International Union of Soil Sciences®

# International Forum of IUSS Inter-Congress 2024

# Abstract

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**Nanjing International Youth Convention Hotel**

**Nanjing, China**

**14:00-17:30 Room 733**

# Content

# Policies to Protect Soil Natural and Cultural Heritage

*Edoardo A.C. Costantini , International Union of Soil Sciences; CNR-IBE, Sesto Fiorentino (FI), Italy*

**Abstract**

Soil is a vital component of ecosystems, providing essential functions that sustain life. While its agricultural and forestry roles are well recognized, there is a growing acknowledgment of the intrinsic cultural and natural value of soil, which extends beyond its economic utility. The cultural functions of soil, such as being an archive of archaeological, paleontological, and paleoethnological artifacts, have positioned it as a "cultural asset”. This concept highlights the need to protect soil not just for its agricultural productivity but also for its scientific and cultural significance.

Soil also has significant value as a “natural asset”, being one of nature’s forms of self-organization. Its ability to self-organize and function ecologically is comparable to the value attributed to biodiversity, with some soils even taking on characteristics that make them rare or endemic at regional or global levels. Additionally, soil has the remarkable ability to record environmental information, preserving vital knowledge of past environmental conditions and historical cultural and agricultural practices. This “memory of the soil” makes it an irreplaceable resource in understanding both natural and human history.

However, despite its importance, soil faces numerous threats due to a lack of awareness among laypeople, policymakers, and land managers. Threats like erosion, overuse of fertilizers, compaction, and sealing lead to the degradation and loss of pedological heritage. To combat these issues, global, continental, and national policies, such as UNESCO’s World Heritage Sites, the Biosphere Reserves, the EU Soil Strategy, and the FAO’s Sustainable Soil Management, emphasize the need to conserve soil health.

One critical step forward is promoting soil literacy, which would educate the

public and raise awareness among institutions about soil's cultural and ecological value. The creation of legislation recognizing the rights of soil would play a vital role in preserving its natural and cultural heritage. Such measures could ensure the inclusion of soil in policies aimed at environmental protection, ensuring that future generations recognize its cultural, scientific, and ecological value.

Integrating soil's cultural and natural values into conservation efforts is crucial for its long-term protection. The preservation of soil as a natural and cultural asset should be incorporated into global policies, including UNESCO Biosphere Reserves and Geoparks. The protection of soil natural and cultural heritage could be also included in the IUSS events, like the World Soil Day and the World Soil of the Year.

# Characterizing and Mapping Redoximorphic Soils in Canada

*Prof. Richard J Heck, University of Guelph, Chair of IUSS Division 1 'Soils in Space and Time', Italy*

**Abstract**

This presentation will provide overviews of two initiatives, related to soil redoximorphism, on-going in Canada. The first initiative involves proposed refinements to our national framework for characterizing soil redoximorphic features, and the consequent implications for horizon designations and taxonomy in the Canadian System of Soil Classification. The second initiative is our current research on the utility of concurrent measurements of soil electrical conductivity and magnetic susceptibility, by electromagnetic induction sensing, combined with digital landform quantification, to refine the delineation of redoximorphism at the landscape level.

# “Blue carbon” assessment on a crossroad between life and Earth sciences

*Dr. Pavel Krasilnikov, Lomonosov Moscow State University, Russia*

*Co author: Dr. Yulia Mikulina, Lomonosov Moscow State University, Russia*

**Abstract**

All C that is captured by marine and coastal ecosystems and stored in their components is called “blue carbon”. The capture and accumulation of blue carbon by coastal ecosystems such as mangroves, marshes, and seagrass meadows have been overlooked until recently, though the amount of stored soil C per unit area in coastal ecosystems is greater than in terrestrial landscapes. In some cases, organic deposits on the shores can reach a thickness of tens of meters, which is associated with regular flooding with seawater and the dominance of anaerobic conditions in soils. Coastal ecosystems, as a rule, are characterized by a mosaic of habitats and a variety of environmental conditions, which leads to different rates of C accumulation in different parts of the landscape. For example, the rate and capacity of accumulation of organic residues in mangroves and marshes will be the highest in the part that is flooded daily at high tide. The accumulation of blue carbon is influenced by multiple factors such as climatic conditions, hydrology, seawater salinity, topography, sedimentation rate, texture of coastal sediments, plant biomass, species composition, faunal activity, etc. The most important factor influencing the accumulation of blue carbon is soil salinity. The degree of salinity depends on the geomorphology of the coast, climate, season, and thalassogenic conditions and can vary significantly within the boundaries of one ecosystem. In our field study on the White Sea coasts, we found that most soil profiles have normal distribution of organic C density, decreasing with depth, but in some soils, we detected irregular distribution due to continuous sediment accumulation in the coastal zone. Thus, mere

linear extrapolation might overestimate, and simple spline might underestimate real C stock in coastal soils.

