of Australian Aboriginal and Torres Strait Islander achievement over the years in music, sport, entertainment and community.

When not in the office, on country, or sharing his knowledge and experience with school kids, Gerry is undertaking a part-time Masters research project related to Aboriginal medicinal plants. For the project, he is examining plants with antioxidants with the hope his work will lead to a cure for *inflammatory bowel disease (IBD)*. He is also working on an Australian Research Council-funded (ARC) project with the University of Queensland which involves working with Indigenous communities to commercialise native bushfoods and ornamental plants.

Gerry has been a member of many Indigenous steering groups and advisory committees, including spending six years on the *Ecological Society of Australia* Board of Directors with the role of Indigenous Engagement. He is now the Chair of the organising committee helping to run the 2026 conference in Australia for the *International Society for Ethnobiology*. This group is a global, collaborative network of individuals and organisations working to preserve vital links between human societies and the natural world. Ethnobiologists recognise that indigenous peoples, traditional societies, and local communities are critical to the conservation of biological, cultural and linguistic diversity.

Rick Flitton



IMAGE: LIN FLITTON

Starting his career in soil late in the piece at age 42, Rick Flitton said his move from military and marine engineering to field science was the best decision he ever made.

Although Rick completed his Environmental Science degree with Central Queensland University in 2006, soil wasn't initially on his radar.

"I planned to do something slow-paced in the University after being injured in my previous job, however, it was the very last bridging course that caught my attention: geology.

"It was on climate in Australia and the different elements to that and I was hooked, so I enrolled in Environmental Science."

Rick spent 18 months carrying out surveys for farmers planning to sub-divide, looking for rare, threatened, or endangered plants and animals, before a move to the Department of Natural Resources in Alice Springs led him, fortuitously, to meet TERN's Associate Professor Ben Sparrow.

"Ben was my boss back then, and when he called a few years later to offer me a job at TERN I took 18 months leave without pay, then ended up staying with TERN for five years.

"It was a very fast career leap from University student in 2002 to becoming the only Soil Scientist on a national survey program in 2011.

"During the five years I worked for TERN, we were inundated with floods, fires, and ants. We swam with freshwater crocodiles and saw parts of the country that few people have seen.

"It was a privilege and pleasure to be involved with the whole program."

Rick and his team gathered more than 16,000 soil samples that have the potential to help scientists across the world. He encourages anyone interested in a diverse and rewarding career to consider being a soil scientist.

"In the years I worked for TERN and the Department of Natural Resources, I never found exactly the same thing," Rick said.

"With vegetation you often find the same species in lots of places, but soil is different and every hole you dig is different. That's what always led me to the next site. You might call it the thrill of the hunt.

"It was one of the most rewarding experiences I have ever had, and I would absolutely still be doing it if I hadn't retired early.

"All I can say is go for it."



IMAGE: TERN AUSTRALIA

Soil samples from one TERN field trip laid out for drying

Gaus Azam


IMGE: PETER MALONEY

Dr Gaus Azam is a soil scientist and manager of the 'Re-engineering Soils' project funded by the Department of Primary Industries and Regional Development (DPIRD) and Grains Research and Development Corporation (GRDC).

Gaus holds a PhD in Applied Soil Physics from The University of Adelaide, a Master of Science in Agricultural Systems from the Asian Institute of Technology (AIT), and a Bachelor of Science in Agriculture, Khulna University. He has more than 20 years of years of experience in Australia and overseas.

Gaus was inspired to pursue a career in agricultural science after growing up on a remote farm in Bangladesh.

"My parents had eight kids, and a little farm in Bangladesh, and they cropped that little farm to feed us – that inspired me to do bachelor of agricultural science and to research innovations to improve farming practices," he said.

"I saw that my dad's crops were always bigger than our neighbours. He always had good management practices in place for high productivity of the paddock.

"During a master of agricultural systems and engineering, I researched 'how different cropping systems affect soil health and how to improve soil health' and then went to work in Thailand for few years.

"In Thailand, I worked on very degraded soil because they crop anything and everything on the hills without adopting sustainable soil management practices.

"I came to Australia when I had a scholarship opportunity to do a PhD at The University of Adelaide. I found out soils in southwestern Australia are very hostile with multiple constraints, so the focus of my PhD was how to improve the establishment of plants on hostile soils.

"My first post-doctoral role was at The University of Western Australia researching interactions between soil and plants.

"I then took a role as a scientist in DPIRD researching innovative ways to manage subsoil acidity under broadacre farming. I was very successful in delivering that project, and we demonstrated that by managing subsoil acidity and compaction, we can double the grain yield and crop water use efficiency.

"After nearly seven years at DPIRD, I got the opportunity to lead the 'Re-engineering Soils' project - it's one of the biggest soil research projects in the country!

"I am very privileged to have had all these opportunities and I feel very satisfied when I see farmers, the primary producers of food, are using my research findings on their farm. I feel great now as I can contribute towards mentoring and training up any young people, from DPIRD and universities."

"To people who want to do good in life, whatever they study for their career path, the first thing you need to do is study it well with a full heart. If you are good at what you do, you will have opportunities like me. I always had job offers before I completed my degrees, in Bangladesh, in Thailand and even in Australia. I am always hungry to develop further and further."

"At the end of the day, as a soil scientist my goal is to help in maintaining sustainable soil health for generations to come.

"Now I am trying to answer two different but linked questions. Can you halve the inputs but produce the same amount food? – this has implications for managing the effects of climate change. Or can you use the same amount of inputs and produce double the amount of food? – this is important for managing global hunger.

"Both sides are important. On one hand, there are small farmers, who may want to minimise chemical use when producing a crop. On the other hand, there are commercial farmers, who produce and export millions of tonnes of food to fight against global hunger, we need to help them produce more food with the same inputs but by improving soil health and crop water use efficiency.

"When I see my research changing farming practices and food productivity, and when farmers give you good feedback and are happy to see you, that is very satisfying. It is fulfilling to see experiments that have for many years with great results sustained.

"As a soil scientist, I work with Mother Earth - if I can contribute to re-engineer and maintain soil health, that is one tick on my bucket list.

