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GEOTROPIK
Centre of Tropical Geoengineering

In Collaboration with

INTERNATIONAL CONFERENCE OF TROPICAL GEOENGINEERING 2026 (TROPICON 2026)

"Geohazard Preparedness: Integrating Geoengineering from Subsurface to Surface with Artificial Intelligence"

8 & 9 SEPTEMBER 2026 | THE PACIFIC SUTERA HOTEL, KOTA KINABALU, SABAH

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FOREWORD ADDRESS DEPUTY CHIEF MINISTER I OF SABAH, MINISTER OF WORKS AND UTILITIES, SABAH



It gives me great pleasure to extend my warmest greetings and congratulations to all delegates, speakers, researchers, industry professionals, government representatives, and participants of the International Conference of Tropical Geoengineering 2026 (TROPICON 2026), held on 8–9 September 2026 at The Pacific Sutera, Kota Kinabalu, Sabah.

The theme of this year's conference, "Geohazard Preparedness: Integrating Geoengineering from Subsurface to Surface with Artificial Intelligence," is both timely and highly relevant. Sabah's unique geological and geographical setting presents various challenges associated with landslides, slope instability, seismic activities, flooding, ground conditions, and infrastructure resilience. Addressing these challenges requires not only sound engineering and scientific knowledge, but also greater collaboration, innovation, and the effective adoption of emerging technologies.

The integration of geotechnical engineering, geology, geomatics, geophysics, highway engineering, and artificial intelligence provides an important multidisciplinary platform for improving our understanding, prediction, monitoring, and management of geohazards. Such an integrated approach is increasingly important as we strive to develop infrastructure that is safer, more resilient, sustainable, and responsive to the effects of climate change and natural hazards.

I am therefore pleased to see TROPICON 2026 bringing together experts from academia, government agencies, professional bodies, and industry to exchange knowledge, research findings, technological advancements, and practical experiences. Conferences such as TROPICON provide valuable opportunities to bridge the gap between research and engineering practice while encouraging innovative solutions that can be translated into policies, planning, design, construction, and infrastructure management.

For Sabah, strengthening geohazard preparedness is particularly important in supporting sustainable development and safeguarding our communities and critical infrastructure. Advances in data analytics, remote sensing, instrumentation, numerical modelling, and artificial intelligence offer tremendous potential to enhance early assessment, risk identification, decision-making, and the implementation of appropriate mitigation measures.

I commend the Centre of Tropical Geoengineering (GEOTROPIK), Universiti Teknologi Malaysia, together with its collaborators, partners, sponsors,

organising committee, and supporting agencies, for their commitment and efforts in organising TROPICON 2026 in Kota Kinabalu. I trust that this conference will stimulate meaningful discussions, establish new collaborations, and generate practical ideas that will contribute toward safer and more resilient infrastructure development in Sabah, Malaysia, and other tropical regions.

To all distinguished speakers, presenters, delegates, and participants, I wish you a productive and rewarding conference. I also encourage our visitors to take the opportunity to experience the warm hospitality, cultural diversity, and natural beauty of Sabah. May TROPICON 2026 be a great success and serve as an important platform for advancing knowledge and innovations in tropical geoengineering and geohazard preparedness.

Thank you.

YB DATUK SERI PANGLIMA DR. JOACHIM GUNSALAM, JP
Deputy Chief Minister I of Sabah
Minister of Works and Utilities, Sabah

FOREWORD ADDRESS BY VICE CHANCELLOR OF UNIVERSITI TEKNOLOGI MALAYSIA (UTM)



It gives me great pleasure to welcome all speakers, delegates and participants to the International Conference of Tropical Geoengineering (TROPICON) 2026, held under the theme "Geohazard Preparedness: Integrating Geoengineering from Subsurface to Surface with Artificial Intelligence."

This timely theme reflects the aspirations of Universiti Teknologi Malaysia (UTM) to advance technological excellence, impactful research, innovation and global engagement. It also highlights the important role of the Centre of Tropical Geoengineering (GEOTROPIK) in bringing together multidisciplinary expertise to address complex geoengineering and geohazard challenges in tropical environments.

Through TROPICON 2026, UTM reinforces its commitment to translating research and technological innovation into practical solutions for resilient infrastructure, sustainable development and safer communities. Integrating artificial intelligence with geoengineering offers new possibilities for strengthening risk assessment, predictive capabilities and geohazard preparedness. Its application must remain guided by scientific rigour, professional integrity and human well-being.

I extend my sincere appreciation to GEOTROPIK, our collaborators and strategic partners, sponsors, distinguished speakers and the TROPICON 2026 organising committee for making this conference possible.

I am confident that TROPICON 2026 will stimulate meaningful knowledge exchange, strengthen international and industry partnerships, and advance UTM's contribution to tropical geoengineering.

I wish all participants a productive, inspiring and rewarding conference.

Thank you.

PROF. TS. DR. MOHD SHAFRY BIN MOHD RAHIM
Vice-Chancellor
Universiti Teknologi Malaysia (UTM)

FOREWORD ADDRESS BY CHAIRMAN TROPICON 2026



Assalamualaikum and warm greetings,

Geohazard Preparedness: Integrating Geoengineering from Subsurface to Surface with Artificial Intelligence. It is my great pleasure to welcome all distinguished guests, keynote speakers, delegates, researchers, industry professionals, government agencies, and participants to TROPICON 2026.

This conference provides an important platform for experts from academia, industry, and government agencies to exchange knowledge, experiences, and innovative ideas in addressing the growing challenges associated with geohazards. With the theme "Geohazard Preparedness: Integrating Geoengineering from Subsurface to Surface with Artificial Intelligence," TROPICON 2026 highlights the importance of integrating conventional geoengineering knowledge with emerging technologies, particularly Artificial Intelligence, to enhance our understanding, prediction, monitoring, and management of geohazard risks.

As geohazards continue to pose significant challenges to infrastructure, communities, and sustainable development, stronger collaboration among engineers, researchers, policymakers, and industry practitioners is increasingly important. I sincerely hope that the discussions, technical presentations, and networking opportunities throughout TROPICON 2026 will lead to new collaborations, practical solutions, and meaningful contributions towards safer and more resilient infrastructure.

On behalf of the Organising Committee, I would like to express my sincere appreciation to all keynote speakers, invited speakers, authors, reviewers, sponsors, strategic partners, supporting organisations, committee members, and participants whose valuable contributions have made TROPICON 2026 possible.

Finally, I wish everyone a productive and memorable conference. May TROPICON 2026 strengthen professional networks, inspire innovative ideas, and contribute towards advancing geoengineering and geohazard preparedness in Malaysia and beyond.

Welcome to TROPICON 2026.Thank you.

IR. TS. DR. BAKHTIAR AFFANDY OTHMAN
Chairman,
TROPICON 2026
Universiti Teknologi Malaysia (UTM)

Tentative Programme for TROPICON 2026	
Day 1: 8th September 2026 (Tuesday)	
08:00 – 08:30	Registration
08:30 – 08:50	Arrival of guests and VIPs National Anthem and Doa recital
08:50 – 09:00	Welcoming speech by Vice-Chancellor Universiti Teknologi Malaysia, YBrs. Prof. Ts. Dr. Mohd Shafry bin Mohd Rahim
09:00 – 09:10	Officiating Address by Ministry office of Works and Utilities, Sabah.
09:10 – 09:20	Montage Appreciation ceremony Group photo Visit to Exhibition Booths by the Guest of Honour
09:20 – 09:45	Morning tea break
09:45 – 10:30	Keynote Speaker 1: **Understanding geohazard in Tropical Environments** by **Prof. P.Geol. Ts. Dr. Edy Tonnizam Mohamad** Distinguished Fellow, GEOTROPIK, Universiti Teknologi Malaysia
10:30 – 11:15	Keynote Speaker 2: **Advances in Geotechnical Engineering for Tropical Infrastructure** by **Ir. Nor Fardzilah Binti Abdul Rahman** Senior Superintendent Civil Engineer, Geotechnical Engineering Branch, Public Works Department.
11:15 – 12:00	Keynote Speaker 3: **Leveraging Artificial Intelligence (AI) in Landslide Hazard and Risk Assessment** by **P.Geol. Dr. Frederick Francis Tating** Director, Department of Mineral and Geosciences, Sabah
12:00 – 12:45	Keynote Speaker 4: **Smart Geotechnics: Enhancing Hazard Prediction and Sustainable Mitigation in Tropical Regions via Artificial Intelligence** by **Prof. Ir. Dr. Hj. Ramli Bin Hj. Nazir** Distinguished Fellow, GEOTROPIK, Universiti Teknologi Malaysia.
12:45 – 14:00	Lunch
Session I	
14:00 – 14:30	**Chairperson:** **Assoc. Prof. Dr. Roohollah Kalatehjari,** **(AUT, New Zealand)**

	Invited Speaker **A Lesson Learned from Expansive Clay Minerals of Chaotic Garinono Melange: Failures in Design Considerations and Quality Assurance Process** by **PMr. Br. Gs. Ts. Ir. Jeffery Anak Pirah** Principal Consultant, Alamega Consults, Sabah.
14:30 – 15:00	**Invited Speaker** **Advancing Geotechnical Investigation Through Integrated Geophysical Solutions** by **P.Geol. Dr. Kiu Yap Chong** Geophysicist, Geospec Sdn. Bhd.
15:00 – 15:08	**001-001** Osama Mohamed El Sayed Mohamed Abdelaal Ground–tunnel Interaction under Jacking Forces: Insights from Advanced Numerical Modelling.
15:08 – 15:16	**002-002** Abideen Adekunle Ganiyu Prediction of Settlement of Shallow Foundations on Cohesionless Soils using a Codeless Machine Learning Tool
15:16 – 15:24	**005-005** Khoo Chee Min Observed Wall Deformation Behaviour in Open Excavation Supported by Buttressed Diaphragm Walls
15:24 – 15:32	**008-006** Nurul Atiqah Asram UAV-Based Automated Slope Defect Detection for Highway Asset Management: A Case Study on PLUS Highway
15:32 – 15:40	**009-008** Rajitha Sachinthaka Assessing the completeness of post storm landslide records: A two-inventory comparison following Cyclone Gabrielle in Auckland, New Zealand
15:40 – 15:48	**002-007** Abideen Adekunle Ganiyu Forecasting Settlement of Single Piles Using CPT Data in Machine Learning Models
15:48 – 15:56	**022-021** Mohamad Syazwan Mohd Roslee Temporal Coupling of Early-Stage Root Architectural Traits and Surface Erosion Mechanics in Vetiver and Lemongrass Nature- Based Slope Stabilization
15:56 – 16:04	**012-014** Azlan Shah Nerwan Shah Digital Image Processing and Multi-Scale Analysis of Desiccation Cracking in Tropical Clays for Shallow Landslide Investigation

