

PEDOMETRON



PEDOMETRON

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Newsletter of the International Society of Soil Science Working Group on Pedometrics (PM)

Pedometrics Chair: Professor Alex B. McBratney

Editor: Dr Inakwu O.A. Odeh

From the Chair

My aim in these articles is to highlight what I think are important issues in soil science where pedometrics, through its quantitative approach, can offer some insight. Here I'd like to discuss the concept of pedodiversity, its measurement and its implications. I think it's a concept that pedometricians can play a significant role in helping to define and measure.



FUN IN ACAPULCO: The Chair of the Working Group, Alex. McBratney (on the right) having a late evening discussion on the latest developments in pedometrics.

Pedodiversity

Soil variation

Conventionally soil variation is considered a nuisance especially when it comes to making precise soil maps or statements about the soil. Much pedometrics research has focused on describing this variation quantitatively. If we consider this variation as diversity in soil attributes, materials and types, then of course in a more modern ecological way of thinking, soil diversity or pedodiversity has its positive features.

Pedodiversity

Therefore, just as biologists and ecologists talk about biodiversity we can talk about pedodiversity. There is some overlap of course because soil contains organisms (biodiversity). As pedometricians how can we quantify pedodiversity? If we consider the soil to be a collection of attributes then we can use the variogram of individual attributes as a measure. This allows the calculation of the variance within a

region of any specified size or shape. (As this subject develops it should not be forgotten that geostatistics provides useful tools for quantifying pedodiversity). If we need to consider a range of attributes then a variogram of their linear combination might provide a useful approach.

A common working model shows that the variance increases as the log of distance. As well as the variance the gradient of this log-linear relationship may be a useful measure of the diversity in different locations.

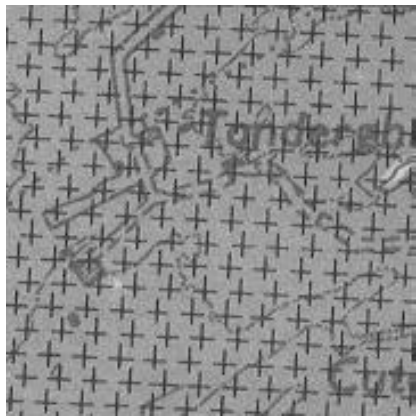
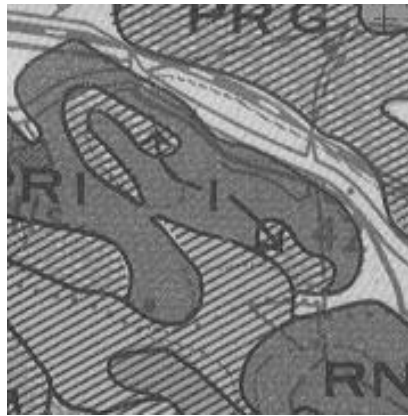
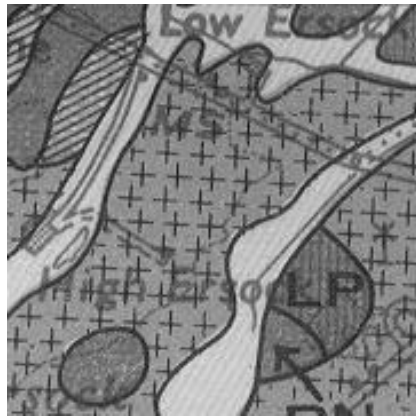
Measuring pedodiversity

If one delves into the ecological literature a plethora of diversity measures can be found. Most of these are based on categorical or unranked multistate variables, e.g., in our context – soil classes or soil types. One of the simplest measures of diversity in ecology is the species richness, a count of the number of species (or different



Best Paper Award

As a result of the election exercise announced in the last issue of the *Pedometron*, the paper by Rasiah, V., Kay, B.D. & Perfect, E. titled "New mass-based model for estimating fractal dimensions of aggregates" published in *Soil Science Society of America Journal*, Vol. 57; pp 891-895, has been voted the best paper for 1993. The certificate of award and citation will be presented by the Chair of the Working Group on Pedometrics, Professor Alex McBratney, in November 1995 at the ASA annual meetings in St Louis, Missouri.