Anna Hopkins



IMAGE: EDITH COWAN UNIVERSITY

Growing up in a science-filled family with fond memories of field trips with her botanist father, Dr Anna Hopkins always knew she'd have a career in science.

Going on to study botany at university, Anna didn't realise that the spark for her fascinating career path in soil science would begin with a classic university student decision.

"I chose soil science in my second year because it was a good addition to botany, but I could also do the second-year subject without the prerequisite of studying it in my first year," Anna said.

"I didn't realise at the time just how interesting it would be."

Anna soon launched into her honours, focused on mycorrhizal fungi – described as an "internet" within soil – for the way in which the fungi link with plant roots to share resources – and after completing her PhD, also on fungi, soon found herself at the other end of the university in a teaching role.

"I was teaching microbiology and plant pathology, which I really enjoyed, but my teaching was based on books and papers, and I wanted to teach from my own experience so I could make it more relatable," Anna said.

Taking a short detour away from soil, Anna worked in Tasmania, New Zealand, and Sweden looking at invasive forest pathogens to see how climate change shaped pathogens and their coping mechanisms.

"I worked in one of the best fungal research laboratories in the world in Sweden, and it was fabulous because I got to see all these new and emerging DNA-based techniques that were developed in these labs but not used extensively elsewhere," Anna said.

Anna eventually moved back to Australia, where she could pass the invaluable knowledge on to the next generation of soil scientists in her home country.

"It was really exciting being back in Australia with this knowledge because these new techniques enabled us to more thoroughly characterise what's in soil, how it responds to climate-related disturbances, such as heat waves, drought, and fire, as well as how the functioning and resilience of soil microbes are affected by urbanisation," Anna said.

"Right now, I'm working out how different parts of an ecosystem work together and highlighting the less well-researched and understood parts of the ecosystem.

"So molecular methods that were initially expensive and time-consuming are now widely accessible, and we're getting to understand cryptic organisms, what they're doing in our ecosystem and how they're supporting the ecosystem as a whole.

"It's also exciting teaching students because soil biology is an emerging field that's only going to get bigger and more important because soil is so crucial.

"Seeing students get excited about it is amazing and showing them they get to work in both the field and labs, with interesting people, while making a difference to their future, and our future as a whole, is great.

"Soil biology is an area where you can make an impact and an important contribution – that's what I love."



IMAGE: CITY OF JOONDALUP

Collecting Quenda scat during a survey at Craigie Bushland, City of Joondalup, Western Australia

Ashlea Doolette



IMAGE: KERYN LAPIDGE

After more than a decade in soil science, Dr Ashlea Doolette has ticked off a plethora of milestones – from completing her PhD studying local agricultural soils, as well as soils from Alaska, Patagonia and the Central Alps in Switzerland, to challenging fundamental understandings of soil chemistry and teaching the next generation of scientists.

Ashlea said the best part was that she fell into the field of soil science by accident.

"I was introduced to soil science in a fresh-water ecology class during my Bachelor of Science degree, and I remember thinking, how cool is this?" Ashlea said.

Ashlea's study led her to research the different forms of organic phosphorus in soils, focusing on how they cycle in soils and how their concentrations in soils are shaped by different plants and climate interactions.

"I started looking at ways to identify organic phosphorus soils, in particular using solution NMR spectroscopy and the techniques or methods being used in this area – that's where it all began," Ashlea said.

"This study led me down a really interesting path of progressing how we identify different types of organic phosphorus in soils and whether phytate, which is the main storage form of phosphorus in seeds, is only found in seeds or whether it is also present in leaves, roots, woody material, fruiting bodies like grapes, native plants such as eucalypts and all sorts of different matter, and what drives these changes in both plants and soils.

"Soil science is a challenge and a puzzle; it's having a question that you're trying to find an answer to but coming up with an answer that didn't even cross your mind.

"Changing direction isn't a downfall – you have to think outside the box in this field."

Ashlea said finding this new direction in science was inspired by a boots-on-the-ground trip to the Victorian Alps.

"You can only learn so much by reading; it's not until you go out and experience it firsthand that you have a lightbulb moment," Ashlea said.

"I'd looked at soils from alpine regions in Victoria and New South Wales during a post-doctorate project, but the samples had always been collected for me and came from a jar, so it wasn't until I worked with TERN and physically ventured into the environment that I was able to fully understand, in a bigger context, the systems and field sites I'd been looking at.

"This allowed me to prove or disprove what I thought should occur, which helped me change direction – that's when it all clicked."

Now teaching the next generation of aspiring soil scientists, Ashlea said both she – and her students – are fascinated by the diversity in career paths.

"Although soil science has been around a long time, there's still so much we don't know; there's so many aspects of soils that people haven't considered or researched yet," Ashlea said.

"For example, soil forensics can take the smallest amount of soil from a person's shoe or clothing and match it to soil at a crime scene thousands of kilometres away or discovering new species of soil bacteria that have the potential to improve human health."

"My tip is there are a lot of pathways within soil science, and many may not be your typical pathway or something you know very little about, but you just have to find the niche you love because there's so much to do in this space."



IMAGE: ASHLEA DOOLETTE

Field work in the mountains of New South Wales



Some TERN sites, such as this one in the Bogong High Plains, are relatively remote. Sample collection here involved a 10km round trip carrying 20 kg

IMAGE: CHRISTINA MCDONALD

Mervin 'Pogs' Manalili



IMAGE: MERVIN 'POGS' MANALILI

Travelling the world to gain experience in your chosen field is a dream for many, and it's one that PhD student Mervin 'Pogs' Manalili has thoroughly enjoyed.

Born and raised in the Laguna province of the Philippines, the natural drive to discover and learn was fostered by Pogs' parents, who both taught at university when he was growing up.

Pogs undertook a Bachelor of Science degree in Agricultural Engineering in the Philippines, and then started his career at an international non-profit research institute looking at water resource management for rice paddies. He then took the brave step of pursuing his master's degree, majoring in soil science, in Belgium.

"I was taken under the wings of world-class soil science researchers and professors, so it was easy for me to realise that I wanted to dive deeper into the world of soil science, which is what I did when I moved from Belgium to Switzerland to join a research project on the effects of soil compaction in agricultural fields caused by heavy agricultural tractors and implements," Pogs said.

