

PROCEEDINGS
1st International Conference
on
Land Degradation & Restoration
BOOK of ABSTRACTS

EDITORS

Artemi Cerdà

Jesús Barrena

Saskia Keesstra

Ying Zhao

ISBN: 978-90-837754-2-5



**International Conference on Land
Degradation & Restoration
València, July 20-26 2026**
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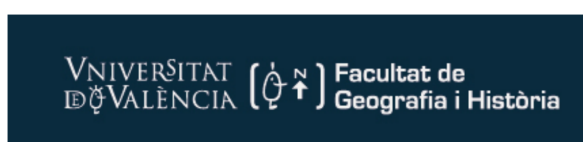
DOI:10.5281/zenodo.22519134



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Index

The index lists every abstract retained in the book, with authors, title and final page number. Abstract numbering follows the order of appearance in the volume.

1. Soil erosion, runoff and sediment — 28 abstracts p. 2

No.	Authors	Title	Page
1	Jianmin Hu	Consolidating Foundations and Enhancing Quality — Reflections on High-Quality Development of Soil and Water Conservation Based on Jiangxi Practice.	2
2	Artemi Cerdà, Diego Gámiz Monterde, Antonio Giménez Morera, Saskia Deborah Keesstra, Jesús Rodrigo Comino, Jesús Barrena	The use of fire in citrus farms. Impact on the soil steady-state infiltration rates.	6
3	Sisay Mekonnen, Bo Ma, Yubin Wang, Xiumei Zhang, Yan Wu, Shaoshan An	Spatiotemporal dynamics of soil erosion in the Upper Blue Nile Basin: Unraveling Land-Use Change impacts and sustainability challenges.	16
4	Lucie Šedová *, Jakub Prudil, Barbora Badalíková	Effect of Cover Crops on Soil Properties and Erosion Control under Variable Climatic Conditions in the Czech Republic.	18
5	Artemi Cerdà, Diego Gámiz Monterde, Antonio Giménez Morera, Saskia Deborah Keesstra, Jesús Rodrigo Comino, Jesús Barrena, Leonardo A. Galera	The use of chipped pruned branches to control high erosion rates in citrus plantations in Eastern Spain.	23
6	Seongho Lim, Junpyo Seo, Wonho Kim, Jun Park, Jeongan Jang, Sungho Park Hakjun Rhee	Soil Erosion Characteristics Following Salvage Logging and Mulching in a Large Wildfire-Affected Area: A Case Study of the 2022 Uljin Wildfire in South Korea.	27
7	Tarik Benabdeluahab, Meryem Touzani	Integrating Phenological Parameters and Machine Learning for Soil Erosion Risk Assessment and Dynamics Monitoring: A Novel Approach for Sustainable Land Management.	31

No.	Authors	Title	Page
8	Meisam Samadi, Christian Conoscenti, Aiding Kornejady, AmirPayam Moslem	Accelerated Gully Expansion in a Semi-Arid Watershed: A Multi-Temporal Analysis (1967–2024).	33
9	Beatriz Olmo Gilabert, Cristina Martín-Moreno, Carolina Martínez Ruiz, José M. Nicolau Ibarra, Juan A. Oliet Pala, Javier de la Villa Albares, Alejandro Guerrero Gutiérrez, Cristina Gil Monteso, Elena Fuertes Fernández	The Mining and Quarry Restoration Network: a new platform to foster progress in mine restoration.	39
10	Hafssa Naciri*, Ahmed Algouti, Fatiha Hadach, Saloua Agli	High-Performance Soil Erosion Susceptibility Mapping Using Random Forest and GIS in the Ankrim Watershed (Souss-Massa, Morocco).	47
11	ALLALI Hemza, HABIBI Brahim	Evaluating the impact of land use scenarios on rainfall-runoff process in the Wadi Ouahrane basin, North Algeria.	49
12	Sara L. Teixeira, José Teixeira, Susana Pereira	Spatiotemporal assessment of microtopography and sediment balance on vineyard slopes with linear erosion.	51
13	Legese Abebaw Getu, Szegedi Sándor, Túri Zoltán, Hailu Kendie Addis	Improving Rainfall Erosivity Mapping Using Bayesian Model Averaging: Evidence from the Ethiopian Highlands.	58
14	Demir, S., *, Flanagan, D.C., Engel, B.A.	Assessment of Future Soil Erosion Risk in Northern Türkiye Using the WEPP Model and Multi-Model Climate Projections.	61
15	Sudabeh Gharemahmudli, Seyed Hamidreza Sadeghi*	Promising Potential of Bio-Inhibitors for Rehabilitating Saline Drylands.	63
16	Kwanele Phinzi, S'phesihle Fanelesibonge Mlungwana, Sibusisiwe Mnembe	Towards assessing hiking-Induced trail degradation in a small nature reserve in South Africa.	68
17	Abid Ouadja, *, Meskine Ahmed, Bilel Zerouali, Sofiane Abaidia, Nour eddine Mekhloufi, Benfetta Hassan	Spatial-Temporal Assessment of Soil Erosion Using the RUSLE Model in the Gargar Dam Basin (Northwestern Algeria).	70

No.	Authors	Title	Page
18	Pengfei Du, Yin Chen, Ying Zhao, Xiangyang Tian, Wanshen Hu, Yuedi Wang	Diagnosis and Remedial Strategies for Failed Gully Erosion Control Measures in the Black Soil Region of Northeast China.	72
19	Yi Wang, Junjia Qi, Ying Zhao, Jian Liu, Quirijn de Jong van Lier	Chracteristics, Driving Mechanisms, and Machine Learning Modeling of Nitrogen Runoff Losses from Chinese Rice Cropping Systems.	74
20	Wanshen Hu, Ying Zhao*, Xiangyang Tian, Pengfei Du, Yin Chen	Suitability Analysis of Soil and Water Conservation Practices for Gullies in the Black Soil Region of Northeast China.	77
21	Hassan Ouakhir*, Josep Fortesa, Hanane Reddad, Julián García-Comendador, Yahia El Khalki, Mohamed El ghachi, Joan Estrany*	Suspended-sediment transport dynamics within two contrasted small catchments at the Middle Atlas of Morocco.	79
22	Haijin Zheng	Reasonable tillage measures for runoff and sediment reduction in typical red soil sloping farmlands under extreme rainfall in southern China.	81
23	Saharnaz Shokoohi Zadegan, Artemi Cerda	Analysis of Research Trends in Biological Soil Crusts and Soil Erosion Control in Dryland Restoration Studies.	87
24	Sarah Moore, Laura Cambronero-Ruiz, Dara Park, Jesús Rodrigo-Comino	UAV-Based Geomorphological and Hydrological Assessment of Gully Connectivity in a Mediterranean Vineyard: Implications for Sustainable Land Degradation Mitigation.	95
25	Jiajun Song, Yifan Donga, *, Li Shend, Wenyue Cao, Xiaoxi Zhou, Ronghua Zhong	Automatic gully mapping using deep learning with boundary-stratified sampling and pixel balancing optimization: a case study of the Yuanjiang dry-hot valley.	97
26	Nodirjon Y. Abdurakhmonov, Musaev Javokhir Batirbekovich, Koraev Aliyor Khasanovich	GIS-Based Assessment of Soil Erosion Risk in the Parkent District, Uzbekistan, Using the RUSLE Model.	99

No.	Authors	Title	Page
27	Houda Lamane, Latifa Mouhir, Abdelmjid Zouahri, Bouamar Baghdad, Rachid Moussadek	Soil Erosion and Sediment Yield Modeling for Land Restoration under Climate Change in a Semi-Arid Watershed.	103
28	Alejandra Arroyo-Cerezo, Laura Cambronero-Ruiz, Lucía Moreno-Cuenca, Jesús Rodrigo-Comino	Spatial variability of soil properties in a Mediterranean cereal field affected by severe gully erosion: insights from XRF and multivariate analysis.	105