The four maps on the left show a 1 km by 1 km block from a soil map. Clearly some blocks have much more diversity in soil classes than others. So we could rank them on the number of different classes or the relative abundance of the different number of classes or the interfacial length of classes with one another. These would be measures of taxonomic diversity. The measures could be improved by knowing which classes are similar and which are not. Of course, caution should be taken. The block with one soil map unit appears to be the least diverse, but this unit represents a complex of two distinct soil types which can't be shown at the scale of the map.

soil classes) within a specified region. Those ecologists interested in community structure have also included the relative abundances of species in composite measures. There is a large literature on this subject. Magurran (1988) gives a good review and Ibáñez et al. (1994) discuss an application to soil maps. It is worth noting here that the Russian soil geography (Fridland 1976) has really been concerned with describing the pattern of the soil cover and, in a sense, the pedodiversity.

The preceding discussion measured diversity relative to soil classes and might be termed *taxonomic pedodiversity*. This approach can be improved by knowing the relative taxonomic distances between classes. Another way of looking at and measuring pedodiversity is to consider what the soil does. In a sense this is what land evaluation, particularly the notion of land capability, or as I prefer to call it – land versatility, does – at a single point. *Functional pedodiversity* may be

measured by the within-block variance of land versatility (to a wide range of alternative uses or to the support of a diverse biological community).

Optimal soil preservation strategies

Is measuring pedodiversity more than an academic exercise? We might wish to preserve, or even reconstruct, the soil cover. Just as biologists argue that organisms need to be maintained we can argue that preserving soil will maintain organisms as well as other unique soil materials equally crucial in insuring our future wellbeing.

We are aware that certain organisms are becoming extinct at an increasing rate. Are certain soil types becoming extinct? How do we save them from extinction? Put more tractably, how do we design a set of reserves to epitomize what is saved? Although we have not yet reached a quantitative understanding of soil genesis (topic to be discussed in a subsequent newsletter) an attempt can still be made.

Using this approach an optimal national soil reserves policy could be established. Given a set of x possible soil reserves we can find the most pedodiverse one and then find the next one that has the highest remaining total excluding the ones already present and so on, always choosing the best region to compensate for groups not yet incorporated. In hierarchical or numerical schemes this can be done using taxonomic distance. Eventually we have a list of the reserves ordered by their importance in preserving a region's (or the world's) soil profile or horizon groups. This, of course, is relatively easy given the tools of informatics: soil information systems, geographic information systems, optimization algorithms, and so on. Alternatively, as discussed above, this might also be done in terms of diversity (or variance) in a set of properties. Using this particular approach the log-linear variogram model implies that, on

↳ Continued on page 3

average, the blocks should be as far apart as possible!

McBratney (1992) gave a simple example. Fifty-one, 10 km by 10 km blocks were extracted by simple random sampling without replacement from the Digital Atlas of Australian Soils. For each block the composition was estimated using the geographic information system, ARC. The 51 blocks were then ordered by their taxonomic diversity. Simple rules were used. The block with the largest number of map units were considered most diverse, provided it did not contain the same map units as other blocks and so on. In the ecological literature, more sophisticated approaches, somewhat related to the travelling salesman problem, have been discussed and attempted by Bedward et al. (1992), Cooks & Baird (1989) and Pressey et al. (1993).

Reconstruction pedology

Finally, for those areas which have been degraded it will become important to reconstruct the variation. A quantitative knowledge of natural pedodiversity will ease the task of the reconstruction pedologist – a person who attempts to rebuild quasi-natural soil systems.

