ΠΕΔΟΜΕΤΡΟΝ

Newsletter of the Pedometrics Commission of the IUSS | Issue 42, July, 2018

From the Chair

Welcome to the new era!

We have a new Chair and Vice Chair, Titia and Nicolas, will take over as your new leader next month in Rio. The pedometrics commission is in good hands. The young and energetic leaders will bring Pedometrics to another level in the next four years.

It has been a pleasure to serve the commission. I have a report that you can read later in this issue.

For now, Thanks for all your support, and Happy Reading!

I am out of here.

Budiman

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Chair: Budiman Minasny Vice Chair: Lin Yang Editor: Jing Liu

My Experience as Chair of the Pedometrics Commission

Budiman Minasny, Chair of the Pedometrics commission (2014-2018)

What a journey. It has been an incredible 4 years and I am very glad and honoured to serve as the chair of the pedometrics commission. I would say that we are still the most active group in the IUSS.

I got the baton from A-Xing 4 years ago at the World Congress in Jeju, Korea. The first immediate task was to look for host for the 2016 Pedometrics conference. Tom Vanwalleghem and Ana Maria Tarquis kindly agreed to host the conference in Cordoba, Spain. It was a tough job as no funding was available, and we had to rely on in-kind support and good will from staff at the University of Cordoba. We set up an ad hoc committee and basically trying to get things done. Of course there was a drama.. we had an uninvited keynote who was going to tell us how our work is useless.. Anyhow, we managed to get the conference going and it was a highly successful conference. The best ever so far, we had great presentations, brilliant keynotes (except one that whimpered and shaky). Many unforgettable moments: Dominique recited Amsterdam, flamenco, social gathering, best student presentations and poster. Despite the tight budget, we had 2 scholarships for students, and the IUSS also supported 3 students sponsorships. You can read all about it in Pedometron #38.

At the Cordoba conference, we decided to have a young pedometrician prize, which is to be awarded every 2 years. And it was decided to be called it the Margaret Oliver Prize to recognize up-and-coming talent in pedometrics. The award is named after Margaret Oliver, in recognition of her outstanding commitment to the promotion and encouragement of pedometricians in the early stages of their careers as well as her overall service to pedometrics.

The next big event was the 25th Anniversary conference in Wageningen in 2017. Gerard Heuvelink and team put up a flawless event. And it was a great pleasure to be able to join this celebration to learn the humble start from a group of people. You can read all about it in Pedometron #41.

Communication wise, we sent out email newsletter for a more randomly regular interaction. We had the π day issue, April 1st issue (unfortunately not many got the joke), locate the soil from a movie, etc.

Overall, it was a great honour to serve the pedometrics commission. I am fortunate as pedometrics is already a strong group in soil science who regularly meet, communicate, and support each other. During this period, we also saw the increasing relevance of pedometrics in global issues: tackling COP21 resolution with soil carbon, sustainable development goal, global soil organic carbon map, global soil moisture maps, concern of land degradation, etc. Nevertheless, pedometricians should present the best evidence of their work, and I would be really worried when our prediction shows that 70% of earth's soil is already degraded. But that's for another debate another time.

Finally, I would like to thank Yang Lin as the vice chair, the wonderful Jing Liu as newsletter editor and webmaster, and David who diligently manage the awards and prizes, and the award team (Sabine Grunwald, Yang Lin, Alex McBratney, Margaret Oliver). Thanks for all of your support.

I list all of our activities below form 2014-2018.

Newsletter:

Pedometron:

- Issue 41, December 2017

Pedometrics Commission Activities (2014-2018)

- Issue 40, June 2017
- Issue 39, November 2016
- Issue 38, December 2015
- Issue 37, July 2015

Monthly email newsletters: Approximately 10 issues per year

Journal Special Issues:

- Advances in DSM, Uncertainty and Soil Carbon Validation. (Incl. **Pedometrics 2013**) Volume 263, Pages 1-284 (February 2016) (Eds. Zhu, Minasny, Grunwald, Winowiecki) https://www.sciencedirect.com/journal/geoderma/vol/263
- Advances in Pedometrics: Special issue of **Pedometrics 2015**, Cordoba. 2017. (Eds. Vanwalleghem, Tarquis, Minasny) https://www.sciencedirect.com/science/article/pii/S0016706117308133
- Pedometrics 25th Anniversary Virtual Issue: https://www.journals.elsevier.com/geoderma/article-selections/pedometrics-25th-anniversary-virtual-issue
- Pedometrics 2017 Special Issue (Geoderma & European Journal of Soil Science, to be published end of 2018)

Conferences:

- **Pedometrics 2015:** 14-18 September, Córdoba (Spain). Pedometrics 2015. 120 participants from 26 countries
- **Pedometrics 2017: C**elebrating 25 years of Pedometrics, 26th June – 1st July 2017. Wageningen, The Netherlands: 260 participants from 51 countries.

Best Student Presentation at Pedometrics conference:

- Best Oral Presentation 2015: Mario Fajardo (the University of Sydney) and Jason Ackerson (Texas A&M)
- Best Poster Presentation 2015: Mouna Feki (Politecnico di Milano)
- Best Oral Presentation 2017: Wartini Ng (the University of Sydney)
- Best Poster Presentation 2017: Alexandre Wadoux (Wageningen University)

World Soil Congress, 2018 Rio

- 1.5.1 - Global soil carbon modeling: This symposium is to bring together scientist both from the soil science and global change community involved in global soil carbon modelling.
- 1.5.2 - Crucial techniques for the critical zone: Soil morphometrics, monitoring & modelling: This co-organized workshop focus on the cross-pollinations between the research areas of soil evolution modelling, sampling and monitoring and morphometric methods.
- 1.5.3 - Reconciling pedometrics and pedology: This symposium is intended to bring together scientists both from pedometrics and pedology to create a synergy on advancing soil resource management.

Best Paper Award:

- 2015 Orton, T.G., Pringle, M.J., Bishop, T.F.A., 2016. A one-step approach for modelling and mapping soil properties based on profile data sampled over varying depth intervals. *Geoderma*, *262*, 174–186.
- 2016 Viscarra Rossel, R.A., T. Behrens et al., 2016. A global spectral library to characterize the world's soil. Earth-Science Reviews 155, 198–230.
- 2016 Poggio, L., Gimona, A., Spezia, L., & Brewer, M.J,. 2016. Bayesian spatial modelling of soil properties and their uncertainty: The example of soil organic matter in Scotland using R-INLA. Geoderma, 277, 69–82.
- 2017: Nomination has been called, and award will be decided in August 2018.

Awards:

- The **Pedometrics Commission** introduced the Margaret Oliver Prize to recognize up-and-coming talent in pedometrics. The award will be given at each biennial meeting of the Pedometrics Commission. **The first award was awarded at Pedometrics 2017**, 26-June – 01-July 2017 in Wageningen (NL). 2017 Margaret Oliver Award Recipient: Tom Orton
- The Richard Webster Medal. Awarded to Gerard Heuvelink in 2014. Medal awarded in Cordoba, September 2015. http://pedometrics.org/?p=931. A call was announced for the 2018 nomination, and the award will be announced in July 2018.

A Great Experience being the Vice Chair

Yang Lin, Vice Chair of the Pedometrics commission (2014-2018)

It was a great honor and pleasure to serve as the Vice Chair of Pedometrics Commission (2014-2018). During my term with Budiman, we successfully organized the regular conferences, Pedometrics 2015 in Córdoba (Spain) and Pedometrics 2017 in Wageningen. We completed the annual Best Paper Awards for 2015, 2016, and 2017. The Richard Webster Medal was awarded to Gerard Heuvelink in 2015. The Pedometrics Commission introduced a new award, named as Margaret Oliver award, for recognizing up-and-coming talent in pedometrics, and the first award was awarded at Pedometrics 2017.

It was a great experience working as the vice-Chair. Budiman and I had efficient communications mostly via emails for working together. He did a great job as the Chair. I am glad that I could contribute to the commission. I learned how to organize conferences, and communicate with people effectively. It is also a great pleasure that I could know many outstanding pedometricians as scientists and friends. I have great cooperation with some of you.

Besides of working internationally, I had good chances as the Vice Chair to promote the development of pedometrics and digital soil mapping in China. More Chinese scientists joined in our field, did excellent work and participated in Conferences on Pedometrics.

The experience as the Vice Chair also encourages me as a young pedometrician and researcher to do more innovative researches. Doing good work is another way to contribute to the commission and our research field, as I learned from you.

The last but not the least, I want to thank Budiman for your help during the term. I also thank all of you for your trust and support, for the opportunity and for working with me! Welcome to the following Sessions in World Soil Congress, 2018 Rio: session 1.5.1 Global soil carbon modeling, session 1.5.2 Crucial techniques for the critical zone and 1.5.3 Reconciling pedometrics and pedology.

My Experience as the Editor and the Webmaster

Jing Liu, Editor of Pedometron and Webmaster of Pedometric.org (2013-2018)

I started my service in 2013. As the editor of Pedometron, the newsletter of the Pedometrics community. My main responsibility is to work with the Chair to compile, edit and prepare for publishing the newsletter every 6 month. Articles come with different types and formats, my main work is to edit the articles and fit them into the Pedometron template. I also frequently consult the Chair for editing suggestions and make changes accordingly.

The main responsibility as the webmaster is to maintain the pedometrics.org website, which is the website of the Pedometrics commission of the International Union of Soil Sciences. The website serves as the main online platform for the Pedometrics community to share news, articles, opportunities, and opinions. It is also one of the main gateways for the public to learn what Pedometrics is and what pedometricians do. As the webmaster, my main duties include ensuring the website is operating correctly; editing and posting news, articles and announcements. I also did some web design work when Prof Minasny, the Chair of Pedometircs, decided to use wordpress to host the website in 2014.

I really enjoyed working with the Chair, the Vice Chair, the Pedometrics Award Committee, and the Pedometrics Advisory Board in the past 5 years! It is rewarding for me every time to see a new issue of the newsletter published. And I am so glad to see the website are growing in a healthy way and help raising more public awareness of Pedometrics. I would like to express my great gratitude to the former Chair, Prof A-Xing Zhu and the Chair, Prof Budiman Minasny, for being as great mentors to me! I also wish the new chairing committee the best in the new era!