2. Desertification, drought and drylands — 10 abstracts p. 107

No.	Authors	Title	Page
29	Sergio M. Vicente-Serrano	Climate Aridification processes: from regional to global scales.	109
30	Saharnaz Shokoohi Zadegan, Artemi Cerda	Desertification Research in Iran: Trends, Gaps, and Future Directions from a Bibliometric Analysis.	114
31	Kimia Javaheri, Tayebbeh Mesbahzadeh	Land Degradation and Sand and Dust Storms: A Review of Global Challenges, Policy Frameworks, and the Path to Land Degradation Neutrality.	121
32	Dieudonné Ilboudo	From Local Workforce to Resilient Landscapes: EIIP Strategy and Cooperatives against Desertification in Burkina Faso.	127
33	Tao WANG	Combating Aeolian Desertification in Northern of China in the Past 70 years.	131
34	Arthur Prudêncio de Araujo Pereira, Victor H.V. Bandeira, Ademir S.F Araújo, Erika V. Medeiros, George R. Lambais, Rodrigo S. Macedo, Raphael M. Beirigo, Diogo P. Costa, Lucas W. Mendes, Maurício R. Cherubin, Vania M.M. Melo, Vanessa N. Kavamura	Bacterial communities associated with biological soil crusts across Brazilian desertification ecoregions.	132
35	Calogero Schillaci, Nils Broothaerts, Felipe Yunta, Arwyn Jones, Panos Panagos	Assessment of land degradation and desertification in Continental Europe.	134

No.	Authors	Title	Page
36	Yun Hu	Drought Resistance and Soil Moisture Conservation Effects of Soil and Water Conservation Measures under Extreme Drought Conditions: A Case Study of the Severe Summer–Autumn Drought in 2022 in Jiangxi Province.	138
37	R. C. Kote, Waman Kulkarni, Sakshi Urmaliya, Vicky Shirole, Ramnath Nawale, Dnyaneshwar More	Geospatial and Socio-Economic Assessment of Land Degradation Neutrality: A Case Study of the Sonoshi Watershed, Maharashtra, India.	140
38	Alen Endalew Terefe, Yuting Hou	Hybrid approach to model the influence of built environment and psychosocial factors on park use behavior: PLS-SEM and Machine Learning.	143

3. Forest, fire and post-fire restoration — 2 abstracts p. 144

No.	Authors	Title	Page
39	Jungyoon Kim, Sangjun Im	Spatial and temporal variation of soil water repellency following wildfires in the Republic of Korea.	147
40	Dahyeon Choi, Sangjun Im	Temporal Changes in Hydrological and Erosional Responses Following Wildfire.	150

4. Wetlands, peatlands, mangroves and coastal systems — 4 abstracts p. 154

No.	Authors	Title	Page
41	Zainuddin Jamaluddin, Harry Yong, Mohd Saman Mohd Sanget, Farah Wahida Ayob and Fathin Haryanni Ahmad Faris	Empowering local communities to mitigate peatland degradation through community fire brigades in Pahang, Malaysia.	156
42	Zainuddin Jamaluddin, Harry Yong, Mohd Saman Mohd Sanget, Farah Wahida Ayob and Fathin Haryanni Ahmad Faris	Assessment of peatland degradation and restoration strategies in peat swamp forests of Pahang, Malaysia: challenges, impacts and future directions.	159

No.	Authors	Title	Page
43	Josphat Mtwana, Samuel Kiboi, Dorcus Sigana, Melckzedek Osore, Rainer Zaiss, Issak Elmi	A novel remote sensing and participation-based approach to characterizing mangrove forests and assessing blue carbon credit feasibility in Lamu, Kenya.	161
44	Abhiroop Chowdhury, Aliya Naz, Santanu Bhattacharyya	Eco-Engineering Mangrove Restoration for Enhanced Blue Carbon Sequestration and Landscape Stabilization in the Indian Sundarbans.	163

No.	Authors	Title	Page
45	Chenxi Li, Jiayin Luo*, Nisha Bao, Fan Zhang, Yian Wang, Shuo Fan, Bo Ding, Qiyun Cao	Identification of Ground Fissures in Pingshuo Coal Mining Area Using Optical and Thermal Infrared UAV Imagery.	168
46	Jhon Mejía, Marc Vallbé, Jorge Gallego, José Cartagena	Mercury contamination indexes in gold mining soils in Colombia.	174
47	Isabella Hill, Dara Park, Sarah Moore	Survey of Water Repellency of South Carolina Surface Soils.	175
48	Ana de Torre Sáez*, Daphne López Marcos, Miguel Manso Arribas, Herminia Alonso Zaldívar, Elena Muñoz Cerro, Carolina Martínez Ruiz, Juan García Duro	Role of shrubs and grazing in shaping topsoil properties of post-mining pastures.	176
49	Yian Wang, Nisha Bao, Jiayin Luo, Chenxi Li, Boyan Liu	Assessing the Coupled Impacts of Mining-Induced Deformation and Soil Moisture Changes on Vegetation Evolution Using InSAR.	179
50	Lorena Salgado, María Larramona, Jose Luis R. Gallego, Leticia Merchán, Antonio Martínez-Graña, Rubén Forján	From Waste to Solution: Valorization of Subproducts for the Rehabilitation of Mining-Affected Soils.	181
51	Lorena Salgado, Ana M. García-Menéndez, Humberto Castillo-González, Rubén Forján	CAFECHAR: integrating soil remediation, circular economy and inquiry-based science education in a post-mining context.	190

No.	Authors	Title	Page
52	Abdullahi Salem, Umar Saleh and Idris Sani Abubakar	Assessment of Soil Quality and Carbon Sequestration Potentials of Re-vegetated coal mine spoil at Maiganga, Akko Local Government Area, Gombe State, Nigeria.	194
53	Chengzhi Li, Younian Wang, Qing Zheng, Shuaiyu Wang	Evaluating Nitrogen Addition Effects on Soil Microbial Dynamics in Xinjiang Coalfield Fire Zones.	199
54	Sara Pelaez-Sanchez, Olaf Schmidt, Ronan Courtney	The belowground players. Soil macro, mesofauna, and soil properties in a chronosequence of rehabilitated mine tailings.	202

6. Agricultural soils, agroecology and land management — 43 abstracts p. 204

No.	Authors	Title	Page
55	Yakov Kuzyakov and Kazem Zamanian	Humankind as the 6th soil-forming factor and soil degradation under agropedogenesis.	207
56	Benukar Biswas	Vegetation Planning through Agroforestry as a Nature-Based Solution for Restoring Degraded Lands.	210
57	Ju Zhao, Chunyan Yin, Feng Tian, Qingmei Li	Effects of Organic Materials on Nitrification Process in Saline-Alkali Farmland Soil.	215
58	Rafla Attia, Mohamed Chams Eddine Harrabi, Mounir Sellami, Maki Abdourahman, Mahmoud Abdelfettah, Brini Rahma, Sana Dridi, Ayda Ben Rhouma, Peng, Yi.	Project SoilFer-Vacs Framework- Enhancing Integrated Soil – Crop Management for Sustainable Food Systems in Tunisia.	217
59	Dossounon Latus Sètonji Berteulot, Sossa Elvire Line, Legrain Xavier, Agbangba Codjo Emile	Contribution of cattle-derived effluent-based soil fertility management to maize grain yield and soil fertility improvement in tropical regions: A Systematic Review.	220
60	Mulugeta Aytenew, *, Aregu Amsalu Aserse, Kristina Lindström, Melkamu Alemayehu, Enyew Adgo	Effects of Bitter White Lupine (<i>Lupinus albus</i> L.) Break Crop on Soil Physicochemical Properties in the Upper Blue Nile Basin of Ethiopia.	224
217	Anna Karczewska, Katarzyna Szopka, Agnieszka Dradrach, Karolina Lewinska	Restoration of landscapes and soil remediation in the sites affected by historical arsenic mining and processing in SW Poland	204

