# You know what ? I'm an indicator

Anne C Richer-De-Forges

# ΠΕΔΟΜΕΤΡΟΝ

**The Newsletter of the Pedometrics Commission of the IUSS**

**Issue 30, August 2011**

**Chair: Thorsten Behrens** **Vice Chair & Editor: A-Xing Zhu**


## From the Chair

Dear pedometricians,

This is the first issue of the Pedometron newsletter since A-Xing Zhu and I took over as vice-chair and chair of Commission 1.5 Pedometrics of the IUSS. So first of all we would like to thank Murray and Budi for the great work they have done for the Commission and their enthusiasm to push things forward! Thank you very much!

This is also Pedometron No. 30! Since the first Pedometron was published in 1991 we are happy to celebrate the 20th birthday of our newsletter this year. Congratulations and a very big thank you for everyone who contributed to make it a success! A lot of things happened within this two decades. The most important thing was that Pedometrics made its way from a working group to an IUSS Commission in 2004. The Pedometrics commission is a very active and healthy community. Currently, we have three working groups Digital Soil Mapping, Proximal Soil Sensing, and Soil Monitoring, which were approved within the last 5 years. We also have biannual Pedometrics conferences and lots of Symposia at larger scientific conferences. Some of us are working on global soil maps. The headline for the second Pedometron newsletter was "Pedometrics matures". Today, I am convinced we can say with pride that "Pedometrics has matured" and is now an integral part of soil science. Hence, there is definitely no need turn anything upside down. However, if you have any suggestions or ideas, we would be happy to learn about.

What we want to change concerning the newsletter is that we will integrate the working groups, so that all related news will be published under one umbrella. What we do not want to change is asking you to participate. For keeping the newsletter attractive it would be great if you can send in short articles. What is also welcome are short notes on failed studies or negative results - something which might prevent us from pursuing ideas that others already have proven wrong. There are some journals where negative results can be published but not really suited for pedometricial research. Maybe we should think about some special issue? So I would like to reprint what Alex prepared for the first Pedometron issue back in 1991:


A-Xing and I wish you a successful Pedometrics conference in Trest, Czech Republic next week. We hope to see all of you there and wish you all the best for the next 20 years of pedometrical research!

With kind regards,

Thorsten

## Inside This Issue



## Feature story

### The soil formation equation: Imaginary scientific priority of Hans Jenny


Igor V. Florinsky[a]

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In this year, there is the 70th anniversary of the book by Hans Jenny (1941) including the well-known soil formation equation (Jenny, 1941, p. 16):

$$S = f(cl, o, r, p, t, \ldots) \quad (1)$$

where S is soil; cl, o, r, p, and t are soil forming factors: climate (cl), organisms (o), topography (r), parent material (p), and time (t); the dots indicate that additional soil formers may be included in Eq. (1). Until now, there are discussions about who did the first step towards the formalization of the soil formation problem, and were there precursors of the Jenny equation (Bockheim et al., 2005, p. 26; Schaetzl and Anderson, 2005, p. 296; McBratney and Minasny, 2008). Hans Jenny, himself, accepted the priority of Vasily Dokuchaev (Jenny, 1961). However, the Dokuchaev and Shaw equations cited by Jenny (1961) differ significantly from the Jenny equation, which ideally describes the idea that soil is a result of interaction of the five forming factors. In this note, we demonstrate that Hans Jenny adopted Eq. (1) from Sergey Zakharov.

In 1883, Dokuchaev has first presented the fundamental postulate of soil science that soil is a result of interaction of the five principal forming factors (Dokuchaev, 1883, p. III): “Soils being a result of a very complicated interaction between local climate, plant and animal organisms, content and structure of parent rocks, topography, and, finally, age of the terrain”.

In 1899, Dokuchaev has proposed the first soil formation equation mathematically describing the postulate (Dokuchaev, 1899, p. 3):

$$\Pi = f(\text{К}, \text{О}, \Gamma)\text{В} \quad (2)$$

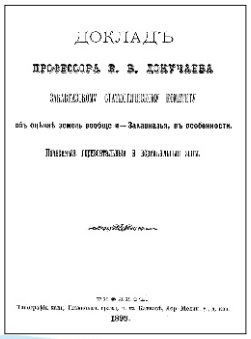
where capital initial letters of Russian terms are used as symbols: П("почва")is soil; К("климат") is climate, О("организмы")is organisms, Г ("грунт") is ground or parent material, and В ("возраст почвы") is age of the soil (Figs. 1 and 2). Topography was not included into the expression due to a stenographer mistake or misprint: Eq. (2) is preceded by two sentences discussing the important role of topography in soil formation (Fig. 2).