"After a couple of years, I went back to the Philippines and resumed research in rice-based cropping systems, this time to study the effect of water-stress on different rice plant cultivars.

"A few years later, I still wanted to pursue a PhD in Soil Science, which led me to Perth."

Pogs said the best part of research was being able to change tack as your understanding or passion for a different area grew.

"My PhD research is on the molecular scale of soil science, studying the components, nature, and dynamics of soil organic carbon through soil fractionation and mid-infrared vibrational spectroscopy," Pogs said.

"Before, when I was studying soil science for agriculture, food production, and food security, the question that drove me back then was, 'how can we maintain soil health in arable lands – so we can intensify our crop production, conserve other land types and not cultivate them?"

"Now the key question is, "how can we improve our understanding of the soil carbon dynamics so we maintain soil health, not for agriculture this time, but for sustaining ecosystem services in the soil matrix and how can we improve our soil carbon sequestration techniques through improved and updated understanding of soil organic matter?"

For Pogs, the highlights so far have come in waves.

"One of the best moments has been visiting different landscapes in Europe, Asia, and now Western Australia. Another is when I present or communicate my science to other people, peers, or even to advanced researchers, and they tell me that they can sense my enthusiasm in what I do.

"The reason I'm enthusiastic is because the work and research I do is deeply linked to finding solutions to global issues like food security, land degradation, climate change mitigation. Everybody needs to be concerned about these issues because, as the saying goes, "there's no Planet B.

Gaining experience with every new day, Pogs said he had advice for future soil scientists. "My advice may seem foreboding, but in general, do not go into the field of research to get rich; you must have passion and grit because you have to get your hands dirty, and not everything goes according to plan.

"You must have that strong reason to keep going because failures will come, and most aspects of soil science research take time. However, it is also fulfilling, and you'll have the chance to improve your craft and grow professionally.

"In soil science, I've found a career, not just a job."



IMAGE: P HAGENBUCHER

Using a soil penetrometer to measure the extent and depth of subsurface compaction in a field for dryland cropping

Cristina Martinez



IMAGE: UQ SCHOOL OF AGRICULTURE AND FOOD SCIENCES

Since 'falling' into soil science during her PhD years, Dr Cristina Martinez has shown how interesting – and diverse – a career in soil can be with regard to career progression, overseas travel, and the chance to teach the next generation of soil scientists.

"During my Honours year, my supervisor won a grant to undertake soil carbon research and asked me to collaborate, so I fell into soils and worked on that for four years before I moved to Italy, where I took on a range of roles, including working as a post-doc in soil carbon and biogeochemical cycling and teaching English," Cristina said.

"I moved back to Australia to be a lecturer in soil fertility at The University of Queensland and have since joined the Grains Research and Development Corporation as a manager to find new, innovative research to improve grain grower profitability."

As a lecturer, Cristina said she aimed to always inspire students and create a strong connection to soils.

"We walk on soil, we eat from soil, soil underpins our existence, but most of us don't appreciate how important it is," Cristina said.

"I knew that my second-year course was compulsory for agricultural science and environmental science students, so in the first lecture I would say, 'by the end of this course, my aim is that you're here because you see the significance and relevance and want to be here.

"These students have no idea where they're going to end up, so having a fundamental understanding of the significance of soils is important; not just from a career or professional perspective, but from an everyday person and environmental perspective."

Cristina said she would often hear from students who wanted to further their knowledge in soils. The advice she gave them stemmed from personal experience.

"I send students to Soil Science Australia because they have a huge range of seminars and social events that you can take part in and build networks – that's important," Cristina said.

"If there's one lesson I would pass on to students, it would be this: when opportunities arise, take them, and make the most of them. Sometimes you start off and it might not feel quite right, which was certainly the case for me. However, while things might be challenging, it's good to push yourself as it helps you to grow personally and professionally.

"Even if something doesn't work out, if you're trying your best and you make a good impression, you never know where that will lead you. There's no single right method for success in this field."

Cristina said she was thankful for the experiences that soil science had provided.

"For me, having a career in soil is fulfilling because I'm working in a field of existential significance and making contributions that raise awareness and improve outcomes, whether that's environmental or agricultural, all surrounding that fundamental resource of soil," Cristina said.

"Making an international move was the best thing I ever did. I got great exposure to thinking and doing things differently, worked at various research institutions in Italy, was a part of numerous European-wide projects, and collected soil cores 2,000 to 2,500 metres above sea level up in the Dolomites, which was surreal.

"The opportunity to get out of your own space and travel provides brilliant mind expansion and has benefits from both a professional and personal development perspective.

"I think it makes you a richer person and scientist – I hope my students see that one day too."

Louise Barton



IMAGE: ROSANNA CANDLER, UWA

Dr Louise Barton's career path was not necessarily planned in great detail, instead, she tended to make the most of opportunities that came her way.

In high school, Louise excelled in economics, English literature and physics. To improve her strength in science, she studied a Bachelor of Science at the University of Western Australia and added soil science to diversify her units – not realising this choice would shape her career.

"I was always interested in improving my knowledge in areas that I thought I should strengthen, which is why I did science instead of economics or social sciences," Louise said.

"While studying soil science, my lecturers gave me an understanding of how soil science is applied to a number of sectors, including agriculture, mining and environmental science, and that really appealed to me."

Louise had never intended to do honours – or a PhD – but both choices led her down rewarding career paths.

"I didn't have a specific career plan, but I had some guidelines along the way, and it's led me to some great places," Louise said.

"After completing Honours, I worked with the Department of Agriculture as a soil conservation officer in a small country town called Moora, getting experience in soil mapping and learning how soil science knowledge is important when taking care of our land.

"I soon realised I wanted more of a leadership role, and to do that I had to do a PhD.

"I decided to travel to New Zealand for my PhD and gain experience outside of agriculture, and skills that I could later use in agriculture. I ended up working on a project at the Forest Research Institute investigating the fate of waste-water nitrogen that was applied to a local plantation forest, which was great.

"A key question I've explored over the last few decades is how to best manage nitrogen fertiliser to still get good productivity from, say, turfgrass or grain production, with minimum impact on the receiving environment."