No.	Authors	Title	Page
61	Muhammad Usman, Qi Feng, Asfaw Bekele, Julide Kahkeci, Yanan Li, Yi Fan, Muhammad Arslan, Benjamin Jaffe, Russell W. Jessup, Eric Bremer, Mohamed Gamal El-Din	Biochar and Torrefied Biomass Soil Amendments: Influence on Nutrient Dynamics in Clayey and Sandy Soils.	228
62	Rui Zhao, Jose L. Gabriel, Javier Pro, Rafael Boluda, José J. Ramos-Miras, Long Kang, Christian Teghe Kum, Josep V. Llinares, Jose A. Rodríguez Martín	Spatio-temporal dynamics of soil nutrient status in Majorca: spatial analysis approaches to assess land degradation and restoration over an 11-year period.	231
63	Jakub Prudil, *, Lucie Šedová, Barbora Badalíková	Impact of Compost Surface Application on Soil Properties.	237
64	Belén Álvarez, Sergio Díez-Pascual, Jessica González, Carolina Mancho, Mar Gil-Díaz, M. Carmen Lobo	Evaluation of the application of compost as an organic amendment for the cultivation of black chickpea (<i>Cicer arietinum</i> L.).	239
65	Jingsong Yang, Hongxin Huo, Jiandong Sheng	Management of Soil Salinity with Composite Interlayer in the Hetao Plain, China.	245
66	Junyao Liua, Yahui Ji, Wenping Xie, Jingsong Yang, Xiangping Wang, Yanfang Feng, Xuan Yu, Rongjiang Yao, Jun R. Yang, Hai Zhu	Synergistic Suppression of Ammonia Volatilization by Biochar–Compost through Soil Physicochemical and Microbial Regulation in Saline–Alkali Soil.	250
67	Meng Xiao, and Guangming Liu*	Microbiome-Driven Restoration of Coastal Saline Soils: The Role of Combined Organic-Nano Carbon Amendments in Modulating Community Structure and Function.	252
68	Federico Mammarella, Ignacio Buesa, Irene Moreno, Daniel Sacristán-Moraga, Camilo Chirivella, Eloy Cámara, Diego S. Intrigliolo*	Searching for a sustainable long-term soil protection and short-term rainfed vineyard performance under semi-arid conditions.	254

No.	Authors	Title	Page
69	Mohamed El Mderssa (,) *, Nora Ouhssaine, Hajar Benali	Biochar as a sustainable solution for restoring degraded agricultural soils and enhancing climate change resilience in Morocco.	260
70	Mohamed Elarbi Brick, Fatima-Ezzahrae Imam, Nicola Riitano, Daniela Smiraglia, Giovanna Seddaiu	Assessment of 30-m GLC_FCS30D for SDG 15.3.1 Land Cover Sub-Indicator Monitoring: the case of Italy.	262
71	Lizandra de Barros de Sousa, Abelardo Antônio de Assunção Montenegro, Ademir de Oliveira Ferreira, Jorge Manuel G.P. Isidoro, João Luis Mendes Pedroso de Lima, Thayná Alice Brito Almeida	Geostatistical assessment of mulching effects under wastewater irrigation in the Brazilian semiarid.	266
72	Sonia Manzini; Weldemichael Tesfahuney; Zaid Bello	Effect of planting geometry on growth, development, and water use efficiency of pigeon pea (<i>Cajanus cajan</i>).	273
73	Bashair Al-Maghatasi, Daniel Blackburn*, Buthaina Al- Siyabi, Said Al Ismaily	Managing Microbial Soil Health Traits Through Integrated Organic and Mineral Amendments in Arid Soils.	275
74	Kecheng Zhong, Johana González-Coria, Pierre Hohmann, Marina Pérez- Llorca, Neus Sola, Joan Romanyà	Substrate quality and nitrogen supplementation shape soil N dynamics, substrate-specific respiration, and decomposer taxa under ramial chipped wood amendment.	277
75	Azekour Asma, Mahmoudi Meriem, Jmaili Karima, Abdelghaffar Houria, Bouatleb Nadia	Innovative approaches to restoring degraded soils through the valorization of organic resources.	280
76	Leonardo de Aro Galera, Lucas Freitas Nogueira Souza, João Leonardo Corte Baptistella, Lucas Pecci Canisares, Victória Santos Souza, Chukwudi Nwaogu, Maurício Roberto Cherubin	Cover crop mixtures in agroecosystems: evidence, mechanisms and design.	282

No.	Authors	Title	Page
77	Fozia Naz Memon, Mazharuddin Keerio, Sanaullah Solangi, Imdad Sahu, Suhail Qureshi, Inzmam-ul-haq Khanzada	Evaluate the Impact of legume (Chick pea) to Improve Soil diversity and health under Changing Climate: A Solution for the Nutrient Restotation.	284
78	Rachel Kazeni Mkwizu, Primitiva Andrea Mboyerwa	Rice Husk Biochar Suppresses Sesame Wilt (Fusarium oxysporum) and Improves Soil Health and Productivity in Eastern Tanzania.	286
79	Sama Desmond Kwayela, Molua Elis-Bright Iteke, Siryk Olena, Vitková Justína, Szewczuk-Karpisz Katarzyna	The Transformation of the Hydrophysical Properties of Sandy Soil Using NH ₄ (aq)-Activated Biochar.	287
80	Hafiz Mohkum Hammad, Zainab Sarwar Alvi, Saeed Ahmad, Khuram Mubeen, Sarfraz Hashim, Ijaz Hussain, Shafqat Saeed	Biostimulant-Mediated Alleviation of Drought Stress for Improving Physiological Traits, Growth and Yield of Maize.	290
81	Ijaz Hussain, Rao Muhammad Ikram, Hafiz Mohkum Hammad, Saeed Ahmad, Muhammad Qaisar Nawaz, Muhammad Ahsan Iftikhar, Taj Muhammad	Enhancing Heat Tolerance in Maize Hybrids using Bacterial Consortium: Modulation of Morpho- Physiological Traits and Antioxidant Mechanisms.	292
82	Luiz Henrique Natalli, Everton Hillig, Kátia Cyrene Lombardi, Marcelo Godinho, Gabriel Fernandes Pauletti, Remigio Paradelo Núñez	Physicochemical characterization of biochar produced from Pinus taeda forest harvesting residues.	294
83	Nataliya Bilyera, Iryna Loginova, Yakov Kuzyakov, Michaela A. Dippold	Phosphorus transformation in soil microbial hotspots improves plant nutrition.	295
84	Habtam Tadele, *, Lewoye Tsegaye, Tesfaye Feyisa, Sintayehu Musie	Synergistic effects of biochar, vermicompost, and blended NPSB-urea on maize yield and soil physical resilience in acidic tropics of Ethiopia.	300
85	Mahmoudi Meriem, Azekour Asma, Jmaili Karima, Bouatleb Nadia	Enhancement of Soil Fertility through Anaerobic Biotransformation of Agricultural Residues for Sustainable Agriculture and Land Restoration-.	302

No.	Authors	Title	Page
86	Seyed Hamidreza Sadeghi*, Sudابه Gharehmahmudli, Fengbao Zhang, Habibollah Younesi, Padidehsadat Sadeghi, Mahboubeh Mirzahosseini, Somayeh Zare, Yahya Parvizi, Mehdi Homaei, Shen Nan, and Li Yao	Enhancing Water-Holding Capacity in Loess Soils Using Porous Biochar.	304
87	Maria Jose Marques, Blanca Sastre, Mariela Navas	Soil Management under Water Limitation: Lessons from On-Farm Studies in Mediterranean Vineyards and Olive Groves.	309
88	Lyudmyla Symochko, Maksym Solokha, Olena Demyanyuk	Land Degradation and Soil Contamination Under Armed Conflict in Ukraine: Evidence and Restoration Perspectives.	313
89	Mahdi Shahabirokni, Hassan Etesami, Alireza Raheb, Mehdi Rashtbari, Dorota Krzyżanowska, Erfan Tavasolian, Kacper Tomasik, Jessica Mirjam, Aarati Ruwali, Bahar S. Razavi	From Halophytes to Wheat: Co-evolutionary Selection Reveals Stress-Adaptive Microbial Consortia for Sustainable Agriculture under abiotic Stress.	326
90	Ashot Amikhanyan, Abhishek Singh, Karen Ghazaryan	Assessment of Saline-Alkaline Soils in the Ararat Province of Armenia.	332
91	Sakshi Singh, Syuzanna Esoyan, Ani Hayrapetyan, Abhishek Singh, Ashot Amikhanyan, Karen Ghazaryan	Nature-Based Soil Amendments for Climate-Induced Salinity and Drought Stress Mitigation.	334
92	Nare Darbinyan, Sakshi Singh, Armine, Chakhmakhchyan, Abhishek Singh, Karen Ghazaryan	Meta-Analysis of Biochar Effects on Salinity Stress Tolerance and Yield in Tomato (<i>Solanum lycopersicum</i> L.).	336
93	Karen Ghazaryan, Abhishek Singh, Anna Harutyunyan, Armine Chakhmakhchyan, Rupesh Singh, João Ricardo	Restoring Plant Health under Salinity Stress Using Nature-Based Solutions: Biochar, Humic Acid, and Microbial Amendments.	338

