AGSE 2026

Applied Geoinformatics for Society and Environment

14th International Summer School and Conference, Kumasi, Ghana, 21. – 26. September 2026

The Challenge of Climate Change & Geoinformation Solutions

Programme and Abstracts

Stuttgart Active Alumni Group

Conference Web Site: http://applied-geoinformatics.org/

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Preface

Applied Geoinformatics for Society and Environment (AGSE) series of conferences and summer workshops started in 2008 in Trivandrum, initiated by the initiatives of alumni and lecturers of the international Master's Degree Programme in Photogrammetry and Geoinformatics of the University of Applied Sciences, Stuttgart, Germany. After the successful follow-up conferences took place in Stuttgart (Germany, 2009), Arequipa (Peru, 2010), Nairobi (Kenya, 2011), Johor Bahru (Malaysia 2012), Ahmedabad (India, 2013), again Stuttgart (2014), on Kish Island (Iran, 2017), Windhoek (Namibia 2018), Stuttgart (2019), as hybrid conference in Kathmandu and Stuttgart (Nepal, Germany, 2021 again Trivandrum (India, 2022) and Bogotá (Colombia, 2025). The conference is closely related to the Master's Programme in Photogrammetry and Geoinformatics which started with the first batch 27 years ago, meanwhile there is a global network of about 600 alumni graduated from the programme. Since its beginning, the course is supported by the German Academic Exchange Service (DAAD) in its program for Development-Related Postgraduate Courses (EPOS).

Also, AGSE 2026 is incorporated into the DAAD supported alumni work of the University of Applied Sciences Stuttgart. Therefore, participants from many countries worldwide contribute with experiences from their home countries.

As in previous years, the conference will address current topics in the field of geographic information (GI) science. With the broad theme of 'The Challenge of Climate Change and Geoinformation Solutions', the conference will focus on contributions from Earth Observation relating to environmental monitoring, natural hazards, and risk assessment in the context of climate change. Additionally, the conference will address new concepts and methods related to machine learning and deep learning for GeoAI applications. Finally, data sharing, which is one of the prerequisites for setting up these applications, will also be discussed.

The concept includes invited talks by invited international experts in combination with presentations and workshops by participants and lecturers on topics related to technological developments and recent data provision by Earth Observation Systems. The sessions feature a dynamic mix of in-person and online presentations. This hybrid format ensures that participants from around the world who cannot attend in person are seamlessly integrated into the networking activities.

The objective of the conference is to 'take the benefits of geographic information technologies to a wide canvas of applicable areas'. Since 2008 we – scientists, practitioners, students and alumni – continue this path to empower one another in a participative way.

We wish this event a successful exchange of knowledge crossing borders and disciplines.

Prof. Dr. Paul Rawiel Prof. Dr. Dietrich Schröder Prof. Dr. Franz-Josef Behr Prof. Dr. Hardy Lehmkühler

Welcome

Dear participants and colleagues,

Greetings from Kumasi, Ghana.

It is a great honour and joy to on behalf of Kwame Nkrumah University of Science and Technology (KNUST) welcome you to AGSE conference 2026. KNUST is delighted to co-host this conference with Hochschule für Technik Stuttgart (HFT). This conference which is organized by the Department of Geomatic Engineering, KNUST coincides with the 50th anniversary of the Department.

This conference brings experts from around the world to foster collaboration on cutting edge research and practical applications in geospatial technologies, remote sensing and GIS which seeks to address one of the major global crises that harms the environment, health and survival of people. Your presence here reflects a shared commitment to addressing one of the most pressing issues of our time and to explore the powerful role geoinformation technologies plays in understanding, monitoring and responding to its impacts.

Under the theme 'The Challenge of Climate Change and Geoinformation Solutions', programmes for this conference outlines keynote speeches, technical sessions for presentation of research and interactive workshops for hands-on training. The Department of Geomatic Engineering will also have its anniversary guest lecture during the conference. There will be a cultural event to celebrate our local heritage and also an excursion to foster informal networking and create shared memories. We hope these activities will foster new collaborations and lasting professional relationships.

On behalf of KNUST, I extend our sincerest appreciation to HFT and Deutscher Akademischer Austauschdienst (DAAD) for the productive partnership that has made this conference possible. To all speakers, session chairs, organizing committee members, sponsors and support staff whose efforts have brought us together, I say 'Ayekoo'.

We are honoured to host you and wish you a productive and enjoyable conference. May your time here be both scientifically rewarding and personally enriching.

Thank you and welcome once again to KNUST, Ghana.

Warm regards,
Kwame Obeng, PhD
Department of Geomatic Engineering, KNUST

Programme

Monday, September 21	
08:30 – 09:30	*Registration*
09:30 – 10:30	**Welcome Addresses** *Moderation: Beatrice Osei Konadu* ***Dr. Kwame Obeng*** *AGSE organizing team, Kwame Nkrumah University of Science and Technology* ***Prof. Dr. Paul Rawiel*** *AGSE organizing team, Stuttgart University of Applied Sciences* ***Prof. Kwabena Biritwum Nyarko, Ph.D.*** *Provost, College of Engineering or Dean, Faculty of Civil and Geo-Engineering (KNUST)* ***Prof. Dr. Hardy Lehmkühler*** *Vice Dean of Faculty Stuttgart University of Applied Sciences*
10:30-11:00	*Coffee Break*
11:00-11:45	**Keynote** *Chair: Dietrich Schröder* **To be announced**
11:45-12:05	**Technical Session: „Geoinformation Worldwide - Disaster and Environmental Monitoring“** *Chair: Dietrich Schröder* *Kaleb Gizaw Negussie* **Multi-Scale Remote Sensing of Urban Surface Runoff and Gully Erosion Dynamics in Rundu, Namibia**
12:05-12:30	**Presentation of Sponsors**
12:30-13:30	*Lunch*

13:30 – 15:00	**Technical Session: „Geoinformation Worldwide - Disaster and Environmental Monitoring" cont'd** *Chair: Hossein Arefi* *Gillie Cheelo* **Using Landsat imagery to evaluate the impact of community-based forest management on deforestation: A case study of areas around Kasanka National Park, Zambia** *Kiran Shakya* **Implementing Localized Weather and Flash-Flood Warning Systems for Vulnerable Communities** *Kenneth Aido* **Mapping Land Cover Dynamics of Ecological Savanna Zones in Ghana** *Yonas Asefa Fufa, Alazar Assefa and Tilahun Derib Asfaw* **As-built Geospatial Database for Addis Ababa River Corridor Development**
15:00-15:30	*Coffee break*
15:30-17:00	**Technical Session: „Geoinformation Worldwide - Disaster and Environmental Monitoring" cont'd** *Chair: Edward Ackom* *Ijeoma Onyeahialam, Richard Bockarie and French Lewis:* **The Heat That Data Forgot: Micro-Scale Thermal Vulnerability in Informal Settlements - Climate Adaptation Evidence from UAV Thermal Mapping, Indoor Sensors and Housing Typologies in Freetown, Sierra Leone (online)** *Moses Murimi Ngigi and James Muiru Wambui* **Development of a Web-Based GIS Decision Support System for Chia Cultivation and Sustainable Substrate Reuse in Oyster Mushroom Farming: A Case Study of Central Region of Kenya (online)** *Francis Dwomoh, Stefanie Kagone and Gabriel Senay* **Geoinformation for Climate Resilience: Operational Satellite-Based Drought Monitoring and Precipitation Forecasting for Pacific Island Water Security (online)** *Chukwuma Ugwu and Zhihang Yao* **A City-scale 3d-Building Model for Enugu, Nigeria: Generation, Flood Risk Analysis, and Smart City Integration Using CityGML, Copernicus DEM, and Open-source Tools (online)**
17:15-20:00	*Come Together and Icebreaker Party*

Tuesday, September 22	
08:30- 8:45	**Recap of previous day activities** *Paul Rawiel*
08:45 – 09:30	**Keynote** *Prof. Leonard Kofitse Amekudzi* **Title to be announced** *Chair: Samuel Ato Andam-Akorful*
09:30 – 09:45	**Welcome Addresses** *Moderation: Samuel Ato Andam-Akorful* **DAAD and German Embassy Ghana representatives**
09:45 – 10:30	**Technical Session: "Climate Change Monitoring through Remote Sensing Imagery and Processing"** *Chair: Paul Rawiel* *Sanjeev Kumar Raut* **Analysis of Climate Change Impact on Flood Frequency Using Geo-Spatial Technology; A case of Rasuwa District, Nepal** *U.A.J. Gunatilake, Vithanage Primali Anuruddhika Weerasinghe and C Wickramaratne* **Spatiotemporal Evolution of the Urban Heat Island Effect in Colombo District, Sri Lanka**
10:30 – 11:00	*Coffee break*

11:00 – 12:30	**Technical Session: "Geoinformation Worldwide - disaster and environmental monitoring with focus on Illegal Mining"** *Chair: Naa Tagoe* ~~*Bennard Ayivor:*~~ ~~**Multi-scale Mapping of Blue–Green–Grey Infrastructure for Urban Climate Adaptation in EO4CAM (online)**~~ *Emmanuel Antwi* **Deep Learning-Based Detection of Illegal Mining Activities in Ghana Using Multi-Sensor Satellite Imagery** *Patrick Adda* **Geospatial Monitoring of Illegal Small-Scale Mining (Galamsey) in Ghana: An Integrated Earth Observation, UAV, and AI Framework for Evidence-Led Compliance (online)** *Samuel Appiah Kubi, Angela Bubune Bleboo and Rahana Ismael* **Multi-Sensor Aerial Surveillance and Deep Learning for Geospatial Detection and Monitoring of Illegal Artisanal Mining in the Atewa Forest Reserve, Ghana**	**Technical Session „Climate Change Monitoring through Remote Sensing Imagery and Processing" cont'd** *Chair: Paul Rawiel* *Dennis Appiah Ansah* **FLOODWATCH: A Geospatial Flood Risk Assessment and Citizen-Facing Early Warning Application for Urban Communities in Ghana A Case Study of Kisseman, Greater Accra Region** *Benjamin Boateng* **Climate-Induced Multi-Geohazard Dynamics and Public Health Vulnerability in Peri-Urban Accra, Ghana: A Geoinformatics-Based Framework** *Vannesah Kporha, Dennis Fox and Mostafa Banitalebi* **Comparative Assessment of Global Building Footprint Datasets: Evaluating Completeness, Accuracy, and Coverage Using a Grid-Based Approach**
12:30 – 13:30	*Lunch*	
13:30- 15:00	**Workshop** *Hardy Lehmkühler* **Data Preparation for GIS using FME Form software**	**Workshop** *Dietrich Schröder* **An Introduction to Programming in QGIS Using PyQGIS and Jupyter Notebook**