A New Era for Pedometrics

Titia Mulder, Chair of the Pedometrics commission (2018-2021)

As newly elected chair and vice-chair, we firstly want thank everyone who voted for us. We are very excited about this new role and are looking forward to chair Pedometrics for the next four years. A few years ago, we were collaborating well together while we were both working at INRA Infosol, France. Therefore, we believe that we will make a great team together for chairing one of the most interesting and active IUSS commissions.

About us

Chair: Titia Mulder

Titia Mulder is Assistant Professor at the Soil Geography and Landscape Group, Wageningen University, the Netherlands. My main research interest involves spatial, temporal and soil-landscape modelling for understanding soil and ecosystem dynamics, from the local to global scale. In my current work, I focus on soil carbon dynamics, eco-pedometrics and the development of soil sensing-based monitoring strategies for soil properties and related soil services.

In Wageningen, we are happy to be actively chairing the commission again. It is great to have the chair positioned here, for several reasons. Did you know that Wageningen University has among the highest concentration of soil scientists of the world and that ISRIC World Soil Information is located on the campus as well? This generates great connections for Pedometrics, the demand for pedometrics is directly here. Finally, over the years, chairs and vice-chairs were hold by Gerard Heuvelink, Dick Brus, Johan Bouma and Jaap de Gruijter. Now, I feel honoured to be elected chair and I will do my best to promote and advance Pedometrics and lead it together with Nicolas Saby into the new era!

Vice Chair: Nicolas Saby

Nicolas Saby is engineer at the Infosol group, INRA in Orléans France. He is in charge of national programs aiming at developing the French soil information system. He is also involved in research activities focusing on discovering how soil changes in space and time from the spatial extent of agricultural plots, regions, and the whole of France to the European Union. He contributed to the development of new methodologies based on advanced statistical tools to monitor soil heavy metal contamination in France, explain and predict soil carbon and biodiversity changes across France.

As far as I know, it is the first time that France is going to take care of the Commission. While checking this information on the website Pedometrics.org, my head was spinning reading through the list of the past chairs. At the same time, my well-known colleague at Infosol, Dominique Arrouays, will chair the new Global Soil Map commission. This will surely generate nice discussions and collaborations. Now, I feel honoured to be elected and I will do my best to help Titia to lead the commission.

A new era for Pedometrics

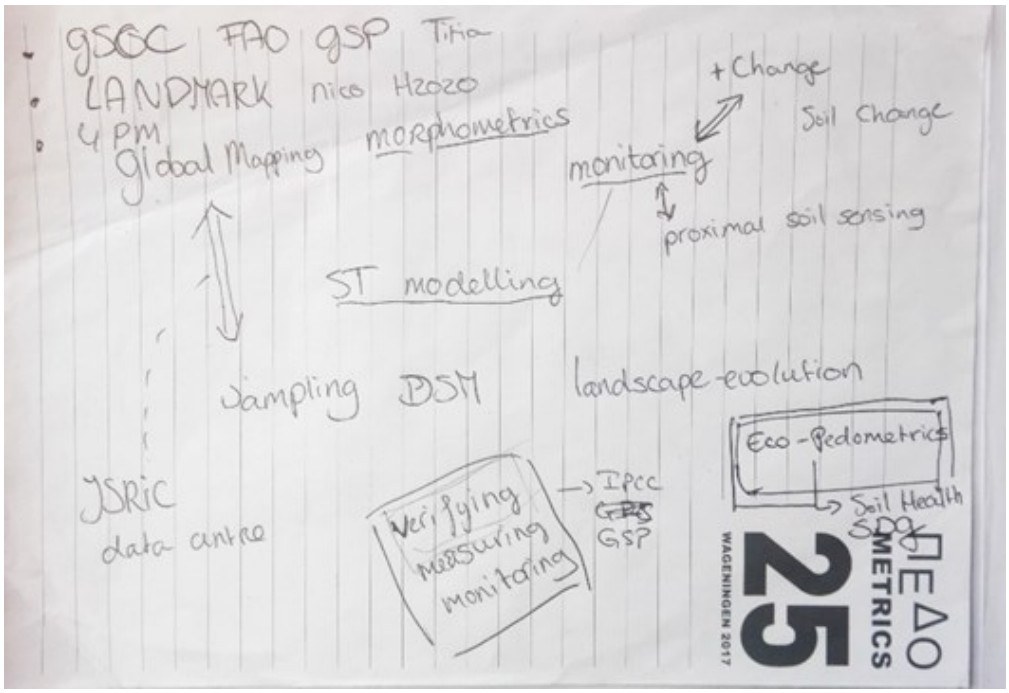
It is obvious that with Chair Budiman Minasny and Vice-Chair Yang Lin, Pedometrics has gained large visibility and many

have been reaching out to us, members of the IUSS Pedometrics commission, to rely on our technological and scientific expertise. This recognition clearly shows that we have matured enough as a discipline and it is time now for us to bring Pedometrics into a new era; a pathway has been cleared for Pedometrics to change from a supply-driven community into a demand-driven community and provide expertise to various international global initiatives.

The future, or this new era, is exciting and challenging for Pedometrics and we realized that even more when we sat together at Pedometrics 2017, drafting a quick sketch linking some recent initiatives and topics together. Of course, this quick sketch was far from complete but it managed to capture some key issues that deserve our attention in the coming years. The main thing that is missing are the connecting dots, how to bring it all together? Well, you can imagine that the answer doesn't fit the small A5 paper but we do aim to further connect the dots in the next 4 years and provide you with a complete, well illustrated flowchart at the end of our term!

For now, we will quickly outline our vision for Pedometrics. As mentioned earlier, we need to establish ourselves as a demand-driven community. This statement is related to the important international initiatives and frameworks to which we may contribute, such as the Paris Agreement 4 per mille Iniative, the Global Soil Partnership (e.g. GSOC map and Pillar 4), the UNCCD Land Degradation Neutrality program, achieving the Sustainable Development Goals and various H2020 projects (e.g. LANDMARK). Within the commission, several working groups are actively involved here and it is key for Pedometrics to maintain and strengthen our position. We see it also as our responsibility to ensure communication between the different working groups and stimulate collaboration between working groups.

Moreover, the goal of Pedometrics is to achieve a better understanding of the soil as a phenomenon that varies over very different scales in space and time. This understanding is important, both for improved soil management and for our scientific appreciation of the soil and the systems (agronomic, ecological and hydrological). In the coming years, we should considering using the Pedometrics methods also for understanding and attributing of changes in soils and coupling above and below ground processes (eco-pedometrics). This will provide scientific challenges for us, such as spatio temporal sampling, modelling, monitoring and associated uncertainty assessments. Another nice option is to investigate how to couple process-based modelling with geostatistics, which clearly is a great opportunity for collaboration between the Working Groups within the Pedometrics Commission.



We hope that the commission will continue in good health and we will do our best for it. We hope also that the dynamics of Pedometrics research continues to be strong. We look forward to attending the joint Global Soil Map group and Digital Soil Mapping group 2019 conference in Puerto Varas (Chile) and Pedometrics 2019 in Guelph.

Something useful to do with fractals?

By Murray Lark

I was intrigued by the fractal model of soil variation when I first encountered in it Peter Burrough's paper of 1983 in Journal of Soil Science (Burrough, 1983). However, not all the literature on fractal scaling of spatial phenomena was equally convincing. I found that I lacked two key traits needed in order to appreciate it. First, too many studies seemed to require an undue readiness to accept that certain plots on log-log scales were clearly linear. Second, when the log-log plot had yielded a fractal dimension I was never entirely convinced that I, or anyone else, had learned much about the soil as a result. Some years later I attended a workshop on fractal scaling at the European Geosciences Union where I had the chance to challenge a well-known soil physicist and fractal-wrangler. "What has all this told us about the soil?" I asked. "That the soil is not fractal", was his reply.

In fact, I think that is the point. Fractals serve as a null model of spatial variation, the interest lies, at least primarily, in how soil variation deviates from it. I have examined this in the context of conventional spatial modelling with colleagues from Zambia (Lark et al, 2017). I have also been intrigued by the way in which geochemists, notably in collaboration with two doyens of mathematical geology: Agterberg (2012) and Cheng (2012), have used deviations from fractal behaviour to identify singularities in spatial data, and, with former colleagues in minerals and geochemistry from the British Geological Survey, I have examined that methodology in the context of soil chemistry, and suggested a tweak (Lark et al., 2018).

Liu et al (2013) define a singularity as a "special phenomenon with anomalous energy release or material accumulation occurring within narrow spatial-temporal intervals". In a geochemical setting a singularity may therefore be a local anomalous accumulation of an element (or, with a change of sign, a depletion). Under a simple fractal model of the distribution of an element in E-dimensional space, the concentration at location $\mathbf{x}$ in a block $B_{\mathbf{x}}(\mathrm{e})$ (e.g. a circle) of size (e.g. radius) ε, is denoted by $\rho(B_{\mathbf{x}}(\varepsilon))$ and does not depend on ε. Under a multifractal model local singularities occur and may be characterized by the proportion:

$$\rho(B_{\mathbf{x}}(\epsilon)) \propto \epsilon^{\alpha(\mathbf{x})-E}$$

where $\alpha(\mathbf{x})$ is the local singularity index, smaller than E for a local enrichment singularity, and larger for a depletion singularity and equal to E for a monofractal background process in which the anomalies are "embedded".

We may calculate this index over a region from values of the mean concentration in local nested windows. The next task is to identify the range of values which are assumed to reflect local sampling fluctuations around an underlying mean value of E. One approach is based on the observation that the survival function of the singularity index (the complement of its cumulative distribution function) can be modelled as a mixture of power laws, which will appear as linear segments with distinct slope on a double-log plot. While there are some nice mixtures of linear segments published in the literature, I have not found it very convincing in examples for soil data. For this reason I propose that one models the singularity index as a variable drawn from a mixture of normal distributions. The parameters of the distribution for the background process can be bootstrapped by simulating data with a variogram estimated robustly from the data. One can then fit a mixture of models, identify the component which corresponds most closely to this notional background process, and then identify additional density in the tails of this distribution, introduced either by a single mixture component of larger variance than background, or by two or more additional components.

Something useful to do with fractals?

Here is an example, based on data from the East Midlands of England. The major river in this region is the Trent, which flows north to join the Humber. The Trent alluvium contains lead, which includes anthropogenic pollutants and lead and derived from galena deposits in the west of the region, where lead has been mined since the Roman Occupation.

