Engagement and Impact 2018

The University of Sydney

SYD05 (HLS) - Impact

Overview

Title

(Title of the impact study)

Saving our soils: embedding precision into soil decisions globally

Unit of Assessment

05 - Environmental Sciences

Additional FoR codes

(Identify up to two additional two-digit FoRs that relate to the overall content of the impact study.)

07 - Agricultural and Veterinary Sciences

Socio-Economic Objective (SEO) Codes

(Choose from the list of two-digit SEO codes that are relevant to the impact study.)

82 - Plant Production and Plant Primary Products
96 - Environment

Australian and New Zealand Standard Industrial Classification (ANZSIC) Codes

(Choose from the list of two-digit ANZSIC codes that are relevant to the impact study.)

01 - Agriculture

Keywords

(List up to 10 keywords related to the impact described in Part A.)

Soil science

Digital agriculture

Precision agriculture

Carbon abatement

Climate change

Digital soil mapping

Soil carbon

Food security

Sustainable agriculture

Sensitivities

Commercially sensitive

No

Culturally sensitive

No

Sensitivities description

(Please describe any sensitivities in relation to the impact study that need to be considered, including any particular instructions for ARC staff or assessors, or for the impact study to be made publicly available after EI 2018.)

Aboriginal and Torres Strait Islander research flag

(Is this impact study associated with Aboriginal and Torres Strait Islander content?
NOTE - institutions may identify impact studies where the impact, associated research and/or approach to impact relates to Aboriginal and Torres Strait Islander peoples, nations, communities, language, place, culture and knowledges and/or is undertaken with Aboriginal and Torres Strait Islander peoples, nations, and/or communities.)

No

Science and Research Priorities

(Does this impact study fall within one or more of the Science and Research Priorities?)

Yes

Science and Research Priority	Practical Research Challenge
Soil and water	New and integrated national observing systems, technologies and modelling frameworks across the soil-atmosphere-water-marine systems.
Soil and water	Minimising damage to, and developing solutions for restoration and remediation of, soil, fresh and potable water, urban catchments and marine systems.
Soil and water	Better understanding of sustainable limits for productive use of soil, freshwater, river flows and water rights, terrestrial and marine ecosystems.

Impact

Summary of the impact

(Briefly describe the specific impact in simple, clear English. This will enable the general community to understand the impact of the research.)

Professor McBratney's team have developed quantitative methods to create detailed maps of soil properties worldwide. This has led to a new Australian soil data infrastructure which is transforming agriculture and ecological management by providing affordable, real-time data accessed by industry and government over 4000 times per week. In Australia it has enabled precise interventions to improve soil and thus increased yields worth $60M annually and reduced environmental degradation by 10% annually. The digital tools the team have developed are being deployed across the world. The team trained personnel in Australia and across all continents to build global capacity in soil management. A downstream impact is the emergence of new businesses in agtech, envirotech and carbon farming.

Beneficiaries

(List up to 10 beneficiaries related to the impact study)

The Environment (reduced environmental degradation)

Farmers

Agricultural industry

Governments internationally

Australian food consumers

International food consumers

Agricultural communities globally

Rural economies globally

Countries in which the impact occurred

(Search the list of countries and add as many as relate to the location of the impact)

Australia

Brazil

Canada
Chile
India
Indonesia
Italy
Korea, Republic of (South)
New Zealand
Russian Federation
Taiwan
United States of America

Details of the impact

(Provide a narrative that clearly outlines the research impact. The narrative should explain the relationship between the associated research and the impact. It should also identify the contribution the research has made beyond academia, including:
- who or what has benefitted from the results of the research (this should identify relevant research end-users, or beneficiaries from industry, the community, government, wider public etc.)
- the nature or type of impact and how the research made a social, economic, cultural, and/or environmental impact
- the extent of the impact (with specific references to appropriate evidence, such as cost-benefit-analysis, quantity of those affected, reported benefits etc.)
- the dates and time period in which the impact occurred.

NOTE - the narrative must describe only impact that has occurred within the reference period, and must not make aspirational claims.)