15:00- 15:30	*Coffee break*	
15:30- 17:00	**Workshop cont'd** *Hardy Lehmkühler* **Data Preparation for GIS using FME Form software**	**Workshop cont'd** *Dietrich Schröder* **An Introduction to Programming in QGIS Using PyQGIS and Jupyter Notebook**
17:15- 19:00	**Alumni Session** • *Experiences after graduation abroad* • *Recommendations*	

Wednesday, September 23	
08:30 – 09:00	**Recap of previous day activities** *Kwame Obeng*
09:00 – 11:00	**Technical Session: "Geoinformation Worldwide – Diverse Applications"** *Chair: Hardy Lehmkühler* *Michael Mutale and Oluibukun Gbenga Ajayi* **Geospatial Frameworks for Gender-Responsive Rainwater Harvesting in Urban Sub-Saharan Africa: A Systematic Literature Review** *Herbert Djaba* **Geomatics in Boundary Management: Strengthening Delimitation, Demarcation, Reaffirmation and Monitoring through Geospatial Technologies** *Felix Enyimah Toffah and Francesco Pirotti* **Unsupervised Mapping of Flood-prone Areas in Ghana Using Sentinel-1 Time-Series (online)** *Moses Murimi Ngigi and Charles Churu Wambui* **Modelling Gully Erosion Susceptibility and its Socio-Economic Impacts Using Machine Learning Algorithms: A Case Study of the Suam River Basin, West Pokot County, Kenya (online)** *Felix Enyimah Toffah, Ruben Cartuyvels, Patrick Ebel and Francesco Pirotti* **Exploratory Study on Using Deep Learning for Monitoring Vertical Ground Displacement Sentinel-1 Time-Series (online)**
11:00-11:30	*Coffee break*
11:00 – 12:30	**Guest Lecture KNUST Anniversary** *Chair: John Ayer* *Dr. Joseph B. Tandoh* *Director of the Ghana Space Science and Technology Institute (GSSTI)* **Positioning Ghana as a Regional Geospatial Hub: Geo-Intelligence for Sustainable, Inclusive Development and the Future of Spatial Science in Africa**
12:30-13:30	*Lunch*

13:30 – 15:00	**Technical Session: "Geoinformation and Artificial Intelligence – current trends and applications"** *Chair: Paul Rawiel* *William Benigno Barragan-Zaque, Lilia Edith Aparicio Pico and Robinson Quintana Puentes* **Multi-Source Geospatial Data Fusion for Geospatial Change Detection via AI** *Emmanuel Fundisi* **GeoAI Solutions for Flood Risk Monitoring and Early Warning Systems in informal Settlements, South Africa** *Pawan Thapa and Mandil Thapa* **Geo Artificial Intelligence of Things (GAIoT): Integrating UAV Based Geoinformation, Sensors, and AI for Environmental and Societal Applications** *Louisa Boakye* **Integrating Traditional Agro-Ecological Knowledge and Machine Learning for Hyper-Local Climate Information Services in the Northern Region of Ghana**
15:00-15:30	*Coffee break*
15:30-17:30	**Technical Session: "Geoinformation and Artificial Intelligence – current trends and applications" cont'd** *Chair: Afua Abasa* *Gabriel Sanya* **GeoAI-Driven GIS-Ready Coffee Plantation Intelligence from High-Resolution Orthomosaics for Climate-Smart Agriculture in Southwestern Saudi Arabia** *James Amoako* **Leveraging multi source spatial temporal data in a hybrid CNN-LSTM-Multi Head Attention architecture for near real time dynamic flood prediction in Ghana** *Emmanuel Amankwah and Samuel Akorful-Andam Roadessy-Omni* **A Low-Cost Vision-Inertial Framework for Road Condition Assessment, Mapping and Management in Ghana** *Sudip Shrestha* **Slope Unit-Based Sampling Strategy for Evaluating Landslide Susceptibility Using Machine Learning Models** *Selorm Komla Darkey* **Towards Urban Tree Species Classification: A Machine Learning Instance Segmentation Approach to Multimodal Species-Classification Dataset Creation and Algorithms Development (online)**
18:30-21:00	**Cultural Event**

Thursday, September 24	
8:30-9:00	**Recap of previous day activities** *Franz-Josef-Behr*
09:00 – 09:45	**Keynote** *Prof. Dr. Hossein Arefi* *Professor of Remote Sensing and Photogrammetry, University of Applied Sciences Mainz* **Street-Level GeoAI for Climate-Resilient Cities: From Crowdsourced Images to Urban Greening Maps** *Chair: Franz-Josef Behr*
09:45 – 10:30	**Technical Session „Data sharing and Collaborative Geoinformation Portals"** *Chair: Franz-Josef Behr* *Winhard Tampubolon* **Implementation on Geospatial-based Policies to Improve the Quality of Excellent Human Resources Toward Golden Vision of Indonesia 2045** *Md Zahid Hasan Siddiquee* **Empowering Local Government through Digital Twin for Urban Decision Making: Integrating UAV and Terrestrial Laser Scanning Data in Rajshahi City, Bangladesh**
10:30 – 11:00	*Coffee Break*

11:00 – 12:30	**Technical Session: "Geoinformation and Artificial Intelligence – current trends and applications II"** *Chair: William Barragan* *Hetti Arachchige Nalani* **Estimation of Above-Ground Biomass Using GEDI LiDAR and Sentinel-Data in Tropical Rainforests** *Jay Makorani and Charles Gaya* **Comparative Spatial Modeling of Flood Susceptibility in the Tana River Basin Using Random Forest and Autoencoder–Multilayer Perceptron Artificial Neural Networks** *Caleb Masinde* **Overcoming Camera Calibration Limitations in HD Mapping via Deep Learning-Based Unposed 3D Reconstruction (online)** *Kashif Ullah* **Spatiotemporal Dynamics of Multi-Hazard Susceptibility Under Climate Change and LULC Change Scenarios (online)**	**Technical Session „Data sharing and Collaborative Geoinformation Portals" cont'd** *Chair: Alex Ayertey* *Abdul-Karim W. Fuseini* **Design and Development of an Integrated Geospatial Intelligence Platform for Climate Vulnerability Mapping and Community-Based Risk Reporting in Northern Ghana** *George Agyenim Amankwah, Jefferson-Aaron Ayerbi Totimeh, Da-Costa Boakye Mensah Asare, Charles Gameti, Ambrose Kannor and Samuel Ato Andam-Akorful* **Colouring Ghana: A Collaborative Open Geoinformation Portal for Building-Stock Data to Support Climate Resilience in Ghana** **Technical Session: „Geoinformation Worldwide - disaster and environmental monitoring II"** *Mohamed Salih Dafalla* **Comparative Study of Vegetation Indices for Assessing Agricultural Land of Gezira Scheme, Sudan** *Sooraj N P, Arun S, Arjun C P, Vishnu M, Aleesha Fathima S L, Sajeev C Rajan and Jaishanker R* **Expansion of Human Footprint and Its Spatial Linkages to Human–Wildlife Conflict: A study from Malyattoor Landscape, Kerala, India**
12:30-13:30	*Lunch*	

13:30-15:00	**Workshop** *Paul Rawiel* **Assessing smartphone sensor data for mobile data capturing and mapping**	**Technical Session: „Geoinformation Worldwide - disaster and environmental monitoring II“ cont’d** *Chair: Dietrich Schröder* *Akoeugnigan Idelphonse Sode, Adandé Belarmain Fandohan, Elias Teixeira Krainski, Achille Ephrem Assogbadjo and Romain Glèlè Kakaï* **Integrating Presence-only and Abundance Data to Predict African Baobab Distribution: A Bayesian Data Fusion Framework (online)** *Metzi Aguilar, Oscar Valencia, David Morán, Erick Ramos, Rafael Alas and Guillermo Cortés* **Assessment of Satellite-Based Methodologies for Estimating Turbidity in Surface Water Bodies (online)** *Michael Aboagye Appiah, Dietrich Schröder and Adel Omran* **Groundwater Potential Mapping Using Machine Learning, Multi-Criteria Decision, and Bivariate Statistical Algorithms: A Modular and Transferable Framework (online)** *Stefanie Kagone, Gabriel Senay, Gabriel Parrish and Michael Budde* **Global Landscape Water Requirement Satisfaction Index for Drought Monitoring over Diverse Landscapes and Land Cover Types (online)**
15:30-16:00	*Coffee Break*	
16:00-17:15	**Workshop cont’d** *Paul Rawiel* **Assessing smartphone sensor data for mobile data capturing and mapping**	**Workshop** *Franz-Josef Behr:* **The European Masterportal: A Contribution for an Open Source Stack for Geospatial Infrastructure**

17:30-19:00	**Informal Gathering and Farewell** • *Commitments* • *Thanksgiving*

Friday, September 25	
	Excursion

Abstracts

Keynotes

To be announced

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Street-Level GeoAI for Climate-Resilient Cities: From Crowdsourced Images to Urban Greening Maps

Hossein Arefi

Hochschule Mainz - University of Applied Sciences, Germany

Urban heat is an increasing challenge for cities, but its impacts are experienced very locally at street level. While satellite remote sensing is essential for mapping land surface temperature, vegetation cover, and urban heat island patterns, it often lacks the pedestrian-scale perspective needed to understand thermal exposure in everyday urban spaces.

This keynote explores how street-level GeoAI can bridge this scale gap by transforming crowdsourced and street-level imagery into spatial indicators for climate-resilient urban planning. Using semantic segmentation and geospatial data fusion, features such as trees, sky, buildings, roads, sidewalks, and facades can be extracted and converted into indicators of visible greenery, shading potential, sky-view conditions, and greening deficits.

The talk discusses how these image-derived indicators can be combined with satellite data, 3D city models, and mobile thermal measurements to support urban greening maps and heat-adaptation strategies. It also highlights challenges such as data bias, temporal inconsistency, validation, transferability, and explainability.