Figure 1 below shows the quartiles of the soil lead distribution in part of this region. Where do you think the Trent valley lies? The coordinates are in metres relative to the datum of the British National Grid.

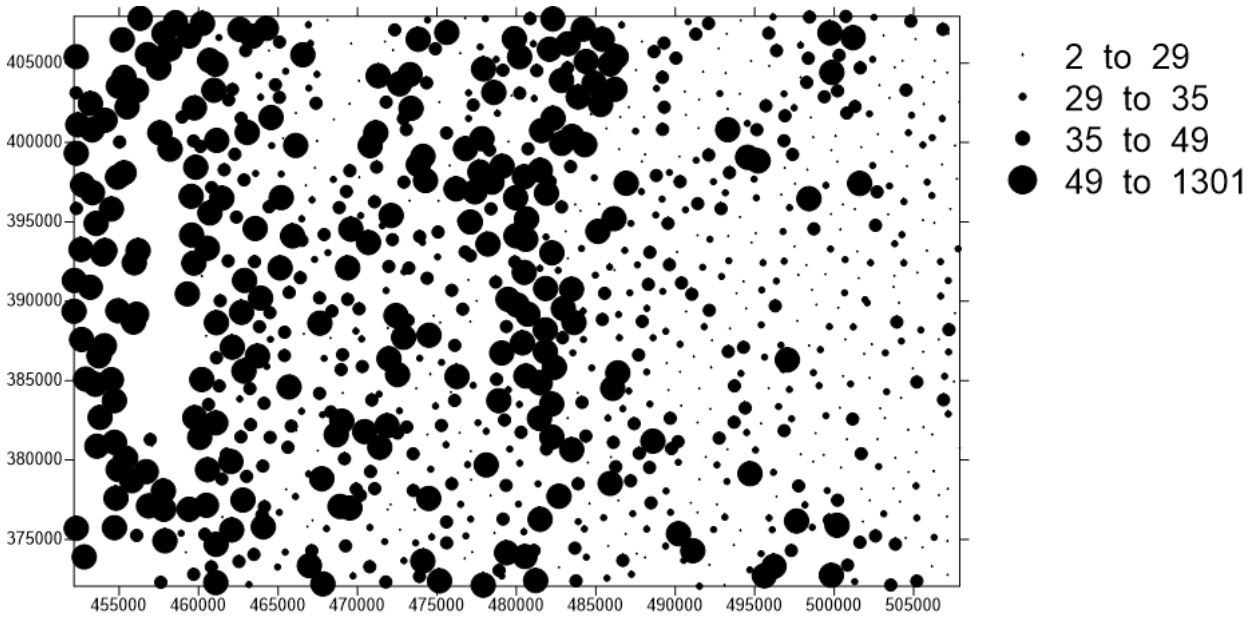
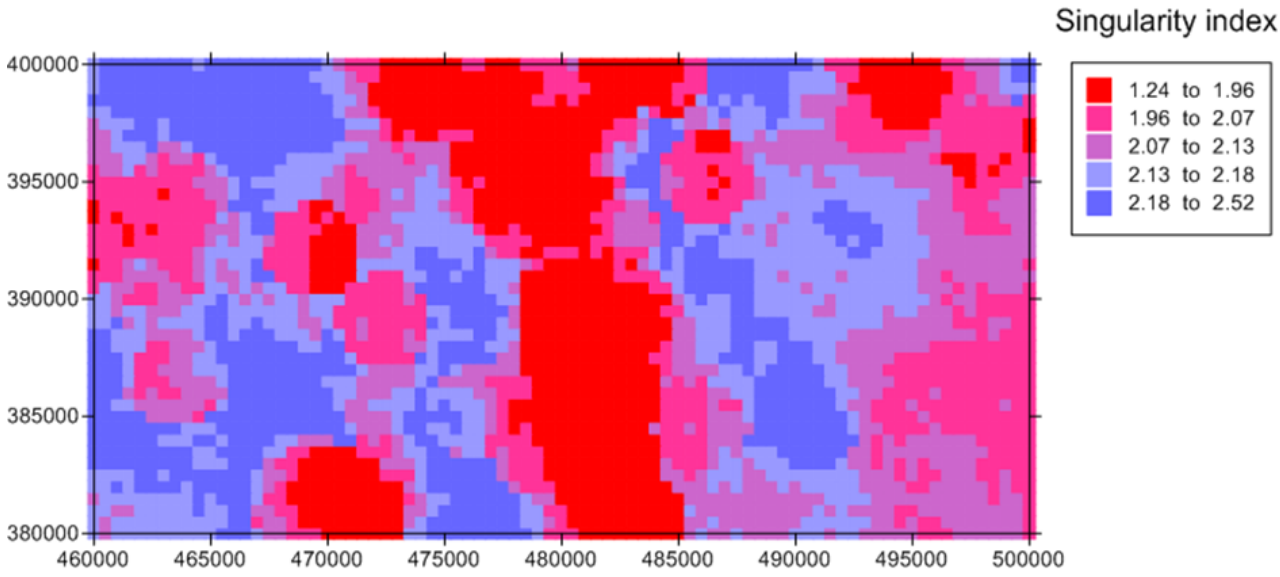
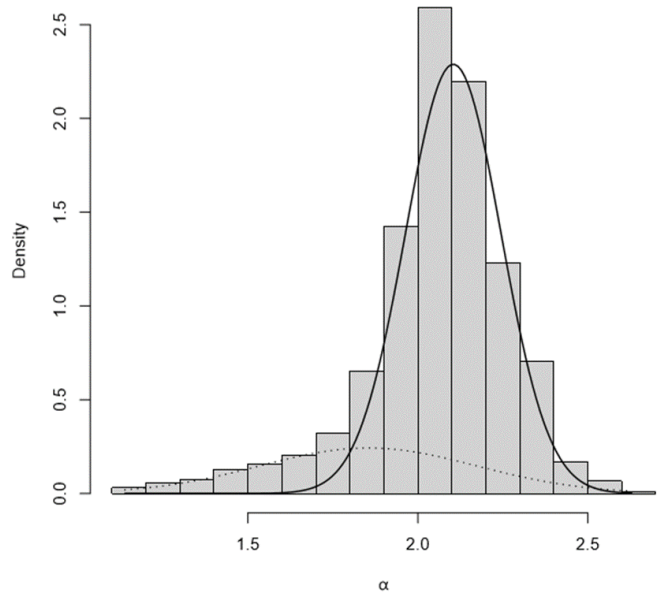


Figure 2 shows the local singularity index within part of this region. As this is a 2-D data set the singularity index for the background process should take values close to 2, and smaller values indicate local enrichment anomalies.

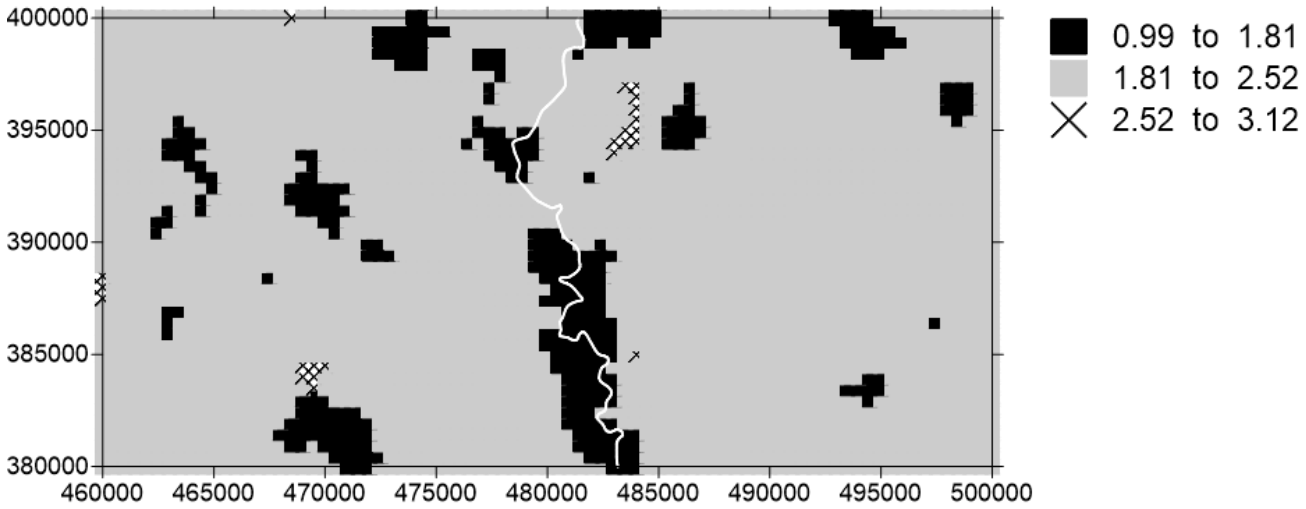


Something useful to do with fractals?

The next figure shows the histogram of values of the singularity index with PDFs for the two components of a normal mixture model. Tests on the likelihood ratios indicated that a two-component model was favoured over a one or a three-component alternative. The smaller component introduces additional mass into the lower tail of the combined distribution. The value of the index at which the density for this secondary contribution equals that for the dominant distribution is proposed as a threshold for identifying areas to be regarded as enrichment anomalies.



In the map below the proposed areas with enrichment anomalies are shown in black. The course of the Trent is the white line running roughly north-south in the middle of the region. This is clearly associated with much of the area of enrichment. Other patches are also of interest. For example, at 470000, 381000 in the coordinate scheme is the town of Retford, a significant point of convergence for two railway lines, a canal and trunk roads. The local river, the Idle, which is a tributary of the Trent, has poor water quality due in part to significant discharges from sewage processing.



Something useful to do with fractals?

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Soil, immune fitness, and infectious disease risk

By Craig Liddicoat

Environmental microbial diversity from soils may represent an important (although unappreciated) influence on immune training and development, and therefore human health. Indeed, immunologists and medical researchers now believe there is a tangible biological link, or an evolutionary need, for humans to connect with the microbial diversity from our natural world.

But when that contact is lacking, it may help explain the raft of immune-related diseases now confronting modern urbanised society. Think allergies, asthma, auto-immune, and inflammatory bowel diseases. There may even be links to depression and cancer. So, if we can better understand links between environments, microbiomes, and people, there may be new cost-effective ways to boost environmental outcomes and immune-related health at the same time.

