

Pan-European monitoring of gully erosion: Spatial patterns, land-use controls and implications for soil security

Pasquale Borrelli, Panos Panagos, Remus Prăvălie, Christine Alewell

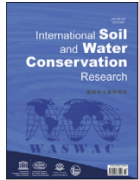




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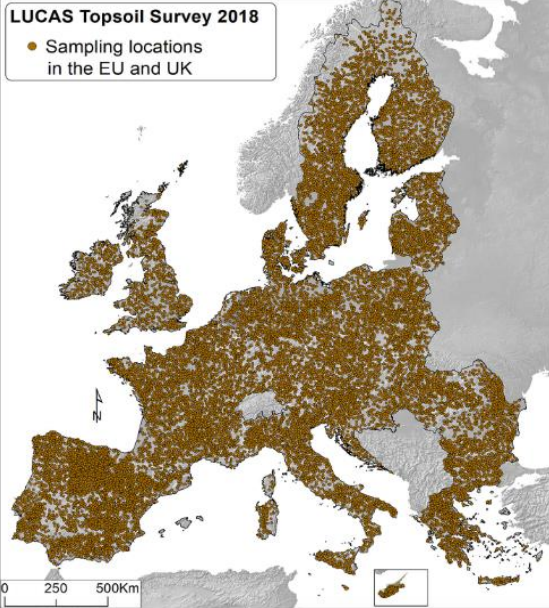
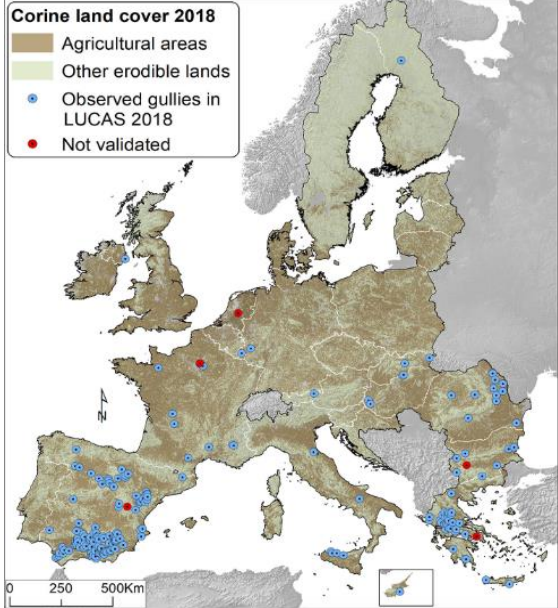


Original Research Article

Monitoring gully erosion in the European Union: A novel approach based on the Land Use/Cover Area frame survey (LUCAS)

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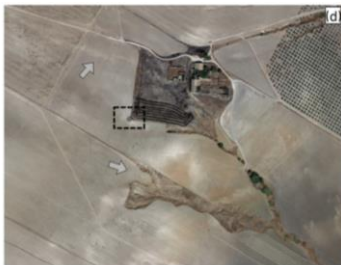
Variables included in the LUCAS Topsoil survey 2018.

Property	Type of analysis and units
Physico-chemical properties	Percentage of coarse fragments (>2 mm)
	Particle size distribution (% clay, silt and sand content)
	pH (in CaCl2 and H2O)
	Organic carbon (g/kg)
	Carbonate content (g/kg)
	Phosphorous content (mg/kg)
	Total nitrogen content (g/kg)
	Extractable potassium content (mg/kg)
	Cation exchange capacity (cmol(+)/kg)
	Bulk density (g/cm3)
	Soil moisture (%)
	Bacteria and Archaea (16S rRNA)
Soil biodiversity	Fungi (ITS)
	Eukaryotes (18S rRNA)
	Microfauna (nematodes)
	Mesofauna (arthropods)
	Macrofauna (earthworms)
Field measurements	Soil erosion by water and wind
	Thickness of organic layer in Histosols

Surveyed 24,759 LUCAS Topsoil sites in 2018
(Gully were defined as linear erosion channels with a depth of more than 30 cm)