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I should welcome some discussion of this topic in the next newsletter.



From the Newsletter Editor

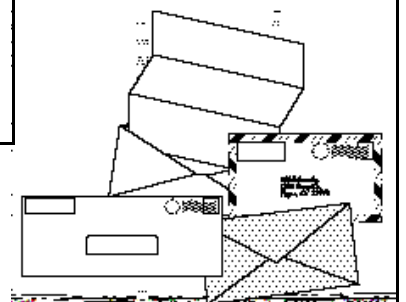
The success of the last edition of Pedometron is indicative of importance of continuous publication of the Newsletter. Our target is to publish at least once every six months. Our continuous success will depend on you. We need input from readers. The next issue of Pedometron is due to be out by September 30, 1995. We are therefore inviting you to contribute items for possible inclusion in the Newsletter. Areas in which we would like contributions to cover include:

1. Short review of a topic of your choice, e.g., recent advances in

pedometrics, developments in soil science and the role of pedometrics, etc.

2. An abstracted version of your recent publication(s) in soil science journals.
3. Titles and abstracts of recent theses in which you were involved.
4. An ode to the gods of earth or something similar.
5. Or any other topic of your choice relevant to pedometrics in particular and soil science in general.

Plans are under way for the Newsletter to be available through the Internet. For the time being, however, hard-copy versions will be mailed to you as usual.



Mailing list

We now have a mailing list for Pedometricians. The mailing address is:

"pedometrics@sola.agric.usyd.edu.AU"

To subscribe, send a message to

"pedometrics-request@sola.agric.usyd.edu.AU"

by typing:

"subscribe pedometrics"

or "unsubscribe pedometrics" if you get fed up :-)





Meetings

**Workshop on
Fuzzy Sets in Soil
Science St Louis
Meeting, Oct. 29 to
Nov. 3, 1996**

A symposium between SSSA-S5 and the ISSS Working Group on Pedometrics (a Working Group of Commission I, Soil Physics)

Fuzzy sets were formalised by Zadeh in 1965 but are based on earlier notions of vagueness considered by philosophers such as Bertrand Russell. Fuzzy sets are a generalisation of hard sets which over the last 30 years have been applied to manifold areas including classification, decision theory, control of instruments and appliances. The theory and applications are well described by McNEILL & FREIBERGER (1993). In soil science there have been two approaches developed so far, the Australo-Dutch fuzzy soil classification approach developed

by MCBRATNEY & DE GRUIJTER (several references cited below) and the Dutch-Belgian approach (BURROUGH 1989; TANG ET AL. 1991) to land evaluation. The work by TANG ET AL. was seen as particularly significant and has been recognised and won the Best Paper Award for 1992 by the ISSS Working Group on Pedometrics.

Recent advances, such as an alternative fuzzy approach to land evaluation developed in the US by the Soil Conservation Service, Lincoln, Nebraska (as yet unpublished) and work on application of fuzzy sets in GIS by the PETER BURROUGH'S group at Utrecht and the Department of Soil Science, University of Wisconsin, Madison, further highlight the timeliness of such a workshop.

The aims of the workshop are:

- to make soil scientists aware of the possibilities of this theory,
- to highlight new applications of the theory in soil science.

The Workshop will cover four main topics which cover the main initial application areas; the number of papers in each topic would depend on the response. There will be a keynote speaker in each of the four areas. Keynote speakers will review the topic, present some of their current work and suggest future directions.

Provisional program

(as at 15th April 1995)

The presses have to roll today but at the time of writing the program looks as follows – but it is still in a state of flux.

The Symposium will be chaired by K McSweeney, University of

Wisconsin - Madison.

Topic 1 FUZZY SETS, FUZZY MEASUREMENT AND FUZZY DECISIONS

Keynote speaker: ALEX. MCBRATNEY, University of Sydney.

A.B. MCBRATNEY* & I.O.A. ODEH, University of Sydney.