Environmental microbial communities (or microbiota) influence our immune systems in at least three ways. First, they add to the protective human (or commensal) microbiota that line our skin, airway and gut. Next, microbes play an active part in immune signaling. This is a big deal – it can mean the difference between tolerating, or having a potential deadly allergic reaction to, something normally harmless in the air or our food. Thirdly, they help build immune memory, for example through antibody production. The condition called dysbiosis – where we have a drastic change in the makeup or balance of the human microbiota – has been associated with a wide range of disease. There is uncertainty and debate in the scientific community whether dysbiosis represents a cause or a symptom. While some suggest that dysbiosis and disease may reflect a self-reinforcing downward spiral when a dysfunctional immune system loses the ability to control the resident human microbiota and opportunists and/or pathogens that may come along. In this way, immune dysfunction can impact both non-infectious and infectious disease.

But what has this got to do with digital soil mapping?

Well, soil-associated microbes can form a significant part of the so-called aerobiology that connects people to their surroundings. We can breathe these microbes in, they can work their way from our airways into our gut; and from there, there is potential for immunomodulatory effects. Belowground biological diversity can also reflect aboveground biodiversity, land use, and management. Links between soils and immune fitness have been suggested– but to our knowledge have not previously been tested at the population level. There is a long pathway of proofs required to connect environments, their microbiotas, human exposures, immune system and human microbiota effects, all the way through to human health outcomes. However, if we can observe associations between different types of environments/soils and available population health datasets, it may provide support to look more deeply into the plausible microbiota-mediated mechanisms linking environments and human health.

To do that, we need digital soil mapping.

In a recent publication, we tested the idea that reduced exposure to environmental microbial diversity – related to soils – might reflect in a broad measure of immune-fitness at the population-level. In particular, we compared ambient soil cation

exchange capacity (CEC) with rates of infectious and parasitic disease across regional Australia. We didn't have enough coverage of soil microbial data to directly compare with population health data. But after examining microbial diversity and CEC relationships from the Biomes of Australian Soil Environments (BASE) database, we justified the use of national soil CEC mapping (from the Soil and Landscape Grid of Australia) as an indicative proxy for soil microbial diversity across regional Australia. Soil CEC typically reflects organic matter and clay content – both of which generally support a greater diversity of microbial habitats.

In the work, we found that low CEC, or typically low biodiversity soils, were associated with the highest rates of infectious and parasitic disease. And this was after accounting for socioeconomic status. We also found that health inequality (ratio of disease risk in poor areas to wealthy areas) is greatest for populations surrounded by low CEC soils.

We also performed randomised probabilistic sampling of environmental exposures and health outcomes to generate 'pseudo -individual'-level data for use in multilevel machine-learning models. Bootstrap resampling and modelling frameworks were used to estimate uncertainty. Through the modelling, we found a significant improvement in predictions of disease risk in unseen test areas, for models that included soil CEC, compared to models that didn't.

We concluded that knowledge of the spatial distribution (i.e., digital soil mapping) of soil CEC can improve the prediction of infectious and parasitic disease risk at the population level.

The article is published in Science of the Total Environment and also featured in a recent eNewsletter story. For more information contact **Craig.Liddicoat@adelaide.edu.au**

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In conversation with Alex

Alex McBratney talked about the recently released Pedometrics book.

When and How did you start conceiving a book on Pedometrics?

"When I put together the first pedometrics lecture and practical course back in 1986, I generated a set of notes, and I thought, 'well one day that'll be a pedometrics book'. Interestingly there was something already published; Webster's 1977 book (Quantitative and Numerical Methods in Soil Classification and Survey) was a really good start on pedometrics. Ironically the second edition of that book moved further away from what I consider to be pedometrics when it became more geostatistical. It was a necessary excursion however.

What we are trying to do here has to be as much about soil science than it is about mathematics and statistics. It takes a mathematical and statistical bent but it needs to be an approach to the understanding of soil. That's what we've been striving to do with the pedometrics book. Actually, doing the book came to my mind in the 1990s. When I went on a sabbatical in 2001, I sketched out the whole book and at that point I was hoping to write it largely by myself. I sketched out the sections of most of the chapters, and I was hoping during that sabbatical to have written a lot of those chapters. Murray Lark was very helpful in commenting on the sketch and making the philosophical position more concrete. But what I realized during that sabbatical that looking at the sketch of the book, probably only half of the work had been done. In other words, to complete it I would have to chop out parts that couldn't be written without doing some serious research. To some degree, the idea for digital soil mapping came from this realisation; as well as the idea of the soil inference systems, and so on. And we hadn't really done the work at that time, so if I were going to write a book in a sense would be more like a novel than a scientific text. Because you have to invent most of it to write the book.

So the answer to when the book was conceived is variously from 1986 to 2006. As time went on, we got busier and busier; we worked our way through the parts that hadn't been done. It also became clear that I couldn't do it on my own, I needed to bring in all the great talent we have in pedometrics to put the book together. That's how it came about, and it's only in the last couple of years that we've managed to get it all together based on the 2001 conception.

I would say we are three-quarters of the way there; there are still some things that we need to do. We need to bring it a bit more the mainstream of soil science but have certainly made a very good start with this book."

Who is the target audience of this book?

"About seven billion people - but we might not get there ☺ We are trying with this book to have an effect on particularly the younger generation of soil scientists. I would like all undergraduates and graduate students doing soil science today to know what's in this pedometrics book and understand it - and it's not very difficult. It will give them a very powerful set of tools for dealing with the variation of soil in all aspects of soil science and how you manage or treat soil into the future. The audience therefore is largely the younger generation of soil scientists in the world.

I also hope that it gets an audience with the hydrologists, the ecologists, and the environmental scientists. We have come up with techniques which may be analogous to what scientists in other disciplines do, but we're not necessarily driven by other disciplines. It would also benefit these other disciplines to learn some of the things that we do."

In conversation with Alex

The book has 23 chapters with 44 authors, how did you manage to get all the authors together?

"By kicking and screaming :-)…but seriously one of great things we did well and correctly is that we organized Pedometrics via the International Union of Soil Sciences. We, particularly Jaap de Gruijter, set it up as a Working Group back in 1986 to 1990; we got this thing going and we've always had an international group of people who worked together to develop this thing called Pedometrics. Deciding authors of the chapters is slightly challenging because of the rich and wide talent we have; but getting the authors isn't so challenging;- we are a keen and hard-working bunch. Because pedometrics is a very active and strong sub-discipline of soil science, it's pretty easy to find very talented people to write for most of these subjects. We are a coordinated group of people who regularly meet and are used to working together, writing journal special issues together; so eventually putting a book together that advances the discipline was not too difficult. I'd like to thank all the authors for helping us to do that, and it's a wonderful team."

What is the relevance of the book to the current soil science research?

"This is really quite a difficult question. I immediately ask, 'well what is the current research in soil science?' From one point of view, it's all about soil carbon (and we do that too): that's what I see more than anything, and everywhere. I do question at the moment whether if there are enough of us working on what I would call fundamental soil science, developing soil physics theory, soil chemistry theory, a theory of soil biology and ultimately a general theory of soil. I would like to think that pedometrics will contribute to some general theory of soil:- where it comes from, how it evolves, why it varies across time and space, and how interventions change that variation across time and space. I hope it will, to some degree, revive research into a fundamental understanding of soil.

What do we know if we make an observation on a small handful of soil, or a soil horizon, or a soil profile, or in a catchment (watershed) or across half a continent how all of these observations relate to one another? How can I infer from one scale to another? If I'm looking at fluoride absorption or a bacterial or fungal species in the soil, or any other phenomenon, how do I gain some understanding of how this looks at one scale, and how looks at another scale. Pedometrics provides the tools and the glue to allow us to do that. This implies that pedometrics should be studied at both introductory and reasonably advanced levels in association with other disciplines so that we can get ourselves out of single-scale thinking about soil. We can break the shackles of single-scale thinking and move across scales that Johan Bouma advocated so effectively in the late 80s and early 90s. We can tackle this problem very well. Thus, the book should be studied and perused by the young soil scientists and applied across all the disciplines of soil science."

Which part of the book do you like most?

"Of course, the obvious, perhaps flippant, answer is page 720, or the last page in the book because with that we can say well this book is done. It was a monumental effort to get it done, and I particularly like to thank my co-editors Budi and Uta for helping me to get it done because there was a fair amount of editing. There was also a great deal of cajoling of some authors to get it done. I like the fact that it is an attempt to be a soil science book; it does attempt to integrate with soil science.

I can start with what I like the least, and that is we haven't succeeded with the integration as much as I would have liked. What I like about the book is there are some chapters which are not in journal papers. Going back to what I said in response to the first question, some of the work hadn't been done, so some of the chapters might seem a little bit idiosyncratic. Like the concepts of valuing soil, and how to describe soil, these are real genuine attempts to make a new kind of synthesis. The approach is not so much based on the methods, but based on what we're trying to do, our objectives for soil understanding.

In summary, I like the last page because that means the books finished, I really like the attempt to integrating it into soil knowledge and science. And I like the fact that there's actually new stuff in there that hasn't been published before."

Classic Art as Covariates in Digital mapping

By Budiman Minasny

Cartography is a blend of art and science. But can art be used as covariates in making digital maps? According to new research, yes, and the results are comparable with maps that used real environmental covariates.

Ecology mappers face the same problem as DSMers, which covariates should be used for digital mapping? Machine-learning algorithms supposedly can handle a large number of predictors and even select and identify the relative importance of the covariates. In a Species Distribution Modelling (SDM) study, the researchers tried to see what happened if classic paintings were used as covariates.

The study was published in the October 2017 issue of Global Ecology and Biogeography. The authors from Sweden and France predicted the distribution of 509 European species (independently) using two scenarios: 20 fake predictors derived from classical paintings, and 20 climatic and topographic variables. The predictors were transformed using PCA, and the first 12 PCs were used to derive a model using MaxEnt (Maximum Entropy model commonly used in SDM).

The data was split into calibration and validation, and the performance of the model was evaluated using AUC and TSS metric.

Their results showed that models that used paintings as predictors are often classified as good or even excellent according to the widely used evaluation measures. (Akin to DSM, some like to make up ratimgs of RPD, AUC values were reated as excellent, good, fair, ..). The authors concluded that the species modelling using unrelated predictors can achieve good results, and thus they question the current practices of model evaluation and variable selection.