Walked along a 250m straight line transect (to East) and recorded all gully forms encountered



scientific **data**nature
portfolio

Check for updates

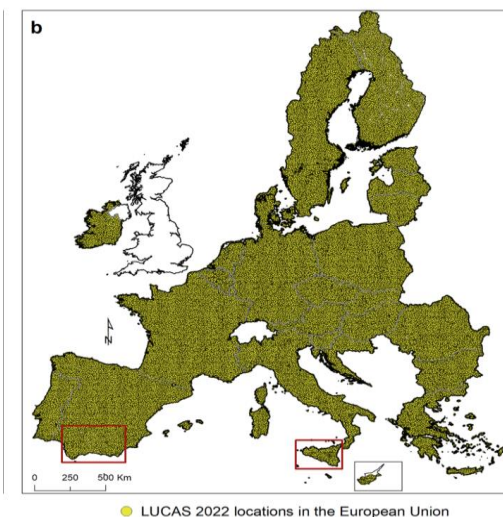
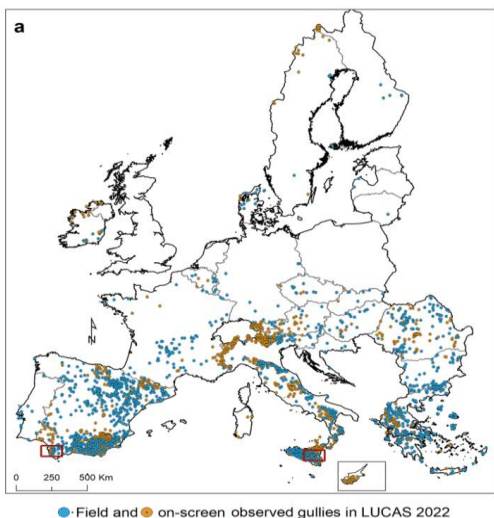
OPEN

DATA DESCRIPTOR

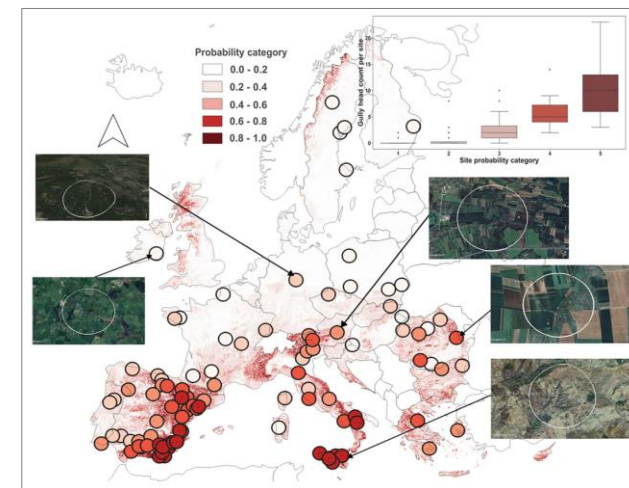
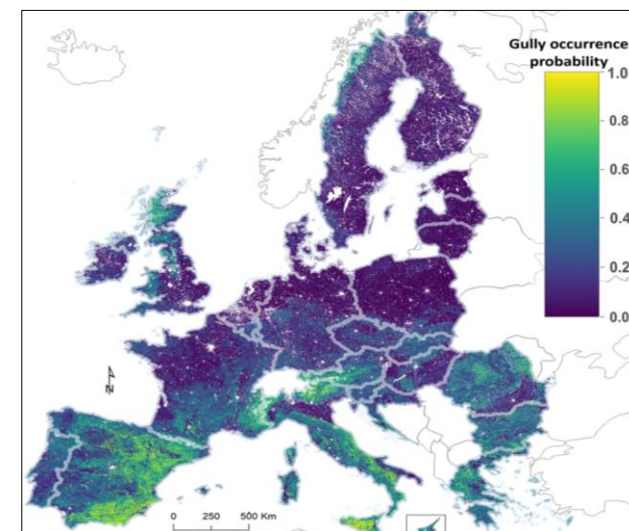
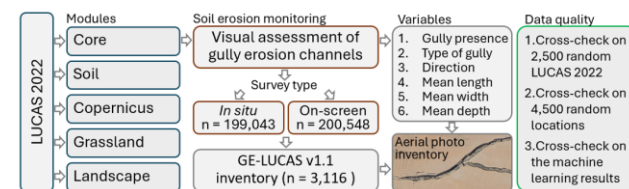
A hybrid *in situ* and on-screen survey to monitor gully erosion across the European Union