Introduction to the application of fuzzy sets in soil science: Fuzzy sets, fuzzy measurement and fuzzy decisions

Topic 2 APPLICATION TO SOIL CLASSIFICATION

Keynote speaker: DR J.J. DE GRUIJTER, Winand-Staring Centre, Wageningen.

Fuzzy sets for continuous soil classification. A review.

B. SLATER* & K. MCSWEENEY, University of Wisconsin - Madison.
Fuzzy horizon classes

PHILIPPE LAGACHERIE* , DURK CAZEMIER, PAULINE VAN GAANS AND PETER BURROUGH, INRA, Montpellier & University of Utrecht.

A fuzzy classification of hydrological units in an elementary watershed.

Topic 3 APPLICATION TO SOIL MAPPING

Keynote speaker: PROFESSOR PETER BURROUGH, University of Utrecht.

Applications of fuzzy mapping in soil survey: spatial correlation and confusion.

A-XING ZHU, Miami University of Ohio.
Representing soil spatial information under fuzzy logic.

B. IRVIN, S.J. VENTURA & K. MCSWEENEY, University of Wisconsin - Madison.
Fuzzy geomorphic classes for soil mapping.

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Topic 4 APPLICATION TO LAND EVALUATION

Keynote speaker: DR TANG HUAJUN,
Institute of Natural Resources and
Regional Planning, Chinese
Academy of Agricultural Science,
Beijing

TANG HUAJUN* & ERIC VAN
RANST,

Institute of Natural Resources and
Regional Planning, Chinese
Academy of Agricultural Science,
Beijing & University of Ghent.

*Impacts of Fuzzy Membership
Functions and Fuzzy Operators on
Land Suitability Assessment.*

D. MAYES*,
Soil Conservation Service, Lincoln,
Nebraska .

Title unspecified as yet.

A. DOBERMANN* & T.
OBERTHUER,
IRRI, Philippines

*Fuzzy classification in regional
assessment of soil fertility - A case
study on irrigated riceland of the
Philippines.*

Panel session

(To be finalised)

Poster papers

ERIC VAN RANST & HUAJUN
TANG,

University of Ghent & Institute of
Natural Resources and Regional
Planning, Chinese Academy of
Agricultural Science, Beijing

*Impacts of Fuzzy Membership
Functions and Fuzzy Operators on
Land Suitability Assessment.*

Software Scene

S.A. MAZAHERI, A.B.
MCBRATNEY* & A.J. KOPPI,
University of Sydney

*ASIS - Australian Soil Identification
Spreadsheet, A Soil Identification
System for fuzzy soil classes*

The Workshop is being organised
by DR K. MCSWEENEY,
University of Wisconsin-Madison

and PROF. ALEX. MCBRATNEY
(Chair, ISSS Working Group on
Pedometrics).

It is planned to publish the
proceedings of the workshop in
Geoderma if permission is given by
the Society.

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*Soil Science Society of
America Journal*. 65, 505-516.

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D. & VAN RANST, E. (1991)
*Land suitability classification
based on fuzzy set theory.*
Pedologie 41, 277-290.

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Information & Control 8, 338-
353.

Workshop on Soil and Water Quality at Different Scales

Organized by the three Working
Groups, **Moisture Variability,
Pedometrics and Soil Pollution**
of the ISSS.

Rationale and aim

During the 1994 International
Congress of Soil Science in
Acapulco, Mexico a special session
was devoted to the future of soil
science. This session resulted in a
statement on proposed activities to
"Seize Opportunities for Soil
Science and its Application in the
21st Century". Some key elements
of this statement refer to the
broadening of soil science
constituencies beyond traditional
agricultural partners and expansion
of the focus of soil science to include
(a.o.) ecosystem management,
sustainability of the biosphere,
environmental protection and urban
environment. A more holistic
interdisciplinary approach to soil
system was proposed and it was
advocated that a definition of soil
quality should be established,
because soil quality is identical as a
key indicator of environmental
health.