In 1927, Sergey Zakharov has presented a general soil formation equation in one of the first fundamental

$$\pi = f(\text{М.Г.П.},\ \text{Р.Ж.Орг.},\ \text{Кл.},\ \text{Возр.стр.},\ \text{Р-ф}) \quad (3)$$

where abbreviations of Russian terms are used as symbols: π ("почва") is soil, М.Г.П. ("материнская горная порода") is parent rock material, Р.Ж.Орг. ("растительные и животные организмы") is plant and animal organisms, Кл.("климат") is climate, Возр.стр. ("возраст страны") is age of the terrain, and Р-ф ("рельеф") is topography (Figs. 3 and 4). In Eq. (3), there were three misprints (Fig. 4): (a) a comma was missed between “organisms” and “climate”; (b) there was a dot instead a comma between “time” and “topography”; and (c) there was an excess close bracket after “climate”. These misprints were fixed in the second edition (Zakharov, 1931, p. 18). 4,000 and 18,000 copies of the first and second editions were printed, correspondingly.

In summer 1927, Zakharov took part in the 1st International Congress of Soil Science hold in Washington, D.C., USA. The reprint of his report at the Congress (Zakharov, 1927b) did not include Eq. (3). We do not know the exact publication date (day and month) of the book (Zakharov, 1927a); therefore we cannot state that Zakharov was able to present


ДОКЛАДЪ

ПРОФЕССОРА В. В. ДОКУЧАЕВА

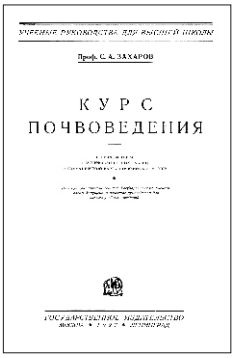
Fig. 1. Title page of the book by Dokuchaev (1899).

Fig. 2. Page 3 from the book by Dokuchaev (1899) with the soil formation equation

This book at the Congress or to give it to other participants. The first review and information on the book were published in the early 1928 (Filatov, 1928;Waksman and Deemer, 1928a, p. 33). However, Hans Jenny had opportunity to learn about Eq. (3) in scientific conversations and personal contacts with Sergey Zakharov during the Congress and the one-month transcontinental soil excursion. It is well-known that very active exchange of scientific ideas between participants from different countries was the outstanding feature of this Congress (Waksman and Deemer, 1928b; Joffe and Antipov-Karataev, 1929).

It is clear that the Zakharov and Jenny equations (Eqs. 3 and 1) are almost the same. However, Jenny did not acknowledge the priority of Zakharov. Thus, Eq. (1) should be called the ZakharovJenny equation.

**Acknowledgements.** I would like to thank J.L. Meshalkina and A.V. Ivanov (Faculty of Soil Science, Lomonosov Moscow State University, Russia) for assistance and discussion.


Проф. С. А. ЗАХАРОВ

КУРС ПОЧВОВЕДЕНИЯ

Fig. 3. Title page of the book by Zakharov (1927).

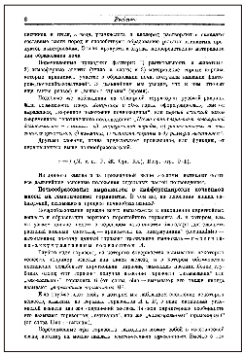


Fig. 4. Page 8 from the book by Zakharov (1927) with the soil formation equation.