The main message I got from this paper is:

- the model (MaxEnt) cannot select useful predictors, it overfits the data
- the goodness of fit metric used in this paper is insensitive. As I repeatedly warn, it is bad to classify goodness of fit into classes of excellent, good, fair, etc.
- The results showed that fake predictors usually perform worse than using real predictors. However, the difference becomes small with increasing number of predictors, again showing overfitting of the model.
- SDM commonly only evaluates the presence or absence of a species at a time. Thus, there is always a random chance that a random model can predict better.
- Proper validation and selection of covariates are important. Don't just trust machine's variables of importance or variable selection.

Inakwu Ominyi Akots Odeh (1956 - 2018)

- Marrying pedology & mathematics: Perspectives on a pioneering Pedometrician

by Associate Professor John Triantafilis (UNSW Sydney)

Inakwu Odeh with Alex McBratney outside The University of Sydney's RD Watt Building (Faculty of Agriculture) circa 1990.

Our esteemed colleague and dearest friend, Associate Professor Inakwu Ominyi Akots Odeh, passed away peacefully in the company of his loved ones on February 4th this year.

Odeh was a first-rate Pedometrician who was an internationally recognised scholar in quantitative methods for soil mapping, land resource inventory and assessment. His main contributions were developing spatial techniques, based on quantification of relationships between soil and digital data, from remote and proximal sensors.

Early Years

Odeh started his soil science career during his BSc Agriculture degree at the University of Ibadan (Nigeria). Graduating with 1st Class Honours he undertook a Masters in Soil Science (Ahmadu Bello University); entitled "A Study of Salt-affected Soil in the Sokoto-Rima Basin." He was subsequently awarded a Commonwealth of Nations Scholarships for a PhD.

The University of Adelaide

Some of Odeh's best work emanated from his PhD, which he undertook while based at the University of Adelaide and supervised by a "Pedologist" by the name of Professor David Chittleborough, in collaboration with the "Mathematically" minded Professor Alex McBratney; who'd just started his tenure at the University of Sydney.

Considering the subject matter…and the times…many asked "How much you wanna risk" your PhD on a marriage between pedology and mathematics? With his team, mild-mannered but indomitable will, he took upon himself the responsibility of applying various techniques across the dry, dusty rolling hills of the Mount Lofty Ranges, north of Adelaide.

Two innovative papers he co-wrote with David and Alex, dispelled long-standing myths about Pedometrics. By the time he had finished, he had put the discipline of Pedometrics on the map in Australia.

First, he pioneered the application of fuzzy set theory to mapping and representing the soil as a continuous land surface body. This ground-breaking research was published in Geoderma in 1992, under the title "Soil pattern recognition with fuzzy-c-means: application to classification and soil-landform interrelationships." It has been cited 166 times.

The second was published in Geoderma in 1995 and entitled "Further results on prediction of soil properties from terrain attributes: heterotopic cokriging and regression-kriging." It was significant because he demonstrated that adding regression residuals improved prediction precision and bias. It has been used and cited widely (361 citations).

But the value in these papers for an up and coming student was far more valuable. Why? They were a formative part of Odeh teaching me how to write; because I read and then re-read these papers, like a small child reads "some fairy-tale bliss!" They were like a testament from an old book, which helped develop my own clear, concise and consistent style."

In fact, when I read drafts Odeh was sending Alex for comment; I marvelled: How can this Japanese student KISS (i.e. keep it so simple) just like this? Yes, I know "Unbelievable!" This misconception of his ethnicity was corrected when Alex introduced me to Odeh in 1990 at the Australian Soils Conference in Adelaide. A lifelong friendship was born!

I once asked him at one of our many "long" lunches, "who taught you how to write so beautifully". Odeh's answer "An Irish missionary" at his school in Nigeria.

Inakwu Odeh with John Triantafilis at the Cape of Good Hope, whilst attending the 3rd World Cotton Conference (Cape Town South Africa) circa 2003.

Obituary : Inakwu Odeh

CRC for Sustainable Cotton Production

After completing his PhD and undertaking a Post-Doctoral Fellowship at the University of Adelaide, he moved to The University of Sydney in 1994 to take up a position as a Senior Research Fellow as part of the CRC for Sustainable Cotton Production. It was the start of his mentoring and casting a closer-eye over my work and that of many others.

I am proud to say my first paper was with Odeh, Alison Todd and Alex based on research in north-west of NSW; on the expansive, flat alluvial Vertosol clay plains of the lower Macintyre, Gwydir and Namoi valleys. I fondly remember Odeh's number one recollection. It is a little irreverent, but fully captures his idiosyncratic humour.

He would retell it something along these lines. Odeh was out in a far-flung corner of the Macintyre valley on the Qld-NSW border. Along with Jock and Pete, they hand-augured holes to take soil samples. After three hot-humid weeks, traversing cotton farms, wheat fields and pastures, the critical moment had arrived; celebrating the 125th and final hole.

But how? To Odeh's immense surprise and horror, Jock dropped his trousers, squatted and deposited remnants of the previous night's mixed grill, in some form of ancient crescent-moon inspired organic manuring ceremony. But wait, there's more! Jock and Pete stripped to their birthday suits and danced around the hole.

I am sure if Odeh was reading this, he would be laughing with his characteristic "kh, kh, kh, kh, kh," or exclaiming "I can't believe what I am hearing!"

During this time, I was completing my own PhD. Whilst Alex was giving me ideas to work on, he was not so keen to look at drafts. To be clear, when I asked when I could give it him, Alex quipped, "When it's finished!" At times like this, Odeh would be known to say, "Oh My…That is Serious!"

Nevertheless, Odeh filled the void, revising drafts, taking the guesswork out of all my numbers and figures and along the way addressing my Achilles Heel; improving my English expression, grammar, and writing style. In some form of Nigerian scam, he was internal PhD examiner, but, ironically still found more things to correct than the international examiners.

During his Senior Research Fellow, Odeh produced baseline soil data and maps for cotton growing regions. At the same time, he laid out a suite of spatial prediction methods regularly used for Digital Soil Mapping, showing how landform attributes derived from DEMs could be used for prediction of soil properties and using landscape models.

He took advantage of rich and novel data sources, including remote sensed LIDAR, Landsat TM7 and gamma radiometric, but also proximal soil sensing data acquired from instruments such as the Veris3100 and EM38. All significant contributions to advances in soil science, landscape information systems, and land management.

This work was funded from the CRC and Cotton Research and Development Corporation. Owing to his contributions, mentoring of the next generation of PhDs; including Damien Field and Tom Bishop, and leadership as the CRC "Wing Commander" Odeh was given the role of Program Leader in the second incarnation of the Australian Cotton CRC.

After more hard work and dedication Odeh in 2004 was deservedly appointed as the University of Sydney Sesquicentenary Senior Lecturer in Rural Spatial Information Systems.

The University of Sydney

Odeh was a lecturer of some reputation, leading and presenting courses at both under-graduate and post-graduate level. He taught aspects of Pedometrics, Digital Soil Mapping and Proximal Soil Sensing into courses including but not limited to Environmental GIS, Biometry, Remote Sensing and Land Management and Rural Spatial Information Systems.

Odeh was renowned for his dry humour and wit in the classroom but also the annual Canberra field trip, where he organised visits to CSIRO, Geoscience Australia and the Bureau of Rural Sciences. On one of these trips where I joined him, the students perpetrated various shenanigans. Two come to mind.

The first was when one student got so "legless," others had to wheel the student back to the hotel stuffed unceremoniously in a shopping trolley! Others, in a similar state of impaired sobriety, collected up sand bags, barricades & flashing lights from local road works and installed these in a post-modernist Warning or blockade outside Odeh's hotel room door!

Now, I never knew Odeh to swear…but I fully expect on opening the door the next morning, he would have exclaimed something just like this and in his characteristic bellow, whilst simultaneously throwing his head back and putting his hands up to his forehead; "JESUS CHRIST of NAZARETH!"

He also trained and mentored many Honours (e.g. Michael Nelson and Ischani wheeler), Master's (e.g. Mark Crawford) and PhD (e.g. Ian Hollingsworth and Marcelo Stabile) students to name a few.

He was also a consistent driver in building and maintaining the enjoyable social fabric of our agriculture community at the University over the years.

Odeh was also an enthusiastic member of Soil Science Australia, including being President of the NSW branch in 2010 and vice-president in 2008-09. He was also an Associate Editor to some of the top-ranking soil science journals including European Journal of Soil Science and Geoderma.

Internationally, he had strong research ties with Africa and China and in recent years, he developed GlobalSoilMap maps for Nigeria.

Final accolades and reflections

Owing to superior contributions in Service, Teaching and Publishing, Odeh was deservedly promoted to Associate Professor in 2009. But Odeh's greatest service and achievements are very clear, as I have heard, read and seen from many of his colleagues and friends. His legacy, as the "moral & spiritual duct tape" that bound the academic fabric of Faculty of Ag. from undergraduates up to the Dean, is assured.

Odeh was no "Superhero;" like Superman, Spiderman or Batman, but his legacy was a function of the "Superhuman" traits of their alter-ego's. 10

These are "Something I can MISS"

- He was mild-mannered like "Clarke Kent" but was not afraid to bring truth to the forefront and fight for the little guy;
- He was like "Peter Parker", learning for himself that with great power comes great responsibility to help those who needed it; and
- Like "Bruce Wayne", he relied on his intellect, detective skill and indomitable will to pursue his scientific investigations.

But, Odeh shunned the limelight; he "was not the kind of person it fits," doing his best-most valuable work on the fringes; behind the scenes.

Nevertheless, wherever he was and whomever he worked, his strength of character shone through. In short, he was "The Chief."

Obituary : Inakwu Odeh

I am nearing “The End” but I just want to say whilst Odeh collaborated with > 100 scientists, his best was with his fabulous wife Abigail (Ugwoma).

Odeh’s love for you and your four daughters was absolute. I thank you for allowing me to spend time with him during his penultimate day. I cherish our last hand-shake & being able to bid him a fond farewell. The only solace I can give you is Odeh was dearly loved and deeply respected by all who he worked with in academia.

While Odeh’s accomplished academic achievements are forever enshrined in the scientific literature. His personal legacy lives fiercely in each of his five fabulous femmes; Abigail, Echa, Ahiegwu, Eneyi and Lydia! Now he is at peace.