No.	Authors	Title	Page
94	Armine Chakhmakhchyan, Abhishek Singh, Nare Darbinyan, Sakshi Singh, Vishnu D. Rajput, Tatiana Minkina, Karen Ghazaryan	Seed Nanopriming with ZnO Nanoparticles and Biochar Amendment as a Sustainable Strategy for Salinity Stress Management in Wheat (<i>Triticum aestivum</i> L.).	340
95	Larbi Djabri, Samir Hani, Azzedine Hani, Hamza Bouguerra, Salah Eddine Tachi	Impacts of the sea and salt formations ns on water and soil: Case of the plains of Annaba, Souk Ahras and Tebessa (extreme eastern zone of Algeria).	342
96	Papadavid George, Hadjimitsis Diofantos, Varvaris Ioannis	Irrigation management using Earth Observation techniques for a resilient agricultural lands' scheme in Cyprus – The NEMESIS project.	345
97	Melkam Alewoye, *, Enyew Adgo, Fei Peng Derege Tsegaye Meshesha	Quantifying CO2 emission from soils of agricultural managed land in North-western highlands of Ethiopia: Insights into global carbon dynamics.	346

7. Soil pollution, waste and remediation — 16 abstracts p. 353

No.	Authors	Title	Page
98	Zulfiya Bayazitova *, Sayagul Zhaparova, Aigul Kurmanbayeva, Natalia Safronova	Ecological and geochemical assessment of soil pollution by heavy metals in the territory of a closed solid waste landfill.	356
99	Ewa Błońska, Jarosław Lasota	Impact of anthropogenic pressure on the formation of PAH content and the response of soil microorganisms.	362
100	Diego Baragaño, Salvador Sánchez, Hiram Castillo, Michael Komárek, Gildas Ratié	Mechanistic insights into nanoscale zero-valent iron remediation of mining soils: Iron transformation, metal(loid) immobilization and soil-plant interactions.	363
101	Dara M. Park, Jack Cuneo, and Debabrata Sahoo	Could Soil Water Repellency Impact Contaminant Removal Efficiencies of Bioretention Cells? A Review.	366
102	Elham Sirjani*, Abdolmajid Sameni	Quantifying wind-driven heavy metal redistribution in arid and semi-arid soils using a portable wind tunnel.	367

No.	Authors	Title	Page
103	Isabella Hill, Dara Park, Robin Mack	Successfully integrating outreach and training reduces environmental degradation of onsite wastewater systems in South Carolina.	371
104	Rakhwe kama, Farhan Nabi, Yuan Liu, Sun Jianfan, Chongjian Ma*, Huashou Li, *	The Safe Use of Arsenic-Contaminated Mining Lands and Surrounding Areas in Southern China.	375
105	Rakhwe kama, Farhan Nabi, Yuan Liu, Sun Jianfan, Chongjian Ma*, Huashou Li, *	Land Degradation findings and Restoration challenges in the 21st century. The Safe Use of Arsenic-contaminated Mining Lands and Surrounding Areas in Southern China.	512
106	Lyudmyla Symochko, Olena Demyanyuk, Maria Nazaré Coelho Pinheiro, Ioannis Anastopoulos	Disruption of Soil Microbial Communities and Functional Networks in War-Affected Lands: A One Health Approach to Restoration.	378
107	P. Elavarasi*, K. Subash Chandra Bose and V. Vinoth Kumar	Efficacy of Organic Amendments for Immobilization of Lead (Pb) and Cadmium (Cd) in Contaminated Soils of SIPCOT, Ranipet.	384
108	Ani Hayrapetyan, Abhishek Singh, Nare Darbinyan, Karen Ghazaryan	Comprehensive Meta-Analysis of Biochar for Heavy Metal Stress Management in Soil Ecosystems.	386
109	Abhishek Singh, Susanna Antonyan, Ani Hayrapetyan, Rupesh Singh, Ashot Amikhanyan, Karen Ghazaryan	Integrated Biochar, Humic Substances, and Azotobacter for Mitigating Heavy Metal Stress in Soil-Plant Systems.	388
110	Sylvia Budzyńska	Arsenic uptake and accumulation in trees: dendrorestoration potential of contaminated environments.	390
111	Gintarė Sujetovienė, Diana Miškelytė, Austra Dikšaitytė, Giedrė Kacienė, Irena Januškaitienė	Integrated Phytoremediation of Shooting Range Contaminated Soil Using Different Amendments.	392
112	Aigul S. Kurmanbayeva, Natalya M. Safronova, Zulfiya E. Bayazitova, Sayagul B. Zhaparova	Soil-Water-Plant Interactions and Heavy Metal Transfer at Municipal Landfill Sites of the Akmola Region (Northern Kazakhstan).	393

No.	Authors	Title	Page
113	Jacek Niedźwiecki, Agnieszka Klimkowicz-Pawlas, Sylwia Pindral	Preliminary Assessment of Agricultural Soil Condition in a Heavily Industrialised Region of Poland under the EU Soil Monitoring Directive.	396

8. Watersheds, rivers and water resources — 14 abstracts p. 398

No.	Authors	Title	Page
114	Arash Malekian*, Bing Liu	Integrated Watershed Management: A Key Point for Sustainable Management of Land and Water Resources.	401
115	Alberto Leombruni, Mike Mueller	Biogeochemical Technology Application for the full-scale treatment of an Aquifer Impacted with Chlorocarbons near a salt pond ecosystem in Sardinia, Italy.	403
116	Rayan Nas, Anil Olgac, Alihsan Sekertekin	Monitoring Land Degradation Through River Geomorphological Dynamics Using Integrated Optical and SAR Satellite Observations.	405
117	Jian Liu	Cover Cropping for Soil Health and Water Quality in Cold Climate Regions.	415
118	Zhipeng Wang, , Xiangping Wang*, Yuhang Wang, , Changcheng He, , Zhang Wen, Yulong Jiang, , Wenping Xie, , Xuan Yu, Rongjiang Yao*	Optimal Groundwater Depth Thresholds for Sunflower in Salt-affected Farmland: A Process-Based Modeling Approach Across Hydrological Years in the Hetao Irrigation District.	418
119	Saeedreza Moazeni, Ali Salajegheh, Artemi Cerdà	Hydrological Response of the Taleghan Watershed to Climate Change Based on CMIP6 Projections and SWAT Modeling.	420
120	Jos de Bijl, Anneleen Geurts, Beatriz Larraz Iribas, Raúl Urquiaga Cela, Camila Kuncar, Aniela Stachnik Pérez, Paul Brotherton	From Land Degradation to Water Retention: Restoring Hydrological Function through Nature-based Solutions in the Ramabujas Catchment, Spain.	422
121	Hassan Benfetta, Abid Ouadja	Water management and sustainable development in the world. Strategies and future visions.	426

No.	Authors	Title	Page
122	Yitong Liu, Nisha Bao, Tianhong Yang, Jiayin Luo, Dantong Meng, Qiyun Cao	Species-Level Vegetation Classification to assess mining impact on arid and groundwater-dependent ecosystems.	428
123	Rahul Kumar Pandey, *Anshumali, Abhay Krishna Singh	Morphometric Assessment of Disappearing Natural Streams in the Ganga River Basin, India.	432
124	Shelby Shockley, Dimas Villa, Ismael López, Manuel Pulido	Reconstruction of fluvial terraces through soil profile description in archaeological sites: Educational experiences.	434
125	Bing Liu*, Arash Malekian, Xiao Wang, Ying Zhao, Wenzhi Zhao, Maliheh Behrang Manesh, Pouyan Dehghan Rahimabadi, Yangyang Meng, Chan Liu, Zhaocen Zhu, Rui Si, Bin Wang, Changkun Yang, Weihao Sun, Wen Li	Response Processes and Mechanisms of Hydrology- Vegetation- Soil Interactions to Hydrological Connectivity in Oasis Wetlands of Northwestern China.	436
126	Ewa Słowik - Opoka, Jose Lizardo Reyna Bowen	From Slope to Stream: Spatial Variation of Granulometric Properties of Soils and Sediments in a Small Forested Mountain Catchment - Implications for Organic Matter Accumulation.	438
127	Anna Klamerus-Iwan, Małgorzata Stopyra, Agata Warczyk, Josef Urban, Lizardo Reyna-Bowen	Mistletoe infestation as an emerging disturbance affecting soil moisture stability and microclimate in coniferous forest ecosystems.	440
128	Rafał Starzak, Maciej Pach, Przemysław Sypka	Microclimatic and Soil Moisture Alterations within a Windthrow-Induced Canopy Gap in a Near-Natural Forest Stand (Łabowiec Nature Reserve, Polish Carpathians).	443
129	Min Zhao, Shujian Xu, Wei Lin, Mingtao Li	Grain Size Characteristics of Hard Clay Layers of the Coastal Tidal Soil in the Yellow River Delta Region and Their Implications.	445
130	Kasye Shitua*, Mastewal Mekuriawa, Tigist Degua, Adibabar Hymiroa, Tadesse Biratua, Workiyie Misganaa	Impact of a Sustainable Land Management Program on Land Use and Land Cover Change at Watershed Level in Western Ethiopia.	450