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# Reports from Working Groups

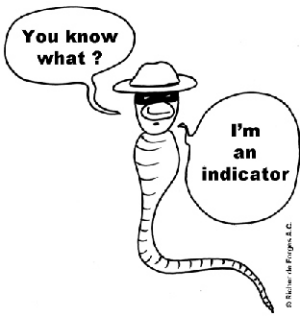
## IUSS Working Group on Soil Monitoring

In August last year the International Union of Soil Science approved the creation of a working group on Soil Monitoring. This was in response to the pressing need to develop monitoring networks that can quantify and explain the threat posed to soil quality by processes such as erosion, declining organic matter, contamination, compaction, salinisation, loss in biodiversity, soil sealing, landslides and desertification. We invite anybody who is interested in participating in this working group or who would like to join the group's mailing list and receive the group's newsletters to contact the chair Dominique Arrouays (dominique.arrouays@orleans.inra.fr) or the secretary Ben Marchant (ben.marchant@bbsrc.ac.uk)

In recent years, initiatives to monitor specific local threats to soil quality and function have been launched throughout the globe. These initiatives require expertise from a large range of disciplines such as statistics, mathematical modelling, soil physics, soil chemistry, soil biology and biochemistry, digital soil mapping and proximal sensing technology. The exact requirements of different soil monitoring networks will vary according to the type and function of the soil and the nature of local threats. However there are a number of generic issues that will be faced by managers of all networks. These include effective interactions with stakeholders, sample scheme design, statistical analyses and uncertainty, inclusion of knowledge of soil processes, ensuring compatibility with existing soil surveys, the choice of indicators and analytical techniques and various practical implementation issues.

The main aims of the working group are to share interdisciplinary soil monitoring expertise from around the world, to identify challenges which require further research, to coordinate this research, to harmonize future soil monitoring efforts whilst respecting the needs of different surveys and to raise the profile of soil monitoring. These will be achieved through multidisciplinary meetings, workshops and training sessions, publications and regular newsletters. If anyone would like to propose a meeting or activity, please contact the chair or secretary.

There will be a Special Session on Soil Monitoring with the Pedometrics 2011 meeting at Trest Castle, Czech Republic (August 30 September 3, 2011). Submissions for this session can be made through the conference website before February 1. A workshop is being planned for the EuroSoils 2012 meeting. Further activities will be communicated through the working group newsletter and mailing list.




Soil monitoring in the French Alps. Copyright Stéphane Barbier, INRA InfoSol, France

## Reports from conferences

### Report from the International Workshop on "Optimizing and Integrating Predictions of Agricultural Soil and Water Conservation Models at Different Scales"

Tom Vanwalleghem, Francisco Jiménez-Hornero, Juan Vicente Giráldez

The workshop "Optimizing and Integrating Predictions of Agricultural Soil and Water Conservation Models at Different Scales " took place from 27-29 September at Baeza, Spain. The event, sponsored by the International University of Andalucia (UNIA), brought together the expertise of 16 internationally renowned scientists working in the broad field of soil and water conservation. Apart from these 16 keynote lectures, the workshop included 17 poster contributions. The overall objective of the workshop was to provide a forum to analyse and revise the fundaments of soil and water conservation models from a multidisciplinary perspective. The different themes covered a wide range of subjects and included:

- general aspects and critical issues concerning soil and water conservation models
- integrating field data in models and dealing with spatial variability of input factors
- scale issues
- analysing sensitivity and uncertainty of models
- Improving numerical treatment

The workshop spanned three days and was organized in 5 sessions covering each of the topics discussed above. Prior to the start of the first session, an introduction was given by the coordinator of the UNIA, Lourdes Soria and the organizers, Juan Vicente Giráldez, Francisco Jiménez-Hornero (University of Cordoba, Spain) and Tom Vanwalleghem (CSIC, Spain). During this introduction, Juan Vicente Giráldez summarized some critical unresolved issues regarding the modelling of soil and water conservation and pointed to its importance for key areas, like the Mediterranean.

The first session was opened by Jean Poesen (KU Leuven, Belgium), who raised the awareness of how limited our current knowledge concerning soil and water conservation actually is. Important processes such as gully erosion are currently not included in common models. The current bottleneck is probably the prediction of the efficiency of soil and water conservation methods. Next, Tom Vanwalleghem (CSIC, Spain), discussed the integrated modelling of soil formation and soil erosion processes. Elías Fereres (CSIC and University of Cordoba, Spain) put all our modelling problems in a wider perspective and pointed us to the hot issues concerning sustainable agriculture.