The central message is that climate-resilient cities require a multi-scale view: from satellites observing city-wide heat patterns to street-level images capturing the spaces where people actually live, walk, and experience heat.

Title to be fixed

Prof. Leonard Kofitse Amekudzi

KNUST

Department of Meteorology and Climate Science, Faculty of Physical and Computational Sciences

Multi-Scale Remote Sensing of Urban Surface Runoff and Gully Erosion Dynamics in Rundu, Namibia

Kaleb Gizaw Negussie

Namibia University of Science and Technology; Windhoek, Namibia

Climate variability and increasing rainfall intensity in semi-arid regions are amplifying surface runoff processes, with significant implications for land degradation and urban resilience. In Rundu, Namibia, recurrent gully erosion has been observed to impact infrastructure and urban expansion, particularly along the southern banks of the Okavango River. Previous investigations combining field observations and remote sensing identified both natural and anthropogenic drivers of gully formation, including sandy soils, steep slopes, vegetation removal, and altered drainage pathways.

This study advances existing work by adopting a multi-scale remote sensing approach to monitor urban hydrological dynamics and land degradation processes. Medium-resolution satellite data (PlanetScope, 3 m) are used to assess spatial patterns of land cover and impervious surface expansion across the town, while high-resolution drone imagery provides detailed observations of micro-topography, drainage pathways, and gully initiation processes. These datasets are integrated with digital elevation models (DEM) and vegetation indices (NDVI) to analyze surface runoff behavior and water accumulation patterns.

Flow accumulation modelling is applied to identify critical drainage corridors, and temporal NDVI analysis is used to evaluate vegetation loss and surface vulnerability. To quantify relationships between urban surface characteristics and erosion processes, statistical methods, including Spearman correlation and binary logistic regression, are employed to examine the influence of impervious surfaces, slope, runoff concentration, and vegetation cover on gully occurrence. Preliminary observations indicate that the expansion of tarred and compacted surfaces significantly reduces infiltration capacity and increases runoff concentration, leading to localized erosion hotspots. High-resolution drone data further reveal how road networks and poorly managed drainage systems channel water flow, contributing to the progressive inland migration of gullies from the riverbanks into urban areas.

The study demonstrates the value of integrating multi-scale remote sensing for climate change monitoring and urban hydrological analysis, providing a rapid and transferable approach for identifying erosion risk in data-scarce environments. The findings support the development of evidence-based strategies for sustainable urban planning and climate-resilient infrastructure design in rapidly growing towns.

Keywords: *Climate Change Monitoring, Urban Hydrology, Surface Runoff, Land Degradation, Impervious Surfaces, Flow Accumulation*

Using Landsat imagery to evaluate the impact of community-based forest management on deforestation: A case study of areas around Kasanka National Park, Zambia

Gillie Cheelo

Copperbelt University, Zambia

Zambia, along with numerous countries in sub-Saharan Africa (SSA), have continued to experience a high rate of deforestation, estimated at approximately 300,000 ha per year. In response to this challenge, a community-based forest management (CBFM) approach was established to sustainably manage forests, enhance local livelihoods, and curb deforestation by granting legal rights to community groups. Several CBFM areas have been approved and implemented in Zambia. However, their effectiveness in reducing deforestation has seldom been evaluated in Zambia. While evaluations of CBFM areas have been conducted in other countries in SSA, they predominantly focus on benefits, assets, and livelihoods, with limited attention paid to their impact on deforestation reduction. Therefore, this study employed Landsat imagery and a Support Vector Machine to create land cover maps for the years 2000, 2010, 2020, and 2025, aimed at assessing the extent of forest deforestation in six CBFM areas surrounding Kasanka National Park in Zambia's Central Province. Contrary to expectations, the land cover change results indicated an increase in deforestation, as evidenced by a significant reduction in forest cover from 84.79% to 52.45% before and after the establishment of CBFMs. This increase was primarily driven by agricultural expansion into CBFM areas. Therefore, our study recommends enhancements in the implementation of CBFMs to achieve the intended goal of reducing deforestation and incentivising small-scale farmers to refrain from expanding into CBFM areas.

Keywords*: Deforestation, Landsat Imagery, Land Cover Change Analysis, Sub-Saharan Africa (SSA), Sustainable Forest Management*

Implementing Localized Weather and Flash-Flood Warning Systems for Vulnerable Communities

Kiran Shakya

International Centre for Integrated Mountain Development (ICIMOD), Nepal

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In mountains and near rivers, the weather can change very quickly. A clear sky can turn into a dangerous flood within minutes. For people living in remote areas, this is not just inconvenient, it can be life threatening. Regular weather forecasts often miss these sudden, local heavy rains, which makes it harder to prepare for disasters.

This presentation talks about how the High-Impact Weather Assessment Toolkit (HIWAT) helps solve this problem. HIWAT gives more detailed and accurate weather forecasts, especially for difficult areas like mountains. It uses different weather models and near real-time satellite data to warn about heavy rain, strong winds, and lightning that can cause floods.

But having good data is not enough. The key is making this information easy to understand and use. HIWAT turns complex weather data into simple tools that local governments and communities can use.
It also helps send warnings directly to people through mobile apps and public displays. This makes sure the information reaches those who need it most, in time to act. With HIWAT, authorities can make quicker and better decisions during dangerous weather.

We cannot stop storms, but tools like HIWAT help us prepare better and protect lives and livelihoods.

Keywords: *Flash floods, Early warning, Weather forecasting, Disaster preparedness, Community safety*

Mapping Land Cover Dynamics of Ecological Savanna Zones in Ghana

Kenneth Aidoo

Ghana Atomic Energy Commission

Land Use Land Cover (LULC) maps play an important role in assessing land cover changes and supporting sustainable land management. They provide essential information for monitoring changing land use patterns and preventing the dominance of particular land cover types within ecological landscapes. This study harmonized the 2006 and 2015 LULC maps of the Guinea and Sudan savanna ecological zones of Ghana and developed a standardized LULC classification framework to support continuous mapping and effective land management. The same classification procedure was subsequently applied to generate LULC maps for 1996 and 2023, spanning a 27-year period, using a combination of Landsat 8, Sentinel-1, and Sentinel-2 imagery integrated with the Random Forest algorithm in Google Earth Engine (GEE). The classification results for 2023 achieved an overall accuracy of 80.21% with a Kappa coefficient of 0.7225, indicating satisfactory classification performance. To predict future LULC dynamics for the year 2050, a Markov Chain and Multi-Layer Perceptron (MLP) neural network model were employed. The findings revealed substantial changes in land use patterns under the Business-as-Usual scenario. Between 2023 and 2050, urban areas are projected to expand by approximately 95%, while cropland is expected to increase by 9.4%. In contrast, water bodies are predicted to decline by 17.7%, vegetation cover by 2.2%, bareland by 0.03%, and grassland by 38.9%. The results provide valuable insights into future LULC dynamics within the Guinea and Sudan savanna ecological zones of Ghana and underscore the urgent need for policies and sustainable land management strategies aimed at balancing urban growth, agricultural expansion, and ecosystem conservation.

***Keywords**: Savanna Ecological Zone, Land Use Land Cover, Classification, Google Earth Engine*

As-built Geospatial Database for Addis Ababa River Corridor Development

Yonas Asefa Fufa, Alazar Assefa and Tilahun Derib Asfaw
Addis Ababa University, Ethiopia

Addis Ababa's corridor development program is a strategic urban renewal initiative that integrates transport, green spaces, and infrastructure to modernize the city's growth. Within this framework, the river corridor development from Entoto to Peacock is a key component, transforming degraded waterways into resilient ecological and social assets that support mobility, recreation, and environmental restoration.
River Corridor Project has been documented through the development of an integrated geospatial database that captures the as built condition of multiple river segments. The geospatial work encompasses boundary delineation, infrastructure mapping, and environmental features, structured into 13 feature datasets and 2 relational tables for consistency and interoperability. Attributes include spatial geometry, construction specifications, land use, and ecological indicators, organized under defined domains to ensure standardized input and analysis. This database supports visualization, monitoring, and decision making by linking hydrological, infrastructural, and socio environmental data into a unified framework. Beyond construction documentation, the system provides a scalable platform for future urban planning, maintenance, and sustainability assessments, demonstrating the role of geospatial technologies in transforming complex corridor projects into transparent and auditable urban assets.

Keywords: *River corridor development, Geospatial database, Construction Metrics, Ecological Indicators, Feature datasets, Relational tables, Attributes and domains*

The Heat That Data Forgot: Micro-Scale Thermal Vulnerability in Informal Settlements - Climate Adaptation Evidence from UAV Thermal Mapping, Indoor Sensors and Housing Typologies in Freetown, Sierra Leone

Ijeoma Onyeahialam[1], Richard Bockarie[2] and French Lewis[2]

[1]Liverpool School of Tropical Medicine, United Kingdom, [2]CODOHSAPA/FEDURP SL, Sierra Leone

Urban informal settlements in Sub-Saharan Africa are increasingly exposed to extreme heat, yet conventional climate datasets inadequately capture fine-scale indoor thermal conditions where health risks are most acute. This study develops and applies a geoinformatics approach to map indoor heat exposure using low-cost temperature sensors integrated with Geographic Information Systems (GIS) and housing characteristics in informal settlements in Freetown, Sierra Leone.

Field data were collected through a network of low-cost thermal sensors deployed across diverse housing typologies, including zinc-roofed, mixed-material, and high-density structures. Indoor temperature data were linked with spatial datasets on settlement morphology, building density, land cover, and environmental exposure. GIS-based analysis was used to identify micro-spatial variations in heat exposure and assess the influence of structural and environmental factors on indoor thermal conditions across the two urban contexts.

Preliminary findings indicate significant intra- and inter-settlement variability in heat exposure, with specific housing types and densely built areas consisten.tly exhibiting elevated indoor temperatures. These micro-heat hotspots are not captured by conventional remote sensing products, underscoring the need for integrated in-situ and geospatial approaches.