Louise has now come full circle, working as an Associate Professor in the same university she first studied, teaching the same subjects that sparked her love of soils. She has experienced some great moments.

"For me, there have been many career highlights; like when I've had a successful research project and industry have been really appreciative, or when a student walks away from my unit with an increased passion or knowledge of soil science," Louise said.

"Working with colleagues both internationally and nationally to achieve even bigger goals has been great too. Plus I have had lots of opportunities to travel overseas."

Louise said her advice for aspiring soil scientists was simple.

"First of all, don't underestimate your abilities," Louise said.

"I was never a star student, but there's a lot to be said for hard work and persistence.

"Don't be scared by what you don't know; just recognise it, be curious and endeavour to fill that gap in your understanding.

"Take some additional chemistry or physics units if you can because there's a strong need for people with this background in soil science.

"Also, it can be quite daunting in seminars or lectures with all the information you're being offered, but don't let that put you off your studies.

"If you have questions, ask and learn from others because with some persistence, you'll get it."

Louise said there was no wrong decision when it came to soil science.

"A lot of people are worried that they're going to make a mistake; they think they might take the wrong job or choose the wrong research or honours project and I always say to students that the topic you research today may not be what you do for the rest of your life" Louise said.

"If it's going to put you one step forward in your knowledge and skills within soil science, it will be a good step.

"Soil is amazingly complicated; that's what makes it interesting and challenging but there's so many career options out there, I see them come up every day, so follow your interests, get involved, make the most of the opportunities that come your way, and you will succeed."

Rob Fitzpatrick



IMAGE: GREG RINDER

With a career that spans more than 50 years Professor Rob Fitzpatrick has led major, multi-disciplinary research projects and conducted more than 500 specialised soil-regolith investigations and surveys, covering a variety of regions worldwide.

While completing his studies at the University of Natal in South Africa, Rob said his final year inspired him to focus on soil and help future students.

"I got to work with practitioners in the field, where as a result, I was asked to be the senior author of a paper before I had even graduated," Rob said.

"That has always stayed with me in the sense that it inspired me to give back to students."

Rob was appointed as a Research Scientist/Pedologist at CSIRO's Division of Soils in 1983, where he worked for 40 years undertaking many practical field and laboratory investigations across Australia, including Norfolk Island and overseas.

These investigations involved solving complex soil-related problems for a wide range of industries and agencies to develop innovative and practical techniques, methods and guidelines, which have been used to obtain critical information and solve complex forensic investigations as part of the Centre for Australian Forensic Soil Science.

"It has been both challenging and rewarding to have successfully presented this complex, new information as evidence to juries and judges in Supreme Court hearings throughout Australia in high-profile criminal cases such as homicide, kidnapping, counter terrorism and major environmental pollution," Rob said.

During his time at CSIRO, Rob also supervised 25 masters and PhD students at The University of Adelaide and Flinders University, providing those students with what his previous mentors and professors did for him.

"I had a PhD student who did very well, and we decided that his external examiner would be the same person who examined my PhD 50 years ago," Rob said.

"So, it explains to you how important it is to have mentors."

In 2011, Rob was appointed Professorial Research Fellow and Inaugural Director of the Acid Sulfate Soils Centre at the University of Adelaide, where he continues to educate and inspire his students.

Rob said he hopes future aspiring soil scientists will engage in the same kind of collaboration that inspired him to become a soil scientist.

"Enjoy your work and freely share expertise and data to inspire others."



IMAGE: MARK RAVEN, CSIRO

Determining soil sample colour by visually comparing against the Munsell Soil Colour Charts



Checking if sediment build up at a tidal restoration trial site is keeping pace with sea level rise

IMAGE: EMILY LEYDEN

Luke Mosley



IMAGE: JAYLIE RYAN

Luke currently teaches and is a researcher in soil and water science at The University of Adelaide. He has a Bachelor of Science and PhD in Environmental Chemistry from the University of Otago, New Zealand.

Luke's interest in science and the environment started early. "I did poorly in humanities subjects at school, so it seemed like a natural decision to do science.

"I spent much of my spare time surfing, diving or fishing with my family and friends. At school, I thought I might be a marine biologist, but at university I became more concerned about how humans are polluting the environment, and that pushed me to focus more on chemistry as my studies progressed."

Luke's career has taken him to some really interesting places. Following his PhD Luke undertook postdoctoral fellowships in the USA, New Zealand and South Pacific. Next, he moved to South Australia where he obtained a position at the Environment Protection Authority (EPA), looking at acid sulfate soils in the Millennium Drought, before joining the University of Adelaide a decade later.

"Working in the Millennium Drought was a really rewarding and high-pressure part of my career. There were unprecedented acid sulfate soil and water quality risks that emerged, and we were doing a lot of new science to understand and make decisions to protect ecosystems, communities, and industries. We had great resources for research in this crisis, and many long-term science relationships were created," Luke said.

Being elected President of Soil Science Australia from 2018-2020 was an honour and career highlight for Luke.

"I led a transformation to a more outwardly focussed organisation that raised the profile of soils and the need for their protection nationally. In this role, it was really good to meet and work with a whole range of new colleagues and see soil rightly take its place much higher on the national agenda.

Science questions keep Luke awake at night and he is constantly thinking of new ones that drive his research agenda.

"A major focus of my current work is the effects of climate change on soil and water quality. Together with many excellent students and collaborators, we have advanced the understanding globally of how climate change can affect soil and water quality. This is vital research as we see more droughts, flooding and sea level rise – and there is a need for science to inform how best to predict and manage their increasing severity."

Luke regards his move back to a research career at The University of Adelaide, after working at the EPA, as a career-defining moment.

"I gave away the security of a permanent job in government but felt I needed a change, and had the support of my family to take that leap. Working at both of those organisations has proved very worthwhile in terms of developing my academic skills while applying them to solving pressing environmental issues."

Training and mentoring students and seeing their development as environmental scientists is most fulfilling to Luke. "It is the top priority in terms of my current work, and it's very satisfying to see students subsequently succeed in their careers."