In the second session, Jose Alfonso Gómez (CSIC, Spain) reviewed the use of tracers in soil erosion studies. Karl Vanderlinden (IFAPA, Spain) illustrated how his group uses different electromagnetic sensors to evaluate soil moisture patterns and how these can contribute to understand the effect of soil management. Alex McBratney (University of Sydney, Australia) discussed his groups´ advances and approach to the monitoring of soil carbon in Australian farms. Finally, Santiago Hurtado (University of Seville, Spain) rounded up this session with his nuclear physicist's view on what soil scientists could do with radionucleides.

The third session on scale issues started at the smallest possible one, with Philippe Baveye (University of Abertay, UK, and Rensselaer Polytechnic Institute, USA) showing us the secrets that are withheld at the pore scale and the importance of the latter for understanding macroscale processes. Murray Lark (Rothamsted Research, UK) reviewed several techniques which can be used to span different scales. Next, Ana Maria Tarquis (Polytechnic University of Madrid, Spain) discussed how to measure and characterize soil structure.

Rafael Muñoz-Carpena (University of Florida, USA) and William Castaings (University of Savoie, France) both provided an excellent overview of the basic principles and the use of global sensitivity and uncertainty analysis techniques, with applied examples from the field of soil and water conservation.

The last session on improving numerical treatment in models encompasses a wide variety of topics. Brian Berkowitz (Weizmann Institute of Science, Israel) probably covered all of them within the framework of continuous time random walk. Franciso Jiménez-Hornero (University of Cordoba, Spain) discussed the modelling of tracer flow with lattice BGK models and a practical example on the use of multifractals for describing the resulting patterns. Finally, Manuel Pastor (Polytechnic University of Madrid, Spain) discussed the application of mathematical models to predict runout distances from landslides.

The theoretical part of the workshop was concluded by a round table discussion. Perhaps a bit hesitating at first, because of the distance that separated the fields of expertise of the different participants, the "provocative" comments by Alex McBratney stimulated this discussion enough to make it cross trans-disciplinary boundaries and touch some interesting points. Although these were maybe not poured into hard conclusions during the workshop, we would like to give it a try here:

- It is clear that an interdisciplinary approach is needed to tackle the problem of soil and water conservation. While this is often advocated for, it is hardly ever practised. In our opinion, this multidisciplinary viewpoint was the strength of this workshop.

- There is an urgent need for people working in the field and modellers to interchange ideas and work together. At present, this is often not the case. In the field, some important processes have been identified which have not been included in models (e.g. gully erosion). On the other hand, modellers have specific data requirements which have only rarely been taken up by people in the field. A good example here could be the rational design of sampling strategies, as discussed by Alex McBratney. Still too often, field sampling is not based on a theoretically well-founded approach.
- Scale issues are inherent to soil and water conservation models and are unresolved at this stage. There are a number of techniques which could possibly help us forward, like wavelets or multifractals. Can we expect such tools to come up with a unifying approach? Is there something to learn from each scale or should focus on the big picture?
- Sensitivity and uncertainty techniques should become an intrinsic tool in model building and decision making.
- Finally, a closer dialogue between mathematicians and people working in soils and water related problems is mandatory. One could say that the first group has the tools we need, but without our collaboration, they do not know where to dig.

The workshop concluded with a field trip, which was Planned for Wednesday 29th of October. Unfortunately, this was also the day that Spanish Worker Unions had elected to organize a nation-wide strike. After some uncertainty (which we handled well thanks to the tools provided by William and Rafael) about whether or not the excursion bus would operate, it was finally decided to use private cars. Thanks to the effort of our 5 drivers (two from UNIA and three from the attendants to the meeting) we got safely on our way through the sea of olive trees that surrounds Baeza. The first stop was a breathtaking natural park, el Piélago, where a Roman bridge, part of the Via Augusta, an important road linking the Southwest to the Northeast of the Iberian peninsula, crosses the river Guadalimar. This place was a good example of several erosive forms of the region. The second stop was the important Ibero-Roman mining site of Cástulo located in the border of a terrace of the Guadalimar River, an affluent of the Guadalquivir River that drains most of Andalucia. Here, Francisco Arias, archaeologist in charge of the conservation of the site, explained us all the details and showed us how this early civilization interacted with its environment. Probably one of the most interesting stops was that of the Roman latrines, since it was the only place providing some cover from the scorching "Andalucian sun".