The study demonstrates how combining low-cost sensor networks with spatial analysis can generate actionable evidence for climate adaptation planning in resource-constrained urban settings. The approach supports targeted, context-specific interventions, including housing upgrades, shading strategies, and community-level heat mitigation planning, contributing to climate resilience and health risk reduction in rapidly urbanizing regions

Keywords: *Geoinformatics, Indoor heat exposure, Informal settlements, Low-cost sensors, Microclimate mapping, Climate change adaptation, Urban heat, Sub-Saharan Africa, Heat vulnerability*

Development of a Web-Based GIS Decision Support System for Chia Cultivation and Sustainable Substrate Reuse in Oyster Mushroom Farming: A Case Study of Central Region of Kenya

Moses Murimi Ngigi and James Muiru Wambui

Dedan Kimathi University of Technology, Kenya

Climate variability and the lack of spatial planning tools pose significant barriers to the successful adoption of Salvia hispanica (Chia) in Kenya, often leading to cultivation in ecologically fragile areas. Additionally, the agricultural potential of Chia crop residues remains underutilized due to inefficient logistical planning for substrate transport, limiting the development of a circular agricultural economy. This study developed a Web-Based Geographic Information System Decision Support System to map suitable Chia cultivation zones and optimize transport routes of Chia substrate to Oyster Mushroom farms, integrating precision agriculture with circular biomass utilization. The research used a comprehensive environmental dataset comprising nineteen bioclimatic variables, soil physical and chemical properties, and topographical data derived from a Digital Elevation Model. To ensure model reliability, thirty-one initial variables were subjected to multi-collinearity testing using Variance Inflation Factor analysis, which identified eleven independent predictors for final modelling. A Maximum Entropy machine learning model was applied to predict land suitability, while a Leaflet Routing Machine engine using the Contraction Hierarchies algorithm was integrated into the web platform to compute efficient transport routes. Results showed that Precipitation Seasonality and Minimum Temperature of the Coldest Month were the dominant environmental drivers, indicating that Chia cultivation is primarily constrained by frost risk and the need for distinct wet and dry seasons. Suitability analysis revealed that Chia is a niche crop, with 56.58 percent (7,422 km²) of the study area classified as unsuitable. High potential zones covered only 5.26 percent (690.61 km²), while 16.68 percent was moderately suitable. The model achieved good predictive accuracy with an Area Under the Curve value of 0.792. The decision support system successfully integrated suitability mapping with routing functions to identify cost-effective transport paths for agricultural residues. The study recommends targeting expansion to high-suitability clusters and using spatial routing algorithms to enhance circular agriculture logistics and resource efficiency.

Keywords: *Salvia hispanica, Maximum Entropy, GIS Decision Support System, Route Optimization, Circular Agriculture*

Geoinformation for Climate Resilience: Operational Satellite-Based Drought Monitoring and Precipitation Forecasting for Pacific Island Water Security

Francis Dwomoh[1], Stefanie Kagone[2] and Gabriel Senay[3]

[1,2] AFDS - Contractor to the U.S. Geological Survey (USGS) Earth Resources Observation & Science (EROS) Center, [3] U.S. Geological Survey (USGS) Earth Resources Observation & Science (EROS) Center

Reliable hydrometeorological monitoring is critical for water-stressed Pacific Island communities, yet they remain underserved by conventional ground-based observation networks. Intensifying El Niño/La Niña-driven precipitation variability, manifesting as multi-month droughts, rapid-onset flooding, and increasing frequency of threshold-exceeding rainfall events, poses direct and compounding threats to water supply, food security, and infrastructure. Under the Asian Development Bank project Strengthening Resilient and Sustainable Urban and Water Service Delivery in the Pacific, we developed two complementary operational satellite-based systems supporting evidence-based water resource management across nine locations in four Pacific Island nations: the Federated States of Micronesia (FSM), the Marshall Islands, Nauru, and the Solomon Islands. The first component is a monthly drought monitoring system built on National Aeronautics and Space Administration (NASA) Integrated Multi-satellitE Retrievals for Global Precipitation Measurement (IMERG) precipitation data, classifying observed conditions using rolling 1-, 3-, and 6-month rainfall indices against a 25-year baseline (2000 – 2024) alongside an absolute precipitation index adapted from Pacific ENSO Applications Climate Center thresholds. Operational results reveal persistent and recurring drought signatures at atoll locations driven by ENSO-related suppression of convective rainfall, contrasting with predominantly wet-to-typical conditions at high-rainfall FSM sites during the monitoring period. This spatial heterogeneity, invisible to regional averages, underscores the necessity of site-specific monitoring for effective water resource planning. The second component is a fully automated 7-day precipitation forecasting pipeline driven by NOAA's Global Forecast System (GFS) output. Developed entirely in R using an open-source stack, the system programmatically downloads and processes GFS data, generates georeferenced forecast maps and animated sequences per study site, produces structured reports, and delivers automated alert emails when daily or weekly precipitation thresholds are projected to be exceeded. Integrating both components closes a critical decision-making gap: the drought monitor identifies accumulating water stress over months while the forecasting system provides advanced warning of imminent high-rainfall events at the same vulnerable locations, enabling anticipatory rather than reactive infrastructure management. Both systems rely exclusively on freely available data and open-source geospatial tools, offering a replicable, low-cost model for climate adaptation monitoring applicable across data-scarce regions in Africa and the broader developing world.

Keywords: *drought monitoring, precipitation forecasting, satellite remote sensing, Pacific Islands, climate change adaptation, early warning systems*

A City-Scale 3d Building Model for Enugu, Nigeria: Generation, Flood Risk Analysis, and Smart City Integration Using CityGML, Copernicus DEM, and Open-Source Tools

Chukwuma Ugwu and Zhihang Yao

Centre for Geodesy and Geoinformatics, Stuttgart University of Applied Sciences, Germany

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Sub-Saharan African cities are largely absent from global repositories of semantic three-dimensional (3D) urban models. This paper presents the first documented city-scale CityGML Level of Detail 1 (LOD1) building model for Enugu, Nigeria, a metropolitan area of approximately 900,000 inhabitants subject to recurrent climate-driven flooding, generated entirely from open data using FME Workbench and the Copernicus 30-metre Digital Elevation Model (GLO-30). The 44,817-building model served as the geospatial foundation for an integrated Smart City Digital Twin platform combining HAND-based building-level flood risk analysis, real-time rainfall-to-flood simulation, SUMO microscopic traffic simulation, and emergency dispatch routing, all visualised in CesiumJS. The flood risk model achieved 78% overall spatial agreement with documented flood events, demonstrating practical utility for climate adaptation planning in a data-constrained West African urban context.

Keywords: *CityGML, digital twin, HAND flood risk, Copernicus DEM, FME Workbench, Nigeria*

Analysis of Climate Change Impact on Flood Frequency Using Geo-Spatial Technology; A case of Rasuwa District, Nepal

Sanjeev Kumar Raut

Kathmandu University, Dhulikhel, Kavre

Climate change is a serious issue to the whole globe and affecting the hydrological processes. It is somehow increasing the frequency and intensity of flood events. This research tries to study the impact of climate change on the frequency of flood using geo- spatial technology over the Rasuwa district of Nepal. The last ten years’ sentinel satellite imagery is used for mapping the flood extent for certain time while climatic variables like rainfall and temperature are analyzed for long term trends.

Geographic Information System (GIS) tools and technology are used to perform spatial analysis along the flood mapping, hotspot identification, and post assessment from the hazards. This research performs the relationship between climate change patterns and flood frequency using the statistical and spatial correlation methods. The results show a strong relationship between increasing rainfall, rising temperatures and rising frequency of flood events, especially in low-lying and floodplain areas.

The research highlights the need of geo-spatial technologies in understanding climatic induced flood dynamics along with the development of effective flood risk management and climate adaptation strategies. This study provides the valuable insights for planners and policymakers for reducing the flood hazards.

Keywords: *Climate Change, Flood Hazards, Risk Management, Spatial Analysis, Spatial Correlation*

Spatiotemporal Evolution of the Urban Heat Island Effect in Colombo District, Sri Lanka (1989-2024)

U.A.J. Gunatilake[1], Vithanage Primali Anuruddhika Weerasinghe[1] and C Wickramaratne[2]

[1] Department of Zoology and Environmental Management, Faculty of Science, University of Kelaniya, Sri Lanka

[2] International Water Management Institute, Pelawatte, Sri Lanka

Accelerating climate change and rapid urbanization are intensifying the urban heat island effect (UHIE) in tropical cities. This study examines the spatiotemporal evolution of UHIE from 1989 to 2024 in Colombo District, Sri Lanka, using multi-temporal Landsat imagery spanning Landsat 5 TM, 7 ETM+, 8 OLI/TIRS, and 9 OLI/TIRS. Land surface temperature (LST) was derived via the emissivity-corrected Jiménez-Muñoz and Sobrino single-channel algorithm, which was published in 2003, and UHIE was quantified as standardized pixel-level deviations from district-wide mean LST. Emerging hot spot analysis, combining Getis-Ord Gi* statistics with Mann-Kendall trend testing implemented in R, classified each grid cell into persistent, intensifying, new, consecutive, sporadic, and diminishing hotspot and cold spot categories over the 35-year period. Results show progressive intensification and spatial expansion of UHIE, with mean district LST rising from approximately 29.8 °C in 1989 to 32.7 °C in 2024 and positive UHIE zones expanding from the historic western urban core towards central and eastern parts of the district. Hotspot-related pattern classes collectively occupy 34.89% of the Colombo District, with a combination of consecutive, persistent, and sporadic annual hotspot types concentrated in the western and northwestern parts of the district. Cold spot-related classes cover 47.45%, dominated by persistent and annual sporadic cold spots in eastern and northeastern areas, while 17.67% of the district in the center exhibits no significant spatiotemporal pattern. These patterns provide a spatially explicit, satellite-derived framework to prioritize climate adaptation interventions targeting persistent and emerging heat mitigation hot spots while conserving thermally resilient cold spot zones as critical urban climate refugia.

Keywords: *Urban heat island effect, Emerging hot spot analysis, Landsat, Land surface temperature, Colombo District*

Multi-scale Mapping of Blue-Green-Grey Infrastructure for Urban Climate Adaptation in EO4CAM

Bennard Ayivor

German Aerospace Center (DLR), German Remote Sensing Data Center (DFD), Land Surface Dynamics, Oberpfaffenhofen, Germany and University of Würzburg, Earth Observation Research Cluster, Würzburg, Germany

Urban climate adaptation requires spatially detailed and scalable information on sealed surfaces, vegetation, water bodies, and the built environment. Within the EO4CAM project, we develop a multi-scale approach for mapping and monitoring Blue–Green–Grey (BGG) infrastructure in urban areas, with an initial focus on Bavaria and a perspective towards Germany-wide application.