To obtain a state-of-the-art picture
of interdisciplinary research in the
context of soil quality, three working
groups of the ISSS will organise a
workshop focused on integrated case
studies on soil and water quality,
with special emphasis on scale
aspects.

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Date and subject of the workshop

The joint workshop will be organized in Wageningen from August 7 to 9 1996 by three working groups of the ISSS: Moisture Variability in space and time (MV), Soil Pollution (SP) and Pedometrics (PM). Emphasis will be on the integrated application of quantitative techniques that have been developed recently in scientific research covered by the three working groups. To achieve this objective, a format for the meeting is proposed that differs from the usual one by not focusing on invited and volunteered papers and posters, but on detailed presentations, oral reviews and discussions of case studies dealing with land use at different scales (e.g. within-field, farm catchment, regional, country-wide, continental, world-wide). Each selected case will receive a time slot of 1.5 hours for plenary presentation, oral reviews and a discussion. To enhance the review and discussion, the case must be submitted 3 months before the workshop.

Research groups interested to contribute a case are invited to contact the secretary of the organizing committee who can provide a set of criteria and questions that we feel should be addressed when formulating a case. A certain degree of homogeneity among cases to be presented is necessary to allow an evaluation of all cases at the end of the workshop and formulate some general conclusions and needs for future research.

The theme of the case studies is: "Soil and water quality at different scales". The workshop will precede a conference at ITC in Enschede, the Netherlands, organized by the new subcommission of ISSS on Land Evaluation. Major conclusions

of the joint workshop will be presented at this conference.

Submission and publication of papers and posters

Abstracts of volunteered papers or posters must be submitted before October 1, 1995 (papers) or January 1, 1996 (posters) to the secretary of the organizing committee. In order to ascertain that the papers for oral presentation are truly integrated case studies, abstracts can be selected only if the case covers the full research chain defined below:

1. Problem definition and design research methods;
2. Model development;
3. Data collection;
4. Model application and evaluation; Presentation of results.

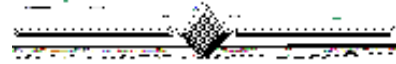
A research group presenting a case will be asked to review during the workshop one or two other cases, with the purpose of intensifying interaction between research groups. Volunteered posters will be accepted if they minimally cover aspects 1+2, 1+3 or 1+4 of the research chain above. We assume that a full research chain cannot be represented on a single poster. Extended poster abstracts, volunteered papers and review papers will, after review, be published in the proceedings.

For further information contact

Dr P.A. Finke
DLO-Winand Staring Centre for Integrated Land, Soil and Water Research, P.O. Box 125,

6700 AG Wageningen,
The Netherlands.

Fax: +31 8370 24812
Phone: +31 8370 74258
Email: p.a.finke@sc.agro.nl



**Fifth
International
Geostatistics
Congress: 22-27
September 1996**

The fifth International Geostatistics Congress will be held in Wollongong, Australia from Sunday evening September 22nd to Friday afternoon September 27th, 1996. The unique event provides a forum for dissemination of innovative ideas in geostatistics. The congress will be held in the Novotel Hotel, Wollongong, NSW with special accommodation arrangements for delegates.

Papers

Papers on theoretical work, applications and case studies are sought. The following topics are a guide:

- New developments in the theory and applications of spatial random functions
- Conditional simulation: theory and application
- Petroleum applications
- Environmental applications
- Mining applications
- Geotechnical applications
- Hydrological applications

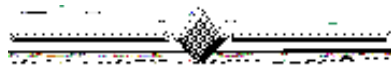
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→Agricultural, health science, soil sciences and other applications

Contact

Ernest Baafi, GEOSTAT 996, Department of Civil and Mining Engineering, University of Wollongong, Wollongong, NSW 2522, Australia.