One last recollection. Damien reminded me that before leaving for the pub, for a beer “or a glass of red wine for Odeh” to celebrate the end of the week, it was “sub-woofers” at 10 paces in the CRC Wing. We’d try out do each other playing loud music. Odeh would play a “God awful” Barry White song like “Can’t get enough of your love baby.”

I, on the other hand, would choose “Something just like this” because it captures everything Odeh meant to me and so many others and it is a collaboration between two tribes “The Chain Smokers” and “Cold Play.”

The legacy of Odeh's Statistically-designed Soil Survey: Beyond making maps

Beyond making maps, Odeh demonstrated the value of a good statistical sampling design for baseline soil survey. The data and soil samples can be used for exploration of temporal trends and testing novel ideas. This design also allows future monitoring of soil conditions.

Odeh conducted a survey for the cotton industry in the mid-1990s. Soil information in the large cotton growing area in northern NSW is scarce. Soil maps were too coarse and not meaningful. Under the Australian Cotton Cooperative Research Centre, he led a survey began in early 1995 in the lower Macintyre Valley and was later extended to the lower Gwydir (1996), lower Namoi (1997) and upper Namoi (1998). Surveys were carried out in St George Irrigation District (1999), Bourke Irrigation District (2000) and Lachlan Valley (2001). Soil colour, structure, and other morphological properties were observed in the field. Thousands of soil samples were collected and analysed for chemical and physical properties in the laboratory. This resulted in over 9,000 measurements for the combined regions.

As described by Odeh

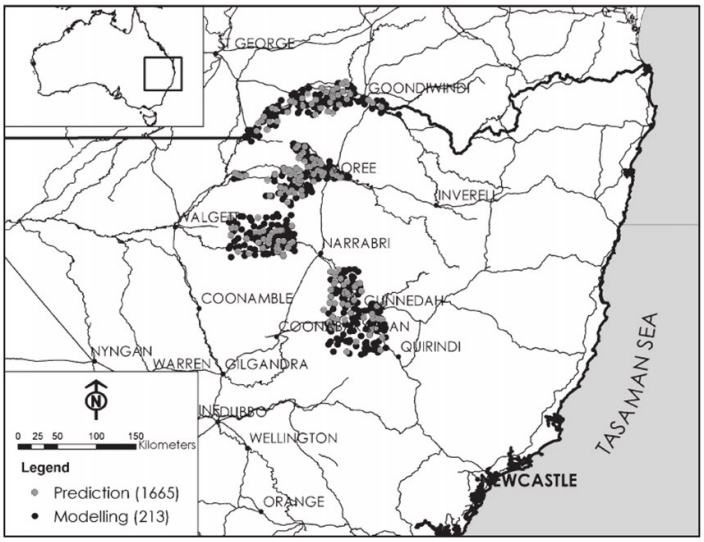
"*This is unprecedented in the realm of land resource survey in Australia, as no other industry has such wealth of soil data in a given region*."

The use of pedometrical techniques at such a scale is rare.

Christian Walter remembered:

"*I made a field trip with him in 1999 in the Namoi River area, and we sampled soils following a stratified random strategy: this was uncommon for me at that time as I came rather from a pedogenetic school; we also just took samples without any morphological observation, and this again was strange for me. But Odeh wanted to have unbiased estimates of soil properties statistics and also be able to construct regression-kriging models.*

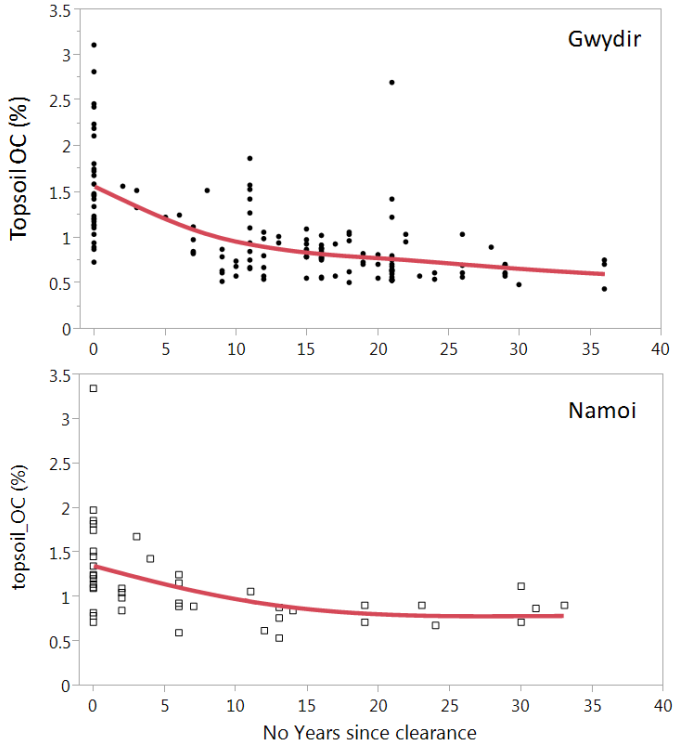
The legacy of Odeh's Statistically-designed Soil Survey: Beyond making maps



It was sometimes difficult to find the points as we had to find the gates which enable to enter in the right area and also our GPS was rather limited at that time. Nevertheless, this was a nice opportunity to see the rural areas of NSW and also to have an overview of its soil diversity. Doing this trip with Odeh was really a nice experience as he was "good man" and an excellent scientist."

The data allowed him to map soil properties using digital soil mapping techniques, for the first time, to such a large extent in Australia. For example mapping CEC and clay content of the soil for the whole region (45,600 km^2) with the help of satellite images and regression kriging.

The legacy of Odeh's survey in the cotton growing area proves that such large-scale survey is not only useful for making maps, but there are further applications.



(1) Soil carbon decline to half its original value after ten years if clearance

Surveys from the Lower Namoi and Gwydir showed that topsoil organic carbon (OC) had decreased substantially compared to native landuse. The native landuse has a mean OC value at 1.5 and areas with more than ten years of cropping have values 0.7 to 1%. This empirical data shows, for the first time in Australia, that agricultural use has halved the topsoil carbon content.

(2) Soil pH changes

The samples were used to calculate the decrease in soil pH assuming net acid input due to agricultural practices. Soil pH buffering capacity and acidification scenarios were used with geostatistics to spatially simulate the decline in soil pH of surface soils over time.

Reference:

Singh, B., Odeh, I.O.A. and McBratney, A.B., 2003. Acid buffering capacity and potential acidification of cotton soils in northern New South Wales. ***Soil Research***, 41(5), pp.875-888.

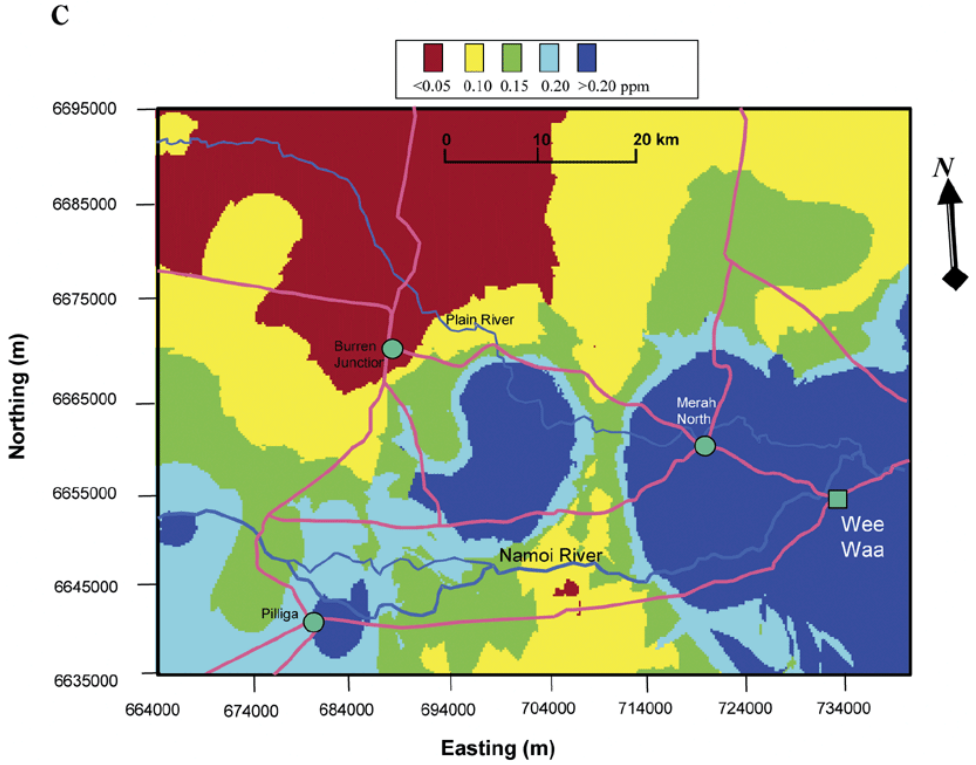
The legacy of Odeh's Statistically-designed Soil Survey: Beyond making maps

(3) Detection of DDT Residues 20 years since it was last applied

The samples collected from the survey were used to analyse DDT residues in the topsoil of the area. They found that despite being almost 20 years since DDT was last applied for cotton growing in these areas, the relationship between sites of greatest application and current residue levels was strong.

Reference:

Shivaramaiah, H.M., Odeh, I.O.A., Kennedy, I.R. and Skerritt, J.H., 2002. Mapping the distribution of DDT residues as



DDE in the soils of the irrigated regions of Northern New South Wales, Australia using ELISA and GIS. ***Journal of Agricultural and Food Chemistry***, 50(19), pp.5360-5367.

(4) **The legacy soil samples become useful when new technologies such as infrared spectroscopy become available.** These samples allow the development of spectral library and calibration functions.

Reference:

Viscarra Rossel, R.V., Jeon, Y.S., Odeh, I.O.A. and McBratney, A.B., 2008. Using a legacy soil sample to develop a mid-IR spectral library. ***Soil Research***, 46(1), pp.1-16.

Photos courtesy of Jason Hill

Vale Jon Hempel

Jon Hempel passed away in June 2018 in Darwin, Australia. Jon was the Director of the National Soil Survey Center for the US Department of Agriculture-Natural Resources Conservation Service (NRCS) from 2009-2015. After retirement, he took up a position as a Principal Soil Resource Officer in Northern Territory, Australia. He enjoyed surveying soils in the field in the remote part of Australia, he once mentioned that he was the luckiest soil scientist in the world, and occasionally shared his incredible passion of soil and landscape in the NT.