The approach combines two complementary product levels. First, very-high-resolution aerial imagery is used for detailed BGG classification at 20 cm spatial resolution. Based on DOP20 RGB-IR data, height information, official geodata, building footprints, and transport infrastructure layers, urban features such as buildings, roads, low vegetation, vertical vegetation, and water bodies are mapped at fine spatial detail. This product supports local-scale interpretation of urban structure and provides detailed information for selected cities and municipalities.

Second, a Sentinel-2/WSF-based greenness–imperviousness product is generated at 10m spatial resolution. This product represents surface conditions along a 0–100 continuum, where low values indicate greener or less impervious areas and high values indicate more impervious surfaces. By combining satellite-derived information with settlement masks, transport infrastructure, and water masking, the product enables consistent large-area assessment and municipal-scale statistics.

The combination of both levels allows detailed urban structure mapping and scalable regional monitoring to be used together. The 20 cm BGG classification provides high spatial detail for local planning, while the 10 m greenness–imperviousness layer supports broader comparison, reporting, and potential time-series monitoring. The resulting information products are intended to support climate adaptation planning, urban monitoring, and stakeholder-oriented geoinformation services within EO4CAM.

Keywords: *Blue-Green-Grey infrastructure; imperviousness mapping; urban climate adaptation; very-high-resolution remote sensing; Sentinel-2; EO4CAM; municipal*

Deep Learning-Based Detection of Illegal Mining Activities in Ghana Using Multi-Sensor Satellite Imagery

Emmanuel Antwi

Kwame Nkrumah University of Science and Technology, Ghana

Illegal small-scale mining, locally known as "galamsey," poses a severe threat to Ghana's forest cover, water bodies, and agricultural land. Despite regulatory efforts, the spatial extent and rapid spread of these activities remain difficult to monitor using conventional ground-based methods, particularly across remote and ecologically sensitive regions.

This study proposes a deep learning framework for automated detection and monitoring of illegal mining activities using freely available multi-sensor satellite imagery. The approach integrates Sentinel-1 Synthetic Aperture Radar (SAR) data, which enables cloud-penetrating, all-weather observation, with Sentinel-2 multispectral optical imagery to exploit complementary spectral and structural surface information. A U-Net-based semantic segmentation architecture will be trained on a multi-region dataset spanning key affected zones in Ghana, including the Ashanti, Western, and Eastern regions.

The framework will incorporate temporal change detection to capture the progression of mining-induced land degradation over time. Key expected outputs include land cover classification maps, change detection results, and spatially explicit alerts suitable for environmental monitoring agencies. By leveraging openly accessible Earth observation data, this work aims to produce a scalable, low-cost solution applicable across Sub-Saharan Africa.

This research contributes to the growing intersection of GeoAI and environmental governance, enabling quantification of mining-driven deforestation and carbon loss. It has direct implications for climate change monitoring, illegal land use enforcement, and sustainable development in mineral-rich African nations.

Keywords: *Illegal mining, deep learning, earth observation, change detection, environmental monitoring*

Geospatial Monitoring of Illegal Small-Scale Mining (Galamsey) in Ghana: From Reactive Raids to Evidence-Led, Regulated, and Sustainable Small-Scale Mining

Patrick W. Adda

Shell Canada

Illegal small-scale mining ("galamsey") in Ghana represents one of the continent's most acute land degradation and water-contamination crises — a challenge that is simultaneously environmental, climatic, and a failure of geoinformation governance. Activities expand rapidly, relocate frequently, and routinely outpace field enforcement, making persistent, spatially authoritative monitoring essential. This paper presents an integrated geospatial framework that transforms enforcement from reactive, politically driven raids to continuous, evidence-led compliance monitoring — directly addressing the AGSE themes of climate change monitoring, AI-assisted geoinformation, and collaborative data portals in an African context. The framework combines five layers: (1) Sentinel-1 SAR time-series change detection; (2) UAV photogrammetry and LiDAR validation; (3) deep learning image segmentation for large-area inventory and inspection prioritisation; (4) a geofenced rules engine delivering real-time alerts; and (5) a community governance layer embedding the system within Ghana's customary land tenure structures. The system produces a transparent, auditable mineral rights cadastre aligned with both international licensing best practice and Ghana's stool land governance, shifting enforcement from anecdote to time-stamped spatial evidence.

Keywords: *Climate, galamsey, ASM, deep-learning, change-detection, compliance, governance*

Multi-Sensor Aerial Surveillance and Deep Learning for Geospatial Detection and Monitoring of Illegal Artisanal Mining in the Atewa Forest Reserve, Ghana

Samuel Appiah Kubi, Angela Bubune Bleboo and Rahana Ismael

Kwame Nkrumah University of Science and Technology

The Atewa Forest Reserve in Ghana is one of the most ecologically significant tropical forests in West Africa, serving as the primary freshwater source for over five million people through five major river systems. Despite its protected status, the reserve has experienced accelerating encroachment from illegal artisanal gold mining, locally known as galamsey, with an estimated 890 hectares lost between 2017 and 2023. Conventional monitoring is hindered by site inaccessibility, safety risks, and persistent cloud cover exceeding 180 days annually, rendering traditional optical remote sensing largely unfeasible.

This study presents an automated multi-sensor deep learning pipeline for systematic detection, spatial mapping, and temporal monitoring of galamsey within the reserve from 2018 to 2024. The framework integrates Sentinel-2 Level-2A multispectral imagery, Sentinel-1 C-band Synthetic Aperture Radar data, and Landsat 8 and 9 surface reflectance products into a 26-channel spatiotemporal feature stack comprising spectral indices, SAR backscatter in VV and VH polarisations, grey-level co-occurrence matrix texture features, and multi-temporal change metrics. A ResNet-50 encoder U-Net architecture trained on ground truth digitised from Google Earth Pro produces per-pixel mining probability maps for each acquisition date.

Unmanned Aerial Vehicle orthomosaic imagery serves two critical roles. A YOLOv8 object detection model identifies individual mining equipment including excavators, water pumps, and settling ponds to support law enforcement response. The sub-decimetre spatial resolution of the UAV data also provides independent validation of satellite-derived mining boundaries at a precision that field GPS measurements alone cannot achieve.

Temporal analysis applies a Kalman filter tracking framework across eleven multi-sensor acquisition epochs to quantify site-level expansion rates and classify activity into expanding, stable, and recovering categories. Fusing SAR with optical data maintains detection continuity through cloud-covered periods, a decisive advantage in the Atewa environment. The pipeline is implemented as a reproducible open-source framework transferable to protected forest monitoring across humid tropical regions.

Keywords: *Illegal Mining, Sentinel-1, Sentinel-2, UAV, Deep Learning, U-Net, Change Detection, Atewa Forest Reserve*

FLOODWATCH: A Geospatial Flood Risk Assessment and Citizen-Facing Early Warning Application for Urban Communities in Ghana A Case Study of Kisseman, Greater Accra Region

Dennis Appiah Ansah

Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

Urban flooding in peri-urban communities across sub-Saharan Africa continues to cause significant loss of life and property due to rapid urbanisation, inadequate drainage infrastructure, and increasing rainfall variability associated with climate change. Despite growing flood vulnerability, accessible citizen-facing flood risk communication systems remain limited in many urban communities in Ghana. This study presents the ongoing development of FloodWatch, a geospatial flood risk assessment and early warning application designed to support localised flood preparedness and risk communication in Kisseman, a peri-urban community in the Greater Accra Region of Ghana.

The project integrates field-collected drainage condition data, terrain analysis, and short-term rainfall forecasting within a GIS-based decision-support framework. Approximately 100 evenly distributed ground survey points are currently being collected across the study area using KoboToolbox-enabled mobile surveys. Field observations include GPS location, gutter type, drainage choke level, flow direction, and photographic documentation of drainage conditions along major roads and flood-prone zones. Terrain slope and flow direction are being derived from a 30-metre SRTM Digital Elevation Model, while seven-day rainfall forecasts are retrieved programmatically through the Open-Meteo API.

A preliminary Flood Risk Score (FRS) model has been developed to estimate localised flood susceptibility by integrating drainage choke level, terrain slope, and forecast rainfall using a weighted composite scoring approach. Risk outputs are classified into Low, Moderate, and High flood-risk categories to support public interpretation and decision-making. The proposed FloodWatch mobile web application is designed to automatically detect a user's location, identify nearby drainage assessment points, and provide simplified seven-day flood risk advisories for surrounding areas.

The study is currently in the field data acquisition and system implementation phase, with validation planned during Ghana's major rainy season through comparison of predicted risk levels with observed rainfall events and community-reported flooding occurrences. The expected outcome is a scalable and low-cost geospatial early warning framework capable of improving citizen preparedness, supporting local disaster risk reduction efforts, and informing urban flood management policy in rapidly developing communities.

Keywords: *Flood risk assessment, GIS, Urban flooding, Drainage infrastructure, Citizen early warning, Ghana, Mobile application, Geospatial analysis*

Climate-Induced Multi-Geohazard Dynamics and Public Health Vulnerability in Peri-Urban Accra, Ghana: A Geoinformatics-Based Framework

Benjamin Boateng

University of Ghana, Accra

Rapid urbanisation and increasing climate variability are intensifying the occurrence, interaction, and spatial complexity of multiple geohazards in peri-urban environments across sub-Saharan Africa. Despite this growing risk, limited research has conceptualised these hazards as interconnected systems or examined how their cascading interactions, mediated by infrastructural conditions, translate into public health vulnerabilities. This study develops a geoinformatics-based framework to investigate climate-induced multi-geohazard dynamics and associated public health risks in communities within the Weija–Gbawe and Ga South Municipal Assemblies of Greater Accra, Ghana.

The study conceptualises a cascade system in which extreme rainfall acts as the principal trigger, initiating flooding as the primary hazard and inducing soil erosion, gully formation, slope instability, and environmental contamination. These processes are shaped by terrain, hydrological conditions, drainage infrastructure, land use, and socio-environmental characteristics.

Methodologically, the research integrates GIS-based multi-criteria decision analysis using the Analytic Hierarchy Process (AHP), field-based geohazard assessments, household surveys, and health facility records. Thematic layers derived from digital elevation models, hydrological analysis, and land use classification were standardised and weighted to generate susceptibility maps for flooding, erosion, and slope instability. Hazard layers were integrated through spatial overlay techniques to delineate zones of multi-hazard interaction and assess environmental contamination pathways and health risks.