16:04 – 16:12	**019-016** Ramesh Murlidhar Bhatawdekar Intelligent techniques for prediction of flyrock at granite quarry in Malaysia
16:12 – 16:20	**018-028** Edy Tonnizam Mohamad Rare Earth Elements Chemistry, Global Resources, Mining, Recycling and Sustainable Supply Pathways Comprehensive Review
16:20 – 16:28	**021-017** Mohamad Fiqry Bin Mohd Latif Geological Characterization and Beneficiation Potential of Sarawak Silica Sand for High-Value Industrial Applications
16:28 – 16:36	**027-029** Nur Syahirah Syuhadah Zakaria Assessment of Long- Term Hydraulic Performance in Lime-Treated Laterite Landfill Liners using Numerical Modelling
16:36 – 16:44	**023-018** Umair Faiz bin Mohd Giman Early Assessment of Liquefaction Potential in Lembah Klang Area Using SPT-Based Liquefaction Potential Index
16:44 – 16:52	**026-026** Mariatul Kiftiah Ahmad Legiman Artificial Intelligence-Driven Integration of Lithology and Weathering Data for Debris Flow Susceptibility: A Systematic Review
16:52 – 17:00	**013-013** Tan Mei Sieng GEOADJUST: Integrating 1D and 3D Network Adjustment with Real Time Tracking for Geohazard Preparedness
17:00 – 17:08	**004-003** Fakhrurazi Awang Kechik Hydro-Mechanical Response of Unsaturated Sandy Soil Slopes under Rainfall Infiltration
17:08 – 17:18	**Q&A session**
17:18 – 17:30	Tea break
END OF DAY 1	

Day 2: 9th September 2026 (Wednesday)	
08:00 – 08:30	Registration
08:30 – 09:15	Keynote Speaker 5**:** **GNSS- Based Group Deformation Monitoring Integrated with Artificial Intelligence for Geohazard Preparedness** by **Dr. Wan Anom Wan Aris** Associate fellow, GEOTROPIK, UTM.
09:15 – 10:00	Keynote Speaker 6**:** **From Sustainability to Resilience: The Strategic Role of ESG in Natural Hazard Management in Malaysia** by **Prof. P.Geol. Ts. Gs. Dr. Rodeano Roslee** Dean, Faculty of Science and Technology, Universiti Malaysia Sabah
10:00 – 10:15	Morning tea break
10:15 – 11:00	Keynote Speaker 7: **Preparing Tropical Road Networks for Geohazard ChallangesL Lessons from Pavement Failures and Rehabilitation Practices.** by **Ts. Mohd. Yazip Matori** Director, IKRAM Works Sdn Bhd
11:00 – 11:45	Keynote Speaker 8: **Proposing an Empirical-driven Machine Learning (EDML) Approach to Predict PPV Caused by Quarry Blasting** by **Dr. Danial Jahed Armaghani** Research Fellow, University of Technology Sydney
Session II	
11:45 – 12:15	**Chairperson:** **Assoc. Prof. Dr. Nordiana Mustaza (USM)** **Invited Speaker** **Composite Geotextile-Reinforced Soil Structures in Residual Soils with Integrated Fibre Optic Monitoring** by **Ir. Ts. Muhamad Nabil Mohd Nordin** Assistant Engineering Business Manager, Solmax Geosynthetics Asia.
12:15 – 12:45	**Invited Speaker** **Ecopave Asphalt Sdn. Bhd. – Trusted Partner in Bitumen Emulsion for Road Construction Industry** by **Mr. Sharman Ramesh** Business Development Executive, Ecopave Asphalt Sdn. Bhd.
12:45 – 14:00	Lunch

14:00 – 14:08	**011-011** Hong Sheng Lee Machine-Learning-Assisted Mineral Prospectivity Mapping Based on Gravity Measurement (MPM-G) in Sarawak, Malaysia.
14:08 – 14:16	**015-015** Muhammad Fawzy Ismullah Massinai Delineating Subsurface Cavities in Tropical Karst Using Cross-Gradient Constraint in Joint Inversion
14:16 – 14:24	**009-009** Roohollah Kalatehjari Interpretable Machine Learning and Future Regional Rainfall Scenario Analysis for Rainfall-Induced Landslide Susceptibility Mapping: A Case Study from Muriwai, New Zealand
14:24 – 14:32	**009-010** Roohollah Kalatehjari A comparison of landslide database availability across Australasia and its impact on landslide hazard assessment
14:32 – 14:40	**030-036** Erlinda Masi Development of Road Deterioration Prediction Model using Artificial Neural Network-Bayesian Statistic
14:40 – 14:48	**029-034** Sitti Hijraini Nur Mechanical and Swelling Characteristics of Silt-Bentonite Mixtures Modified with MICP Methods
14:48 – 14:56	**014-019** Nazatul Armielia Nazar Multi-Temporal Land Use and Land Cover Change and Transition Analysis along the Pan Borneo Highway Corridor in Siburan, Sarawak (2010 – 2024)
14:56 – 15:04	**031-037** Shahrul Izwan Sukri Assessment of UAV–LiDAR Elevation Bias on Raster and TIN-Based Beach Volume Estimation
15:04 – 15:012	**031-038** Teo En Thong Numerical Evaluation of Geosynthetic-Reinforced Retaining Walls under Cyclic Loading with Insights from Engineering Practice
15:12 – 15:20	**018-030** Bakhtiar Affandy Othman Blast Fragmentation Optimization in Tropically Weathered Limestone using Intelligent Techniques
15:20 – 15:28	**007-012** Nilashini M L Supparamaniyan

	GNSS-Derived Crustal Velocity Estimation across the Geological Settings in Peninsular Malaysia
15:28 – 15:36	**026-025** Mariatul Kiftiah Ahmad Legiman Characterization of Debris Flow Cascading Zones under Rainfall and Seismic Conditions in Tropical Region
15:36 – 15:45	**Q&A session**
15:45 – 16:00	Tea Break
Closing Ceremony	
16:00 – 16:20	Closing Montage
16:20 – 16:30	Closing speech by Ts. Dr. Bakhtiar Affandy bin Othman, Chairman of International Conference of Tropical Geoengineering (TROPICON 2026)
16:30 – 17:00	Prize- giving ceremony for Best Presenter and Best Paper.
	Group photo session
End of Day 2	

UNDERSTANDING GEOHAZARD IN TROPICAL ENVIRONMENTS



Prof. P.Geol. Ts. Dr. Edy Tonnizam Mohamad
Distinguished Fellow,
Centre of Tropical Geoengineering (GEOTROPIK),
Universiti Teknologi Malaysia (UTM)

Tropical environments present a distinctive geohazard setting where intense rainfall, high temperature, and prolonged chemical weathering interact to progressively transform rock masses and landscapes. Unlike many temperate environments, tropical terrains commonly develop thick and highly variable weathering profiles, in which the transition from fresh rock to completely weathered materials can occur over relatively short vertical distances. These weathering profiles are not merely geological records of past environmental processes; they represent active controls on slope stability, sediment availability, groundwater movement, and the initiation and propagation of geohazards. A particularly important but often overlooked component of tropical weathered terrains is the presence of residual boulders and corestones. Formed through differential weathering of fractured rock masses, boulders may remain embedded within highly weathered soil or saprolite while the surrounding materials progressively lose their original rock structure and strength. Their presence creates strong spatial heterogeneity within slopes and introduces considerable uncertainty into conventional geotechnical assessments. Under intense rainfall and slope disturbance, these boulders may become detached, transported, fragmented, or incorporated into rapidly moving sediment-water mixtures, substantially influencing the magnitude, mobility, erosive capacity, and depositional characteristics of debris flows. This presentation explores geohazards through the lens of the weathering profile– boulder–sediment system, emphasising how geological inheritance governs the availability and behaviour of materials within tropical landscapes. The discussion will move beyond viewing weathering simply as a reduction in rock strength, towards

understanding weathering as a process that progressively creates, stores, and redistributes potential sediment sources. Particular attention will be given to how boulder size, lithology, degree of weathering, spatial distribution, and interaction with the surrounding weathered matrix influence the transition from slope instability to debris-flow initiation, transportation, and deposition. Ultimately, understanding tropical geohazards requires an appreciation of the subsurface geological architecture beneath the landscape surface. The weathering profile provides the material framework, while boulders represent both the geological memory of the parent rock and a potential source of large sediment during catastrophic events. Recognising this relationship can provide a stronger geological basis for hazard assessment, prediction, and mitigation in tropical mountainous regions.

Keywords: Geohazard, Weathering Profile, Boulders, Debris flow

FROM SUBSURFACE DIAGNOSTICS TO SURFACE SAFETY: JKR'S FORENSIC EXPERIENCE AND AI-ENABLED SITE INVESTIGATION IN GEOHAZARD MANAGEMENT



Ir. Nor Fardzilah binti Abdul Rahman
Senior Superintendent Civil Engineer,
Geotechnical Engineering Branch, Public Works Department

What lies beneath the ground can determine the safety, performance and resilience of the infrastructure built above it. For JKR Malaysia, managing subsurface uncertainty has therefore become more than a technical requirement—it is an important part of protecting lives and ensuring resilient public infrastructure. Under the 12th Malaysia Plan (RMK-12), JKR is managing more than 1,400 federal projects across Malaysia. The wide range of tropical geological conditions, together with increasingly unpredictable weather patterns, creates significant challenges for geotechnical engineering. Conventional Site Investigation (SI), often constrained by limited time and fragmented datasets, may not always provide a complete understanding of ground conditions. When critical geological risks remain unidentified, the consequences can include delays, redesigns, additional costs and, in more serious cases, infrastructure failure. JKR's experience in forensic geotechnical investigations has provided valuable lessons on the importance of understanding the ground before problems occur. These lessons are now driving a shift from conventional, compliance-based SI towards a more integrated, digital and risk-informed approach. Through platforms such as MySIDOS, JKR is progressively centralising and visualising nationwide subsurface information. Combined with Artificial Intelligence (AI) and Machine Learning (ML), these data provide new opportunities to identify patterns, assess risks and support better engineering decisions. This keynote presents a practical example of this transformation through the application of ML to identify potential landslide hazard zones along the mountainous terrain of the Aring Project Route in Kelantan. By integrating geological structures,

rainfall patterns and high-density geospatial data, JKR is moving beyond a reactive approach based on forensic investigation towards proactive hazard identification and mapping. The key message is clear: AI is not a replacement for engineering judgement. It is a tool that enhances the engineer's ability to understand complex ground conditions, identify emerging risks and make faster, better-informed decisions. The journey from subsurface diagnostics to surface safety represents an important step towards geohazard preparedness—where lessons from past failures, better site investigation and emerging digital technologies come together to build safer and more resilient infrastructure for the future.

Keywords: Subsurface Intelligence, Geohazard Preparedness, Machine Learning, Site Investigation, Ground Resilience, JKR

KEYNOTE SPEAKER

LEVERAGING ARTIFICIAL INTELLIGENCE (AI) IN LANDSLIDE HAZARD AND RISK ASSESSMENT



P.Geol. Dr. Frederick Francis Tating
Director,
Department of Mineral and Geosciences, Sabah

As landslides continue to threaten communities, infrastructure, and the environment, particularly within mountainous and tropical regions, the need for more efficient and proactive approaches to geohazard assessment has become increasingly important. For decades, landslide hazard and risk assessment has depended on conventional geological approaches such as field mapping, geomorphological interpretation, geotechnical investigation, and historical landslide analysis. These methods remain indispensable and continue to form the backbone of professional geological practice. Rather than presenting AI from the perspective of a computer scientist, this presentation approaches the topic from the viewpoint of a geologist engaged in traditional landslide assessment. The focus is not on replacing conventional methods, but on understanding how Artificial Intelligence can practically assist and enhance existing geological workflows. The presentation demonstrates how AI technologies, including Machine Learning, Deep Learning, and Computer Vision can help process the rapidly growing volume of geospatial and environmental data obtained from LiDAR, satellite imagery, UAV surveys, InSAR monitoring, rainfall records, and field instrumentation. Through AI-assisted analysis, landslide features such as scarps, deformation zones, and tension cracks may be identified more rapidly and consistently than through manual interpretation alone.Beyond mapping and detection, AI also offers new opportunities for improving susceptibility modelling, hazard prediction, rainfall threshold analysis, and Early Warning Systems by identifying hidden relationships within complex geological and environmental datasets. These capabilities have the potential to support faster interpretation, better spatial analysis, and more informed decision-making in

geohazard management. However, the presentation also stresses a critical message: AI is only as effective as the geological understanding behind it. Technology cannot replace field experience, engineering judgment, or professional interpretation. Instead, AI should be viewed as a powerful supporting tool that complements traditional geological expertise. Ultimately, the presentation provides a realistic and practical perspective on how AI can be progressively integrated into landslide hazard and risk assessment to support safer, smarter, and more proactive geohazard management practices in the future.