"Many of the applied projects we have done have led to improvements in the environment and it has also been really rewarding to see how our science has helped benefit ecosystems and the communities they support.

To aspiring scientists, Luke recommends soil science wholeheartedly as a rewarding and highly valuable career path, with many opportunities.

"If you are an early career soil scientist I would say science is a long journey, so try to work through any barriers and keep moving forward as best you can; focus on quality rather than quantity of science outputs; look for collaboration opportunities to expand your body of work; build and maintain a wide network and develop applied skills to diversify your employment prospects; and lastly, be kind to yourself and others, help people as much as possible."

Tim Cavagnaro



IMAGE: TIM CAVAGNARO

Tim Cavagnaro is a Professor of Soil Ecology in the School of Agriculture, Food and Wine and Associate Dean Research Partnerships, Faculty of Science Engineering and Technology at The University of Adelaide. He received a Bachelor of Agricultural Science with First Class Honours and a PhD in Science from The University of Adelaide, and a Graduate Certificate in Higher Education from Monash University.

Tim said he has always had an interest in the natural world, and his original intention was to study plants and botany at university. "I got interested in how plants interact with micro-organisms, both beneficial and pathogenic, and then I realised that as many of those organisms live in the soil or come from the soil, to understand plants and how they interact with microbes, I really needed to understand the soil environment, so that's what got me into soil ecology".

After completing his undergraduate studies at Adelaide, Tim was employed as a Research Associate on a project that saw him working between Adelaide, Denmark and Japan, looking at the phosphorous physiology of plants and plant-microbe interactions.

Later in his career, while working in California, Tim was assigned to a project for the California Energy Commission and the Governor's office (which was Governor Schwarzenegger's office at the time) trying to identify the potential impacts of climate change on agriculture, which was then still a relatively novel concept.

"I led the preparation of a report that was commissioned to look at potential impacts of climate on agriculture, accompanied by a host of reports from other groups looking at different sectors across the economy, all of which led to changes in legislation mandating fairly aggressive reductions in greenhouse gas emissions," Tim said.

Besides watching his PhD students graduate and going off to do amazing things, Tim considers the highlight of his career was having the opportunity to travel the world to work on various projects.

"I've been very fortunate to travel extensively throughout my career," Tim said.

"I've been involved in research in North America, Europe, South-East Asia and Sub-Saharan Africa, and getting to go to different places and work with different people is a great privilege as well."

According to Tim, as soil is the basis of terrestrial life, we need to understand more about it because it is essential for our survival.

"We live in a time of tremendous change, both in terms of how we manage our environment, but also through environmental change, so the over-arching question that interests me is, 'how are changes in management/environmental change impacting upon soils and the ecosystem services that they provide?'," Tim said.

"Whenever I do research, I try to make sure that it has a link to the 'real world'," Tim said.

"For me, it's really important to do research in that context and see the development of knowledge through to some sort of impact somewhere in the real world."

Tim feels that now is such an exciting time to be a soil scientist, working with an incredibly complicated material that's the basis of life and has a role to play in solving the big issues of our time.

"I can just see the growing importance of these kinds of skills, and certainly the opportunities are tremendous. Soil lies at the heart of solutions to major issues, including climate change, food security, and biodiversity loss."

Richard Doyle



IMAGE: RICHARD DOYLE

Dr Richard Doyle is an Associate Professor in Soil Science at the University of Tasmania and the Tasmanian Institute of Agriculture.

Starting his studies in physical geography, majoring in geology, Richard eventually moved into the soil science offerings at university.

"Growing up in a semi-rural New Zealand environment, the son of a country school headmaster, and being outside in the environment all the time had a big impact on me," Richard said.

"My father was also very curious about geology. He studied it, and he would ask us to explain things, or he would tell us about landscapes as we travelled through them.

"While at university, I clearly remember enjoying a field trip where we looked at some soil profiles and discussed how they were basically a chemical chromatograph of nature. I wouldn't say it totally convinced me, but I did like it.

"In my first job in the New Zealand Forest Service, we were basically helping map NZ rainforest soils in wilderness areas. What started as a holiday job turned into a two-to-three-year job before I went back to university to do Honours on the mineralogy of aggregates in New Zealand rivers used for making concrete, which is perhaps a little industrial, but it does show how sediments are important to society.

"My first full-time job was with the state government in Tasmania, mapping soils to protect soil resources from urban encroachment, erosion and to plan irrigation."

Richard's next position was at the University of Tasmania, where he could do a PhD while teaching. He has been there for 27 years now.

"I've had a few career highlights. I was quite proud of our team for the excellent soil conference that we ran with the Tasmanian branch of the Australian Soil Association in Hobart. The current Soils CRC that I'm working with is also a very significant high point. The Soil CRC is a major venture, providing an avenue for work, employment and focus for soil scientists and allied disciplines.

As my career winds down, one of the things I'm thinking about is 'what's the next thing after the Soils CRC for the next generation of young soil scientists?', and our focus is certainly very much around PhD programs and building that emerging set of capable soil scientists for the future.

"The things that drove me the most were soils and landscapes: how landscapes are put together and how weathering earth and materials fit within those landscapes, because from that stem all functions and processes for life.

"Training students, seeing their growth and developing an interest in soils and eventually building their own companies and businesses are things that have driven me in my work.

"Standout moments in my career have been participating in ACIAR (Australian Centre for Agricultural Research) projects in Papua New Guinea, working on the roles of soils in food security, receiving a Rotary International scholarship to teach soil science and landscape science at the University of Namibia in Africa, which was amazing, and my work on a geo-archaeological art project in Greece for my Masters and PhD," said Richard.

"My work is fulfilling because it constantly provides a level of intellectual challenge and exposure to bright and emerging soil scientists. Soil is a very diverse, complex medium that's always throwing out challenges. There are so many facets to soil challenges that need improved solutions."

"My advice is to focus on what drives your curiosity and internal passion. This may change and evolve, and you may have to think of innovative ways to support what you want to do. You need to be ready to work with other teams, don't be too proud, and be adaptable. Find out what you really like doing, find the experts in those areas, talk to them, ask them what could be done or what should or hasn't been done yet.