No.	Authors	Title	Page
131	Songhua Xie	Practice and Insights of Ecological Clean Small Watershed Construction in Jiangxi Province, China.	451
132	Wang Liu	Digital Twins Empower Smart Management: Integrating Soil Conservation into Hydraulic Engineering Practices in Jiangxi, China.	453
133	Yanay Farja, Patrick Chavel, Matan Ben Yona, Roey Egozi	Balancing Ecological Gains and Social Costs: A Multi-Scenario Assessment of Mediterranean Agriculture Stream Restoration.	455

9. Vegetation, biodiversity and ecosystem restoration — 27 abstracts p. 457

No.	Authors	Title	Page
134	Paul Melsom	Trials, tribulations and successes: a snapshot of a 20-year forest landscape restoration project arising from a previously deforested and severely degraded hillside in Hong Kong.	460
135	Cristina Branquinho, Adriana Príncipe, Maria Espírito Santo, Bruna Reis, Maria Alexandra Gomes Oliveira, Alice Nunes	Let It Grow or Help It Grow? The importance of microclimate for restoration in drylands.	461
136	Xiao-ping Zhang, Xiao-ming Xu, Tang-long Yu-wen, Zhao-liang Gao, Rui Li	Effects of Vegetation Restoration Approaches on Understory Vegetation and Soil Hydrophysical Properties on the Loess Plateau.	463
137	Ewa Błońska, Jarosław Lasota, Anna Ilek	A study of the relationships between tree root architecture and soil properties in uniform habitat settings.	468
138	Santiago Sardinero, Alberto Ortego, Pilar Gegúndez, Fernando Púa	Relationships between vegetation types and soil physico-chemical properties along a 100-year natural succession gradient in a limestone quarry under semiarid climate in central Spain.	469
139	Alona Bunas, Yevheniia Tkach, Olena Sherstoboieva	Systemic Environmental Consequences of the War in Ukraine: Synergistic Effects of Ecosystem Degradation.	471

No.	Authors	Title	Page
140	Jennifer Sinclair	From Science to Market: How Environmental Market Frameworks Can Finance Restoration at Ecological Timescales.	473
141	Irene Morell Rodríguez, Sara Peláez-Sánchez, Pilar Gegundez, Mariano García	Land Degradation Findings and Restoration Challenges in the 21st Century. Recovering Degraded Landscapes through the IUCN Global Standard for Nature-based Solutions™: Lessons from La Veguilla Crypto wetland and the Cañada Real Conquense Corridor.	512
142	Wonho Kim, Junpyo Seo, Jun Park, Sungho Park, Seongho Lim, Kwanghyun Nam, Eunho Choi, Hakjun Rhee	Changes in Fluvial Geomorphology and Vegetation in Six Disturbed Forest Catchments in South Korea.	481
143	Atsede Ayalu, Mulatie Mekonnen, *, Enyew Adgo, Tesfaye Shiferaw, Firew Tegegne, Mulunesh Abebe Alkebachew, Zenebe Adimasu, Degifie Tibebe, Berhanu Belay, Wuletawu Abera, Lulseged Tamene	Nature-based Soil Quality Restoration in the Northwest Ethiopia: The case of Mount Birr Adama.	485
144	Erwin Domínguez, Milenka Seguich, Sebastián Pérez, Gerardo Moreno	Land degradation and natural regeneration in cold, dry grasslands disturbed by underground pipelines in southern Patagonia.	490
145	Kevin Z. Mganga	Native perennial grasses for restoring African drylands – what do we know?.	492
146	Vivek Verma, Nagaraja Tejo Prakash, Sheikh Adil Edrisi*	Harnessing Urban Marginal Lands for Sustainable Vegetation and Biomass Production in Indian Megacities.	494
147	Omar ZENNOUHI, Fatima EL LAMTI, Youssef OUADJANE, Houria NEKHLA, Mariame NAJEM, Mohamed BENADDOU, Khalid SELLAM, Laila NASSIRI	Assessing the Potential of Bituminous Clover (<i>Bituminaria bituminosa</i> (L.) Stirton) for the Rehabilitation of Degraded Silvopastoral Lands.	499

No.	Authors	Title	Page
148	Mónica Q. Pinto, Ondina Ribeiro, Simone Varandas, Sandra Sarmiento, Edna Cabecinha	Exploring Soil Biodiversity dynamics in the Côa Valley and the impacts of Land Use on Ecosystem Restoration.	501
149	Salim A. Lossindilo, (PEng, MIET, M. ASCE)	Decentralized Nature-Based Wastewater Treatment for Mitigating Land Degradation and Nutrient Pollution in Hilly Urban Catchments: A Case Study of Mwanza City, Tanzania.	508
150	Jan Amanullah	Decarbonizing Agriculture in Pakistan: Securing Sustainability and Climate Resilience through Smart Agriculture.	510
151	Mohamed A.E. AbdelRahman	Land Degradation Findings and Restoration Challenges in the 21st Century.	512
152	Tshegofatso K.J. Sebitloane*, Klaus Kellner, Pieter W. Malan and Hendri C. Coetzee	Restoring Degraded Semi-Arid Savannas Using Brush-Packing After Bush Encroachment Clearing in South Africa.	513
153	Karima Benhattab, Christophe Sené	Optimizing the lifespan of dams and retention structures in Algeria: modeling a nature-based solution chain as an alternative to conventional dredging.	515
154	Belstie Lulie, *, Tesfaye Shiferaw Sida, Mekonnen Getahun, Enyew Adgo	Extent and Spatial Distribution of Subsoil Acidity and Its Implications for Nature-Based Soil and Landscape Restoration in the Upper Blue Nile Basin, Ethiopia.	517
155	Chunyang Song, Pengfei Du, Yng Zhao, Liang Liu, Yuqing Zhang	Functional dominance outperforms functional diversity in driving ecosystem multifunctionality during vegetation restoration in a desert steppe.	521
156	Sonia Goel, Veronica Cereno, Paolo Bonini, Gorka Erice	Harnessing Microbial Consortia for Sustainable Land Restoration: Impacts on Plant Metabolism, Productivity, and Resilience.	524
157	Hao Chen, Luuk Fleskens, Johanna Schild, Simon W. Moolenaar, Fei Wang, Coen J. Ritsema	Cost-Benefit Analysis of Large-Scale Land Restoration in the Chinese Loess Plateau: Ecosystem Service Valuation and Future Restoration Pathways.	528

No.	Authors	Title	Page
158	Rui Li, Xiao-ping Zhang, Quangang Yu, Qin-ke Yang, Fei Wang, , Zhaoliang Gao	A Good Example of Ecological Restoration - the Loess Plateau of China.	529
159	Hasnaa Lahchimi, Wessal Ouedrhiri, Salahddine Chafiki, Mohamed Alouani, Abdallah Oukarroum, Rachid Bouharroud, Hicham El Arroussi	Microalgae as Nature-Based Bioelicitors for Sustainable Land Management: Enhancing Primary Metabolism and Terpenoid Biosynthesis in <i>Rosmarinus officinalis</i> .	533
160	Julius Katana, Kiganane Sabali, Flora Awilo, Victor Mwanga, Josephine Masanju, Josphat Mtwana	'Beyond trees': synergizing bamboo agroforestry and apiculture to buffer mangrove restoration in kilifi county.	536