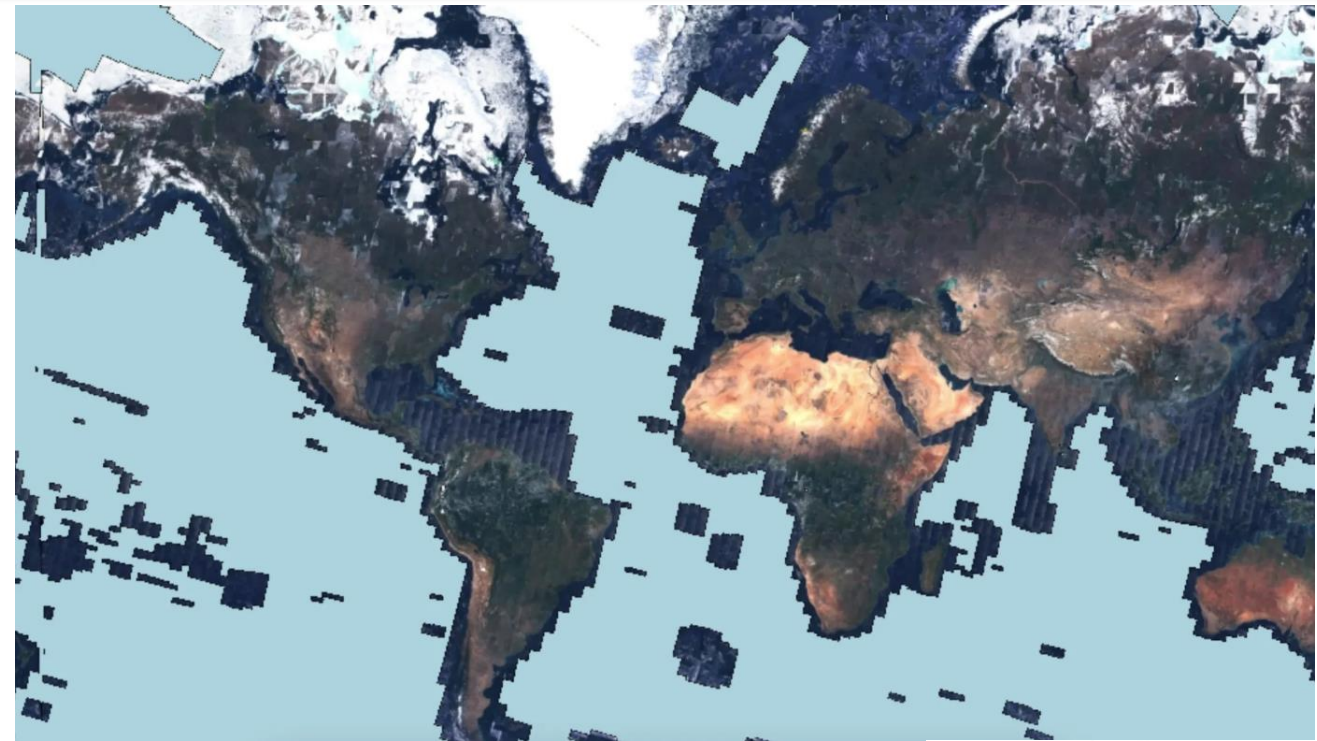
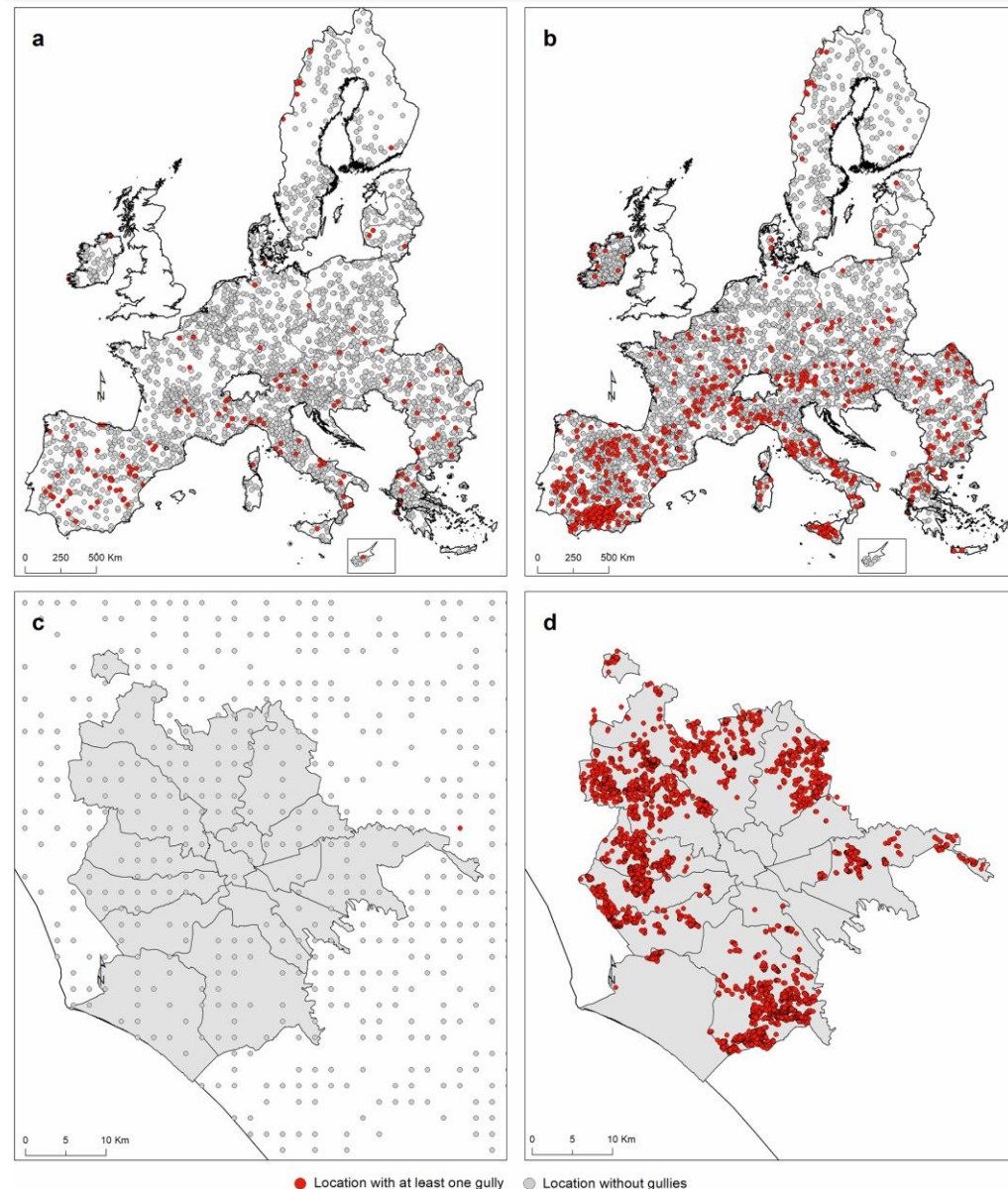
Pasquale Borrelli^{1,2}, Francis Matthews¹, Christine Alewell², Konstantinos Kaffas¹, Jean Poesen^{3,4}, Philipp Saggau¹, Remus Prăvălie^{5,6,7}, Matthias Vanmaercke³ & Panos Panagos^{1,8}