Keywords: Landslide, Hazard, Risk, Geohazard, Artificial Intelligence (AI)

KEYNOTE SPEAKER

SMART GEOTECHNICS: ENHANCING HAZARD PREDICTION AND SUSTAINABLE MITIGATION IN TROPICAL REGIONS VIA ARTIFICIAL INTELLIGENCE



Prof. Ir. Dr. Hj. Ramli Bin Hj. Nazir
Distinguished Fellow,
Centre of Tropical Geoengineering (GEOTROPIK),
Universiti Teknologi Malaysia (UTM)

Tropical regions present a unique and challenging environment for geotechnical engineering, characterized by intense seasonal precipitation, deep weathering profiles, and the prevalence of problematic soils such as residual soils and highly compressible peatlands. Traditional deterministic and probabilistic models often struggle to capture the non-linear, time-dependent behavior of these materials, leading to significant risks regarding slope stability, long-term soil settlement, and seismic liquefaction. This presentation introduces the framework of "Smart Geotechnics," an evolutionary approach that integrates Artificial Intelligence (AI) and Machine Learning (ML) with fundamental soil mechanics to enhance hazard prediction and optimize sustainable mitigation strategies. The core of this discussion focuses on how AI-driven algorithms ranging from Random Forests to Deep Neural Networks can process vast, heterogenous datasets from site investigations (SI), remote sensing, and real-time instrumentation. In the context of slope failures, AI enables the development of early-warning systems that account for the critical relationship between pore-water pressure fluctuations and rainfall intensity in tropical climates. For soil settlement, particularly in the vast peatlands of Southeast Asia, ML models provide superior predictive capabilities for creep and secondary compression, moving beyond the limitations of classical 1D consolidation theory. Furthermore, the "Smart" paradigm extends into the realm of Sustainable Mitigation. As the industry shifts toward "nature-based" solutions, AI serves as a powerful optimization tool for designing reinforcements that utilize local, renewable materials. We explore the synergy between predictive modeling and the application of sustainable materials such as

bamboo-based soil reinforcement and geobag systems to stabilize riverbanks and embankments. By utilizing AI to simulate the long-term performance of these bio-engineered solutions, practitioners can ensure compliance with rigorous engineering standards while significantly reducing the carbon footprint of geotechnical works. Ultimately, this session aims to bridge the gap between academic innovation and practical application. By transitioning from reactive "fail-and-fix" mindsets to proactive, data-driven management, the engineering community can build more resilient infrastructure. The integration of AI does not replace engineering judgment; rather, it empowers the practitioner with deeper insights into the complex mechanics of the tropical zone, ensuring that hazard mitigation is both technically robust and environmentally sustainable.

Keywords: Artificial Intelligence, Tropical Soil Mechanics, Slope Stability, Peatland Settlement, Sustainable Mitigation, Machine Learning, Geohazards.

KEYNOTE SPEAKER

GNSS- BASED GROUP DEFORMATION MONITORING INTEGRATED WITH ARTIFICIAL INTELLIGENCE FOR GEOHAZARD PREPAREDNESS



Dr. Wan Anom Wan Aris,
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Centre of Tropical Geoengineering (GEOTROPIK),
Universiti Teknologi Malaysia (UTM)

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Geohazards such as earthquakes and crustal deformation pose significant risks to regions. Global Navigation Satellite System (GNSS) continuously operating reference station (CORS) networks provide a valuable geodetic infrastructure for monitoring ground deformation with high spatial and temporal resolution. This presentation highlights a research trajectory that has evolved from long-term GNSS-based crustal deformation analysis towards seismic signal detection, earthquake parameter estimation and, ultimately, intelligent geohazard preparedness. Long-term GNSS coordinate time series can reveal tectonic, co-seismic and post-seismic deformation and provide insights into regional strain accumulation and crustal dynamics. Building upon this capability, high-rate GNSS observations have demonstrated the potential to capture earthquake-induced ground motion and seismic wave signatures beyond the conventional role of GNSS as a positioning technology. Research using Malaysian CORS data has investigated seismic time-of-arrival (TOA), path velocity estimation and earthquake epicentre localisation through time-frequency analysis and multilateration. These studies demonstrate that existing GNSS infrastructure can complement conventional seismic observations, particularly for regional and far-field earthquake monitoring across Malaysia and Southeast Asia. The next frontier is to integrate GNSS-derived deformation and seismic observations with Artificial Intelligence (AI) to transform large, continuous geodetic datasets into actionable geohazard information. AI-based approaches offer opportunities for automated anomaly detection, signal classification, deformation pattern recognition and rapid event characterisation. Such integration can strengthen

situational awareness and support earlier, evidence-based decision-making for disaster risk reduction. The presentation discusses this evolution from observation to intelligence and proposes an integrated GNSS-AI framework for advancing geohazard monitoring, preparedness and resilience.

Keywords: GNSS, CORS, Crustal Deformation; Earthquake Monitoring, Seismic Signal Detection, Artificial Intelligence, Geohazard Preparedness, Disaster Risk Reduction.

FROM SUSTAINABILITY TO RESILIENCE: THE STRATEGIC ROLE OF ESG IN NATURAL HAZARD MANAGEMENT IN MALAYSIA



Prof. P.Geol. Ts. Gs. Dr. Rodeano Roslee
Dean,
Faculty of Science and Technology,
Universiti Malaysia Sabah (UMS)

Malaysia is increasingly facing the impacts of natural hazards, including floods, landslides, earthquakes, coastal erosion, droughts, and extreme weather events. These challenges pose significant threats to environmental sustainability, socio-economic development, public safety, and national resilience. In response, Environmental, Social, and Governance (ESG) principles have gained prominence as an integrated framework for promoting sustainable development while addressing emerging environmental and disaster - related risks. This paper examines the strategic role of ESG in enhancing natural hazard management in Malaysia. The environmental pillar of ESG supports sustainable resource management, ecosystem conservation, climate change mitigation, and the adoption of nature-based solutions that reduce vulnerability to hazards and environmental degradation. The social pillar emphasizes stakeholder engagement, community resilience, disaster preparedness, and social inclusivity, all of which are essential to strengthening adaptive capacity in hazard-prone areas. Meanwhile, the governance pillar promotes transparent decision-making, risk-based planning, regulatory compliance, and institutional accountability, thereby improving the effectiveness of disaster risk reduction and climate adaptation strategies. The paper highlights the application of ESG principles in managing major natural hazards in Malaysia, particularly floods, landslides, earthquakes, and coastal erosion. It also discusses the growing role of advanced technologies in supporting hazard assessment, environmental monitoring, and risk-informed decision-making. Furthermore, the study examines key challenges and

opportunities associated with ESG implementation, including policy integration, financing mechanisms, stakeholder awareness, and technological advancement. The study concludes that ESG has evolved beyond a corporate sustainability framework and has become an important strategic tool for enhancing environmental sustainability, strengthening climate resilience, and reducing disaster risks. Effective integration of ESG principles into national development planning and hazard management policies can contribute significantly to building a more sustainable, resilient, and climate- adaptive Malaysia.

Keywords: ESG, environmental sustainability, natural hazard management, disaster risk reduction, resilience, Malaysia.

KEYNOTE SPEAKER

PREPARING TROPICAL ROAD NETWORKS FOR GEOHAZARD CHALLENGES: LESSONS FROM PAVEMENT REHABILITATION AND REHABILITATION FACILITIES.



Ts. Mohd. Yazip Matori
Director,
IKRAM Works Sdn Bhd

Road networks in equatorial climates such as Malaysia encounter severe environmental stressors, wherein heavy seasonal monsoons, elevated humidity, and prolonged thermal exposure significantly accelerate structural degradation. This chapter investigates the compounding geohazard challenges threatening tropical infrastructure, focusing on the disruptive impacts of terrain landslides, flash flooding, and deep subgrade supersaturation prevalent in highly weathered residual soils. Drawing upon lessons from recent Malaysian pavement rehabilitation projects, the text underscores the imperative to transition from reactive maintenance methodologies toward proactive, climate-resilient engineering paradigms. Adaptive rehabilitation strategies are critically evaluated, encompassing the deployment of moisture-resistant polymer-modified asphalt binders and geosynthetic reinforcements tailored to stabilize saturated tropical subgrades. Furthermore, the analysis examines the logistical operations of rehabilitation facilities, highlighting how strategically localized asphalt batch plants and material staging areas facilitate rapid post-disaster recovery while mitigating raw material degradation under extreme humidity. By synthesizing localized field data with operational case studies derived from recent monsoon cycles, a comprehensive life-cycle management framework is proposed. Ultimately, this work delineates region-specific methodologies essential for civil engineers and policymakers to upgrade tropical transportation corridors, ensuring their long-term structural survivability against the escalating unpredictability of equatorial weather systems.

Keywords: Tropical Road Infrastructure, Climate Resilience, Pavement Rehabilitation, Geohazards, Polymer-Modified Asphalt,

Geosynthetic Reinforcement, Monsoon Resilience, Life-Cycle Management.

PROPOSING AN EMPIRICAL-DRIVEN MACHINE LEARNING (EDML) APPROACH TO PREDICT PPV CAUSED BY QUARRY BLASTING



Dr. Danial Jahed Armaghani
Research Fellow,
University of Technology Sydney,
Australia

Blasting in mining and quarrying serves multiple purposes but poses environmental challenges, notably generating shockwaves and vibrations through peak particle velocity (PPV) from explosions. Previous efforts to predict PPV values have relied on empirical equations using parameters such as maximum charge per delay (MC) and distance from the blast face (D). Numerous attempts have employed machine learning (ML) to estimate PPV with the same input parameters. This study introduces a novel approach called empirical-driven ML (EDML), which integrates empirical equations and their outcomes as inputs for PPV prediction. EDML leverages existing knowledge to enhance model performance, interpretability, and generalization. For the EDML approach, four empirical equations, namely USBM, CMRI, General Predictor, and Ambraseys-Hendron have been chosen based on prior research. These four empirical equations were selected based on their good performance as reported in the literature. Using these equations' PPV values as inputs, three advanced tree-based techniques (random forest, deep forest, and extreme gradient boosting) have been employed for model training. Comparison with the conventional ML approach (using only maximum charge per delay and distance from the blast face) reveals EDML's superior predictive capacity for PPV estimation. Note that the inputs of these databases were directly and indirectly extracted from MC and D with the same PPV values. The proposed EDML approach effectively integrates data-driven insights with domain expertise, improving accuracy and interpretability through the inclusion of PPV and blasting observations.