"It's always good for young people to seek a good mentor, someone they respect. Don't be frightened to contact them and ask them for tips. Be interested and passionate, keep moving towards what you enjoy, and you'll be surprised how you can make that energy, creativity, drive, and confidence work for you."

Lynette Abbott



IMAGE: LYNETTE ABBOTT

Majoring in botany, followed by a PhD in soil microbiology, Lynette has been a long-term researcher and university lecturer in soil biology and soil biological fertility.

"My lecturer in mycology at The University of Sydney was inspirational – a great communicator who was enormously enthusiastic about plants and mycology", said Lynette.

Her research career began at The University of Western Australia studying symbiotic associations formed by arbuscular mycorrhizal fungi, especially in pasture plants.

"I received a postdoctoral fellowship to investigate the roles of mycorrhizal fungi in agriculture in making more efficient use of phosphate fertiliser. It later evolved to take on the broader aspect of soil biology related to plant nutrition and soil health.



IMAGE: CASSIE HOWELL

Inspecting landcare project at UWA farm

Collaboration with eminent soil scientist and plant nutritionist, Dr Alan Robson was particularly beneficial and also interesting because it required cross-disciplinary studies in different aspects of soil science and plant science."

It was also at The University of Western Australia where Lynette's teaching career began, eventually embracing the integration of knowledge of soil biology with plant nutrition, and other areas of soil microbiology and environmental science, including the roles of soil organisms in the restoration of disturbed land following mining.

"Subsequently, I developed workshops for the farming community, which explored soil biological fertility and the wide-ranging roles of soil organisms associated with soil bio-physical and bio-chemical processes which are pivotal in sustainable land management and best practice farming systems.

Career highlights for Lynette include diving deep into research questions around beneficial interactions between plants and soil organisms.

"Studying complex processes is very satisfying. There are no simple yes / no answers when addressing the full dimensions of soil function. Investigation of the living aspects of soil in a physical and chemical environment within the framework of time and space is both challenging and rewarding."

"An overriding question for me was how do you capture the full benefits of soil biological processes in farming systems?

As some land management practices can work against soil biology, the objective is to work out how to minimise potential constraints and maximise soil biological benefits.

Another highlight was the development of resources for land users, including the SOIL HEALTH app. This free app was funded by the Australian National Landcare Program to provide essential information about complex aspects of soil health in a digital format. The app includes an eBook ("SOILS ARE ALIVE"), which is a summary of key points about soil health, and podcasts which expand on the key points summarised in the eBook.

Lynette points out that there is great satisfaction in conducting research on soils in different environments and under different management practices. It is also rewarding to collaborate in research and to teach others about soils, whether they are children, gardeners, land managers, university students or school students looking for a science project. It is a process of continuous learning for everyone involved.

"I have had many opportunities to travel throughout my career," said Lynette. "In addition to attending conferences, I have taught soil biology short courses related to organic agricultural practices to students at Kerala Agricultural University and Amity University in India.

Lynette's advice to students and early career researchers is to take opportunities as they arise, including in areas which might be unfamiliar. Collaborate and learn from exploring new ideas and situations.

Alex McBratney


THE UNIVERSITY OF SYDNEY / JAYNE ION

Alex McBratney is Professor of Digital Agriculture and Soil Science at The University of Sydney. He is best known for major contributions to soil science and agriculture through the development of the concepts of Pedometrics, Digital Soil Mapping and Precision Agriculture.

Coming from a farming background, when Alex was beginning university, he tried to find something that interested him that was related to farming but wasn't necessarily just agriculture.

"That's when I discovered something called soil science, so I decided to study that, as it also involved things that I was good at such as physics, chemistry, maths and geography," Alex said.

Not being the type of person who liked to move around a lot, after finishing his PhD, Alex travelled to Australia, where he joined the CSIRO in Brisbane for seven years in a research position.

"But I also fancied the idea of teaching soil science," Alex said.

"So, when the opportunity came up to get a teaching and research role, I went for that and came to the University of Sydney in 1989, and I'm still here."

In 2014, for major research accomplishments in his field, Alex was awarded the highest honour recognised in the soil sciences discipline.

"I feel my greatest achievement in all of this has been getting the Dokuchaev Award, given every four years by the International Union of Soil Sciences (IUSS). It is really the highlight in soil science to receive that," Alex said.

"It's also very fulfilling when you talk to government and give them some ideas, and they take up those ideas, and you can see that it's filtering out into society."

Most of Alex's research came about while lecturing on soil science at the University of Sydney – finding that his answers to students' questions and the subject matter felt lacking and incomplete.

"The things that I have worked on, like digital soil mapping and precision agriculture, have all arisen from trying to teach students and realising what you're telling them doesn't add up or could be answered better," Alex said.

"That's why I think teaching and research go so well together, and teaching is as important to research, as research is to teaching."

Alex hopes the next generation of soil scientists will continue to investigate and develop what is already known about soil.

"Sometimes I say to people that 50 percent of what we know about soil isn't quite right, and the other half is wrong. So, a good place to start is to question everything."


IMAGE: DAMIEN FIELD

Inspecting lithosol near Whithorn in south west Scotland

John Leys


IMAGE: JAANA DIELENBERG

John describes himself as semi-retired, however he runs a consultancy, and is an honorary researcher at The ANU, CSIRO and the NSW Department of Planning and Environment.

John joined the workforce as an extension officer in the NSW Soil Conservation Service (SCS), helping farmers with clearing and cropping to reduce wind erosion in the mallee. It soon became apparent that Australian-based research on erosion was badly needed.

A 1982 drought shifted John's career path to dust. A hydrologist by training, John had rain gauges set out on experimental areas on the Hay Plain.

"I regularly read the rain gauge, but it was full of dust. I asked my colleague, "where did this come from?" and he replied, "we'd better go for a drive and find out", says John.

In 1983, the SCS won a research grant to build a portable wind tunnel to investigate how dust behaves.

"With the help of the WA Department of Agriculture and CSIRO, we built Australia's first fully calibrated field wind tunnel. Over the next decade, we learned that: soils with >13% clay content are erodible to wind and should not be cleared; 50% ground cover mitigates wind erosion, and dust contains, on average, about four times the nutrients of the soil it came from."