10. Remote sensing, GIS, modelling and monitoring — 26 abstracts p. 538

No.	Authors	Title	Page
161	Morteza Gheysouri, Ataollah Kaviani*, Mahin Kalehhouei	Application of new remote sensing technologies in monitoring and assessing land degradation using the vegetation sensitivity index to drought: A case study of Kermanshah Province.	541
162	Muhammad Arslan, Foroogh Mehravaran, Akeem O. Bello, Mohamed Gamal El-Din	Diffusion-Limited Release of Tailings-Derived Organics Drives Stabilization in PASS-Treated End Pit Lakes.	544
163	Ognen Onchevski, Ivan Minchev, Bozin Trendafilov, Ivan Blinkov, Anastazija Dimitrova	Assessing the Loss, Degradation, and Restoration Potential of Tree Windbreaks in the Ovche Pole Region, North Macedonia.	547
164	Fatima-Ezzahrae Imam, Nicola Riitano, Gregory Giuliani, Ioannis Manakos, Afroditi Kardamaki, Daniela Smiraglia, Mohamed Elarbi Brick, Audrey Lambiel, Francesca Assennato, Giovanna Seddaiu	Fine resolution assessment of Land Productivity Dynamics from a fused Landsat-MODIS NDVI time series in Asterousia, Crete.	549

No.	Authors	Title	Page
165	Jammat Khaoula, ALGOUTI Ahmed, ALGOUTI Abdellah, GHACHOUI Hayat, MOUJANE Said	GIS and Sentinel-2-Based PAP/CAR Modeling for Soil Erosion Risk Assessment in the Ourika Watershed, High Atlas Mountains (Morocco).	555
166	Christina G. Rodríguez, Sinan Demír	Map Risk. Guide Action. Toward Transferable and Physically Interpretable Earth Observation for Climate Hazard Intelligence.	558
167	Nisha Bao, Dantong Meng	Groundwater-Dependent Vegetation Monitoring using an Endmember-Based Vegetation Index and Multivariate Time-Series Analysis in Arid Mining Areas.	560
168	Sylwia Pindral, João Augusto Coblinski, Agnieszka Wnuk, Bożena Smreczak	Synthetic approach to quantifying regulating soil-based ecosystem services using multiple indicators.	563
169	Carmen Orts, Ramón Pons-Crespo, María Desamparados Soriano, Rafael Boluda, Ángel Marqués-Mateu	Remote Sensing-Based Monitoring of Green Cover Variability in Fruit Tree Orchards.	565
170	Sinan Demír, Yasin Altay, Levent Başayığit	Bibliometric Analysis of Artificial Intelligence Applications in Land Degradation Research (1990–2026).	571
171	Faiza Hallouz, Mohamed Meddi, Salah Eddine Ali Rahmani	Spatial chronological land use evolution in Wadi Mina basin-northwest of Algeria.	573
172	Karima Nifa, Maryem Ismaili, Jérôme Chenal, Rida Azmi, Mohammed Hlal, Seyid Abdellahi Ebnou Abdem, El Bachir Diop, Mariem Bounabi, Mohamed Adou Sidi Almouctar, Hamza Kharti	A Geospatial LLM Framework for Indicator Recommendation in Ecological Restoration.	574
173	Hassan Ait Naceur, Farid El Wahidi, Benazun Hoda, Lassiane youssef, Mohamed Reda Najem	Advancing Gully Erosion Susceptibility Mapping through Ensemble Machine Learning Approaches: A Case Study from the N'fis River Basin, High Atlas, Morocco.	575

No.	Authors	Title	Page
174	Princewill Odum	Integrating Open-Source Data for SDG 15 (Life on Land) - Tracking Land Use Change Across Africa from Space.	580
175	Tamara Martínez-Martínez, Rubén Forján Castro, Asunción Cámara-Obregón, Iyán Teijido-Murias	High-resolution (10 m) soil pH mapping using environmental and Sentinel-2 covariates in Asturias (NW Spain).	583
176	Ahmed M. M. Hasoba, Kornel Czimmer	Mapping Land Degradation Hotspots in a Savanna Forest Using Multi-Decadal Remote Sensing: Implications for Conservation and Restoration.	585
177	Pawan Thapa	A Spatial Monitoring and Reporting Approach.	591
178	Ehsan Moradi, Wahaj Habib, John Connolly	European Peatlands Under Degradation: Drainage and Land Use Change as Main Factors.	593
179	Owais Ali, Mudassir Sohail, Abdur Rehman, Musfria Aakash	Spatial and Temporal Assessment of Land Degradation in Rawalpindi Division: A Multi-Indicator Approach.	594
180	Princewill Odum	Monitoring SDG 15 from Space: A Sub-National Remote Sensing Decision Support System for Land Degradation Assessment in Nigeria (2015–2024).	601
181	Houria Es-suktani, Khadija El Houfy, Soumaya Elkanbouh, Lahcen Daoudi	Spatial Assessment of Soil Degradation by Salinization Using Physicochemical Analyses and GIS.	605
182	Nándor Csikós, Annamária Laborczi, Katalin Takács, Gábor Szatmári, László Pásztor, and Gergely Tóth	Mapping agricultural marginality using geospatial and unsupervised data-driven approaches.	606
183	Abdessamad Hilali, Yassine Bouslihim, Tarik Benabdelouahab	Spatial Prediction of Soil Salinity Based on Sentinel-2 Imagery and RF and XGBoost Models in the Tadla Plain (Morocco).	608
184	Annette Achieng*, Ana Cristina Costa, Pedro Cabral	Evaluating the Shifting Spatial Dynamics of Seasonal Spectral Bands for SOC Prediction using Spatial Cross-Validation.	610

No.	Authors	Title	Page
185	Sylwia Pindral, Grzegorz Siebielec, João Augusto Coblinski, Monika Pecio, Artur Łopatka, Antonios Morellos, Abdul M. Mouazen	Field vs. regional scale digital soil mapping for trace elements monitoring: insights from the WHEATWATCHER project (Silesia, Poland).	613
186	Carmen Vega Valdés, Montserrat Ferrer-Julia, Sara Alcalde-Aparicio	Digital Soil Mapping of soil surface properties in northwestern León (Spain).	614

No.	Authors	Title	Page
187	Pasquale Borrelli, Panagos Panos, Remus Prăvălie, David A. Robinson, Sirio Modugno, Christine Alewell	MEDALUS-R: A multi-temporal framework for assessing desertification susceptibility across Europe.	623
188	Davoud Omarzadeh, Estefania Blanch PCP WISE Member	Translating Space Data into Decision Support for Soil, Water, and Vegetation: Insights from the PCP WISE Initiative.	625
189	Gintarė Sujetovienė, Giedrius Dabašinskas	Restoring Lithuania's Peatlands: Assessing Ecosystem Service Losses and Recovery Potential.	627
190	Gerardo Moreno, Alejandro Carrascosa, Ángel Valverde, José M. Igual, Sara Rodrigo, Víctor Rolo	Scattered trees reinforce soil carbon stocks and multifunctionality of semi-arid grassland but effects fade out with management intensity and aridity.	628
191	João Augusto Coblinski, Sylwia Pindral	Can land use changes compensate for climate-based soil organic carbon losses? A projected scenario for Poland in 2050.	633
192	Jan Amanullah	Integrated Nutrient Management as a Tool for Soil Restoration, Climate Resilience, and Sustainable Land Use.	635
193	Juline Diken Malounghou Bounangnan, Asbai Zakaria, Mohammed Bennani, Hilma Bessi, Rolf Gael Mabicka Obame, Maurice Ognalaga, Nadia Boutaleb	Sustainable Agriculture as a Strategic Pathway for Soil Carbon Sequestration and Climate Mitigation: a review.	637