Keywords: Blasting, Peak Particle Velocity (PPV), Empirical-Driven Machine Learning (EDML), Ground Vibration; Empirical Equations

A LESSON LEARNED FROM EXPANSIVE CLAY MINERALS OF CHAOTIC GARINONO MELANGE: FAILURES IN DESIGN CONSIDERATIONS AND QUALITY ASSURANCE PROCESS



PMr. Br. Gs. Ts. Ir. Jeffery Anak Pirah
Principal Consultant,
Alamega Konsult, Sabah

Garinono Melange is one of many tectonic melanges that naturally occur in Sabah and have caused significant hindrances in the construction of the Pan Borneo Highway. In the previous study conducted in 2023, the initial finding indicated a lower potential for slope failure across the project site due to the predominantly low swelling potential, despite the site being flagged as having argillaceous soil. However, over the years, the issue has remained omnipresent and requires a different approach: treating this melange soil as block-in-matrix (bim)soils or (bim)rocks when it comes to slope stability design. This presentation explores a new perspective based on observations and lessons learned from the way melange slopes were designed, other considerations from various literature, and mitigations that could optimise slope stability design as a pragmatic and workable solution.

Keywords: Garinono Melange; Block-in-Matrix (BIM) Soils; BIMrocks; Slope Stability; Pan Borneo Highway; Slope Design; Geotechnical Mitigation.

ADVANCING GEOTECHNICAL INVESTIGATION THROUGH INTEGRATED GEOPHYSICAL SOLUTIONS



P.Geol. Dr. Kiu Yap Chong
Geophysicist,
Geospec Sdn. Bhd

Geotechnical investigation plays a critical role in understanding subsurface conditions and supporting the safe and economical design of engineering infrastructure. Conventional methods, including boreholes, standard penetration tests, cone penetration tests, and laboratory testing, provide reliable and detailed information at discrete locations. However, complex ground conditions often require a more continuous understanding of the subsurface to identify lateral variations, weak zones, geological interfaces, cavities, seepage pathways, and changes in soil or rock properties. This presentation highlights the advancement of geotechnical investigation through the integration of geophysical solutions with conventional site investigation methods. Geophysical techniques such as Multichannel Analysis of Surface Waves (MASW), seismic refraction, electrical resistivity tomography (ERT), and other non-invasive methods provide continuous subsurface information and enable the investigation of larger areas with improved efficiency. When integrated with borehole and in-situ testing data, these techniques can significantly enhance subsurface interpretation, reduce uncertainty, and improve the understanding of complex geological and geotechnical conditions. Case studies from engineering projects involving soft soils and peat, embankments, slopes, rock investigations, seepage assessments, and infrastructure developments will be presented to demonstrate the practical application of integrated geophysical and geotechnical approaches. The presentation will discuss the strengths and limitations of individual methods, the importance of ground-truthing geophysical results, and the value of combining complementary datasets for more reliable engineering interpretation.

The integration of geophysical solutions into geotechnical investigations represents a shift from isolated point-based information towards a more comprehensive and spatially continuous understanding of ground conditions. By adopting a multidisciplinary and integrated approach, geotechnical investigations can become more efficient, informative, and capable of addressing increasingly complex engineering challenges.

Keywords: Geotechnical Investigation, Geophysical Solutions, MASW, Seismic Refraction, Electrical Resistivity Tomography (ERT), Subsurface Characterisation, Integrated Site Investigation.

ECOPAVE ASPHALT SDN. BHD. – TRUSTED PARTNER IN BITUMEN EMULSION FOR ROAD CONSTRUCTION INDUSTRY



Mr. Sharman Ramesh
Business Development Executive,
Ecopave Asphalt Sdn. Bhd.

This presentation provides an overview of Ecopave Asphalt Sdn Bhd and our commitment to delivering reliable and high-quality bitumen emulsion solutions for the road construction industry. The presentation begins with an introduction to our company, capabilities, and role in supporting contractors and road projects with quality pavement materials and technical solutions. The presentation will cover the production flow of bitumen emulsion, its key components, and the range of products offered by Ecopave Asphalt Sdn Bhd. It will also explain the recommended spray rates, road curing requirements, and proper application procedures to achieve optimum performance on road projects. A key focus will be the importance of quality bitumen emulsion in road construction and maintenance, including proper bonding, waterproofing, surface treatment, and pavement durability. The presentation will also highlight the consequences of using low-quality or unsuitable bitumen emulsion, such as poor adhesion, premature pavement failure, surface defects, and increased maintenance costs. Several case studies from different project sites will be presented to demonstrate the effects of using different products and application methods. The presentation will also explain why Ecopave Asphalt Sdn Bhd is a trusted partner, supported by our own laboratory testing facilities, where quality testing is carried out for every production batch to ensure product consistency and reliability. The presentation will conclude by showcasing our completed projects, valuable clients, technical capabilities, and commitment to continuous improvement. Our objective is not only to supply bitumen emulsion, but to provide reliable products, technical support, and complete road construction solutions that our customers can trust.

Keywords: Bitumen Emulsion; Road Construction; Pavement Maintenance;Quality Control; Spray Application; Pavement Durability; Technical Solutions

INVITED SPEAKER

COMPOSITE GEOTEXTILE-REINFORCED SOIL STRUCTURES IN RESIDUAL SOILS WITH INTEGRATED FIBRE OPTIC MONITORING



Ir. Ts. Muhamad Nabil Mohd Nordin
Assistant Engineering Business Manager
Solmax Geosynthetics Asia

Residual soils present challenges for reinforced soil structures due to their variable properties and sensitivity to moisture and environmental conditions. This presentation explores the use of composite geotextile reinforcement integrated with fibre optic sensing technology for reinforced soil structures in residual soils. The composite geotextile provides tensile reinforcement while the integrated fibre optic system enables continuous, distributed measurement of strain and deformation, allowing structural behaviour to be monitored during construction and service. Field applications include a reinforced slope at Bukit Batok, Singapore, and infrastructure projects in France, including the Arbois railway and road project associated with sinkhole risks and an abutment wall at Saint-Saturnin. These case studies demonstrate how intelligent geosynthetics can combine reinforcement and structural health monitoring within a single system. The fibre optic technology also offers resistance to corrosion, electromagnetic interference, radiation, and lightning, making it suitable for demanding environments. This approach supports improved performance assessment, early detection of abnormal deformation, and more resilient geotechnical infrastructure.

Keywords: Residual Soils; Composite Geotextile, Fibre Optic Sensing, Reinforced Soil Structures; Structural Health Monitoring, Distributed Strain Measurement, Intelligent Geosynthetics

ABSTRACT

ID: TropICon 2026: 001-001

Ground–tunnel Interaction under Jacking Forces: Insights from Advanced Numerical Modelling.

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Abstract

Construction process of a bored tunnel is a risky and involved a complex process. During tunnel boring machine advancement, surrounding loads were acting on tunnel. In order to support the excavation, tunnel lining was installed with application of jack force. Jack force is exerted during the tunnel advancement and the same time to enhance tunnel face stability. However, the complexity of how much the jack forces exerted to the variation of segment's thickness with the respect of ground stability, especially in soft and shallow ground is not fully understand yet. Hence, the impact of jacking force on segmental tunnel lining and surrounding soil during the tunnel advancement is still unclear. Therefore, in this paper, variation of tunnel lining thickness versus jack forces effect is explored here in. A series of three-dimensional numerical modelling of tunnel-soil-jack force by using ABAQUS software were simulated. The behaviour of the soil above the tunnel crown changes from elastic behaviour to plastic behaviour and their relationship with tunnel lining and shield were also investigated. From the findings, relationship has been established between the segment's thickness and the jacking force for a specific loads' cases. Results also found that the complex geological features and loads case applied caused stress on the tunnel face which must be encountered by a certain thrust magnitude to advance the tunnel. This study also presents ground surface and subsurface reaction, soil radial reaction to the segment (because of the axial force that is exerted by jack thrust) and bending moment (due to strata load), respectively. These findings benefited for future tunnelling construction and helps deepened the understanding of ground reaction behaviour induced by the soft ground tunnelling.

Keywords: Tunnelling, Soft ground, Simulation, Jack forces.

ID: TropICon 2026: 002-002

Prediction of Settlement of Shallow Foundations on Cohesionless Soils using a Codeless Machine Learning Tool

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Abstract

Settlement of shallow foundations on cohesionless soil must be accurately determined and analysed to ensure stability, structural integrity and safety of the imposing structure. Conventional methods of settlement predictions were developed using empirical equations based on simplified foundation properties and specific soil parameters. Machine Learning (ML) is an emerging tool capable of predictions based on learning from historical data. In this research, a comparative analysis of different ML algorithms modelled in an open-source codeless tool, Waikato Environment for Knowledge Analysis (WEKA) was employed to predict the settlements of shallow foundations on cohesionless soils using a dataset collated from 189 field tests. The input parameters encompass footing width, length, net applied pressure, SPT values, footing embedment depth, depth of water table, thickness of soil layer, soil type and density, while the measured settlement is the output variable. The modelling steps include data preprocessing and visualisation, hyper parameter tuning, and feature selection. The coefficient of determination, R2, and the root mean square error, RMSE were deployed to measure the performance and comparison of results. The implementation of feature selection was successful in identifying the influential parameters which aided in obtaining optimal results of settlement predictions. The optimal model is a support vector machine algorithm with sequential minimal optimization for regression, SMOreg tuned with Pearson VII function-based universal kernel (PuK) with R2 = 0.8367 and RMSE = 14.1676 mm. The outcome compares reasonably with results of simulations in other conventional coding platforms, and this affirms the potentials of WEKA algorithms as a promising tool for the prediction of settlement of shallow foundations on cohesionless soils.

Keywords: Shallow Foundation, Settlement, Cohesionless Soil, Machine Learning

ID: TropICon 2026: 004-003

Hydro-Mechanical Response of Unsaturated Sandy Soil Slopes under Rainfall Infiltration

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Abstract

Rainfall infiltration is a primary trigger of slope failures in tropical regions, where unsaturated soils dominate near-surface conditions. Conventional slope stability assessments often overlook the coupled interaction between hydraulic and mechanical responses during rainfall events, leading to an incomplete understanding of slope behaviour. This study investigates the hydro-mechanical response of unsaturated sandy slopes subjected to rainfall infiltration, with particular emphasis on stability evolution under transient conditions. Numerical simulations were conducted to model rainfall infiltration and its influence on pore-water pressure distribution, matric suction dissipation, and factor of safety variation with time. Well-graded and poorly graded sandy soils were analysed under identical rainfall and geometric conditions to examine differences in response behaviour. The results indicate that slope stability is governed by the combined effects of infiltration rate, suction loss, and soil hydraulic behaviour rather than soil classification alone. Distinct hydro-mechanical response patterns were observed between the sandy soils, despite similar material types, highlighting the limitations of parameter-based assessment without considering transient processes. The findings demonstrate the importance of incorporating hydro-mechanical interaction in rainfall-induced slope stability evaluation and provide insight for more reliable assessment and design of sandy slopes in tropical environments.

Keywords: Unsaturated sandy slopes; Rainfall infiltration; Hydro-mechanical response; Transient slope stability

ID: TropICon 2026: 005-005

Observed Wall Deformation Behaviour in Open Excavation Supported by Buttressed Diaphragm Walls

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Abstract

Buttressed diaphragm wall systems are increasingly adopted for deep open excavations in constrained urban environments where conventional internal strutting or ground anchor systems may be impractical. While previous studies have demonstrated their effectiveness in controlling wall deformation, published field case histories focusing on the interpretation of observed wall deformation mechanisms remain limited, particularly for open excavations where the buttressed walls function as the principal retaining system. This paper presents an observational study on the wall deformation behaviour of a geometrically complex open excavation supported by buttressed diaphragm walls. A comprehensive instrumentation and monitoring programme was implemented throughout the excavation works, with multiple inclinometers installed to capture the wall deformation profiles under varying wall embedment ratios and buttress restraint configurations. The measured deformation profiles revealed that the wall embedment ratio (D/H) is the primary governing parameter influencing the overall deformation mode, ranging from near-pure cantilever behaviour for D/H < 1.0 to increasing toe restraint as D/H approached 1.5 and beyond. The field observations further showed that local buttress spacing can significantly influence wall deformation magnitude, even under similar wall embedment conditions, highlighting the inherently three-dimensional nature of buttressed diaphragm wall systems. The measured wall displacements were compared against the original three-dimensional finite element design predictions and showed generally good agreement, although the design predictions were found to be conservative, particularly at locations directly restrained by buttresses. The findings provide practical insights into deformation interpretation, design calibration and future optimisation of buttressed diaphragm wall systems for deep open excavations.