GE-LUCAS v1.1 2022

(200,000 *in situ* + 200,000 onscreen sites)

LUCAS 2022 ~ US \$18,740,000





Google Earth Engine

Although the LUCAS 2022 survey reports **1 gully erosion channels in Rome**, extensive mapping efforts identified a total of **6,354 gully features** (i.e., gully heads).

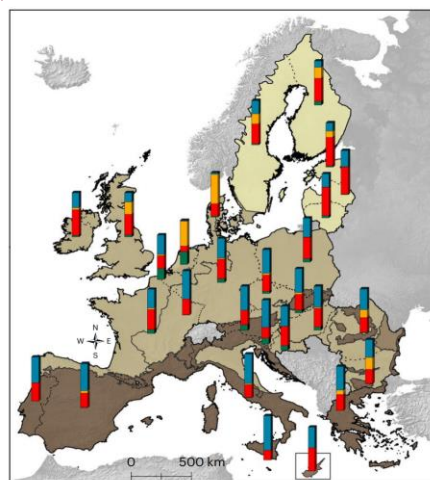
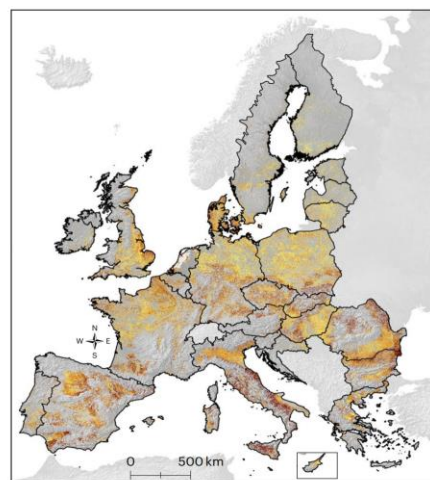
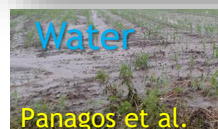
Policy implications of multiple concurrent soil erosion processes in European farmland