No.	Authors	Title	Page
194	Cristina Branquinho, Maria Espírito Santo, Alice Nunes, Adriana Príncipe, Ana Paula Portela, Maria Alexandra Gomes Oliveira	Phenological Regimes and Climate Thresholds in Rain-Fed Pastures.	638
195	Mohsin Mahmood, Yang Zhiping*	Distinct Soil-type-Depth Specific mechanisms mediate Carbon and Phosphorus Coupling in Tropical soils.	639
196	Tiago Silva, M. Cristina da Costa Vila, João Santos Baptista	Multi-response framework for technosol formulation from mining tailings, compost and topsoil.	640
197	Marijana Kapović Solomun, Milica Vranešević, Svetlana Lazić, Stojanka Dražić, Ilija Čigoja	Soil Contamination Hotspots in Republika Srpska (Bosnia and Herzegovina): Challenges for Assessment, Risk Prioritization, and Environmental Governance.	642
198	Roja Eliza, Rahul Kumar Pandey * Anshumali	Spatio-temporal Dynamics of Carbon Storage and Ecosystem Services in a Small Watershed under Multi-Scenario Projections using PLUS-InVEST Model.	645
199	Wudu Abiye, *, Jasper Knight, Alex Schoeman, Olaotse Lokwalo THABENG, Stefano Biagetti, Carla Lancelotti	Remote sensing-based spatiotemporal analysis of land degradation trends in the Ethiopian Highlands under climate variability.	648
200	Afshin Tahmasbi Sarvestani, Hassan Khosravi, Behzad Rayegani, Esmail Heydari Alamdarloo	Analyzing the Temporal Trend of Extreme Dust Emissions from the Salehieh Wetland: A 20-Year Study of Event Frequency and Dominant Wind Regimes (2003-2023).	650
201	Brook Legese, Ashish Pandey, Mohit Prakash Mohanty	Land Degradation, Ecosystem Service Decline, and Restoration Prioritization in a Semi-Arid Rift Valley Landscape.	656
202	Uttam Kumar Sahoo, * and Ashish Singh	Effect of land use change on soil aggregates and soil carbon inventories in the India's Eastern Himalaya.	664
218	Vicenc Carabassa, Pere Rovira, Carlos Cantero, Jordi Garcia-Pausas, Neus Puy, Meri Pous, Ralph K. Rosenbaum, Maite Martinez-Eixach, Miriam Gonzalez	Soil carbon in Mediterranean agroforestry systems: integrated evidence, knowledge gaps and policy-oriented outcomes from the Soil Carbon project in Catalonia	677

No.	Authors	Title	Page
203	Daniel Morant, Luis Roca, Oscar Andreu, Carlos Rochera, Antonio Picazo, Antonio Camacho	Linking restoration status and soil management to carbon and greenhouse gas balances in Mediterranean coastal wetlands.	665
204	Waman Kulkarni, R. C. Kote, Dnyaneshwar More, Sagar Chavan, S Sasitharan	BAIF's Water-Centric Livelihood Approach for Sustainable Land and Water Management.	671

12. Governance, policy, economics and participation — 12 abstracts p. 673

No.	Authors	Title	Page
205	Miodrga Zlatic, Stanimir Kostadinov, Ivan Blinkov, Velivor Spalevic, Faruk Bojaxhi	Disaster Risk Reduction – DDR in Western Balcan.	676
206	Diego Gamiz Monterde*, Jaime Escribano Pizarro, Artemi Cerdà	The psychological dimensions of forest fires. A bibliometric review.	680
207	Keesstra, S.D., Cerdà, A., Gimenez Morero, A., Gamiz Monterde, D. Soleymani, M., de Rooij, B.	Nature-Based Solutions for Wildfire Risk Mitigation in Europe: A Comparative Analysis of Northern and Southern Case Studies and Barriers to Scaling.	684
208	Irene Orts, Raquel Paz, Jesús Barrena, Manuel Pulido, Juana Labrador	Educating to teach how to learn: soil health literacy for secondary school teachers using citizen sciencebased resources.	686
209	João Augusto Coblinski, Grzegorz Siebielec	NBSOIL Academy: Training soil advisors to promote soil health.	689
210	Manuel Pulido, Simone Priori, Jesús Barrena	A Master in Soil Science for Mediterranean Areas is coming soon.	691
211	Maryem Ismaili*, Karima Nifa, Jérôme Chenal, Rida Azmi, Mohammed Hlal, hamza Kharti, Seyid Abdellahi Ebnou Abdem Mohamed Adou Sidi Almouctar, El Bachir Diop, and Mariem Bounabi	A Comprehensive Monitoring System Supporting Sustainable Restoration along the Great Green Wall in Senegal.	693

No.	Authors	Title	Page
212	Manuel Pulido, Juana Labrador, Irene Orts	Engaging citizens in Soil Science: The case study of Extremadura, Spain.	695
213	Sihle Pokwana, Charlie Shackleton	Understanding complex and interacting drivers of arable field abandonment that lead to land degradation in villages of the Eastern Cape and KwaZulu-Natal, South Africa.	697
214	Yingshan Lau	Examining overlaps in the '+' of REDD+ and ecosystem restoration: interdisciplinary lessons from Vietnam and the Lao PDR.	705
215	Rahul Kumar, Soumyajeet sahu, Rahul Kumar, Abhishek Kumar, Anil Kumar Kewat, Manoj Kumar, Vijender Pal Panwar, Kumud dubey	Socio-ecological Determinants of Land Degradation and Restoration: Evidence from Mahua-based Livelihood Systems in Central India.	708
216	Melpomeni Zoka, Salvador Llado, Nikolaos Stathopoulos*, Charalampos Kontoes	Addressing Land Degradation in Europe: Identifying Priority Knowledge Gaps through the SOLO project Land Degradation Think Tank	711

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ABSTRACTS

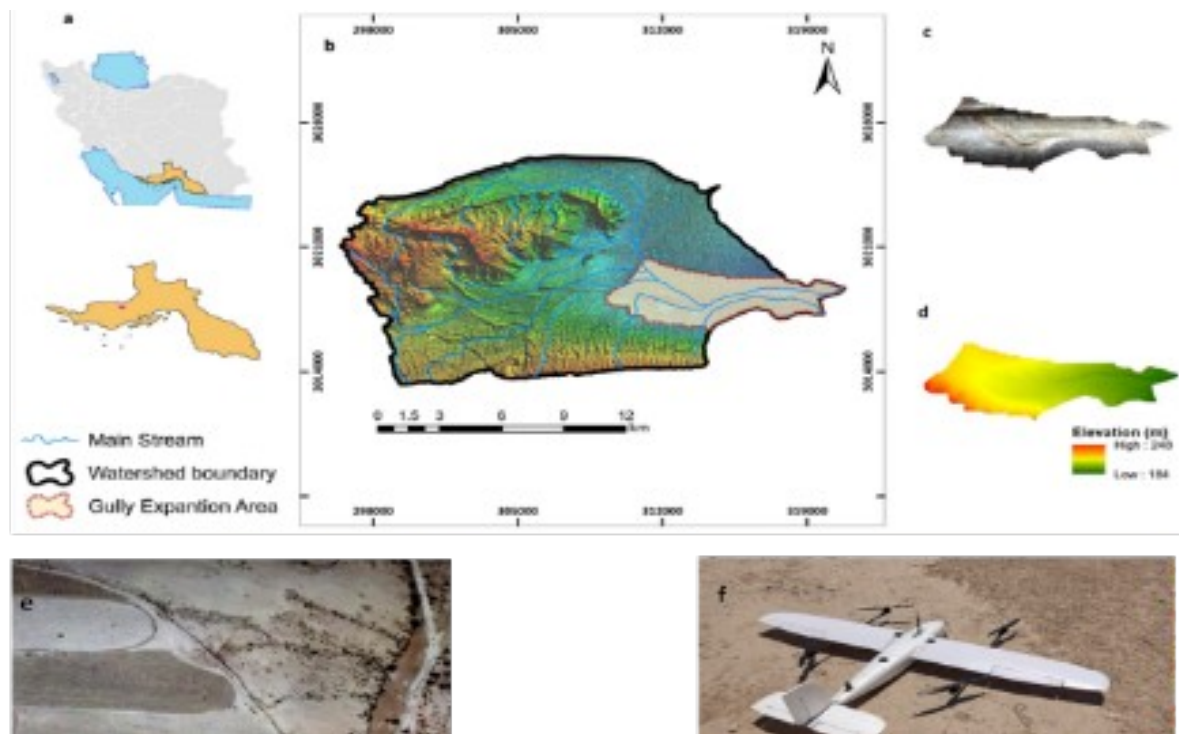


Figure 1. Study area in Iran (a), watershed boundary and gully expansion area (b), UAV orthophoto (c), and UAV-derived digital elevation model (6 cm resolution) (d), gully encroachment toward agricultural lands (e), and UAV used for imaging (f) Multi-temporal gully mapping.