Keywords: Deep excavation, Diaphragm wall, uttress wall, Wall deformation mode

ID: TropICon 2026: 008-006

UAV-Based Automated Slope Defect Detection for Highway Asset Management: A Case Study on PLUS Highway

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Abstract

Slope instability along highway corridors presents significant safety concerns to road users and requires continuous and reliable monitoring. Conventional inspection methods, which rely on manual and on-site assessment, are often labour-intensive, time-consuming, and may expose maintenance personnel to safety risks during field operations. This study presents an automated slope inspection approach integrating unmanned aerial vehicle (UAV) imagery with artificial intelligence (AI) and machine learning (ML) to improve defect detection efficiency, consistency, and overall inspection safety. The assessment was conducted on selected critical slope sections along the PLUS highway in Malaysia, which is characterised by a tropical climate with frequent heavy rainfall, increasing the risk of slope instability. High-resolution aerial imagery was captured using UAVs and processed through a structured workflow comprising data acquisition, cloud-based processing, and automated defect identification using AI/ML models. Key defects analysed include slope failure, barren or surface erosion, defective drainage, fallen trees, and vegetation overgrowth. The results demonstrate that the proposed approach is capable of detecting multiple slope defect types with reliable and satisfactory accuracy while significantly reducing inspection time compared to conventional methods. In addition, UAV-based slope inspection and monitoring enables consistent and repeatable data acquisition, supporting temporal analysis and early identification of potential slope-related issues. This study also discusses the challenges and limitations of AI in slope defect detection, such as model generalization, sensitivity to image quality, environmental factors, and variations in slope and defect characteristics. Overall, this study demonstrates the practical application of UAV, AI and ML in supporting more efficient, consistent, and safer highway slope monitoring, contributing towards improved asset management and proactive maintenance practices.

Keywords: Slope Monitoring, Unmanned Aerial Vehicle (UAV), Artificial Intelligence (AI), Machine Learning (ML), Highway Asset Management

ID: TropICon 2026: 002-007

Forecasting Settlement of Single Piles Using CPT Data in Machine Learning Models

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Abstract

Piles are deep foundation systems which transfer superstructure loads through weak or compressible soil layers to more competent strata below. The Cone Penetration Test (CPT) is an extensively used in-situ geotechnical investigation method which is routinely used to estimate pile axial capacity and to develop models for predicting load-settlement behaviour. This study focuses on predicting the settlement of single piles using Cone Penetration Test (CPT) data using machine learning techniques implemented in WEKA. The main objective is to develop an accurate and efficient model to estimate pile settlement based on key geotechnical and pile parameters, reducing the need for costly and time-consuming field testing. A dataset of 499 data points obtained from 56 full-scale pile load tests, covering various soil conditions, pile types, and loading scenarios was used. The input variables include pile geometry, axial stiffness, applied load, and CPT measurements including cone resistance and sleeve friction. Several machine learning algorithms were evaluated, including K-Star, Random Forest, and ensemble models. The dataset was randomly divided into ratio 80:20, training and testing sets, respectively and validation methods such as cross-validation and percentage splits were used. Model performance and result comparisons were assessed using the coefficient of determination R^2, and the root mean square error, RMSE. The results showed that the KStar algorithm is the best-performing model with R^2 value of 0.9605 and RMSE of 3.7915. The results indicate strong predictive capability and excellent generalization performance on unseen data which highlights the effectiveness of the model. This approach provides a practical, accurate, time-efficient, and reliable alternative to traditional field-testing methods, supporting improved decision-making and more efficient and sustainable foundation design.

Keywords: Machine Learning, Cone Penetration Test, Pile Foundation, Settlement

ID: TropICon 2026: 009-008

Assessing the completeness of post storm landslide records: A two-inventory comparison following Cyclone Gabrielle in Auckland, New Zealand

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Abstract

Landslide inventories are fundamental to hazard assessment, but their completeness after major storm events is rarely tested against independent evidence. This study examines the completeness of post-storm landslide records for Cyclone Gabrielle in February 2023 within a 4.08 km² residential hillslope catchment in West Auckland, New Zealand. An agency validated landslide database was compared with an independent inventory mapped systematically from post-event aerial imagery. Records from the two datasets were paired using nearest neighbour matching at three tolerance distances: 25, 50, and 100 m. Omission patterns were then assessed in relation to landslide size and spatial clustering. The two inventories showed strong agreement where they overlapped. At the 50 m tolerance, 93 of the 96 validated database points, equivalent to 97%, corresponded to an independently mapped landslide source area, indicating that both datasets describe the same broad event population. However, systematic imagery based mapping identified additional failures. Of the 92 mapped source areas, approximately 60% had a counterpart in the agency validated database, while 37 failures, equivalent to 40% of the mapped inventory, were absent from the official record. Bootstrap resampling gave a 95% confidence interval of 30-50% for this omission rate. The omitted failures showed no clear size dependence, with statistically similar size distributions between recorded and unrecorded landslides (Mann Whitney U test, $p = 0.79$), near-uniform omission rates across size quartiles, and only weak, non-significant spatial clustering (Moran's $I = 0.19$, $p = 0.07$). These findings reflect the different purposes served by operational and systematic landslide inventories. Agency validated databases are essential for response, reporting, and asset or property management, but they may provide a conservative snapshot of the full landslide population produced by a major storm. Systematic post-event imagery mapping can therefore provide a valuable complementary dataset, improving inventory completeness and strengthening the evidence base for landslide hazard assessment and AI-based preparedness.

Keywords: Landslide inventory, Data completeness, Cyclone Gabrielle, Hazard preparedness, Machine learning training data.

ID: TropICon 2026: 009-009

Interpretable Machine Learning and Future Regional Rainfall Scenario Analysis for Rainfall-Induced Landslide Susceptibility Mapping: A Case Study from Muriwai, New Zealand

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Abstract

Machine learning has become a useful tool for mapping landslide susceptibility, but two problems are limiting how well it works in practice. First, most models do not provide details on why a specific location is identified as at risk, which makes it difficult for decision makers, policy makers, and communities to understand and act on the results. Second, susceptibility models are rarely tested against future climate conditions, even though rainfall patterns are expected to intensify under climate change scenarios, particularly for rainfall-induced landslides. This study addresses both issues in two parts, using a case study from Muriwai, New Zealand, where 471 landslides occurred during Cyclone Gabrielle in February 2023. In the first part, seven machine learning models are trained and benchmarked on the 2023 landslide inventory using conditioning factors at 30 m resolution, and SHapley Additive exPlanations (SHAP) is applied to interpret individual predictions, showing how factors such as slope, lithology and rainfall intensity affect risk at specific locations, in contrast to conventional feature importance measures, which provide only a single ranking averaged across the study area. In the second part, the same trained models are applied to a future rainfall scenario, based on a regional climate projection of 25 percent increased rainfall intensity, to assess how the susceptibility map may change under future extreme rainfall events. The findings demonstrate how machine learning susceptibility frameworks can be extended to provide more transparent and prospective hazard assessment, with relevance for other regions facing similarly weak, weathered slopes and increasing rainfall intensity.

Keywords: Landslide susceptibility mapping, Machine learning, Interpretable machine learning (SHAP), Climate change scenario, Rainfall induced landslides, Muriwai, New Zealand

ID: TropICon 2026: 009-010

A Comparison of Landslide Database Availability Across Australasia and its Impact onLlandslide Hazard Assessment

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Abstract

The inadequacy of traditional landslide hazard assessment methods in addressing escalating climate-driven risks across Australasia highlights the need for a systematic methodological study of current practice in this region. Despite strong institutional connections between Australia and New Zealand, systematic comparative studies of landslide hazard assessment methodologies remain limited. This bibliometric analysis of 111 Australian and 498 New Zealand peer-reviewed publications (1975-2025) following PRISMA guidelines examines methodological practices, with particular focus on machine learning adoption, and identifies critical knowledge gaps. Both countries show parallel reliance on traditional geological methods (Australia 30.6%, New Zealand 29.1%), but critical disparities emerge. Australia demonstrates severe hydrological and meteorological deficit at 0.9% versus New Zealand's 19.7%. Advanced computational techniques remain severely underutilised: machine learning and hybrid modelling adoption rates are 9.0% and 0.9% in Australia versus 2.2% and 1.0% in New Zealand, contrasting sharply with international trends showing superior predictive performance. A key contributing factor is Australia's fragmented state-based landslide database system, which constrains national-scale research and limits the consistent datasets essential for machine learning applications, in stark contrast to New Zealand's centralised GNS Science national database. Temporal analysis reveals parallel peak output during 2010-2020 (Australia 54.1%, New Zealand 52.8%), while geographic distribution concentrates in urban centres, leaving vulnerable rural regions understudied. Regional collaboration in developing next-generation assessment methodologies, supported by improved database infrastructure, represents a critical opportunity for advancing landslide risk management as climate change intensifies extreme weather and slope instability risks.

Keywords: Landslide, Natural Hazard, Machine Learning, Risk Assessment, Australasia

ID: TropICon 2026: 011-011

Machine-Learning-Assisted Mineral Prospectivity Mapping Based on Gravity Measurement (MPM-G) in Sarawak, Malaysia

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Abstract

Gravity surveying provides indirect information on subsurface geological structures through spatial variations in the gravitational field associated with density contrasts and is widely used in mineral exploration. Gravity-based mineral exploration over large regions is commonly constrained by the effort required to interpret extensive survey profiles and by the limited availability of verified negative observations. This study proposes Mineral Prospectivity Mapping Based on Gravity Measurement (MPM-G) as a machine-learning-assisted first-pass regional screening approach for Sarawak, Malaysia. Airborne gravity observations were processed to derive the Absolute Robust Z-score of Density-contrast index (ARZD), which characterizes anomalous density responses relative to geological background. Positive-Unlabelled (PU) learning was then used to integrate ARZD with geological formation information and known mineral occurrences to estimate a Mineral Relative Prospectivity (MRP) score. Model hyperparameters were optimized using spatial cross-validation, with performance assessed using global and within-formation predictive gain and geology-only and ARZD-ratio baselines. Across the five spatial folds, the complete model achieved a mean top 10% predictive gain of 6.696, compared with 5.843 for the geology-only and 2.119 for the ARZD-ratio baselines, indicating that geological formation provides the dominant regional contribution, while gravity-derived ARZD provides incremental discriminatory information across all five spatial folds. MPM-G therefore provides a computationally efficient framework for prioritizing regional exploration targets where gravity data and known mineral occurrences are available, while its outputs should be interpreted as relative prospectivity rather than probabilities of mineral occurrence.