John focussed his attention on dust storms during the 1994 drought.

"We used Bureau of Meteorology data going back to the 1940s to measure the extent and severity of dust storms. The limiting factor was the availability of the observations made with data updated annually", he said.

"In the 2002 drought, a massive dust storm hit Sydney. I emailed everybody in my email contacts asking them to note what colour the dust was, what direction it had come from, how far could they see, and send photos. I got over 200 replies in 24 hours, spawning the birth of DustWatch – a group of volunteer observers reporting dust events. What was missing was where dust was not noted. We set about building relatively cheap dust monitoring stations and had them operational by 2005."

A massive dust storm hit Sydney at the end of the Millennial Drought. It was called "Red Dawn" – the colour of the sky when people woke up on 23 September 2009. DustWatch had 40 stations operating that day.

"I took 40+ interviews with the media, and we answered all the big questions on the day due to the availability of this real-time data", said John.

"But we still couldn't say where the dust had come from. That question took another ten years (2007 – 2017) to answer. In collaboration with many federal and state agencies, we developed and delivered monthly national vegetation cover data for Australia. Much of the infrastructure and advice on how to do this came through TERN. Data from this work is now freely available on the RaPP Map website."

In his last decade of work, John turned to understanding and implementing methods of how best to use science to answer wicked problems.

"I built a Knowledge Service team with Aboriginal cultural staff, an archaeologist, GIS experts, facilitators, a social scientist, an engineer and a data analysist. With this diverse team, we made inroads into cultural science, fire science, natural resource management and soil erosion. I learnt that people are both the cause and solution to many environmental problems. We have to work with culturally diverse people and use the best available science."

A career highlight was winning the NSW Premier's Prize for Science & Engineering: Innovation in NSW Public Sector Science and Engineering for the work on Community DustWatch.

John's advice to young soil researchers is to link up with others that share your passion, "be collaborative, not competitive, find areas of science with elbow room, i.e. a place that is not already crowded, and remember to enjoy yourself and have fun; there are many exciting places and people to visit and work with."

IMAGE: JAANA DIELENBERG



John Leys talking to NRM practitioners about the importance of vegetation cover for conserving soil and how to measure cover with RaPP Map

Julia Jasonsmith



IMAGE: MARGUS LAPP

Navigating the path to your ideal career is rarely smooth; however, it's often in the process of accepting opportunities you'd never considered – or pivoting – that you find your true passion.

Dr Julia Jasonsmith, Director and Environmental Chemist at Murrang Earth Sciences, is a great example.

"I studied Ecology at Otago University in New Zealand because I really liked the outdoors and didn't want to be stuck inside an office, which is ironic because I'm a consultant working mostly from the office now," Julia said.

"Ecosystems are broad and complex, so I studied a range of subjects in ecology, but realised in first year that it wasn't living organisms I enjoyed researching — they kept dying, and I couldn't bear it — it was the more physical basis for ecosystems such as soil and water.

"I liked the chemistry aspect of it; it was really rewarding."

Julia's study led her overseas to research sediments and lake ecosystems in environmental chemistry, then across the 'ditch' to Australia to do honours, and then a PhD on the origins of salinity in the Hunter Valley.

It was after Julia's PhD that she encountered the first roadblock and realised the importance of pivoting and being quick to accept opportunities.

"When I left university to get my first job, I found a lot of jobs in water were snapped up, but there was an opportunity in soils, doing contaminated land work," Julia said.

"I quickly found that you can have an idea of what you want to do, but you get bumped in the direction where the work is, and that's not bad — in fact, it can be really rewarding.

"I originally studied so I could work outside in the environment, then I moved from mostly water to mostly soils, and while I work outside less than I'd like, I still get to do a lot of hands-on work and have a lot of variety in my day."

Julia said despite the changes there was always one question that stuck in her mind.

"What drove me then, and what drives me now is, what is the chemical basis for life? It sounds like a really big question, right? But chemistry drives the whole system.

"Having the right proportion of nitrogen to carbon in the soil will make all the difference between a plant starving or getting the nutrients it needs – I saw this in my undergraduate years and just thought, wow, this is amazing."

When it came to advice for the next generation of soil scientists, Julia said that while it could be difficult, it was a rewarding career.

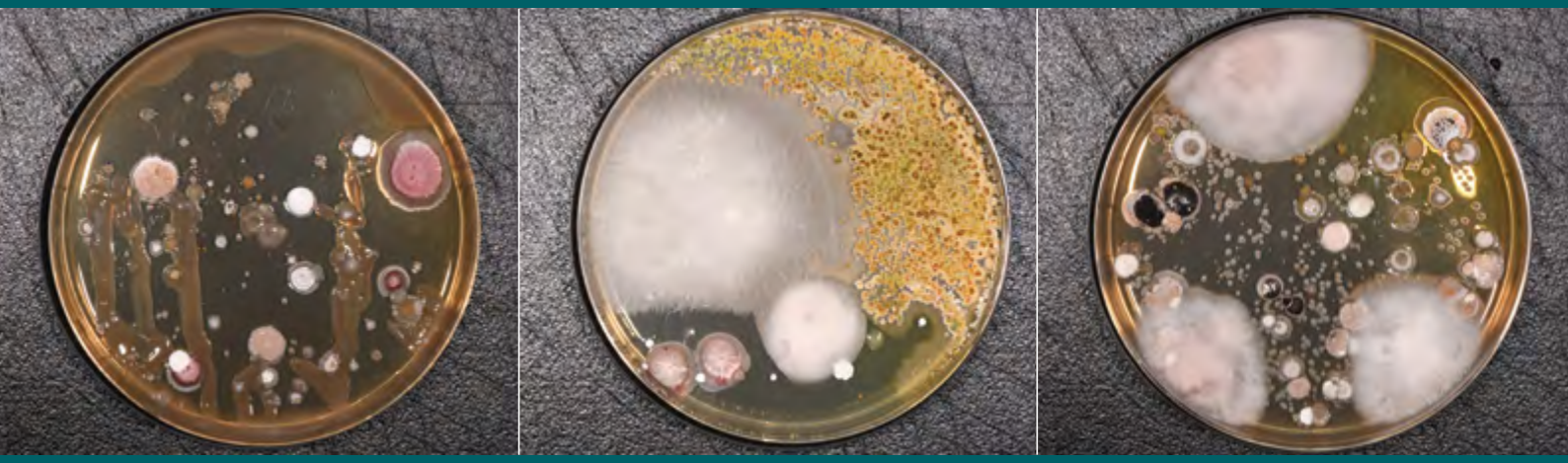
"Soil science is technical, and sometimes it's hard to understand undergraduate lecturers. They're talking about orthogonal, triangular? What? But in the end it's hard for everybody, and the people who make a good career of it aren't necessarily the ones with the best marks but the best at working with their knowledge.