Received: 4 May 2022

Accepted: 27 September 2022

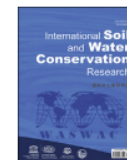
Published online: 27 October 2022

Pasquale Borrelli^{1,2}✉, Panos Panagos³, Christine Alewell⁴, Cristiano Ballabio³, Hugo de Oliveira Fagundes⁵, Nigussie Haregeweyn⁶, Emanuele Lugato³, Michael Maerker⁷, Jean Poesen^{8,9}, Matthias Vanmaercke⁸ and David A. Robinson¹⁰



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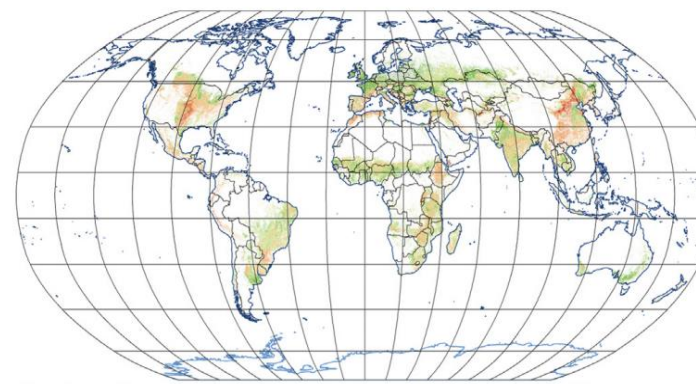
Towards a better understanding of pathways of multiple co-occurring erosion processes on global cropland