97% of the world's food comes from agricultural soils. Soil erosion, salinisation and acidification negatively affect both the ecosystem and food production. Having good information about soil can improve food security, water management and biodiversity conservation. Prof Alex McBratney, Director, Sydney Institute of Agriculture and his soil-science team have worked with governments, industry and farmers to multiply the availability of data on soil composition and function. They are global leaders in digital soil mapping (DSM) and precision agriculture (PA), also known as site-specific farming. They have provided farmers with tools to help them apply fertilisers and pesticides more precisely and economically. This has led to increased knowledge and to changes in agricultural practice, which have brought higher returns to farmers in Australia of approximately $60M a year and have reduced environmental degradation by 10% annually.

The team have worked with grower groups, the Grains Research and Development Corporation (GRDC) and farmers directly to transfer their research techniques and findings to agricultural practice in Australia. It has directed the PA programs of four large farmer-grower groups that cover the expanse of Australia. These programs inform practices of some 10,000 farmers. The collaboration since 2010 with the Society of Precision Agriculture Australia (SPAA), one of the four grower groups, which aims to facilitate research, extension and the adoption of PA, has trained 150 agronomists and extension officers.

Since 2005, when the PA lab made available a Windows program for mapping soil and crop data, Vesper has been registered and used by researchers, advisors and farmers in Australia and more than 20 other countries, including the USA, Russia, India, UK, Brazil and China. In Brazil, Vesper is used by the Department of Agriculture to inform site specific management decisions.
The Soil and Landscape Grid of Australia (SLGA) is the Australian component of GlobalSoilMap, a project that started in 2008 with a USD$18M from the Bill & Melinda Gates Foundation and aims to make a new digital soil map of the world using state-of-the-art technologies for soil mapping and for predicting soil properties at fine resolution to enable soil management at a specific site. With the CSIRO and state and territory agencies, the team developed the SLGA, freely available on the internet from 2014, which has dramatically enhanced the availability of soil data for spatial biophysical modellers across government and industry in Australia.
SLGA brought data collected by the States and Commonwealth over the last 60 years with a cost of hundreds of millions of dollars' together with new data. Used by government organisations and industry, the maps provide freely available information that can be accessed within seconds and generate on average more than 4000 views a week. The Corangamite Catchment Management Authority in Victoria uses the SLGA as an easily accessible

source of soil information for its Soil Health Knowledgebase, a project started in 2013. The knowledge base facilitates identification and implementation of activities required to improve the condition of soils used for agriculture in South West Victoria.
A collaboration with the Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE) (2012 to 2014) used the DSM framework for assessing operational land resources. The project developed crucial information to support sustainable land management practices to increase production and/or mitigate environmental risks. This demonstration of the efficacy of digital mapping has stimulated rapid acceleration in learning and uptake of the latest technologies into operational core business of DPIPWE to deliver key outputs, such as Enterprise Suitability Mapping under the Tasmanian Government's 'Water for Profit' program. The collaboration led to "the transformation of our work practices to a level where we (DPIPWE) were considered to be leading the country in digital soil assessment for land evaluation" according to Dr Darren Kidd, the senior land resource analyst within DPIPWE. The DSM code developed by DPIPWE in partnership with USYD has been supplied to most other States in Australia to facilitate their own DSM development.

Internationally, the team has worked with governments in Italy, India, Indonesia, South Korea and Taiwan to improve availability and accessibility of soil data, and provide training for professionals in resource assessment using new approaches. This has enabled these governments to make better informed decisions relating to food security or meet their international climate change obligations, such as providing soil carbon stock information to the Intergovernmental Panel on Climate Change (IPCC). In South Korea, the digital techniques developed by Prof McBratney's team, have, according to Suk-Young Hong, Director of Soil and Fertilizer Management Division, National Institute of Agricultural Science, allowed for "a more efficient and accurate way of delivering soil carbon stock information to the FAO and the IPCC National Greenhouse Inventories".

The team also worked with industry to develop commercial technology and has influenced the development of public policy. In partnership with Environmental Earth Sciences International P/L and 3d-ag.com.au, they created a world-first and patented tool for measuring soil carbon on a portion of landscape thus allowing precise auditing of the carbon. It was then licensed by 3d-ag.com.au, an agricultural consultancy that conducts soil carbon baseline surveys to inform a carbon trading scheme. Prof McBratney's scientific contribution to the 2014 National Soil Research Development and Extension Strategy, influenced the development of a national, coordinated and forward-thinking approach to managing Australia's soil. He now sits on the Department of Agriculture's committee that implements the strategy.