Flood susceptibility indicates that 13.50% and 29.79% of the study area fall within very high and high susceptibility classes. Erosion susceptibility mapping shows that 16.51% and 30.43% of the area are classified as very high and high risk, while slope instability analysis identifies 31.17% and 25.83% as moderate and high susceptibility zones. Integrating hazard intensity, exposure characteristics, and adaptive capacity indicators, the study identifies spatial hotspots of compounded climate–geohazard–health vulnerability across environmentally stressed and rapidly urbanising areas. The findings underscore the need for integrated planning and targeted public health interventions in rapidly expanding peri-urban settlements.

Keywords: Multi-Geohazard, Peri-urban, Climate-induced hazards, GIS, Analytic Hierarchy Process, Susceptibility mapping, Public health vulnerability

Comparative Assessment of Global Building Footprint Datasets: Evaluating Completeness, Accuracy, and Coverage Using a Grid-Based Approach

Vannesah Kporha, Dennis Fox and Mostafa Banitalebi and Edward Martey

Université Côte D'Azur, France

Accurate knowledge of the built environment is increasingly critical for climate change adaptation. Building footprint datasets serve as foundational inputs for surface imperviousness modelling, urban flood risk assessment, heat island analysis, and several other analyses that are urgently needed across rapidly urbanizing regions. Yet, while globally available open building datasets offer unprecedented coverage, their accuracy, completeness, and reliability for environmental modelling remain largely unquantified.

This study presents a systematic spatial accuracy and completeness assessment of three widely used global building footprint datasets: the JRC Digital Building Stock Model (DBSM), EUBUCCO, and Microsoft Bing Maps. These were compared to the reference official French national cadastral dataset, BD TOPO for 211 cities in France. Using a 100-meter gridded Building Area Ratio (BAR) framework, where BAR represents the fraction of each grid cell covered by building footprints, we evaluated spatial agreement across two filtering scenarios: a Benchmark-Based scenario which evaluates each dataset wherever buildings are known to exist in the reference data, and (2) an intersection-based scenario restricted to grid cells where all datasets jointly report building presence. Results are stratified into three urban density classes based on BAR values: Low Density, where buildings cover 10–40% of a grid cell; Moderate Density (40–70%); and High Density, where buildings cover 70–100% of the cell area.

Our results demonstrate that, under the benchmark-based scenario, JRC DBSM achieves the strongest overall agreement with BD TOPO ($R^2 = 0.82$), while EUBUCCO shows moderate correlation ($R^2 = 0.46$) and Microsoft Bing the weakest ($R^2 = 0.23$), with substantial underestimation driven largely by building omissions. Under the intersection-based scenario, agreement improves markedly and converges across datasets (JRC: $R^2 = 0.88$; EUBUCCO: $R^2 = 0.87$; Bing: $R^2 = 0.86$), confirming that discrepancies are primarily attributable to incomplete spatial coverage rather than systematic geometric error. Performance nonetheless degrades with increasing urban density across all datasets: while agreement remains strong in low-density areas ($R^2 = 0.76$–0.82), it declines substantially in moderate-density zones ($R^2 = 0.33$–0.58) and further in high-density urban cores ($R^2 = 0.16$–0.39), where building omissions and segmentation errors are most consequential.

These spatial inaccuracies have direct implications for environmental risk modelling. Underestimated building coverage translates to underestimated impervious surface area, a key driver of surface runoff and a primary input to urban flood and heat island models. Datasets that systematically undercount buildings in dense urban areas will therefore tend to underestimate flood peak flows and misrepresent urban thermal environments, potentially leading to inadequate drainage design and inaccurate hazard mapping.

The gridded BAR framework presented here is scalable and transferable, offering a practical tool for validating open building datasets in any urban context. These findings highlight both the potential and constraints of global building datasets, emphasizing the importance of understanding spatial context, coverage variability, and morphological complexity when applying them to urban analysis and geospatial modeling.

Keywords: *Building footprint datasets, Building Area Ratio, Urban imperviousness, Geospatial accuracy assessment*

Geospatial Frameworks for Gender-Responsive Rainwater Harvesting in Urban Sub-Saharan Africa: A Systematic Literature Review Protocol and Research Agenda

Michael Mutale[1,2] and Oluibukun Gbenga Ajayi[2,3]

[1]Department of Geomatics Engineering, Copperbelt University, Kitwe, Zambia
[2]Department of Land and Spatial Sciences, Namibia University of Science and Technology, Windhoek, Namibia
[3]Department of Geography, Geoinformatics and Meteorology, University of Pretoria, South Africa

Urban and peri-urban communities across sub-Saharan Africa face intensifying water insecurity driven by climate variability, rapid urbanisation, and infrastructure deficits. Rainwater harvesting (RWH) has emerged as a promising decentralised adaptation strategy, with Zambia's National Water Policy (2024) and National Rainwater Harvesting Strategy (2024) explicitly mandating its scale-up. Yet RWH spatial planning remains technically fragmented, socially unresponsive, and largely gender-blind — a critical gap where women spend three to five hours daily collecting water, and approximately 70% of urban residents live in informal settlements with acute infrastructure deficits.

This paper introduces a systematic literature review (SLR) under a PhD research programme at the Namibia University of Science and Technology, aimed at developing a multi-scale geospatial framework for gender-responsive RWH planning in Zambian urban and peri-urban areas. Following PRISMA protocols, a structured search of peer-reviewed literature published between 2000 and 2025 across Scopus, Web of Science, and Google Scholar will identify studies applying: (i) GIS, remote sensing, or spatial modelling to RWH; (ii) urban/peri-urban contexts in sub-Saharan Africa or analogous settings; and (iii) gender or social dimensions of technology adoption. Thematic synthesis will assess methodological approaches, analytical scales, data sources, and the integration of gender-disaggregated indicators into geospatial workflows.

The review addresses three compounding gaps motivating this research. First, despite advances in GIS-based RWH suitability analysis — integrating terrain, land cover, and multi-criteria frameworks — gender considerations remain peripheral, with prior scoping indicating fewer than 15% of spatial studies include gender-disaggregated data. Second, most existing frameworks operate at a single spatial scale, failing to link household adoption decisions to neighbourhood and watershed hydrological outcomes. Third, sub-Saharan African urban contexts, particularly Zambia, are severely underrepresented in spatial RWH literature despite high climate exposure and urbanisation pressure.

Grounded in Feminist Political Ecology, this paper argues that integrating gender-responsive indicators — such as time-distance modelling, participatory spatial data co-produced with women in informal settlements, and social feasibility criteria — is both a normative imperative and a technical necessity for sustainable RWH adoption and hydrological co-benefits. Finally, it outlines a research agenda positioning this multi-scale geospatial framework as a contribution to socio-hydrology and climate-resilient urban water planning across sub-Saharan Africa.

Keywords: rainwater harvesting, systematic literature review, gender-responsive GIS, multi-scale geospatial framework, urban water security, socio-hydrology, Feminist Political Ecology, Zambia, sub-Saharan Africa

Geomatics in Boundary Management: Strengthening Delimitation, Demarcation, Reaffirmation and Monitoring through Geospatial Technologies

Herbert Djaba

Ghana Boundary Commission

Boundary management is central to national sovereignty, territorial integrity, peaceful coexistence, security, resource governance and cross-border development. In an era where borders are no longer viewed only as political lines but also as dynamic spaces of movement, settlement, trade, environmental interaction and security concern, the role of geomatics has become increasingly important. This paper examines the contribution of geomatics to modern boundary management, with an emphasis on the application of geospatial science, surveying, GNSS, GIS, remote sensing, photogrammetry, LiDAR, hydrography, geodetic control, spatial databases, and digital cartography in the delimitation, demarcation, reaffirmation, and monitoring of international and administrative boundaries.

The paper argues that effective boundary management requires more than legal descriptions and historical records; it demands accurate spatial data, reliable coordinate reference systems, interoperable geospatial databases, field-verifiable evidence and continuous monitoring of boundary corridors. Geomatics provides the technical foundation for identifying boundary features, reconstructing historical boundary alignments, positioning boundary pillars, producing authoritative maps, managing cross-border infrastructure, supporting joint technical commissions and resolving disputes through evidence-based analysis. The study further highlights the importance of integrating geospatial technologies with legal, diplomatic, institutional and community-based processes to ensure that boundary decisions are not only technically accurate but also politically acceptable and socially sustainable.

The paper concludes that geomatics should be recognised as a strategic tool for boundary governance, especially in Africa, where many boundaries remain under-demarcated, poorly documented or affected by rapid settlement growth, environmental change and transboundary resource pressures. Strengthening national boundary institutions with modern geospatial capacity, standardised data frameworks, trained professionals and collaborative platforms will improve boundary certainty, reduce conflict risks, support regional integration and promote sustainable development in border areas.

Keywords: Geomatics, Boundary Management, Delimitation, Demarcation, Reaffirmation, GNSS, GIS, Remote Sensing, Geospatial Data, Border governance

Unsupervised Mapping of Flood-prone Areas in Ghana Using Sentinel-1 Time-Series

Felix Enyimah Toffah[1] and Francesco Pirotti[2]

[1] Sapienza University of Rome, Italy, [2] University of Padova, Italy

This study investigates the long-term impacts of climate change and land use/land cover (LULC) dynamics on streamflow within a transboundary section of the lower Okavango River Basin, spanning northeastern Namibia and southern Angola. Employing the SWAT+ hydrological model, we simulated historical and future hydrological responses under combined scenarios of climate and LULC change using four CMIP6 general circulation models (GFDL-ESM4, IPSL-CM6A-LR, MPI-ESM1-2-HR, NorESM2-MM) and 1-km resolution global land projection datasets. The model was calibrated and validated with historical streamflow data at Rundu, achieving reliable performance statistics. Future scenarios—spanning the periods 2025–2040, 2041–2070, and 2071–2100—were run under moderate (SSP2-4.5) and high (SSP5-8.5) emission trajectories.

Results indicate a consistent decline in precipitation and an amplified reduction in streamflow, with peak runoff periods significantly shortened and dry-season flows nearing collapse by 2100. Model projections show strong agreement in the direction of change, particularly in the latter half of the century. Parallel LULC projections reveal a rapid loss of wetland and natural vegetation, coupled with an expansion of cropland and urban areas—particularly around Rundu. These land use transitions further intensify hydrological losses by reducing infiltration capacity and enhancing surface runoff.