Gully erosion represents one of the most severe forms of soil degradation, leading to rapid landscape dissection and significant sediment redistribution (Poesen et al., 2003). While traditionally associated with steep slopes, increasing evidence suggests that gully systems can extensively develop in low-gradient environments where runoff concentration and soil surface conditions play a dominant role (Valentin et al., 2005; Castillo and Gómez, 2016). Understanding gully development requires integrating multi-temporal analysis with environmental and morphometric characterization. Although several studies have investigated individual controls, the combined role of land use, runoff potential, and lithology in long-term gully expansion remains poorly explored (Torri & Poesen, 2014). This study aims to (i) quantify long-term gully expansion, (ii) evaluate its relationship with key environmental factors using spatial overlay

analysis, and (iii) interpret dominant erosion processes using morphometric evidence derived from high-resolution UAV data.

The Jeyhoon watershed is located in Hormozgan Province, southern Iran, covering approximately 20,276 ha. The region is characterized by a semi-arid climate, low rainfall, and dominant alluvial plains composed of erodible sedimentary materials.

Multi-temporal aerial photographs (1967 and 1994), satellite imagery (Google Earth, 2012), and UAV imagery (2024) were used to map gully boundaries.

Newly developed gullies were identified using a multi-temporal change detection approach based on the comparison of gully polygons between consecutive time periods (1967–1994, 1994–2012, and 2012–2024). This method allowed separation of newly formed gullies from pre-existing ones.

To assess the relationship between gully expansion and environmental factors, a GIS-based spatial overlay analysis was performed. Newly formed gully polygons for each period were intersected with thematic layers including slope classes, land use, curve number (CN), and geology. The area of gullies falling within each class was calculated and expressed both in hectares and as a percentage of total gully expansion for each period. This approach allowed identification of dominant environmental conditions associated with gully development.

A total of 481 cross-sections were extracted from a UAV-derived DEM with a spatial resolution of 6 cm. For each cross-section, depth, top and bottom width, width-to-depth ratio, and bank slopes were calculated.

Total gully area increased from 132.64 ha in 1967 to 167.32 ha in 1994, followed by a more rapid increase to 247.36 ha in 2012 and 326.39 ha in 2024, representing an overall growth of approximately 146%. The rate of expansion shows a clear acceleration, increasing from 1.28 ha yr⁻¹ during 1967–1994 to 4.45 ha yr⁻¹ during 1994–2012, and further to 6.58 ha yr⁻¹ during 2012–2024. This nonlinear trend indicates intensification of erosion processes over time.

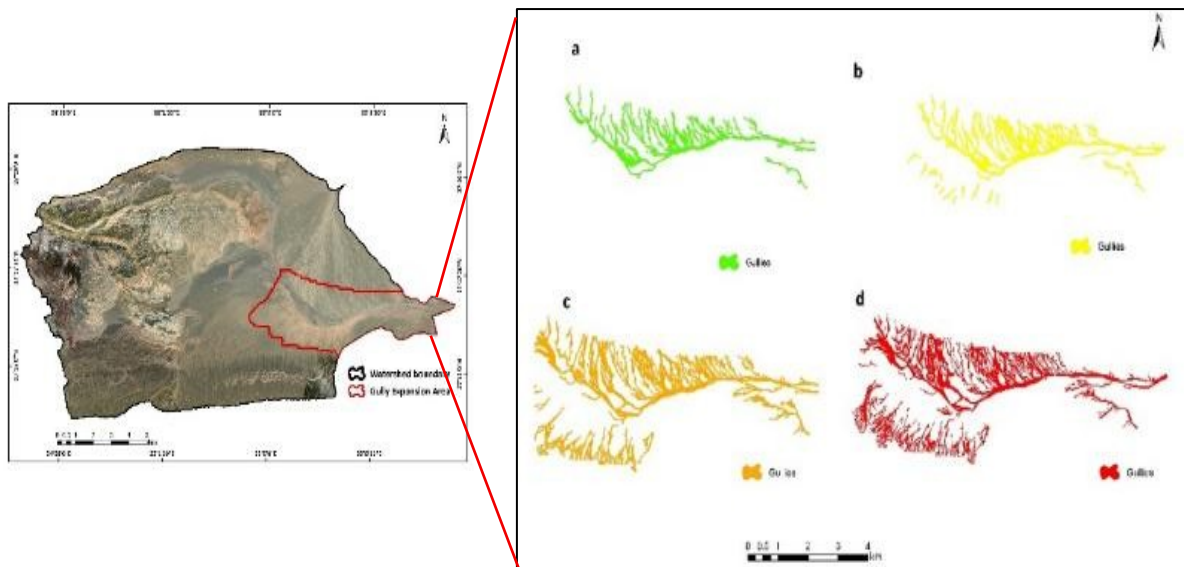


Figure 2. Temporal evolution of gully distribution in the Jeyhoon watershed in 1967 (a), 1994 (b), 2012 (c), and 2024 (d). Spatial concentration of gully expansion

Gully expansion is not uniformly distributed across the watershed. Instead, it is highly concentrated, with a single dominant gully contributing between approximately 58% and 74% of total expansion across different periods. This highlights the importance of localized geomorphic processes in controlling overall erosion dynamics.

Environmental controls of gully expansion

More than 96% of gully expansion occurs within the lowest slope class (<2%), indicating that slope gradient is not the dominant controlling factor. Land use analysis shows that 90–98% of new gullies formed in rangelands. Expansion is also strongly associated with $CN \approx 68$ and erodible geological units.

Morphometric characteristics

Morphometric analysis based on 481 cross-sections (Table 2) shows that gully depth is generally low (mean = 0.95 m; median = 0.72 m), indicating a predominance of shallow channels. In contrast, the width-to-depth ratio is relatively high (mean = 19.04), reflecting significant lateral expansion. The frequency distributions (Figure 3) reveal positively skewed patterns, particularly for the width-to-depth ratio, highlighting the presence of a limited number of large sections.

Overall, these results indicate that gully evolution in the study area is primarily controlled by widening processes rather than vertical incision.

Table 2. Summary statistics of gully morphometric parameters

Parameter	Min	Max	Mean	Std. Dev.
Depth (m)	0.31	3.35	0.95	0.70
Top width (m)	1.40	182.90	18.00	21.53
Bottom width (m)	0.40	114.80	9.54	13.64
Width-to-depth ratio	0.65	103.87	19.04	14.68
Left bank slope (%)	2.54	136.31	33.02	22.93
Right bank slope (%)	4.00	138.04	31.47	22.30

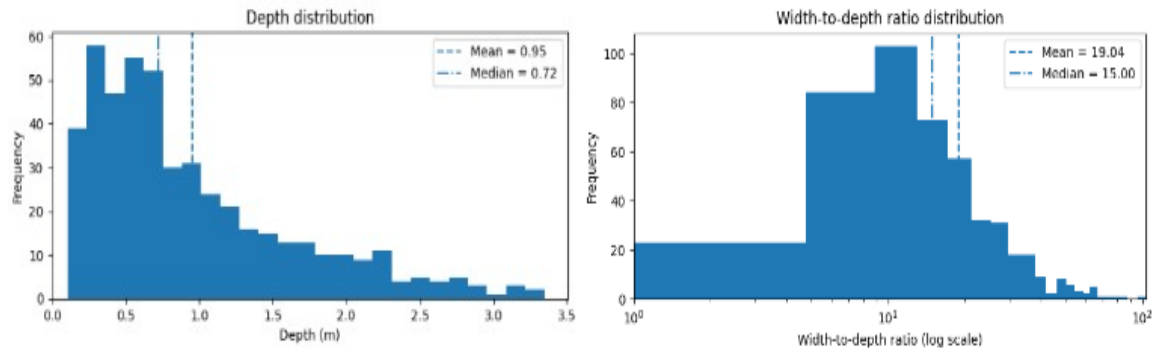


Figure 3. Distribution of gully morphometric parameters

The results demonstrate a strong acceleration in gully expansion, indicating intensification of erosion processes over time. Contrary to traditional assumptions, slope is not the primary control, as most gullies occur in very low-gradient areas. Hydrological conditions, represented by CN values, play a dominant role by controlling runoff generation. The dominance of rangelands suggests that vegetation degradation enhances surface runoff and erosion. Morphometric

results further support this interpretation, as high width-to-depth ratios indicate that lateral widening dominates over vertical incision. This pattern is consistent with runoff-driven erosion in alluvial plains (Poesen et al., 2003; Valentin et al., 2005).

Gully expansion has significantly accelerated and is mainly controlled by hydrological and land surface conditions, while slope plays a minor role.

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