Fax: 62 42 21 3238
Phone: 62 42 21 3031 or 62 42 21 3040



Proposed Meetings by PM

1996

1 day conference in Australia, in association with meeting of the Australia Society of Soil Science

Venue: University of Melbourne

Subject: general

1 day workshop as a part of meeting organized by ISSS Subcommittee on Land evaluation

Venue: Wageningen, the Netherlands

Theme (provisional): 1. Soil sampling. 2. Statistical aspects of model validation.

1997

3 day conference in USA, August/September

Venue: University of Wisconsin

Organisation: **Dr Kevin McSweeney** (Dept of Soil Science)

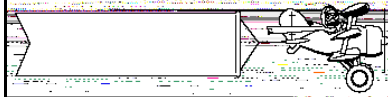
Subject: general

1998

1 day symposium in association with the ISSS meeting in August, in

Montpellier, France.

Subject (provisional): Scale in soil science.



Some doctoral theses in Pedometrics (1994)

Liu, X. 1994. Fractal geometry for characterizing macropore-scale solute transport parameters. University of Missouri, The USA.

McVoy, C.W. 1994. Measurement of temporal and spatial variability of soil-water in a grass meadow. Cornell University, Ithaca, USA.

Tsegaye, T. 1994. Geostatistical evaluation of soil and plant properties in a "uniform" field. University of Maryland, USA.

Oztas, T. 1994. Assessment of erosion rates and patterns from spatial variability of Cesium-137. University of Nebraska, USA.

Tenywa, M.M. 1994. Soil erosion and overland flow processes on spatially variable soils. Ohio State University, USA.

Zollweg, J.A. 1994. Effective use of

geographic information systems for rainfall-runoff modelling. Cornell University, Ithaca, USA.

Okae-Anti, D.T.A. 1994. Spatial variability in relation to pedogenic studies in alluvial soils. The University of Reading, Reading, The UK.



Short articles and theses information should be sent to:

The Editor
Pedometron
CRC for Sustainable Cotton Production,
Department of Agricultural Chemistry & Soil Science, A03 Ross St, The University of Sydney, Sydney AUSTRALIA 2006

or emailed to:

pedometron@sola.agric.usyd.edu.AU

DEADLINE FOR THE NEXT ISSUE IS September 1, 1995.

Pedometrics is a Working Group of Commission I (Soil Physics) of the International Society of Soil Science (ISSS). Information about ISSS is available from the Secretary General:

Prof. Dr W.E.H. Blum,
ISSS Secretariat,
Institut für Bodenforschung, Universität
für Bodenkultur,
Gregor-Mendel-Strasse 33,
A-1180 Vienna,
AUSTRIA

Committee (1994-1998)

Chair

Prof. A.B. McBratney,
Department of Agricultural Chemistry &
Soil Science, A03 Ross St
The University of Sydney, NSW 2006,
AUSTRALIA

Past Chair

Prof. D.E. Myer
Dept of Mathematics,
University of Arizona,
Tucson, Arizona AZ 85721,
USA

Deputy Chair

Prof. J. Bouma,
Dept of Soil Science & Geology,
Agricultural University,
P.O. Box 37,
6700 AA Wageningen,
THE NETHERLANDS

Secretary

Dr J.J. de Gruijter,
DLO Winand Staring Centre,
P.O. Box 125,
6700 AC Wageningen,
THE NETHERLANDS

PEDOMETRON

prepared & edited by

Dr. I.O.A. Odeh,
Cooperative Research Centre for
Sustainable Cotton Production,
Department of Agricultural Chemistry &
Soil Science, A03 Ross St
The University of Sydney, NSW 2006
AUSTRALIA



In order to obtain some indication of those interested in the working group and receiving this newsletter please fill in the form below **if you have not previously done so**. Photocopy it and distribute it to interested colleagues. The return will be used as a mailing list for the newsletter and the list will be distributed to all those on it.

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return to * the Editor