Water yield simulations reflect this compounding impact, with historically high-yield zones gradually shrinking and nearly disappearing by the end of the century. The study highlights the disproportionate sensitivity of streamflow to both upstream rainfall and local land management, underscoring the urgent need for coordinated adaptation strategies. Findings provide critical insight for water resource managers and policymakers aiming to address long-term water security and ecological stability in one of Southern Africa's most vulnerable transboundary river systems.

Keywords: *Flood, Change Detection, Topography, Ghana, Earth Observation*

Modelling Gully Erosion Susceptibility and its Socio-Economic Impacts Using Machine Learning Algorithms: A Case Study of the Suam River Basin, West Pokot County, KenyaTitle

Moses Murimi Ngigi and Charles Churu Wambui

Kenya Dedan Kimathi University of Technology

Gully erosion is a major environmental challenge in arid and semi-arid regions as it leads to the loss of productive land, damage to infrastructure, and declining agricultural productivity. This study modelled gully erosion susceptibility and assessed its socio-economic impacts in the Suam River Basin in West Pokot County, Kenya. Support Vector Machine (SVM) and XGBoost algorithms were applied, and their outputs were combined using a geometric mean ensemble approach to improve prediction accuracy. A wide range of environmental and topographic conditioning factors: elevation, rainfall, R-factor, slope, slope length-steepness (LS factor), flow accumulation, topographic wetness index, slope aspect, plan and profile curvature, convexity, convergence index, terrain ruggedness index, topographic position index, landform, valley depth, stream power index, land use and land cover, bare soil index, normalized difference vegetation index, transformed vegetation index, drainage density, distance to streams, soil properties (clay, sand, cation exchange capacity, and bulk density), and lithology were used in the modelling. Model performance was evaluated using the Receiver Operating Characteristic (ROC) curve and the Area Under the Curve (AUC) metric. The SVM model achieved an AUC of 0.950, XGBoostrecorded 0.978. Socio-economic proxies: proximity to roads, hospitals, markets, schools, and population density, were integrated with the gully erosion susceptibility maps to generate socio-economic vulnerability maps. This study demonstrates that ensemble machine learning models can significantly improve the accuracy of gully erosion susceptibility mapping and provide a scientific basis for sustainable land management and infrastructure planning in data-scarce regions such as the Suam River Basin.

Keywords: gully erosion, machine learning, ensemble modelling, SVM, XGBoost, land degradation, socio-economic vulnerability

Exploratory Study on Using Deep Learning for Monitoring Vertical Ground Displacement

Felix Enyimah Toffah[1,2], Ruben Cartuyvels[3], Patrick Ebel[3], Francesco Pirotti[2,4]

[1] Department of Civil, Building and Environmental Engineering, Sapienza University of Rome
[2] Interdepartmental Research Centre of Geomatics (CIRGEO), University of Padova, Italy
[3] ϕ - lab of the European Space Agency, Frascati, Italy
[4] Land, Environment and Agro-Forestry (TESAF) Department, University of Padova, Italy

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Vertical Ground Displacement (VGD), encompassing both subsidence (downward displacement) and uplift (upward displacement), has significant implications for infrastructure stability and environmental sustainability. This phenomenon is influenced by a variety of natural and anthropogenic factors, with groundwater extraction emerging as a prominent driver on the global scale (Davydzenka et al. 2024). Italy serves as an illustrative case study, as several regions across the country exhibit pronounced ground motion dynamics: active volcanoes in Napoli and Sicily, tidal influence in Venice, ground water extraction for irrigation purposes in areas such as the Veneto region etc. An initial study of VGD over Italy using ground displacement measurement data from 2018-2022 obtained from the European Ground Motion Service (EGMS) ortho-products revealed the occurrence of both uplift and subsidence in varying areas of Italy with significant uplift in the northern sector of the territory and subsidence in Emiglia-Romagna, Sicily, Apulia, Toscana and Umbria regions.

Traditionally, displacements are studied using SAR interferometric data processing approach which requires huge computational resources for wide area (e.g. country wise) applications. The emergence of deep learning has advanced societal efforts in for instance natural hazard assessment and monitoring the impact of ground displacement on infrastructures. This study aims to exploit deep learning to model and spatially densify VGD over the Emilia-Romagna region of Italy. Specifically, we train a spatio-temporal model to predict VGD at a given measurement point (MP) and time step (t) using environmental predictors (e.g., temperature, precipitation and drought index) from that MP and its surrounding areas at preceding time steps (0: t-1). This approach addresses the spatial sparsity and computational limitations of satellite interferometry. To assess the model's generalization capability and robustness to unseen spatial contexts, evaluation is performed on spatially held-out test sets, which ensures that predictions are validated over regions not used during training. To identify the relative importance of the various predictors and how they contribute to the model's prediction of VGD, a Post-hoc Model-agnostic explanation method in the SHAP (SHapley Additive exPlanations) library available in Python was used.

Keywords: CNN-ConvLSTM, Explainable AI, spatio-temporal features, vertical ground displacement

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Multi-Source Geospatial Data Fusion for Geospatial Change Detection via IA

William Benigno, Barragan-Zaque, Lilia Edith Aparicio Pico, Robinson Quintana Puentes

Universidad Distrital Fancisco Jose de Caldas, Colombia

The integration of geospatial data from multiple sources has emerged as a key strategy for monitoring, analyzing, and understanding complex territorial dynamics. This work presents an advanced approach for geospatial change detection through the fusion of Digital Surface Models (DSM) derived from LiDAR and high-resolution RGB imagery, employing object-based methodologies combined with artificial intelligence techniques to efficiently and accurately analyze multitemporal datasets.

The proposed approach enables the processing of datasets from different time periods, generating representative image objects for surface features and infrastructure, from which comparative features are extracted, including elevation differences, area changes, spectral variations, and alterations in texture or shape. These features form the basis for automated change identification, allowing changes of different types to be classified and differentiated in a reproducible and objective manner.

The workflow emphasizes the importance of rigorous preprocessing and harmonization, including spatial co-registration of datasets, radiometric and elevation normalization, and noise reduction in DSM models. Multiresolution segmentation oriented to objects ensures that captured information realistically represents scene elements, overcoming the limitations of pixel-based approaches.

Additionally, refinement strategies based on context and spatial rules are incorporated to minimize false positives, ensuring robustness of the results. The methodology is scalable and flexible, allowing the integration of other sensor types or geospatial layers without compromising analytical consistency. This approach provides a reliable and reproducible platform for detecting changes in geospatial environments, representing a significant contribution to the advancement of artificial intelligence applied to geoinformatics and dynamic cartography.

Keywords: Geospatial data fusion, Digital Surface Models – DSM, Multitemporal imagery, Artificial intelligence

GeoAI Solutions for Flood Risk Monitoring and Early Warning Systems in informal Settlements, South Africa

Emmanuel Fundisi

Human Sciences Research Council, South Africa

Informal settlements, particularly in flood-prone regions face escalating risks from extreme hydro-meteorological events, brought about by Climate Change. These communities are characterised by high building density and inadequate drainage infrastructure, often situated within flood plains. Traditional disaster management is frequently hampered by the lack of granular, real-time spatial data necessary to monitor rapid informal densification and its impact on hydrological runoff. This study develops a GeoAI-driven Flood Risk Monitoring and Early Warning System using the Google Earth Engine (GEE) platform. The methodology integrates multi-temporal Sentinel-1 (SAR) and Sentinel-2 (optical) imagery to detect surface water changes. A Random Forest (RF) machine learning algorithm is utilized for automated classification of damaged areas, while high-resolution building footprints from the Google Open Buildings dataset are intersected with flood extent layers. A localized runoff risk index was generated by integrating the Topographic Wetness Index (TWI) and Normalized Difference Water Index (NDWI) to identify structural exposure at a dwelling level. Accuracy assessment was established using the SANSA developed flood layer. Implementation across informal settlements demonstrated that the GeoAI model achieves a classification accuracy of 70% in identifying inundated structures. The system successfully mapped high-risk hotspots, where significant flood destruction in 2025 and 2026 was correlated with localized topographic depressions. The use of SAR data was critical for bypassing cloud cover during peak storm events, providing near real-time hazard scoring that outperformed traditional optical-only monitoring. The study concludes that GeoAI provides a scalable, cost-effective framework for enhancing disaster resilience in informal settlements. By automating damage detection and calculating hazard scores, this system facilitates proactive early warnings and can bridge the gap between geospatial intelligence and community-led response, ultimately reducing socio-economic vulnerability in South Africa's urban centers.

Keywords: Informal Settlements, GeoAI, Flooding, Climate Change

Geo Artificial Intelligence of Things (GAIoT): Integrating UAV Based Geoinformation, Sensors, and AI for Environmental and Societal Applications

Pawan Thapa[1] and Mandil Thapa[2]

[1] Nepal Kathmandu University and University of Alabama
[2] Nepal Tribhuvan University

Recent advances in geospatial data acquisition and artificial intelligence have significantly expanded the role of applied geoinformatics in addressing environmental and societal challenges. In this context, the concept of Geo Artificial Intelligence of Things (GAIoT) represents an emerging framework that integrates geospatial observations, Unmanned Aerial Vehicles (UAVs), sensor networks, and AI based analytics to support spatially informed decision making. UAV platforms equipped with multispectral, hyperspectral, thermal, LiDAR, and navigation sensors enable high resolution and flexible geospatial data collection, particularly in environments where satellite observations are limited by scale, temporal resolution, or cloud cover. This contribution positions UAV based systems as intelligent geospatial sensing nodes within a broader GAIoT framework. By combining UAV derived geoinformation with machine learning and deep learning approaches, GAIoT systems support key geospatial tasks such as object detection, change analysis, environmental monitoring, and near real time situation assessment. From an applied geoinformatics perspective, the paper reviews recent open and accessible research on UAV based GeoAI workflows, emphasizing data acquisition strategies, sensor fusion, spatial processing pipelines, and integration with geospatial information systems. The paper further discusses societal and environmental applications of GAIoT, including climate monitoring, disaster risk assessment, precision agriculture, and emerging urban use cases. In addition to technical opportunities, critical challenges related to data management, interoperability, regulatory constraints, energy limitations, and trustworthy AI are highlighted. The study concludes by outlining future directions for GAIoT research, emphasizing open geospatial standards, explainable AI, and sustainable sensing technologies to ensure that UAV enabled geoinformation systems effectively support society and the environment.