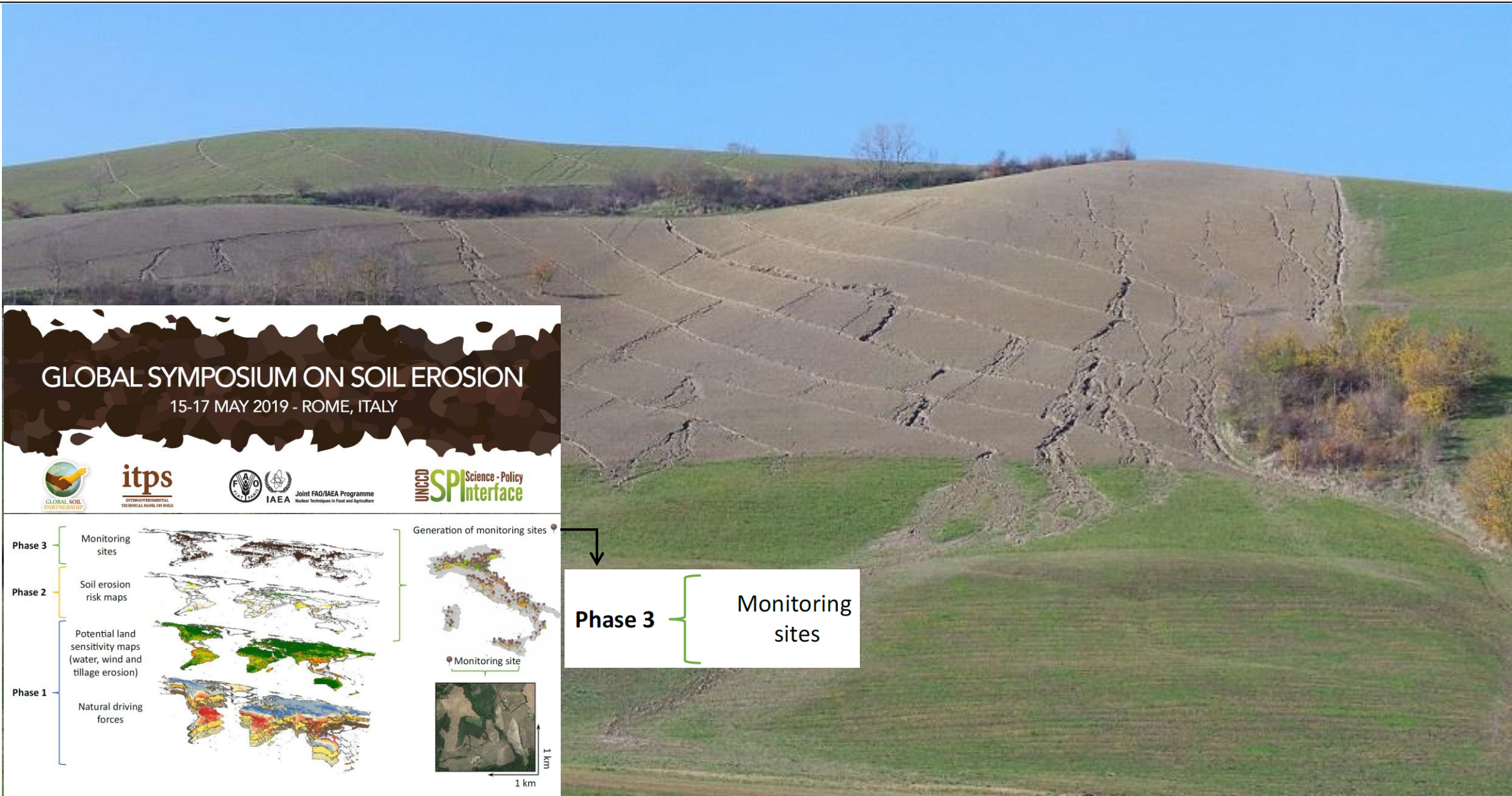


Pasquale Borrelli^{a,b,c,*}, Christine Alewell^a, Jae E. Yang^b, Nejc Bezak^d, Yixian Chen^e, Ayele Almaw Fenta^f, Arthur Nicolaus Fendrich^{g,h,i}, Surya Gupta^a, Francis Matthews^{e,g}, Sirio Modugno^{j,k}, Nigussie Haregeweyn^f, David A. Robinson^l, Florence Tan^e, Matthias Vanmaercke^e, Gert Verstraeten^e, Diana C.S. Vieira^g, Panos Panagos^g