Jon is known in the pedometrics and digital soil mapping community as one of the pioneers of GlobalSoilMap project. He was an inaugural member of the International Technical Panel on Soils (ITPS) and contributes to the Global Soil Partnership. He chaired the IUSS Working Group on a Universal Soil Classification System. He travelled around the world studying, documenting and promoting the world's most important natural resource.

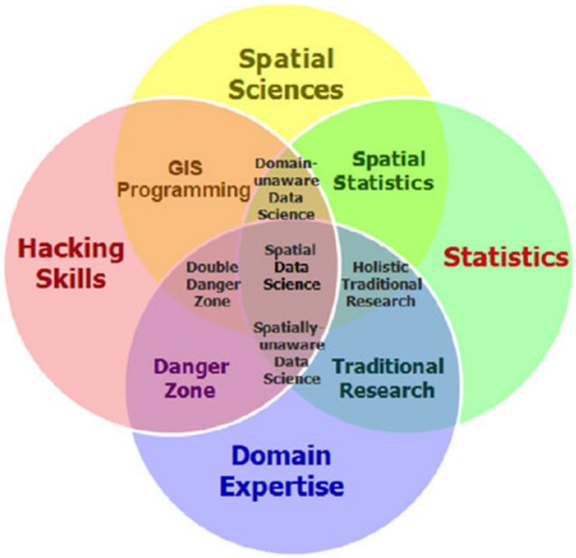
His kindness will be greatly missed by colleagues and friends all over the world!

Highway to the Danger Zones

By Budiman Minasny & Yuxin Ma

I was thrilled when Laura Poggio presented a slide with a Venn diagram with sections labelled "Danger Zone" at the Pedometrics 2017 conference in Wageningen, June 2017. It brought me back to the 1980s and the song was stuck in my head for a few days.

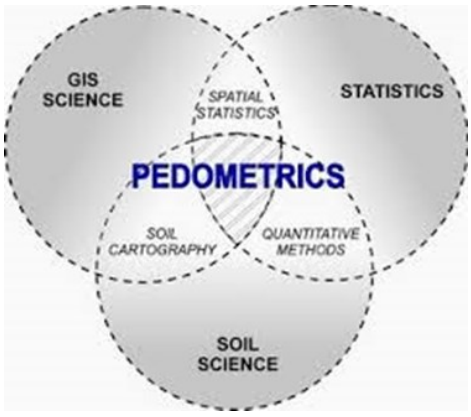
Laura's keynote is on Fusing data and expert knowledge for digital soil assessment and she highlighted various tools that Pedometricians use to solve their problems. She showed a diagram as below:



Danger Zones Diagram (after Laura Poggio, modified after Santacruz, 2016)

The Venn diagram is a modification of Drew Conway and Michael Malak's Data Science diagram. The main point is that there are few Danger Zones should be avoided in Pedometrics.

It is also interesting to compare it to Tom Hengl's pedometrics diagram made more than 10 years ago. Probably it reflects how "data science" has grown into pedometrics.



Highway to the Danger Zones

The “danger zone” Venn diagram depicts common tools used by pedometricians nowadays: statistics (and maths), spatial sciences, domain expertise (soil science) and hacking (programming) skills. The interface of all four skills create a “good” Spatial Data Science.

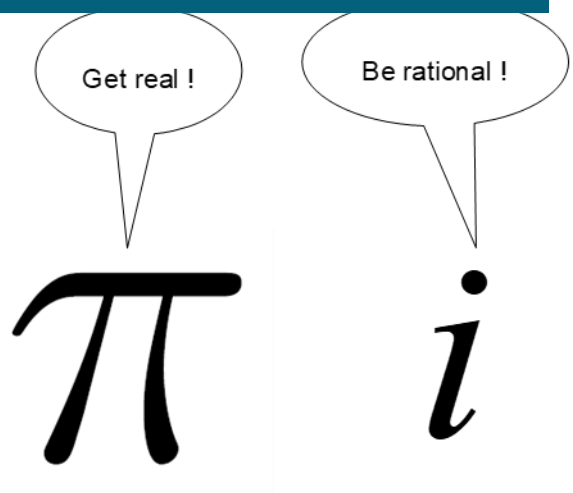
However, the mixture of only 2 or 3 specific skills can create interesting zones which we often see and experience nowadays.

A soil scientist can do lots of statistical analysis without the need for spatial statistics in *spatially-unaware data science*. That is still quite common, and we need to make them aware that there is an additional benefit if we consider spatial information.

Someone can create a beautiful soil map using correct statistics and raster packages in R in *domain-unaware data science*. This is commonly done by machine learning professionals who tend to apply algorithms without an understanding of the domain they’re analysing. I think this should be called the *Triple Danger Zone* following description below. Many have taken a ride into this zone. It is just a reminder that basic soil science is as important as hacking and statistical skills.

There are the *Danger and Double Danger Zone* where one can have a great hacking (or R programming skills) working with a soil scientist in analysing their data. With the proliferation of packages in R or freely available software where one can simply plug soil data in the model without understanding the mathematical and statistical principles behind it. We can blindly use machine learning models and pull out the best R^2 but lack an understanding of what the assumptions of the model and what the parameters mean. Conway called these “know enough to be dangerous”, but I think the domain-unaware data science could be more dangerous in pedometrics.

With the proliferation of models and hacking skills, although it sounds cool, we don’t want to drive ourselves in a Highway to the Danger Zone. I am not claiming to be an expert on all of these, but it is always good to acknowledge limitations of our models and collaboration with people with different skills can make progress in pedometrics.



π is ubiquitous, we use π in various calculations, but often took this irrational number for granted. On March 14th this year we celebrated π Day (you can figure out why). Hence we selected some of the best πedometrics papers and the best π researcher

π soil papers

Here are some interesting soil papers that use π

- Dexter, A.R., 1987. Compression of soil around roots. Plant and Soil, 97(3), pp.401-406. The author calculated soil compression around plant roots using the expansion of cylindrical cavities (which depends on π)
- Young, I.M. and Crawford, J.W., 1991. The fractal structure of soil aggregates: its measurement and interpretation. European Journal of Soil Science, 42(2), pp.187-192. The calculation the radius of an aggregate, which depends on π
- Ringrose-Voase, A.J., 1996. Measurement of soil macropore geometry by image analysis of sections through impregnated soil. Plant and Soil, 183(1), pp.27-47. Measured various pore geometry using π
- Ringrose-Voase, A.J. and Sanidad, W.B., 1996. A method for measuring the development of surface cracks in soils: application to crack development after lowland rice. Geoderma, 71(3-4), pp.245-261. Measured soil cracks based on Buffon Needle's principle that requires π
- Chen, Y.W., and Li, X.R., 2012. Spatio-temporal distribution of nests and influence of ant (Formica cunicularia Lat.) Activity on soil property and seed bank after revegetation in the Tengger Desert. Arid land research and management, 26(4), pp.365-378. Calculated the area and volume of ant hill using π

However, the winner is…

Best π paper:

Evidence for π− π electron donor− acceptor interactions between π-donor aromatic compounds and π-acceptor sites in soil organic matter through pH effects on sorption. Environmental science & technology, 38(16), pp.4361-4368. By Zhu, D., Hyun, S., Pignatello, J.J. and Lee, L.S., 2004.

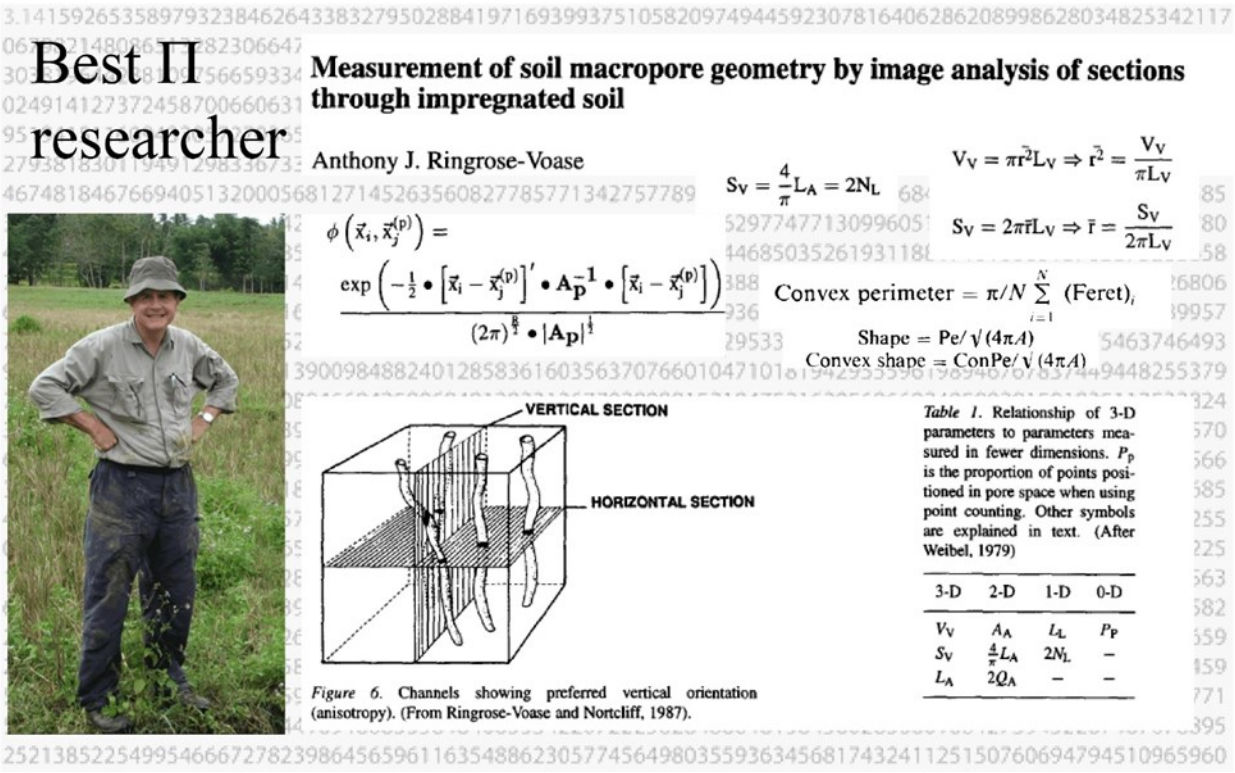
Although the paper has nothing to do with 3.1415…, the title has the most number of π

Pi

Best π researcher in soil science

After lots of searching, we finally found a researcher who loves pie more than other pedometricians.