Keywords: Gravity Surveying, Mineral Prospectivity Mapping, Machine Learning, Positive-Unlabelled Learning, Density-Contrast Index, Mineral Exploration, Spatial Cross-Validation, Sarawak

ID: TropICon 2026: 007-012

GNSS-Derived Crustal Velocity Estimation across the Geological Settings in Peninsular Malaysia

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Abstract

Peninsular Malaysia lies within the Sunda Plate but remains influenced by regional tectonic activity associated with the Sunda subduction system and Sumatran Fault. This study determines its three-dimensional crustal velocity field in 2021 and evaluates Least-Squares Collocation (LSC) performance across the Western, Central and Eastern geological belts. Daily observations from 65 Malaysian Real-Time Kinematic Network (MyRTKnet) stations were processed with 18 selected International GNSS Service reference stations. Following quality screening, 54 stations were used for the horizontal LSC model and 41 for the vertical model. The models represented velocities at all 65 MyRTKnet locations. Cartesian coordinates were transformed into local North, East and Up components, followed by time-series cleaning and linear velocity estimation. Component-specific covariance models were applied for LSC estimation, while leave-one-out cross-validation independently assessed prediction performance. The observed horizontal field is dominated by eastward motion with a smaller southward component across all three belts. LSC preserves this regional pattern while reducing station-to-station variability. Belt-wise boxplots show generally close agreement between median observed and LSC-estimated velocities, although differences and outliers remain. The combined LOOCV RMSE values are 2.51, 2.07 and 3.41 mm/yr for the North, East and Up components, respectively. The East component is predicted most consistently, whereas the Up component exhibits weaker spatial coherence and greater sensitivity to observational noise. Overall, LSC reliably represents the regional horizontal velocity field, while individual vertical estimates require cautious interpretation. The findings identify spatial variations in prediction performance without implying direct geological control.

Keywords: GNSS, Coordinate Time Series, Crustal Velocity, Plate Motion, LSC.

ID: TropICon 2026: 013-013

GEOADJUST: Integrating 1D and 3D Network Adjustment with Real Time Tracking for Geohazard Preparedness

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Abstract

Accurate and reliable geospatial data are fundamental to geohazard preparedness, particularly for monitoring ground deformation, infrastructure stability, surface movement, and field operations in hazard-prone environments. This paper presents GEOADJUST, a software platform that integrates survey network adjustment with real-time geolocation tracking to enhance the quality, reliability, and operational efficiency of geospatial workflows. At its current stage, the system has successfully implemented 1D levelling adjustment, 3D network adjustment, and a real-time tracking module for field-user monitoring. The 1D adjustment module was validated against MicroSurvey Star*Net, where the adjusted reduced levels showed excellent agreement, with a maximum absolute difference of 0.0279 mm. The 3D network adjustment module was evaluated through comparison with Trimble Business Center (TBC) using selected control stations, namely ISK1, ISK3, ISK4, JHJY, KUKP, and TGPG. The comparison indicates millimetre-level consistency, with maximum absolute coordinate differences of 0.3619 mm in X, 0.5519 mm in Y, and 0.3047 mm in Z. Furthermore, the real time tracking module successfully streams live mobile positioning to provide actionable field position awareness during survey execution. By connecting rigorous least-squares adjustment computations with continuous situational awareness, GEOADJUST provides a dependable foundation for risk-informed decision-making and geohazard monitoring operations.

Keywords: Geospatial network adjustment, real-time geolocation tracking, least-squares adjustment, 1D levelling adjustment, 3D survey network.

ID: TropICon 2026: 012-014

Digital Image Processing and Multi-Scale Analysis of Desiccation Cracking in Tropical Clays for Shallow Landslide Investigation

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Abstract

Desiccation cracking resulting from progressive drying compromises the integrity of near-surface tropical clay soils, leading to shallow slope failures and landslides. This research couples automated image monitoring with geotechnical and microstructural analyses to quantify crack propagation in multi-mineral tropical clay soils across varying dispersion states and particle fractions. Time-lapse digital image processing quantified crack intensity factor (CIF) and crack density factor (CDF) throughout continuous drying, revealing distinct mineralogical variations where dispersed montmorillonite exhibited the greatest failure vulnerability. Small-angle X-ray scattering was further employed to correlate the microstructural alterations linked to the evolution of the diffuse double layer and associated pore-interface morphological transitions. Statistical analysis and Principal Component Analysis (PCA) compressed the multidimensional soil data by explaining 55.57% of variance and effectively integrating the monitoring indicators into stable empirical predictive multiple regression equations where CDF=2.543SSA0.486SAR-0.014 and CIF=3.034FST0.401SAR-0.004. The findings offer quantitative metrics that may enhance shallow landslide investigation, refine slope stability evaluations and strengthen data-driven geohazard monitoring in tropical settings.

Keywords: Digital image processing, Desiccation cracking, Tropical clays, Liquidity index, Geohazard monitoring.

ID: TropICon 2026: 015-015

Delineating Subsurface Cavities in Tropical Karst Using Cross-Gradient Constraint in Joint Inversion

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Abstract

Tropical karst environments are characterised by intensive limestone dissolution processes that form subsurface cavities with complex geometries that may develop into surface depressions and, under certain conditions, trigger sinkholes. Accurate subsurface characterisation is essential for supporting hazard assessment and mitigation in karst terrains. Electrical Resistivity Tomography (ERT) and Seismic Refraction Tomography (SRT) are widely used geophysical methods for karst investigations. However, independent interpretation of these datasets often results in inconsistencies in cavity delineation because of their different sensitivities to subsurface conditions. This study evaluates the effectiveness of cross-gradient constraint in joint inversion (CGJI) for improving subsurface cavity delineation in a tropical karst environment. Six co-located ERT and SRT lines were acquired at Gua Ikan, Dabong, Kelantan, Malaysia. Conventional inversion results were compared with CGJI to evaluate the capability of both approaches for subsurface cavity delineation. The results indicate that CGJI produces a more structurally coherent representation of the subsurface by integrating the complementary structural information provided by ERT and SRT. This integration improves cavity delineation and reduces interpretational ambiguity, leading to greater confidence in cavity identification. Three subsurface units were identified, with cavities predominantly occurring at depths of 2–4 m within the weathered limestone zone, except along Line 1 where shallower cavities (0–1 m) were detected. The interpreted cavities were further supported by the spatial correspondence between geophysical anomalies and observed surface depressions. These findings demonstrate that CGJI provides a robust basis for improving subsurface cavity delineation and supports more reliable sinkhole hazard assessment and sustainable karst management.

Keywords: **C**ross-Gradient Joint Inversion Electrical Resistivity Tomography Seismic Refraction Tomography Subsurface Cavity Tropical Karst

ID: TropICon 2026: 019-016

Intelligent techniques for prediction of flyrock at granite quarry in Malaysia

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Abstract

Granite is extensively used to produce Aggregate and Manufactured sand to produce Ready Mixed Concrete. Blasting is an essential economical activity for breaking hard granite. Optimum fragmentation is the most expected favourable result due to blasting. However, blasting is associated with adverse environmental effects such as flyrock, ground vibration, airblast and dust. Flyrock is the most crucial as it is likely to cause property damage, endangering human life. There were two major accidents due to flyrock due to blasting in Johor granite quarries involving fatality. Prediction of flyrock is useful for planning blast and remove machinery near blasting face and evacuate nonessential personnel from the blasting site. 262 blasting data sets were collected from six granite quarry in Johor, Malaysia. Rock mass properties were found to be similar. There are controllable parameters based on the blast design and non-controllable parametes based on rock mass parameters. Based on various studies and information from these quarries it was found that blast geometry design parameters and explosives related parameter are the major contributors for flyrock. Blast geometry design parameters include hole diameter, stemming length, hole depth and burden to spacing ratio. On the other hand, explosives related parameters such as maximum charge per delay and powder factor too contribute to cause flyrock. Three different hybrid models were developed Viz CATBOOST+Genetic Algorithm (Catboost+GA), XGBOOST+ Particle Swarm Optimization (XGBOOST+PSO), and Random Forest +Sparrow search Algorithm (RF+SSA). After 209 data sets were trained and 53 data sets are tested for each model. On seven different parameters (R2, RMSE, MAE, MAPE, NSE, VAF, A20) are evaluated for training and testing data sets. Coefficient of variation (R2) values for training data sets with CATBOOST+GA, XGBOOST+ PSO and RF+SSA are 0.89,0.94 and 0.96 respectively. RF+SSA is found the best model for prediction of flyrock with ranking system. Thus, intelligent models are useful for prediction of flyrock. Prior to blasting,

blasting team can review or adjust controllable parameters and flyrock can be within safe limit.

Keywords: Flyrock, CATBOOST, XGBOOST, Random Forest (RF), Particle Swarm Optimization (PSO), Genetic Algorithm (GA), Sparrow Search Algorithm

ID: TropICon 2026: 021-017

Geological Characterization and Beneficiation Potential of Sarawak Silica Sand for High-Value Industrial Applications

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Abstract

Silica sand suitability for higher value applications depends on particle characteristics, impurity mineralogy, and the amenability of impurity hosts to separation, rather than bulk silica content alone. This study evaluates two in situ silica sand samples, BKG01 and BKG02, collected during fieldwork in Marudi, Sarawak. Macroscopic examination, dry-sieve particle-size analysis, petrographic microscopy, X-ray diffraction, X-ray fluorescence with loss on ignition, and semi-quantitative inductively coupled plasma mass spectrometry were used. Both samples are quartz-rich fine sands. BKG02 is finer and better sorted, with a median particle size of 0.231 mm compared with 0.276 mm for BKG01. Semi-quantitative X-ray diffraction recorded 92.6% quartz and 7.4% metamict or partially metamict zircon in BKG01, compared with 95.9% quartz and 4.1% zircon in BKG02. Silica contents were 97.3026 and 98.2505 mass%, respectively. However, BKG02 contained higher iron oxide (0.0747 versus 0.0465 mass%) and titanium oxide (0.3409 versus 0.2874 mass%), whereas BKG01 had higher loss on ignition (1.92 versus 0.98 mass%) and zirconium oxide (0.0693 versus 0.0294 mass%). Petrography identified localized ferruginous coatings in BKG01 and trace accessory heavy minerals in both samples. These contrasts support testing washing and classification followed by attrition, desliming, magnetic separation, and density separation where warranted. The raw samples justify further assessment for general industrial silica, foundry, filtration, and selected glass applications, but low iron and high purity uses remain unqualified. Because only two samples were characterized and no beneficiation experiments were performed, the proposed processing route and product potential require experimental validation.

Keywords: Silica Sand; Geological Characterization; Beneficiation; Mineralogy; Industrial Applications; Sarawak.

ID: TropICon 2026: 023-018

Early Assessment of Liquefaction Potential in Lembah Klang Area Using SPT-Based Liquefaction Potential Index

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Abstract

Soil liquefaction is an important geotechnical hazard associated with the loss of strength and stiffness of saturated loose granular soils during earthquake shaking. Although Peninsular Malaysia is generally characterised by low-to-moderate seismicity, local ground conditions and earthquake-induced ground motion may contribute to liquefaction susceptibility at specific locations. Putrajaya is of particular interest due to its extensive urban development, presence of man-made lakes and reservoirs, and relatively higher peak ground acceleration (PGA) compared with several other regions of Peninsular Malaysia. This study presents an early assessment of liquefaction potential within a selected precinct of Putrajaya using available borehole investigation data. Preliminary screening of the borehole database is used to identify a study area characterised by potentially susceptible subsurface conditions, particularly the occurrence of loose sandy or silty-sandy deposits with relatively low Standard Penetration Test (SPT-N) values, together with groundwater and PGA conditions that may favour liquefaction. The selected boreholes are subsequently analysed using the SPT-based simplified stress procedure of Idriss and Boulanger, in which the cyclic stress ratio (CSR) induced by earthquake loading is compared with the cyclic resistance ratio (CRR) of the soil to determine the factor of safety against liquefaction. The calculated factor of safety with depth is then incorporated into the Liquefaction Potential Index (LPI) to represent the cumulative severity of potentially liquefiable layers within the upper 20 m of the soil profile. The LPI values at the borehole locations are spatially interpreted to identify zones of relatively low, moderate, and high liquefaction susceptibility within the selected precinct. The proposed approach provides a practical preliminary screening method for identifying areas in Putrajaya that may require more detailed site-specific liquefaction investigation and may support future geotechnical planning and seismic risk assessment.