GloSEM





GLOBAL SYMPOSIUM ON SOIL EROSION

15-17 MAY 2019 - ROME, ITALY

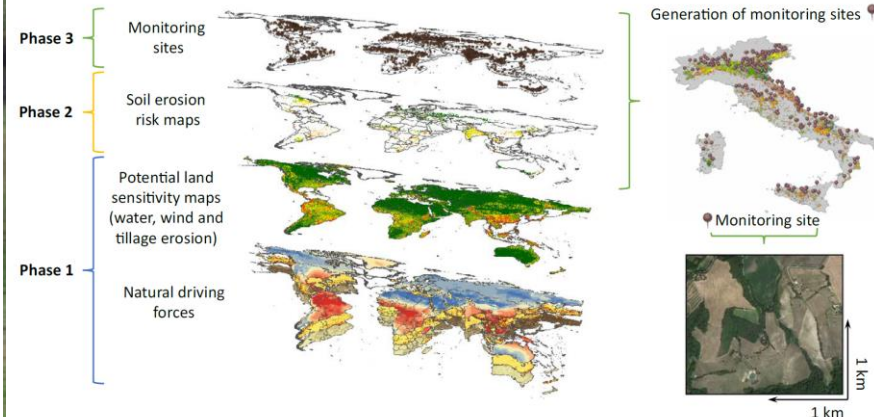


itps
INTERGOVERNMENTAL
TECHNICAL PANEL ON SOILS

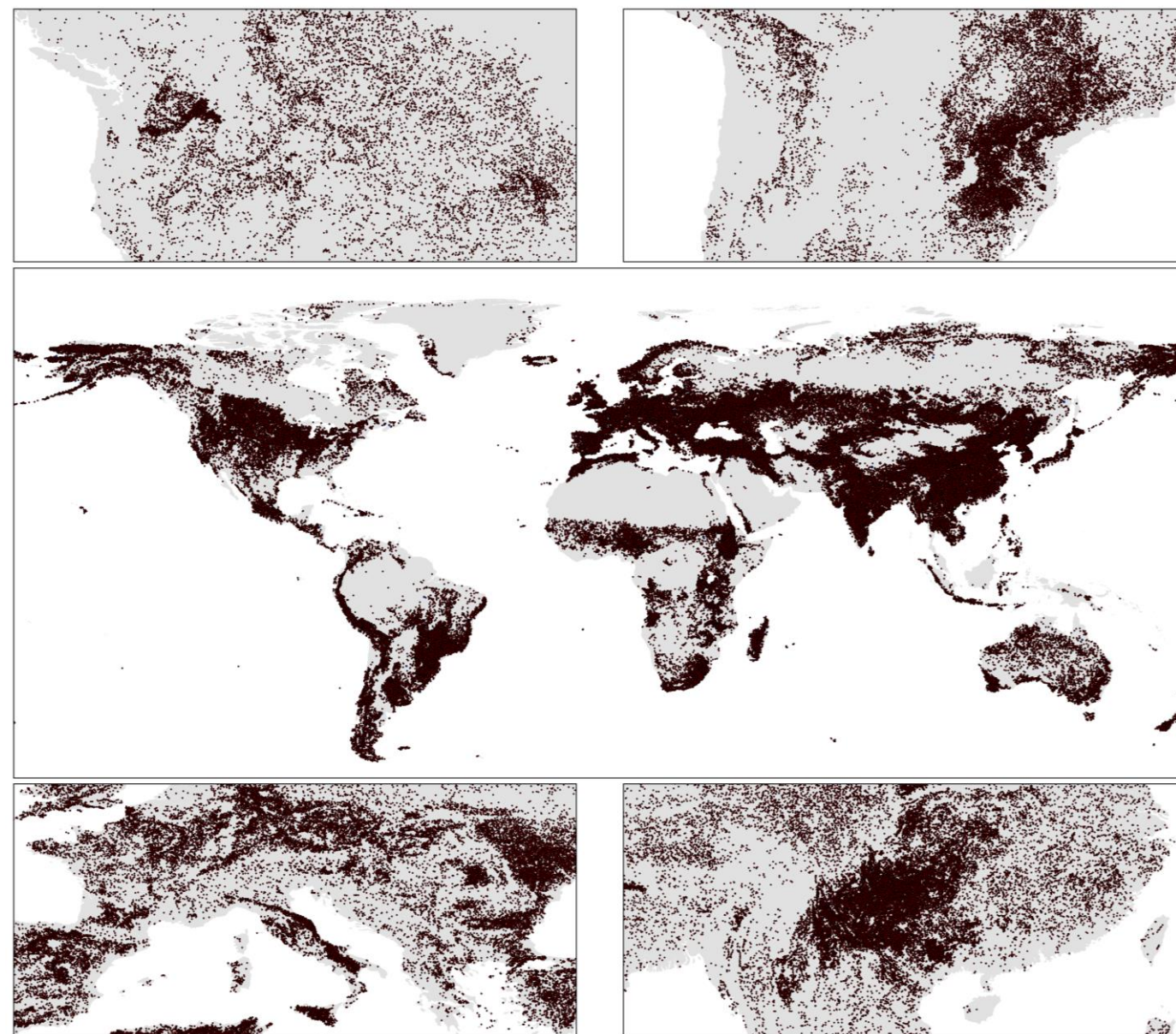


Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

UNCCD
SPI
Science - Policy
Interface



Phase 3 { Monitoring sites



- ❑ Long-Term Research Initiative Overview
- ❑ Stage 1: Completion by December 2025
 - Target: 2-300,000 sites
 - Mapping box: ~340x340m
 - Outcomes: 2 peer-reviewed publications planned for mid 2026

Info: pasquale.borrelli@uniroma3.it

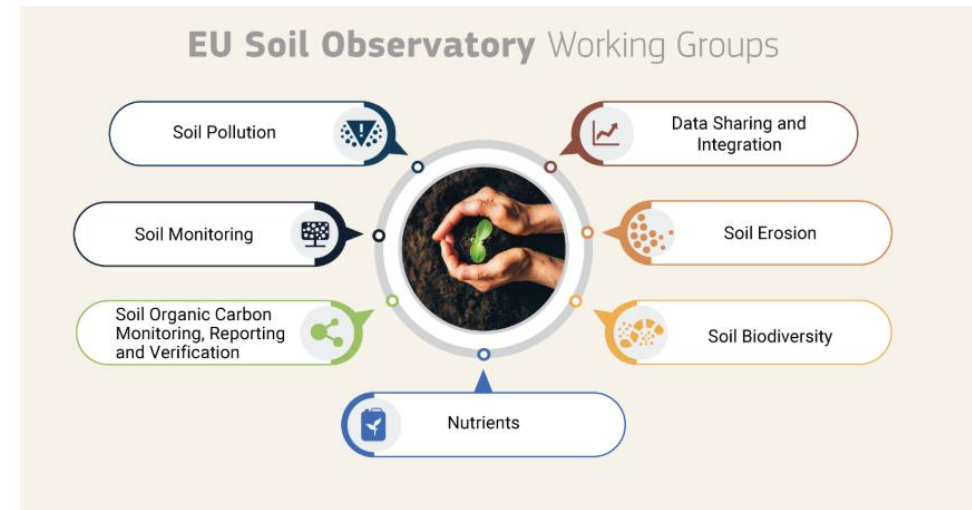
Objective: promote participatory opportunities across Europe and beyond