Anthony Ringrose-Voase, has endlessly but rationally contributed the use of π in soil measurements, from pore structure to cracks! Congratulations Tony.



Pedometrics 2019

Pedometrics 2019 will be held in Guelph, Ontario, Canada. Hosted by Asim Biswas and colleagues at University of Guelph with a theme: “Connecting Existing to the New Data and Methods for Process-based Ecosystem Modelling”

The proposed dates are June 4-7, 2019. The host promises an exciting adventure in the City of Guelph, and also a field trip to Niagara Falls and Niagara Peninsula.

Best Paper Award Nomination 2017

Vote for the Best Paper in Pedometrics 2017

D G Rossiter, Chairman Pedometrics Awards Committee
Pedometrics commission of the International Union of Soil Sciences
e-mail: d.g.rossiter@cornell.edu

Dear fellow Pedometricians,

The Pedometrics Awards committee for the best paper award (Grunwald, McBratney, Oliver, Rossiter, Yang) received only 12 nominations spread over six journals (last year 26 papers, 16 journals). It seems that the enthusiasm leading up to Pedometrics 2017 was so great that people found time to nominate papers, this year back to normal work?

These were scored by the committee. As per the published procedure, we present for your enjoyment and assessment the top five papers. These are a good mix of pedometrics: assessing DSM uncertainty, accuracy assessment of categorical maps, structural equation modelling, global mapping by machine learning, and carbon mapping. Reading these papers will bring you up-to-date on some of the most exciting developments in pedometrics published in 2017.

The 2017 award will be presented at the 21st World Congress of Soil Science, Rio de Janeiro, 12—17 August 2018 (see information athttp://www.21wcss.org/). In order to have the award ready for presentation in Rio, I request that you please send in your votes for the best paper 2017 by 01-August-2018. This gives you almost two months to add these papers to your reading list.

Please rank the papers in the "instant runoff" system: first choice, second choice, etc. up till the last paper you are willing to vote for, i.e., the last paper that you think would deserve the award. Votes should then be sent to me from a traceable e-mail address (to prevent over-voting). I will apply the instant runoff system to determine the winner. A co-author may not vote for her/his own paper(s). What defines "best"? It's up to you to decide, but I think the best paper should be the one that most advances pedometric theory or practice.

(You will note that one of my papers has been nominated and included in the list of five, you'll have to trust me to not vote for the paper, and to honestly tally the votes!)

The papers and their abstracts are listed here in order of DOI:

1. **Vaysse, K., & Lagacherie, P. (2017). Using quantile regression forest to estimate uncertainty of digital soil mapping products. Geoderma, 291, 55–64. https://doi.org/10.1016/j.geoderma.2016.12.017**

Digital Soil Mapping (DSM) products are simplified representations of more complex and partially unknown patterns of soil variations. Therefore, any prediction of a soil property that can be derived from these products has an irreducible uncertainty that needs to be mapped. The objective of this study was to compare the most current DSM method - Regression Kriging (RK) - with a new approach derived from RandomForest - Quantile Regression Forest (QRF) - in regard to their ability of predicting the uncertainties of GlobalSoilMap soil property grids. The comparison was performed for three soil properties, pH, organic carbon and clay content at 5-15 cm depth in a 27,236 km(2) Mediterranean French region with sparse sets of measured soil profiles (1/13.5 km(2)) and for a set of environmental covariates characterizing the relief, climate, geology and land use of the region. Apart from classical performance indicators, comparisons involved accuracy plots and the visual examinations of the uncertainty maps provided by the two methods. The results obtained for the three soil properties showed that QRF provided more accurate and more interpretable predicted patterns of uncertainty than RK did, while having similar performances in predicting soil properties. The use of QRF in operational DSM is therefore rec-

ommended, especially when spatial sampling of soil observations are too sparse for applying RK.

2. **Rossiter, D. G., Zeng, R., & Zhang, G.-L. (2017). Accounting for taxonomic distance in accuracy assessment of soil class predictions. Geoderma, 292, 118–127. https://doi.org/10.1016/j.geoderma.2017.01.012**

Evaluating the accuracy of allocation to classes in monothetic hierarchical soil classification systems, including the World Reference Base for Soil Classification, US Soil Taxonomy, and Chinese Soil Taxonomy, is poorly-served by binomial methods (correct/incorrect allocation per evaluation observation), since some errors are more serious than others in terms of soil properties, map use, pedogenesis, and ease of mapping. Instead, evaluations should account for the taxonomic distance between classes, expressed as class similarities, giving partial credit to some incorrect allocations. These can then be used in weighted accuracy measures, either direct measures of agreement or measures that account for chance agreement, such as the tau index. Similarities can be determined in one of four ways: (1) by the expert opinion of a soil classification specialist; (2) by the distance between classes in a numerical taxonomy assessment; (3) by distance within a taxonomic hierarchy; or (4) by an error loss function. Expert opinion can be from the point of view of the map user, to assess map utility, or map producer, to assess mapping skill. Examples are given of determining similarity between a subset of Chinese Soil Taxonomy classes by expert opinion and by numerical taxonomy from soil spectra, and then using these for weighted accuracy assessment. A method for assessing the accuracy of probabilistic predictions of several classes at a location is also proposed.

3. **Angelini, M. E., Heuvelink, G. B. M., & Kempen, B. (2017). Multivariate mapping of soil with structural equation modelling. European Journal of Soil Science, 68(5), 575–591. https://doi.org/10.1111/ejss.12446**

In a previous study we introduced structural equation modelling (SEM) for digital soil mapping in the Argentine Pampas. An attractive property of SEM is that it incorporates pedological knowledge explicitly through a mathematical implementation of a conceptual model. Many soil processes operate within the soil profile; therefore, SEM might be suitable for simultaneous prediction of soil properties for multiple soil layers. In this way, relations between soil properties in different horizons can be included that might result in more consistent predictions. The objectives of this study were therefore to apply SEM to multi-layer and multivariate soil mapping, and to test SEM functionality for suggestions to improve the modelling. We applied SEM to model and predict the lateral and vertical distribution of the cation exchange capacity (CEC), organic carbon (OC) and clay content of three major soil horizons, A, B and C, for a 23 000-km2 region in the Argentine Pampas. We developed a conceptual model based on pedological hypotheses. Next, we derived a mathematical model and calibrated it with environmental covariates and soil data from 320 soil profiles. Cross-validation of predicted soil properties showed that SEM explained only marginally more of the variance than a linear regression model. However, assessment of the covariation showed that SEM reproduces the covariance between variables much more accurately than linear regression. We concluded that SEM can be used to predict several soil properties in multiple layers by considering the interrelations between soil properties and layers.

4. **Hengl, T., Jesus, J. M. de, Heuvelink, G. B. M., Gonzalez, M. R., Kilibarda, M., Blagotić, A., … Kempen, B. (2017). SoilGrids250m: Global gridded soil information based on machine learning. PLOS ONE, 12(2), e0169748. https://doi.org/10.1371/journal.pone.0169748**

This paper describes the technical development and accuracy assessment of the most recent and improved version of the SoilGrids system at 250m resolution (June 2016 update). SoilGrids provides global predictions for standard numeric soil properties (organic carbon, bulk density, Cation Exchange Capacity (CEC), pH, soil texture fractions and coarse fragments) at seven standard depths (0, 5, 15, 30, 60, 100 and 200 cm), in addition to predictions of depth to bedrock and distribution

of soil classes based on the World Reference Base (WRB) and USDA classification systems (ca. 280 raster layers in total). Predictions were based on ca. 150,000 soil profiles used for training and a stack of 158 remote sensing-based soil covariates (primarily derived from MODIS land products, SRTM DEM derivatives, climatic images and global landform and lithology maps), which were used to fit an ensemble of machine learning methods—random forest and gradient boosting and/or multinomial logistic regression—as implemented in the R packages ranger, xgboost, nnet and caret. The results of 10–fold cross-validation show that the ensemble models explain between 56% (coarse fragments) and 83% (pH) of variation with an overall average of 61%. Improvements in the relative accuracy considering the amount of variation explained, in comparison to the previous version of SoilGrids at 1 km spatial resolution, range from 60 to 230%. Improvements can be attributed to: (1) the use of machine learning instead of linear regression, (2) to considerable investments in preparing finer resolution covariate layers and (3) to insertion of additional soil profiles. Further development of SoilGrids could include refinement of methods to incorporate input uncertainties and derivation of posterior probability distributions (per pixel), and further automation of spatial modeling so that soil maps can be generated for potentially hundreds of soil variables. Another area of future research is the development of methods for multiscale merging of SoilGrids predictions with local and/or national gridded soil products (e.g. up to 50 m spatial resolution) so that increasingly more accurate, complete and consistent global soil information can be produced. SoilGrids are available under the Open Data Base License.

5. **Somarathna, P. D. S. N., Minasny, B., & Malone, B. P. (2017). More data or a better model? Figuring out what matters most for the spatial prediction of soil carbon. Soil Science Society of America Journal, 81, 1413–1426. https://doi.org/10.2136/sssaj2016.11.0376**

Modeling techniques used in digital soil carbon mapping encompass a variety of algorithms to address spatial prediction problems such as spatial non-stationarity, nonlinearity and multi-colinearity. A given study site can inherit one or more such spatial prediction problems, necessitating the use of a combination of statistical learning algorithms to improve the accuracy of predictions. In addition, the training sample size may affect the accuracy of the model predictions. The effect of varying sample size on model accuracy has not been widely studied in pedometrics. To help fill this gap, we examined the behavior of multiple linear regression (MLR), geographically weighted regression (GWR), linear mixed models (LMMs), Cubist regression trees, quantile regression forests (QRFs), and extreme learning machine regression (ELMR) under varying sample sizes. The results showed that for the study site in the Hunter Valley, Australia, the accuracy of spatial prediction of soil carbon is more sensitive to training sample size compared to the model type used. The prediction accuracy initially increases exponentially with increasing sample size, eventually reaching a plateau. Different models reach their maximum predictive potential at different sample sizes. Furthermore, the uncertainty of model predictions decreases with increasing training sample sizes.