Keywords: Liquefaction Potential Index (LPI); Standard Penetration Test (SPT); Idriss and Boulanger; Putrajaya; Borehole; Preliminary assessment

ID: TropICon 2026: 014-019

Multi-Temporal Land Use and Land Cover Change and Transition Analysis along the Pan Borneo Highway Corridor in Siburan, Sarawak (2010 – 2024)

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Abstract

Large transport infrastructure can influence surrounding land use and land cover (LULC), especially in fast-growing peri-urban zones. The study focus on the multi-temporal LULC changes along the Pan Borneo Highway corridor in Siburan, Sarawak with spatial data from year 2010, 2016, and 2024. LULC features were developed by manual visual interpretation and vector digitisation to harmonise into six classes (built-up land, open land, Pan Borneo highway, transport infrastructure, vegetation and water bodies). The analysis involves incorporating net area change, percentage change, annual dynamic degree, transition matrices and gain–loss assessment for assessing the magnitude and direction of landscape transformation. The transport infrastructure grew by around 30.32 ha, while vegetation decreased by around 61.30 ha between 2010 and 2024. The total area of the landscape that is being transformed was 41.66 ha from 2010 to 2016, but rose to 175.29 ha from 2016 to 2024, showing significantly higher landscape transformation in the latter period. The main changes in 2016-2024 include converting an area of vegetation into an area of open land (54.3 ha) as well as converting an area of open land to an area of transport infrastructure (29.0 ha) and from vegetation to transport infrastructure (26.9 ha). The results show that net area change alone does not fully represent landscape transformation because substantial land exchange may occur within individual LULC classes. Overall, combining net change, transition analysis and gain–loss assessment provides a clearer understanding of LULC transformation and can support spatial planning and land management along rapidly developing transport corridors..

Keywords: Land use and land cover (LULC), Pan Borneo Highway; Multi-temporal analysis, Transition matrix, Gain–loss analysis, Peri-urban development, Geographic Information System (GIS).

ID: TropICon 2026: 022-021

Temporal Coupling of Early-Stage Root Architectural Traits and Surface Erosion Mechanics in Vetiver and Lemongrass Nature-Based Slope Stabilization

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Abstract

Bioengineering through vegetative slope protection is increasingly employed to mitigate tropical geohazards; however, the temporal relationship between early-stage root architectural development and surface erosion processes remains insufficiently quantified. Existing studies largely assume fully established root systems and therefore overlook the highly vulnerable period immediately following planting. This study evaluates the temporal performance of Vetiver (Chrysopogon zizanioides) and Lemongrass (Cymbopogon citratus) over a 12-week establishment period (at Week 2, 4, 6, 8, 10 and 12 post-planting). Field experiments and simulated rainfall tests were conducted to examine root reinforcement, surface runoff and sediment loss in plots planted with vetiver, lemongrass and unplanted control at different slope gradients. The results demonstrate that lemongrass exhibits deeper root penetration, with both species substantially reduce soil erosion. The growth responses of both species can be categorized into three distinct phases. During the initial observation period (Weeks 1–6; Phase 1), the soil remained highly vulnerable to erosion, while variation in plant performance was relatively limited. A transitional stage occurred between Weeks 6 and 10 (Phase 2), characterized by progressive root development and the formation of soil macropores with increasing root-soil interactions. By Weeks 10-12 (Phase 3), erosion protection reached an optimal level, suggesting a critical tipping point at which increased root density and greater belowground development effectively restricted sediment detachment and transport. Progression from initial establishment to enhanced root-mediated soil reinforcement suggests that the timing of vegetation establishment is an important consideration in the design of nature-based erosion-control strategies. These findings indicate the potential of both grass species for early-stage use bioengineering and slope-management applications, thereby supporting more sustainable land-use practices in erosion-prone regions.

Keywords: Vetiver, Lemongrass, Nature-based Solution, Erosion, Vegetative Roots

ID: TropICon 2026: 026-025

Characterization of Debris Flow Cascading Zones under Rainfall and Seismic Conditions in Tropical Region

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Abstract

Debris flow is a complex cascading geohazard involving the progressive transformation and downstream movement of unstable materials from slope failure to deposition. In tropical mountainous regions, debris flow initiation and propagation can be influenced by multiple triggering and conditioning factors, particularly intense rainfall and seismic activity, which may alter slope stability and sediment availability. However, the spatial variability of geomorphic, geological, hydrological, and environmental factors across different stages of the debris flow cascading process, particularly under rainfall and seismic conditions, remains insufficiently characterized. This study aims to characterize the spatial variability of controlling factors across four debris flow cascading zones, namely the landslide zone, debris flow zone, debris flood zone, and mudflood zone, considering rainfall and seismic influences. Six historical debris flow events in Malaysia were investigated using a GIS-based spatial analysis framework. The cascading zones were delineated based on the observed spatial distribution of landslide initiation, debris flow transport, debris flood deposition, and mudflood deposition. A set of geomorphic, geological, hydrological, environmental, rainfall, and seismic-related factors, including slope gradient, elevation, topographic wetness index, plan and profile curvature, lithology, weathering grade, soil thickness, vegetation characteristics, rainfall conditions, and seismic conditions, were extracted and compared across the four zones. The results are expected to demonstrate distinct spatial variability in factor characteristics along the debris flow cascading pathway, with several factors exhibiting systematic changes from initiation to transport and deposition zones. The landslide zone is primarily associated with terrain and geological conditions conducive to slope instability, whereas the debris flow and debris flood zones reflect the combined influence of topographic, hydrological, channel, and sediment-transport conditions. The mudflood zone is characterized by relatively low-gradient terrain and conditions favourable for the deposition of finer

materials. Rainfall and seismic conditions are further evaluated to determine their contribution to slope instability and sediment mobilisation. The proposed zone-based characterization provides a process-oriented framework for understanding debris flow evolution under rainfall and seismic conditions and establishes a basis for improved assessment and prediction of cascading debris flow hazards in tropical mountainous regions.

Keywords: Debris flow, Cascading process, Geohazard

ID: TropICon 2026: 026-026

Artificial Intelligence-Driven Integration of Lithology and Weathering Data for Debris Flow Susceptibility: A Systematic Review

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Abstract

Debris flows are complex natural hazards strongly influenced by geological and geomorphological factors, particularly lithology and weathering characteristics. With the growing availability of spatial data, artificial intelligence (AI) techniques have emerged as powerful tools for modelling and predicting debris flow susceptibility. This systematic review aims to critically examine how AI has been employed to integrate lithological and weathering profile data in debris flow susceptibility assessment. Using PRISMA guidelines, relevant peer-reviewed studies published between 1990 to 2025 were retrieved from major academic databases, resulting in 488 and 1174 articles from Web of Science and Scopus, selected for in-depth analysis based on strict inclusion and exclusion criteria. The review identifies the most commonly used AI techniques, includes machine learning models such as random forest (RF), support vector machines (SVM), artificial neural networks (ANN), and deep learning to evaluate their effectiveness in incorporating lithological and weathering data. The findings provide valuable insights for researchers, practitioners, and policymakers aiming to improve predictive models for debris flow hazard assessment and risk mitigation.

Keywords: Debris flow, Weathering profile, Boulder, Artificial Intelligence

ID: TropICon 2026: 018-028

Rare Earth Elements Chemistry, Global Resources, Mining, Recycling and Sustainable Supply Pathways Comprehensive Review

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Abstract

The fifteen lanthanides, plus scandium and yttrium, are known as rare earth elements (REE) and are crucial for the materials that are a critical part of clean-energy technology, electronics and defense systems, such as permanent magnets, catalysts, phosphors, electrocatalysts and biomedical materials. Problem statement. Demand for REE is growing at a rapid pace, with EVs, wind turbines and enhanced electronics increasing as demand grows, but primary supply and midstream separation and refining is widely dispersed among a limited number of countries led historically by China. This concentration has occasioned geopolitical tensions, for example, in export-control decisions, and mining and processing have serious environmental and social implications such as the release of radioactive tailings, leachate with an acid pH, and contamination of ecosystems. As volumes of end-of-life magnets, electronic waste and batteries increase, secondary recovery (recycling) is still a small percentage of total supply. Method. This narrative review collates literature published during the last six years (from ~2020 to 2026) on REE chemistry, endowment of resources in the world and China, and mineralogy and beneficiation of main ore types, such as ion-adsorbed clays, bastnaesite, monazite and mixed Bayan Obo-type carbonatite ores; as well as secondary recovery routes, which include hydrometallurgical leaching, solvent extraction with deep eutectic solvents and ionic liquids, novel amine and diglycolamide extractants, ion-imprinted polymers, and bio-based adsorbents and biosorbents. The selectivity, recovery efficiency, reagent and energy use, and environmental impact of primary and secondary routes are compared and key technical, economic and policy factors influencing the resilience of the REE supply-chain are provided. Conclusion. The REE supply-sustainability tension

cannot be solved by any single technology, as the primary routes to these REE vary widely in grades, co-management burden of radioactivity, and reagent needs, while new green solvents, imprinted polymers, and biosorbents display potential for ore beneficiation and recycling, with most only at laboratory or pilot scale. A combination of diversifying primary sources, green extraction chemistry, scaling up recycling for magnets, e-waste, and batteries, as well as coordinated policy on critical-mineral supply-chain security would seem to be the best way forward to a more resilient and sustainable REE value chain.

Keywords: Rare Earth Elements (REE), Critical minerals, Bastnaesite, Monazite, Ion-adsorption ore, Recycling, Solvent extraction, Circular economy

ID: TropICon 2026: 027-029

Assessment of Long-Term Hydraulic Performance in Lime-Treated Laterite Landfill Liners using Numerical Modelling

Nur Syahirah Syuhadah Zakaria[1], Bakhtiar Affandy Othman[1], Nor Zurairahetty Mohd Yunus[1*], Siti Norafida Jusoh[1], Dayang Zulaika Abang Hasbollah[1], Sitti Hijraini Nur[2], Tri Harianto[2]

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Abstract

Global increases in municipal solid waste have intensified the need for secure landfill containment, as leachate migration poses severe contamination risks to surrounding soils and groundwater resources. While conventional compacted clay liners (CCLs) and geosynthetic clay liners (GCLs) serve as hydraulic barriers, they remain highly susceptible to dry-wet cracking and chemical degradation, respectively. Consequently, widely available tropical laterite soil has emerged as a promising alternative barrier material. However, untreated laterite soil exhibits high hydraulic conductivity and volume instability, necessitating quicklime stabilisation to refine the pore structure via pozzolanic reactions. Despite these mechanical improvements, the long-term hydraulic performance of quicklime-treated unsaturated barriers under extended field conditions remains insufficiently investigated, prompting the integrated experimental and numerical approach developed in this study. Therefore, this study evaluates the long-term hydraulic performance of quicklime-treated laterite soil by integrating laboratory-derived hydraulic properties with numerical simulation under unsaturated conditions. Preliminary laboratory testing demonstrated that the addition of 7% quicklime increased the unconfined compressive strength from 194 kPa to 583 kPa, reduced the linear shrinkage from 6.0% to 3.0%, and decreased the saturated hydraulic conductivity from 2.38×10^{-7} to 9.15×10^{-10} m/s. The experimentally determined soil-water characteristic curve (SWCC) and saturated hydraulic conductivity were subsequently incorporated into the SEEP/W model to evaluate the long-term seepage behaviour of landfill liners with thicknesses of 1.0, 1.5, 2.0 and 2.5 m over a 15-year service period. The simulation results indicated that increasing liner thickness significantly reduced leachate infiltration, with the predicted infiltration depth decreasing from 0.138 m for the 1.0 m liner to only 0.001 m for the 2.5 m liner. The proposed integrated approach bridges laboratory characterisation and long-term field performance prediction, providing a more reliable basis for the design and assessment of sustainable landfill liner systems in tropical environments.