EUSO – Soil Erosion working group

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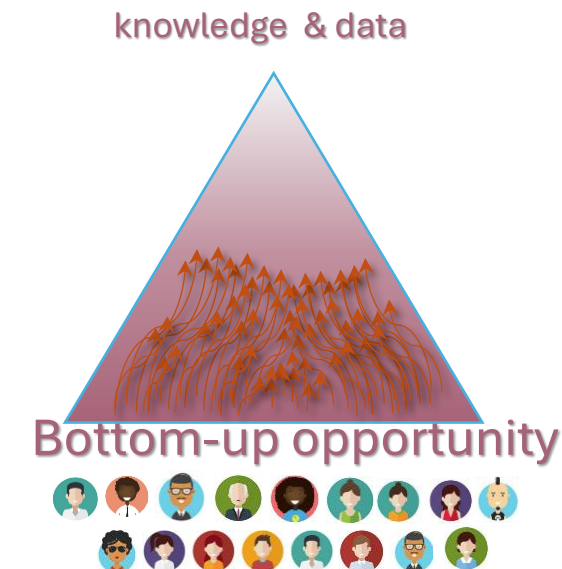
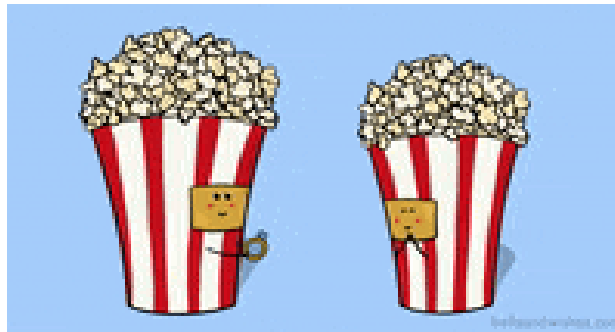


Data – Open data for secondary applications

Collaboration opportunities – collaborative studies

Open code and resources – tools to work with published datasets

Open for proposals



Comment

nature sustainability

<https://doi.org/10.1038/s41893-025-01628-3>

Unsustainably losing ground

Pasquale Borrelli, Francis Matthews, Philipp Saggau, Antonio J. Manzaneda, Panos Panagos, Konstantinos Kaffas & Christine Alewell

 Check for updates

Mediterranean olive groves, which have long been symbols of tradition and culinary heritage, now reveal warning signs of rapidly declining soil health across Europe's agricultural landscapes. Driven by intensive farming, climate pressures and policy gaps, accelerating soil loss threatens both ecosystem health and rural livelihoods, signalling a critical need for sustainable soil management and adaptive strategies.

impacts of EU olive production and its derivatives, such as olive oil, serve as a clear example of the complex interplay between policy choices, soil management, market dynamics and climate pressures. The resilience of this system rests on a fragile balance. The cultivation of *Olea europaea* (olive trees) is the most prominent and socioeconomically important of fruit trees in Mediterranean Europe. Domesticated around 5000 BCE, olives remain integral to Mediterranean agroecosystems, producing 70% of global olive oil (~3 million tonnes per year)⁷. In 2024, the EU's approximately 5 million hectares of olive groves (approximately 3% of utilized agricultural area) generated an annual production value of €8.5 billion. In the past five years, growing sustainability threats have affected olive oil-related food security. Andalusia, Spain, the EU's top olive-growing region, producing ~35% of global olive oil, has experienced a 55% yield decline over the past three years owing to rising temperatures and prolonged droughts



EUroLand



Acknowledgements

This work was funded by the EU's NextGenerationEU instrument through the National Recovery and Resilience Plan of Romania – Pillar III-C9-2022-I8, managed by the Ministry of Research, Innovation and Digitalization, within the project entitled “Complex modelling of multiple land degradation processes in Europe. Towards an integrative scientific framework for sustainable land management across the continent”, contract no. 760051/23.05.2023, code CF 216/29.11.2022.