*The research was supported by the BRICS project "Coastal wetlands potential for carbon sequestration under climatic change", Russian part supported by the Ministry of Science and Higher Education, Agreement No. 075-15-2024-656.*

**Profile**

Dr Pavel Krasilnikov, Doctor of Biological Science (2009), Corresponding Member of the Russian Academy of Sciences (2016). His scientific areas are pedology, soil geography, and soil classification. Dean of the Faculty of Soil Science of Lomonosov Moscow State University. Author of more than 200 publications, including 14 books. Editor-in Chief of the journals "Eurasian Soil Science", "Moscow University Soil Science Bulletin", member of the Editorial Boards of multiple international journals. Representative of the Russian Federation in the Intergovernmental Technical Panel on Soils (2013-2018). Honorary Member of the IUSS since 2020, the President of the Docuchaev Soil Science Society since 2022.

# Carbon and nitrogen cycling characteristics over the past 15000 years recorded in peatland soils in Northeast China

*Prof. Edith Bai, Northeast Normal University, China*

## Abstract

Peatland soil is a nice and important carrier of ancient plant tissues for reconstructing ancient environments. Here we collected two peatland soil cores in Northeast China that date to 8500 and 15,000 cal. year BP, respectively. Carbon (C) and nitrogen (N) isotope compositions of plant tissues in the peatland were measured to study C and N cycling and accumulation rates in response to environmental changes. Results showed that pre-industrial increases in global atmospheric $CO_2$ concentrations corresponded with a decrease in the $\delta^{15}N$ of both Sphagnum moss and Ericaceae when constrained for climatic factors. This was because plant-microbe symbioses that facilitate N acquisition are enhanced under rising atmospheric $CO_2$ concentrations. The mean carbon accumulation rate (CAR ) was higher during the bog phase than during the fen phase in our studied peatland, consistent with the results of previous studies. Because the input rate of organic matter was considered to be lower during the bog phase, the decomposition process must have been much lower during the bog phase than during the fen phase and potentially controlled CAR. These results highlight the importance of peatland soils to the study of ecosystem feedbacks to global changes over the long term.

## Profile

Edith Bai is the dean and professor of the School of Geographic Sciences at Northeast Normal University. Her research mainly focuses on soil carbon and nitrogen cycling and their responses and feedbacks to global changes. She uses stable isotope technique and microbial molecular technology to study the roles of soil microbes on carbon and nitrogen cycling. She is PI of more than ten national projects and has published more than 100 SCI papers. She is now the associate editors of Global Change Biology, Ecology Letters, Global Biogeochemical Cycles and other SCI journals.

# Quantifying biological pedoturbation of Mollisols by single grain OSL technology

*Prof. Ganlin Zhang, Nanjing Institute of Geography and Limnology, CAS, China*

## Profile

Director of Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences and Professor of Soil Science, Institute of Soil Science, Chinese Academy of Sciences. More than 30 years of research and teaching experience on soil genesis, soil classification and digital soil mapping. Publications appear in Science， PNAS， National Science Review， Science Bulletin, Geoderma and other soil science journals. Currently Chief scientist of the 3rd National Soil Survey of China, First Vice chair of Division 1, IUSS and Leader of GSM East Asia Node.

# Progress and challenges in assessing the factor time in pedogenesis

*Prof. Daniela Sauer, University of Göttingen, Germany*

**Abstract**

Which soil-forming processes are taking place in different environments, and at which rates are they operating? Soil chronosequences can give answers, but they also come with challenges (Sauer, 2015). Which specific challenges do we face when studying soil chronosequences in different climates, different parent materials, and over different time scales? These questions will be addressed on four examples:

1) a Holocene chronosequence in a gravelly semi-desert;

2) a Holocene chronosequence on loamy marine sediments in humid-temperate climate;

3) a Holocene chronosequence on sandy beach deposits in humid-temperate climate;

4) a Pleistocene-Holocene chronosequence in a Mediterranean environment.

