THE UNIVERSITY OF
SYDNEY
—
Sydney Institute
of Agriculture

Soil: digital mapping, modelling and assessment

Analysing and predicting field soil attributes for soil security

Expertise

We are one of the strongest university-based research groups on soil resource assessment and management internationally. Working on the basic theoretical, methodological and applied aspects. Our work has revolutionised the availability of accurate soil information which led to improved agricultural practices with reduced environmental impacts and enhanced security of the world's soil.

Our group developed the concepts of digital soil mapping, proximal soil sensing and soil security. Our research comprises cutting-edge fundamental science, with changes in practice, from global and national digital soil mapping to landscape-scale carbon management, precision agriculture and contaminated-site assessment. We specialise in:

— **Soil carbon auditing:** delivering a reliable and cost-effective method for farmers to gain carbon credits for good management practices that increase carbon in their soil.
— **Digital soil mapping and soil sensing:** cost-effective delivery of accurate and precise information on soil assets from the globe down to the paddock.
— **Space and time predictions from paddock to landscape scale:** Quantifying the separate influences of climate and management on agricultural production and surrounding landscape health
— **On-farm experimentation:** University-owned and commercial farms are used to establish fertiliser and ameliorant trials to determine optimal site-specific management options.
— **Biochar Analysis:** A guide to laboratory techniques as a standard for scientists and industry for characterising biochar in soil and environmental applications.
— **Soil contamination:** Assessment of soils and areas for a range of contaminants.

Tools and methodologies used

Our researchers use technologies and methods such as:

— **Proximal soil sensing** with emerging technologies such as microwave, infrared, x-ray, and gamma spectrometers to be able to predict soil properties accurately in any location.
— **A patented soil carbon auditing technology**, utilising soil carbon maps and optimised sampling strategy to maximise farmer's profit in soil carbon sequestration.
— **Non-destructive techniques** to measure how plants and microbes affect soil carbon and the mineralisation, uptake and loss of nutrients.
— **Digital technology**, utilising remote earth observation data, machine learning algorithms in open source computing environment, and high-performance computing facilities that enables big data analytics to accurately predict soil conditions to inform better decision making.
— **Synchrotron X-ray computerized microtomography** to look deep into how major and trace elements react in clay minerals to help understand how nutrients are released to plants.

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Industry links

Precision agriculture: partnerships with Society of Precision Agriculture Australia and grower groups and commercial companies around Australia provide research and extension collaboration. Research programs with GRDC and CRDC enable cutting edge research in site-specific soil and crop management.

Tasmanian Agriculture: working with the Tasmanian Government provided a state-wide land suitability assessment, identifying suitable areas for a range of crop and horticultural enterprises under agricultural expansion and intensification into newly established irrigations schemes.

Soil health and root traits: with support from the GRDC we identified how variation in root traits among wheat genotypes affect soil microbial communities and their role in releasing nutrients to plants under variable climate and management conditions. This enables breeding programs to target for root traits that maintain healthy soils.

Decisive soil assessment: we developed a method for assessing soil properties more efficiently and objectively, which is now adopted by FAO in their global soil carbon program and being used in the national Terrestrial Ecosystem Research Network Soil and Landscape Grid of Australia program.

Global Soil Mapping: instrumental in establishing this global project, supported by the Bill and Melinda Gates foundation, the first detailed mapping of the properties of the world's soils. It is the first step to assessing the capacity of global soils to meet the challenges of food security, and to include soil in models of global carbon sequestration and climate change.

Soil change: working with the CRDC and local farmers to assess the extent of change in soil condition in cotton-growing regions.

Soil carbon audit with 3-D Ag is licensed to conduct world first patented soil carbon measurement protocol for whole of farm measurement of baseline soil carbon stocks as a basis for future carbon trading and as a key performance indicator of farm sustainability.

Dryland salinity and water yield: partnerships with local producers on targeting salinity management and developing management strategies to improve water quality and maintain water yield with government partners.

Our experts

Professor Budiman Minasny (Research Capability Coordinator): is passionate about soil and the environment, trying to find what is the causes and controls of soil distribution in the landscape and the role of soil in managing climate change, food, water, energy security and maintaining biodiversity.

Associate Professor Thomas Bishop: modelling and predicting the variation of environmental properties in space and time with an emphasis on applying this to soil and water science.

Associate Professor Stephen Cattle: focusses on the effects of dust emission and deposition in agricultural landscapes and urban settings and the impacts of waste application to arable soil.

Associate Professor Feike Dijkstra: plant-microbial interactions on soil carbon and nutrient dynamics in response to climate change and land management.

Associate Professor Damien Field: interested in the role of soil security in addressing some of the existential global sustainability challenges.

Professor Alex McBratney: basic theoretical, methodological and applied aspects of soil resource assessment for application across all relevant industries.

Professor Balwant Singh: focuses on mineral-organic interactions in soils, biochar in long-term carbon storage and improving soil properties and properties of soil clay minerals.

Associate Professor Willem Vervoort: interested in identifying data to make crop, water and climate forecasts to improve on-farm and landscape management decisions

Associate Professor Brett Whelan: improving the efficiency of crop management in terms of input by understanding the natural variability in crop production and management responses.

For further enquiries contact:

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