Finally, on behalf of the organizers of this workshop,we would like to thank the International University of Andalucia for sponsoring and hosting the event and all the participants making the event into a successful one.


IUSS WORKING GROUP ON PROXIMAL SOIL SENSING
www.proximalsoilsensing.org

## The Second Global Workshop on Proximal Soil Sensing

**May 15-18, 2011**
**Montreal, Quebec, Canada**

Viacheslav Adamchuk and Raphael Viscarra Rossel

This workshop was organized to bring together those developing and using proximal soil sensors for applications in soil and environmental sciences and engineering. It was held under auspices of international union working group on sensing (WG-PSS) organized locally by McGill University (Montreal, Quebec, Canada). Researchers from various disciplines were present, including soil scientists, agricultural engineering, geophysicists, spectroscopists, agronomists, statisticians, as well as commercial entities involved in the development and use of proximal sensors.

With 60 attendees from 18 countries (Australia, Belgium,Brazil,Canada,Czech Republic, Denmark, France, Germany, Italy, Japan, New Zealand, Poland, Saudi Arabia, South Africa, Sweden, The Netherlands, UK, and USA) the workshop included 40 oral research presentations spread over seven sessions. In addition, 10 posters were presented during the breaks. The workshop also had a field day that allowed industry representatives to share information about their technologies. Selected papers have been invited to a special issue of the international journal of soil science Geoderma, to be published in 2012. The workshop proceedings and presentations are posted at: http://adamchukpa.mcgill.ca/gwpss.

Main highlights of the workshop were:

1) There were good discussions on the scope of proximal soil sensing that are helping to define this new discipline. The main point of the discussions was that proximal soil sensing refers to field measurements made from close by i.e. not laboratory measurements and not remote sensing.

2) The use and development of proximal soil sensing is growing. As well as the more traditional electrical conductivity and optical reflectance measurements there were presentations that showed the use of gamma-ray radiometry, ground penetrating radars, ion-selective electrodes and neutron activation techniques.

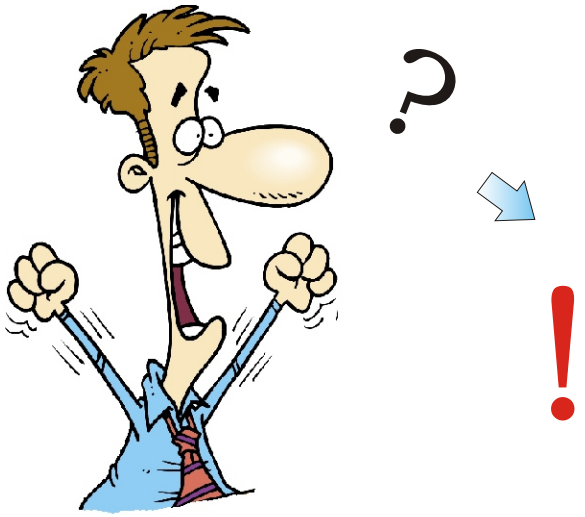
2) Sensor data fusion was recognized as a promising approach to deal with sensor data as well as interfering effects.

3) The number of proximal soil sensing applications is growing and presentations included the use of PSS in ecological, horticultural, viticultural, forestry, archeological, and other studies.

4) Integration between spatial and temporal proximal soil sensing, between remote and proximal sensing systems and betweens soil and crop sensing technologies allow better understanding of living systems to be managed according to their local needs.

The third Global Workshop on Proximal Soil Sensing will take place in 2013 in Europe. In 2012, several symposia may be arranged during other meetings, and will include a session in EUROSOIL and in SAGEEP.

## Pedomathemagica Answers



PLEASE SEND

short articles on your work,etc.

TO

azhu@wisc.edu

before **Nov. 30th, 2011** for the next issue

### Answers to Pedomathemagica NO. 29

① Let l be the distance from Alf's and Bert's base-camp to the foot of the mountain, and let s be the distance (along the track) from the foot of the mountain to its summit. From the information provided we can see that l/2 + s/3 + s/6 = 6, and I shall not insult a pedometrical audience by showing from this that l + s = 12, and so the total distance walked that day by Alf and Bert can be recorded as 24 miles.