A major process in the gravelly semi-desert (example: East Patagonia) is dust entrapment between the gravel; this dust carries carbonates which are dissolved in moist winters and re-precipitated 30-60 cm below the surface. Under humid-temperate conditions (example: southern Norway), Retisols develop in loamy marine sediments, whereas Podzols form in sandy beach deposits.

Main processes in a Mediterranean environment (example: southern Italy) include 1) carbonate leaching and accumulation at some depth, 2) weathering; 3) clay formation and translocation; 4) iron oxide formation, leading to brown Holocene soils, and progressively reddish older soils;

Soil thickness (T) increases with soil age, resulting from the interplay of soil

deepening (D) through weathering, soil upbuilding (U) due to accretion of material, and soil removal (R):

T = f (D + U – R) (Johnson, 1985).

For each of the four examples, lessons learnt from the individual soil chronosequences will be presented, but also the specific challenges will be pointed out for each case.

References:

Johnson, D.L. (1985). Soil thickness processes. Catena Suppl. 6: 29–40.

Sauer, D. (2015). Pedological concepts to be considered in soil chronosequence studies. Soil Research 53 (6): 577-591.

**Profile**

Daniela Sauer is a Full Professor and Head of the Department of Physical Geography of the University of Göttingen and currently the President of the German Soil Science Society. In the IUSS, she served as Chair of the Paleopedology Commission (2010-2018), and in the EGU as Chair of the Subdivision "Soils as Records in Time and Space" (2016-2020).

Her main scientific achievements include the quantitative study of soil development over time in various climates (desert, Mediterranean, temperate), the development of novel techniques to assess different silicon phases in soils, and the use of paleosols as archives of landscape development.

## Soil Science-Informed Machine Learning

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

### Abstract

Machine learning (ML) has been widely applied in soil science research, a shift towards data-driven research addressing soil security. Despite these advancements, challenges remain, particularly concerning soil science knowledge, data availability and the interpretability of ML models. This paper stresses the need for Soil Science-Informed ML (SoilML) models that harness the power of ML while integrating soil science knowledge to produce more reliable and generalisable predictions. This paper demonstrates how to embed soil science knowledge into ML models, including observational priors to enhance training datasets, designing model structures based on soil science principles, and supervising model training with soil science-informed loss functions. We illustrate these concepts with examples from digital soil mapping, and dynamic soil property models. SoilML is advocated to improve the relevance and generalizability of ML predictions while upholding principles of soil science, transparency, and reliability.

### Profile

Budiman Minasny is a Professor in soil-landscape modelling at the University of Sydney. He is a Fellow of The Australian Academy of Science, and recognised as a Highly Cited Researcher since 2019 by Clarivate Web of Science. He has an undergraduate degree from Universitas Sumatera Utara in Indonesia and a MAgr and PhD degrees in soil science from the University of Sydney. He is passionate about the role of soil in managing climate change, food, water, energy security, and maintaining biodiversity. He has more than 160 international journal publications and is recognised as the leader in digital soil mapping and modelling.

## From soil sensing to soil mapping: lessons from China

*Associate Prof. Songchao Chen, Zhejiang University, China*

### Abstract

Detailed and updated soil information are urgently needed to guide evidence based decision making. Here we demonstrate how proximal soil sensing and digital soil mapping help us to better understand the status of Chinese soils spatially. We also discuss the perspectives for soil monitoring in space and time.

### Profile

Songchao Chen is a principal investigator in Hangzhou Scientific and Technological Innovation Center, Zhejiang University. His research is mainly focused on digital soil mapping, proximal soil sensing and soil biogeochemical modelling. He has more than 60 peer-reviewed journal articles, and is an editorial board member of Geoderma, Soil & Environmental Health, and Journal of Integrative Agriculture. He received the IUSS Dan Yaalon Young Scientist Medal (2022) and IUSS Best Paper in Pedometrics award (2019), is recognised as Stanford/Elsevier's Top 2% Scientists (2023 and 2024).