"You don't have to be a total gun — a lot of it is applying the science, and that part is really fun. Just be prepared to go where your career takes you.

"I get to make mud pies for my job and get dirty — how cool is that? Especially in Australia where the variety of soils is so amazing.

"You could be playing with soil that literally bends like plastic, and I've seen it break big drill rigs because it was so strong. Then you have soils that just fall apart. Soils are amazing."

Are you a soil citizen scientist and want to help discover new life-saving medicines?



Superbugs are becoming increasingly resistant to antibiotics and threaten to cause 10 million deaths per year worldwide by 2050. In Australia, the death rate from antibiotic-resistant bacteria is higher now than 10 years ago. But the answers may be hiding in soils, and citizen scientists are helping to unearth them.

More than half of all antibiotics available worldwide have been developed from microbes found in soil and nature.

Australia's vast and diverse landscapes are ripe for the discovery of microbes that could be developed into new antibiotics and other life-saving medicines.

Soils for Science is an Australian-first citizen science program dedicated to finding new antibiotics needed in the fight against the scourge of drug-resistant infections, better known as superbugs. Soils for Science is a program run by the University of Queensland Institute for Molecular Bioscience.

Citizen scientists can request a soil kit to send in samples. Soils for Science researchers will test the soil samples looking for life-saving antibiotics! During the process they create amazing, detailed images of bacteria and fungi that are fighting it out in the soil beneath your feet, and you can check out these images in their gallery.

Go to imb.uq.edu.au/soilsforscience to request a soil kit, learn more and to see the gallery.

PETRI DISH IMAGES (ABOVE): ONCE YOU SEND IN A SOIL SAMPLE, SCIENTISTS GROW CULTURES OF THE MICROBES IN A PETRI DISH. IT TAKES 6-8 WEEKS FOR THE MICROBES TO GROW ENOUGH TO SEE THEM WELL.

A SOILS FOR SCIENCE SOIL SAMPLE BAG READY TO SEND IN FOR ANALYSIS.



ALL IMAGES: THE INSTITUTE FOR MOLECULAR BIOSCIENCE, THE UNIVERSITY OF QUEENSLAND.

TERN Australia's support for soil science

Soil is both a natural resource and a public good that underpins wider sustainable development. Soil is a critical component of all ecosystems and a basic resource underpinning food production and the functioning of terrestrial ecosystems. Knowledge and understanding of its function and properties are vitally important in ecosystem management. Managed carefully, soils are a reusable resource, but in a scale of human lifetimes, they cannot be considered as a renewable resource.

The importance of healthy soils is being recognised in recent and national and international policy. Soil health is becoming a central element of the research and innovation program of the European Union, aiming to reach a 75% of healthy soils by 2030, and Australia's policy is also recognising the central role of soils to our sustainable development – for example, the National Soil Strategy 2021-22.

The United Nations 2030 Agenda for sustainable development increases the demand on soils to provide food, water and energy security, protect biodiversity, and mitigate climate change, increasing the centrality of soils in global environmental and development politics. Sustainable management of soil health is important to achieving several Sustainable Development Goals.

Australia is fortunate to have a large amount of soil profile data based on observations and measurements taken over many years by dedicated researchers and which are publicly available through State and Federal government agencies as well as some universities.

Regrettably, these data are collected and managed by a broad range of custodians across the country, for their own specific business purposes and in disparate data systems. The result has been that researchers and practitioners interested in using these datasets have, in the past, had to integrate source data from individual custodians on a case-by-case basis.

To address this issue, TERN and CSIRO built the SoilDataFederator to unify and serve data to users quickly and without preparation, with the data remaining managed by the individual custodians.

Another important product from TERN and CSIRO is the Soil and Landscape Grid of Australia. The Grid combines historical and current data generated from sampling, laboratory sensing, modelling and remote sensing. It represents Australia as a digital grid made up of two billion 'pixels' that are about 90 by 90 metres in size, down to a depth of two metres below the surface.

The result is the world's first comprehensive, continental soil data system that is easily accessible to urban and regional planners, land managers, farming groups, scientists and engineers. Since its release in 2014, the Grid has been in high demand, with over 1.3 million downloads.

Another TERN resource is its growing collection of soil samples available for analysis, collected from more than 900 sites across the continent, and representing every major ecosystem. The samples are housed at the TERN Australia Soil and Herbarium Collection facility at The University of Adelaide Waite Campus.

The collection includes metagenomic samples of top-layer soil for isotopic and DNA analysis to determine species present, and also 500 g 'bulk' soil samples for physical and chemical analyses. The bulk samples have supporting information on soil classification, bulk density, pH and salinity and are scanned with a spectrometer. The instrument measures reflected electromagnetic radiation at 2,500 separate wavelengths, giving an indication of soil properties, including mineral composition.

Together, TERN's resources are essential pieces of national research infrastructure that can support researchers to advance Australia's national soil strategy and its vision of ensuring that Australia's soil resources are sustainably managed for the benefit of our environment, economy, food and infrastructure security, health and biodiversity – now and into the future.



IMAGE: TERN AUSTRALIA
BACK COVER IMAGE OF SOIL SAMPLES: NICOLAS RAKOTOPARE

TERN Australia collects soil samples across the country to support soils research. The collection has over 20,000 soil samples and over 10,000 soil metagenomic samples which can be used to study organisms in soils.



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Ecosystem Research Infrastructure

NCRIS
National Research Infrastructure for Australia
An Australian Government Initiative

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