Associated research

(Briefly describe the research that led to the impact presented for the UoA. The research must meet the definition of research in Section 1.9 of the EI 2018 Submission Guidelines. The description should include details of:
- what was researched
- when the research occurred
- who conducted the research and what is the association with the institution)

Prof McBratney has pioneered research in pedometrics, a system that quantifies mathematical and statistical understanding of soil variation. From 2002 onwards, the Associate Prof Brett Whelan and Prof Budiman Minasny at USYD have used geostatistics and generalised linear and non-linear models to devise methods of spatial analysis for describing predicting and managing field soil attributes. These methods have been applied in precision agriculture, and digital soil mapping and assessment.

The team's research demonstrated that many cheap lower-precision, but spatially dense, geo-located field observations are more useful for spatial management than a few very precise measurements for the same overall cost. From 2005, the team went on to develop a set of field-sensing technologies for gathering high-resolution soil data. This Proximal Soil Sensing is less expensive than laboratory measurement tools. They also devised technologies to enable a systematic approach to in-field management of soil pH and to conduct diffuse-reflectance spectral analysis.

From 2003, McBratney and his team formalised the concept of digital soil mapping. This is a technique for making detailed three-dimensional grids of soil property and class information with associated uncertainty. The group developed sampling and statistical methodologies for achieving this, with the significant impact of moving soil information from the qualitative to the quantitative sphere.

FoR of associated research

(Up to three two-digit FoRs that best describe the associated research)

05 - Environmental Sciences
07 - Agricultural and Veterinary Sciences

References (up to 10 references, 350 characters per reference)

(This section should include a list of up to 10 of the most relevant research outputs associated with the impact)

1. Whelan, B.M., McBratney, A.B.& Minasny, B. (2002). Vesper 1.5 – spatial prediction software for precision agriculture. In P.C. Robert, R.H. Rust & W.E. Larson (eds) Precision Agriculture, Proceedings of the 6th International Conference on Precision Agriculture, ASA/CSSA/SSSA, Madison, Wisconsin, 14p.

2. A.B. McBratney, M.L. Mendonça Santos & B. Minasny (2003). On digital soil mapping. Geoderma 117, 3-52.

3. R.A. Viscarra Rossel, D.J.J. Walvoort, A.B. McBratney, L.J. Janik & J.O. Skjemstad (2006) Visible, near-infrared, mid-infrared or combined diffuse reflectance spectroscopy for simultaneous assessment of various soil properties. Geoderma 131, 59-75.

4. B. Minasny and A.B. McBratney (2006) A conditioned Latin hypercube method for sampling in the presence of ancillary information. Computers & Geosciences 32, 1378-1388.

5. P.A. Sanchez, S. Ahamed, F.Carré, A.E. Hartemink, J. Hempel, J. Huising, P. Lagacherie, A. B. McBratney, N.J. McKenzie, M.L. Mendonça-Santos, B. Minasny, L. Montanarella, P. Okoth, C.A. Palm, J.D. Sachs, K.D. Shepherd, T.-G. Vågen, B. Vanlauwe, M.G. Walsh, L.A. Winowiecki & G.-L. Zhang. (2009) Digital world soil map. Science 325, 680-681.

6. Odgers, NP, Sun, W, McBratney, AB, Minasny, B & Clifford, D (2014) Disaggregating and harmonising soil map units through resampled classification trees. Geoderma 214-215, 91-100.

7. A.B. McBratney, B. Whelan, T. Ancev & J. Bouma (2005). Future directions of precision agriculture. Precision Agriculture 6, 1-17.

8. McBratney, A., Minasny, B., De Gruijter, J., Mulvey, P. (2015). Soil Carbon Auditing Protocol. Patent No. 2011261179, 2012/09641

9. N.W. Chaney, E.F. Wood, A.B. McBratney, J.W. Hempel, T.W. Nauman, C.W. Brungard, N.P. Odgers, 2016. POLARIS: A 30-meter probabilistic soil series map of the contiguous United States, Geoderma 274, 54-67.

Additional impact indicator information

Additional impact indicator information

(Provide information about any indicators not captured above that are relevant to the impact study, for example return on investment, jobs created, improvements in quality of life years (QALYs). Additional indicators should be quantitative in nature and include:
- name of indicator (100 characters)
- data for indicator (200 characters)
- brief description of indicator and how it is calculated (300 characters).)