Keywords: Laterite soil, Lime stabilisation, Landfill liner, Numerical simulation, Hydraulic performance.

ID: TropICon 2026: 018-030

Blast Fragmentation Optimization in Tropically Weathered Limestone using Intelligent Techniques

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Abstract

5 million T per annum limestone quarry in Thailand situated 100 KM from Bangkok is selected for the Blast Optimization Study. Limestone is utilized for manufacturing aggregate and M sand supplied to for captive internal consumption Ready Mix Concrete (RMX) Limestone is tropically weathered which can be classified as Fresh/ Slightly Weathered(W1), Moderately Weathered (W2), Highly weathered (W3) and Completely Weathered (W4). Rock mass properties vary based on degree of weathering which make challenging for blasting and obtaining good fragmentation. In hard rock quarry operation, blasting plays crucial role as it impacts efficiency of loading blasting rock, transportation through dump truck with better fill factor, improved crushing efficiency. Total 8 input parameters were selected consisting of blast design parameters (Burden to hole diameter ratio and Stiffness ratio); Explosives related parameters (Powder factor and Maximum charge per delay) and Rock mass properties (RQD, Blastability Index, Weathering Index and Mean Block Size). Mean blast fragmentation size is output to determine performance of each blast. Total 140 blasting data sets were utilized. Wheel Optimization Algorithm (WOA), Grey Wolf Optimizer (GWO), Gradient Boost Optimizer (GBO)and Particle Swarm Optimizer (PSO) basic algorthim techniques are selected. Hybrid models are developed with extreme Gradient Boosting (XGBOOST) Coefficient of Variation(R2) of Hybrid models WOA-XGBOOST, GWO-XGBOOST, GBO-XGBOOST and PSO-XGBOOST is (0.95, 0.96, 0.98 and 0.99). PSO-XGBOOST is also found best model based on four evaluation criteria for each model.

Keywords: Blast optimization, Wheel Optimization Algorithm (WOA), Grey Wolf Optimizer (GWO), Gradient Boost Optimizer (GBO), Particle Swarm Optimizer (PSO)

ID: TropICon 2026: 029-034

Mechanical and Swelling Characteristics of Silt-Bentonite Mixtures Modified with MICP Methods

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Abstract

Expansive soil is highly susceptible to volumetric change under variations in moisture content, making stabilization essential before use as construction subgrade or foundation base. This study evaluates the mechanical and swelling characteristics of silt-bentonite mixtures prepared at bentonite contents of 0% (B0), 50% (B50), 70% (B70), and 100% (B100) stabilized using a six-day-old bacterial culture applied at concentrations of 4%, 6%, and 8%, with curing periods of 7, 14, and 28 days. Unconfined compression tests, direct shear tests, and swelling pressure tests were conducted to assess strength improvement and expansive behavior. Results show that bacterial treatment substantially improved unconfined compressive strength, with the highest increase of approximately 273% in B100 at 8% bacterial concentration and 28-day curing (356.92 to 1331.40 kN/m²), accompanied by an elastic modulus improvement of up to 131% under similar conditions. Direct shear results indicate cohesion increased by up to 436% in B70 at 8% concentration and 28-day curing, while the internal friction angle increased by up to 234% in B50 at 6% concentration and 28-day curing. Swelling pressure results reveal clear dependency on bentonite content and compaction density, ranging from 127.64 kPa in B50 at 80% relative density to 482.80 kPa in B100 at 100% relative density, confirming that higher bentonite content and denser compaction increase swelling potential. These findings demonstrate the effectiveness of bacterial treatment in enhancing mechanical performance of silt-bentonite mixtures, while highlighting the continued importance of density and mix-ratio control in managing swelling behavior for expansive soil stabilization practice.

Keywords: Expansive Soil, Silt-bentonite mixture, Bacterial culture, Unconfined compressive strength, Direct shear, Swelling pressure

ID: TropICon 2026: 030-036

Development of Road Deterioration Prediction Model using Artificial Neural Network-Bayesian Statistic

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Abstract

Road deterioration is a complex and progressive process influenced by various factors, including traffic loading, weather conditions, geometrical characteristics, and geological conditions. Accurate prediction of road deterioration is therefore essential for supporting effective pavement maintenance planning and improving the allocation of limited maintenance resources. This study aims to develop a road deterioration prediction model by integrating Artificial Neural Network (ANN) and Bayesian statistical approaches. The proposed approach utilizes hypothetical deterioration data to establish the relationship between deterioration progression and its influencing factors. The ANN component is employed to identify and model the relationship between the input variables and road deterioration, while the Bayesian statistical approach is incorporated to improve the prediction process by accounting for uncertainty associated with the model and observed deterioration behaviour. Based on the preliminary results, the developed prediction demonstrates a close agreement with the observed deterioration values over the 20-year analysis period. These results indicate that the integration of ANN and Bayesian statistical techniques has potential to support the development of road deterioration prediction model. The proposed model can subsequently support road maintenance agencies in forecasting deterioration trends, identifying appropriate intervention methods, and improving long term maintenance planning and decision making.

Keywords: ANN, Bayesian Statistic, road deterioration, prediction, model

ID: TropICon 2026: 031-037

Assessment of UAV–LiDAR Elevation Bias on Raster and TIN-Based Beach Volume Estimation

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Abstract

Unmanned Aerial Vehicle (UAV) photogrammetry provides an efficient approach for high-resolution coastal topographic mapping and beach volume estimation. However, systematic elevation differences in UAV-derived surfaces may propagate into volumetric estimates and reduce their reliability. This study assessed the influence of UAV-photogrammetry and UAV–LiDAR digital elevation model (DEM) bias on raster and triangulated irregular network (TIN)-based beach volume estimation at Teluk Gorek Beach, Mersing, Johor, Malaysia. UAV photogrammetry and UAV LiDAR-derived elevation surfaces were harmonised to the same coordinate system, 0.5 m resolution, analysis boundary, and common base elevation. The UAV DEM showed a mean positive elevation difference of 1.282 m relative to UAV-LiDAR, resulting in approximately 55.7% overestimation of whole-beach volume for both raster and TIN approaches. Diagnostic mean-bias correction substantially reduced the aggregate volume discrepancy, although local residual variability remained. The findings indicate that systematic surface elevation bias exerted a greater influence on total beach volume estimates than the difference between raster and TIN-based computation methods.

Keywords: UAV-photogrammetry, UAV-LiDAR, DEM bias, Beach volume, Raster, TIN

ID: TropICon 2026: 031-038

Numerical Evaluation of Geosynthetic-Reinforced Retaining Walls under Cyclic Loading with Insights from Engineering Practice

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Abstract

This study evaluates the performance of a geosynthetic reinforced retaining wall (GRRW) constructed using marginal silty sand backfill under static surcharge and 1 Hz traffic induced cyclic loading. A topographical survey was conducted to establish the existing site profile, ground elevations, roadway alignment, and retaining wall geometry, providing site-specific geometric information for the development of the numerical model. Based on the surveyed site conditions, two-dimensional finite element model was developed in PLAXIS 2D using the Hardening Soil with Small Strain Stiffness model, with geogrid reinforcement and Keystone modular facing. The reinforced configuration increased the calculated factor of safety from 1.691 to 1.867, representing an improvement of approximately 10.4%. Under 1,000 cycles of 1 Hz loading, the reported roadway settlement reached 68.5 mm, while the maximum lateral facing displacement was 48.6 mm. A maximum geogrid tensile force of 34.5 kN/m was reported at approximately 4.8 m above the wall base. The results indicate that wall performance is governed by the interaction between backfill deformation, shear strength mobilisation, reinforcement tensile resistance, facing response and stress redistribution. Overall, the reinforced system provides improved stability while controlling the response of marginal backfill under repeated loading.

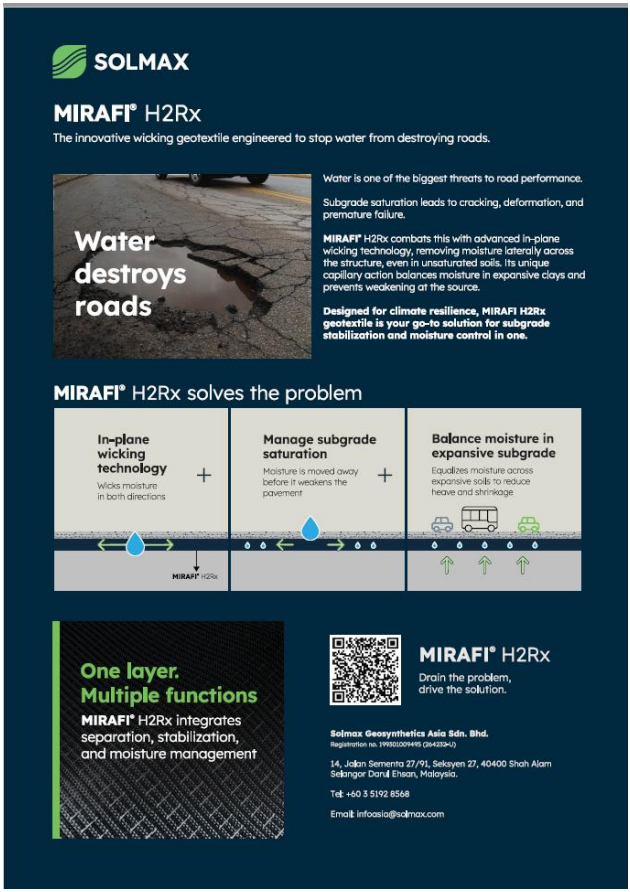
Keywords: GRRW, marginal backfill, cyclic loading, geogrid, PLAXIS 2D

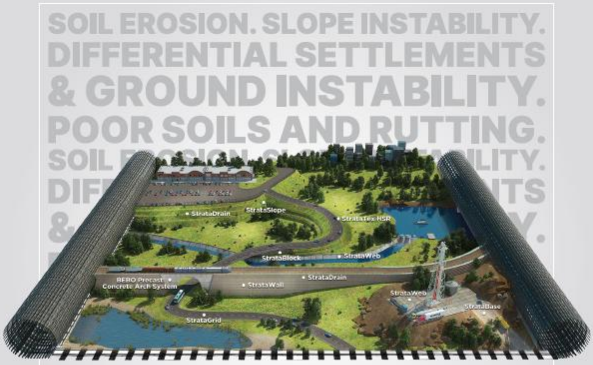
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Main Product	**Controls, IPC Global, Wykeham Farrance, SNL, Endecotts**

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