But we seem to have a problem with time, because there is no further information. However, let us consider two limits. First, allow l to shrink to zero, so s = 12; then the surveyors spent four hours climbing up the mountain, and two hours walking down, arriving at the summit at 4.00 p.m. Alternatively, allow the height of the mountain to shrink to zero, so l=12; the surveyors spent three hours walking to the (infinitessimal) summit, arriving there at 3.00 p.m., and three hours walking back. The truth must lie somewhere in this range, so the surveyors can put down 3.30 p.m. as the time that they reached the summit and be within half an hour of the correct answer. I realize that this could put the error in the time spent discussing any one survey at more than half an hour, but Alf and Bert

② Count the number of letters in each word and you get 2 7 1 8 2 8, put a decimal point after the 2 (which is why I said ignore the punctuation) and you have e, the base of natural logarithms truncated at five decimal places. There is quite an industry, called piphilology, deriving such mnemonics for the digits of □ . For example, How I want a drink, alcoholic of course, after the heavy lectures involving quantum mechanics gives 14 decimal places. For some reason memorizing the terms of e does not attract the same attention

## Advisory Group

**Dominique Arrouays**, Director of the INRA InfoSol Unit, Orléans, France.

**Research interests:** digital soil mapping, spatial analysis and modelling, soil organic carbon, trace elements, soil monitoring and detection of changes, soil quality, soil contamination, soil sampling, pedogenesis

**Janis L. Boettinger**, The Utah State University, US.

**Research interests:** the origin, spatial distribution, and function of soils in ecosystems, and build a vibrant and well-funded program in Pedology that synergizes Cooperative Soil Survey and outreach activities

**David Brown,** Department of Crop and Soil Sciences, Washington State University, US.

**Research interests:** measuring, modeling and explaining the spatial variability of soil properties and processes at hillslope to regional scales

**Gerard Heuvelink**, Department of Environmental Sciences and Alterra, Wageningen University and Research Centre, Netherlands.

**Research interests:** geostatistics, pedometrics and spatial accuracy assessment

**Philippe Lagacherie**, INRA-LISAH, Montpellier, France.

**Research interests:** soil mapping (esp. soil properties) at sub-regional scale with limited samples

**Murray Lark**, Environmental Statistician, British Geological Survey, UK.

**Research interests:** spatial sampling design, multiscale analysis, non-stationary extensions of the linear mixed model and statistical models of soil based on stochastic geometry

**Bob MacMillan**, LandMapper Environmental Solutions Inc. Wageningen, Gelderland, Netherlands.

**Research interests:** the scientific coordinator of the GlobalSoilMap.net project, developing and applying computer-based procedures for enhancing soil survey products

**Alex McBratney**, The University of Sydney, Australia.

**Research interests:** soil resource assessment, precision agriculture, numerical soil classification and mapping of soil classes using the theory of fuzzy sets, spatial analysis for describing and predicting field soil attributes based on goestatistics and generalised linear and non-linear models, spatial sampling, soil inference using pedotransfer functions and infrared spectroscopy

**Lou Mendonca-Santos**, EMBRAPA Solos - Brazilian Agricultural Research Corpoation, National center of Soil Research, Brazil.

**Research interests:** Digital soil mapping

**Budiman Minasny**, The University of Sydney, Australia.

**Research interests:** pedometrics, modelling soil formation and soil processes, soil inference systems and digital soil mapping.

**Marc Van Meirvenne**, Department of Soil Management, Ghent University, Belgium.

**Research interests:** proximal soil sensing, soil geophysical prospection, geostatistics, precision agriculture, soil pollution mapping, soil sampling strategy

**Raphael Viscarra-Rossel,** Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia.

**Research interests:** develop methodologies to measure, model and map soil using sensors and mathematical and statistical techniques

**Leigh Winowiecki,** African Soil Information Service (AfSIS) Project**,** International Center for Tropical Agriculture (CIAT), Kenya.

**Research interests:** mapping and modeling soil conditions, developing new field and analytical methodologies to