Keywords: GeoAI, Geo Artificial Intelligence of Things (GAIoT), UAV based geoinformation, remote sensing, sensor fusion, applied geoinformatics, environmental monitoring, societal applications

Integrating Traditional Agro-Ecological Knowledge and Machine Learning for Hyper-Local Climate Information Services in the Northern Region of Ghana

Louisa Boakye

KNUST Department of Environmental Science, Ghana

Climate variability increasingly threatens smallholder farming systems in Ghana, where access to timely, reliable, and locally relevant climate information remains limited. Although conventional climate information services (CIS) provide useful forecasts, they often lack the spatial specificity and contextual relevance needed for farm-level decision-making. At the same time, smallholder farmers rely on Traditional Agro-Ecological Knowledge (TAEK), an important but under-documented source of localized climate intelligence. The weak integration of indigenous knowledge with formal forecasting systems limits the development of inclusive and context-sensitive climate services. This study addresses that gap by developing a hybrid CIS that combines digitized TAEK indicators with machine learning to generate hyperlocal climate information for smallholder farmers. The study documents, categorizes, and digitizes farmers' TAEK indicators of climate variability and forecasting in the study area. These indicators are integrated with historical meteorological data to develop a machine learning model for short-term and seasonal climate forecasting. The hybrid CIS is then evaluated against conventional climate services and farmers' observed climate patterns in terms of forecast accuracy and timeliness. The study also examines how the co-developed system influences farm-level decisions, particularly planting dates, crop variety selection, and resource allocation, and identifies the socio-economic and institutional factors shaping adoption and perceived utility across gender and age groups.

By integrating indigenous knowledge systems with data-driven forecasting, the study contributes to current work on geoinformation and artificial intelligence. It aims to inform the design of inclusive, AI-enabled climate services that improve adaptive decision-making and strengthen resilience among smallholder farmers.

Keywords: Machine learning, Traditional Agro-Ecological Knowledge, Hyperlocal climate information services

GeoAI-Driven GIS-Ready Coffee Plantation Intelligence from High-Resolution Orthomosaics for Climate-Smart Agriculture in Southwestern Saudi Arabia

Gabriel Sanya

GIS and Remote Sensing Consultant, Kenya

This study presents an operational GeoAI framework for generating GIS-ready coffee plantation intelligence from high-resolution orthomosaic imagery in the mountainous coffee-growing landscapes of southwestern Saudi Arabia. The framework integrates tiled deep learning inference, spatial post-processing, georeferenced crown extraction, and GIS-compatible outputs to support climate-smart agricultural monitoring and plantation management.

High-resolution RGB GeoTIFF orthomosaics were processed using a scalable GeoAI workflow designed for small-object tree crown detection under complex terrain conditions characterized by terrace farming, heterogeneous canopy density, and shadow interference. The workflow employs dual-scale tiled inference with overlap-aware processing and spatial calibration to improve crown continuity and reduce duplicate detections across tile boundaries.

Unlike studies focused primarily on model benchmarking, this research emphasizes institutional usability and operational deployment. Detection outputs were transformed into GIS-ready products including GeoJSON layers, Shapefiles, centroid datasets, and interactive web-based visualization maps suitable for ArcGIS Pro, QGIS, and extension-support environments. Spatial outputs enabled visualization of plantation density variability, stand-gap identification, and rehabilitation prioritization across coffee production zones.

Results demonstrate that GeoAI can provide a practical pathway from satellite imagery to actionable agricultural intelligence in arid and mountainous plantation systems where traditional field inventories remain expensive and difficult to scale. The proposed framework contributes toward climate-smart plantation governance, digital agriculture transformation, and geospatial decision-support systems aligned with sustainable agricultural development initiatives.

Keywords: GeoAI, Deep Learning, Precision Agriculture, Agricultural Intelligence

Leveraging multi source spatial temporal data in a hybrid CNN-LSTM-Multi Head Attention architecture for near real time dynamic flood prediction in Ghana

James Amoako

Kwame Nkrumah University of Science and Technology, Ghana

Flooding remains one of the most destructive natural hazards globally, driving widespread socio-economic disruption and loss of life. Conventional forecasting systems, however, frequently struggle to integrate highly heterogeneous datasets and fully capture the complex spatio-temporal dynamics inherent to flood events. This research addresses these limitations by leveraging artificial intelligence to develop a near-real-time dynamic flood prediction model optimized for Ghana, West Africa. A robust preprocessing pipeline was engineered to clean and integrate multi-source spatial and temporal data, including seasonal meteorological records, historical flood events, NASA POWER variables, a 30m SRTM Digital Elevation Model (DEM), and hydrological shapefiles for rivers, lakes, and settlements.

Utilizing this unified framework, we developed a hybrid Convolutional Neural Network–Long Short-Term Memory (CNN–LSTM) architecture enhanced with Multi-Head Attention. Rigorous validation against 12 documented historical flood events demonstrated outstanding predictive capabilities. The model achieved approximately 96% training and validation accuracy within just 5 epochs, climbing to approximately 98% by epoch 10. Comprehensive performance evaluations confirmed its structural robustness, yielding macro and weighted F1-scores of 0.962, ROC-AUC values 0.998, and Precision–Recall scores 0.985. Granular class-level analyses revealed excellent discrimination across all five risk categories, maintaining high fidelity with only marginal declines in the moderate (F1 = 0.948) and severe (F1 = 0.946) risk bands.

Furthermore, hydrological validation against NASA POWER observations demonstrated strong alignment, featuring outstanding agreement for surface pressure (NSE = 0.97), acceptable wind speed modeling (NSE = 0.44), and robust rank-order consistency for precipitation (Spearman = 0.552, p = 0.001), despite expected baseline magnitude discrepancies (MAPE = 78). Spatiotemporal error analysis validated the model's reliability, confirming spatially random residuals (Moran’s I approx 0) and statistically significant temporal convergence for temperature and precipitation (Mann-Kendall $p < 0.05$), indicating progressive model adaptation. To translate these capabilities into practical utility, a scalable Application Programming Interface (API) was designed for dual deployment across web platforms and edge devices. This strategy ensures that accessible early warning systems can be seamlessly adapted to diverse technological infrastructures. Ultimately, this study highlights the potential of combining rigorous multi-source data processing with attention-enhanced deep learning, offering a validated, replicable, and operational tool to deliver timely intelligence and strengthen community resilience in data-constrained regions.

Keywords: CNN-LSTM, Dynamic flood prediction, Multi Head Attention, Multi source data

Roadessy-Omni: A Low-Cost Vision-Inertial Framework for Road Condition Assessment, Mapping and Management in Ghana

Emmanuel Amankwah, Samuel Akorful-Andam

Department of Geomatic Engineering Kwame Nkrumah University of Science and Technology, Ghana

The poor condition of roads in sub-Saharan Africa is a major challenge for economic development, with more than 40% of the roads rated as being in poor or very poor condition, partly due to climatic conditions including frequent wet–dry cycles, high temperatures, heavy rain and flooding which reduce the life of the road. Additional factors that lead to poor pavement conditions are lack of maintenance activities, heavy traffic volume and the use of inappropriate materials or construction methods. The traditional methods of assessment like class 1 laser profilers are highly accurate, but are impractical and expensive to implement in developing countries. This study presents a robust and cost-effective Vision-Inertial Fusion (VIF) framework for high frequency network supervision of tropical lateritic pavements in the Ashanti region of Ghana.

The methodology adopts a "democratised" sensing layer of dashboard-mounted 4K cameras and 100 Hz tri-axial accelerometers to simultaneously acquire road-surface anomalies, and vehicular vibrations. The system features a Geospatial Medallion Architecture in a centralised backend system using Python FastAPI and PostGIS to offload the computational "heavy lifting" from resource limited edge devices. This refinery uses the Automated Map Matching algorithm to automatically match the GPS traces to the road centreline, and retrieves the UTC time to match forward-looking visual data with delayed mechanical data.

Structural integrity is assessed with a YOLOv11 model for multiple tasks, which makes integrated detection, classification, and delineation of distresses including those geotechnically inherent desiccation cracks, in a single forward pass, at inference speed of approximately 60 frames per second (FPS). The functional serviceability is determined by passing denoised mechanical signals through a mathematical “Golden Car” Quarter-Car Simulation (QCS) set at a constant speed of 80 km/h to estimate the International Roughness Index (IRI). The framework segments the road network sections used for Pavement Condition Index (PCI) calculation and road network segments used for IRI reporting that meet the requirements of ASTM D6433 and Information Quality Level 3 (IQL-3).

The results of the validation showed that the coefficients of correlation (R2) of the curves generated using computerization of deduct values by parametric cubic splines are 0.989 compared with the software available in the industry. The final system provides actionable intelligence via the Next.js Web-GIS digital twin which allows the Ghana Highway Authority (GHA) and other relevant stakeholders to visualize and see network-level deterioration and help them prioritize maintenance with objective, data-driven intelligence. This study offers a scalable template for addressing the infrastructure data gap in resource constrained areas.

Keywords: Climate, Vision-Inertial Fusion (VIF), Pavement Condition Index (PCI), International Roughness Index (IRI), YOLOv11, Ghana Highway Authority (GHA)

Slope Unit-Based Sampling Strategy for Evaluating Landslide Susceptibility Using Machine Learning Models

Sudip Shrestha

Nepal Survey Department, Kathmandu

The present study has evaluated the effect of slope unit-based sampling strategies for landslide susceptibility modelling in the Himalayan terrain. Different machine learning (ML) models: logistic regression model (LR), support vector machine (SVM), random forest (RF) and boosting algorithms are used based on training and validation datasets utilizing twelve conditioning factors to predict landslide susceptibility. The performance of the model predictions was elaborated based on parameters of receiver operating curve (ROC) in area under the curve (AUC), precision, recall, F1 score, accuracy (ACC), and Matthew's correlation coefficient (MCC). The statistical indices, AUC values achieved well in Random Forest (84%) and boosting algorithms Adaboost (82%), XGboost (82%) and Gradient Boosting (83%). SHAP analysis further revealed the statistical significance of influencing factors, with a synergistic effect. The landslide susceptibility map is prepared by calculating the probability distribution function.

Keywords: Landslide, Slope unit, sampling, machine learning, model performance

Towards Urban Tree Species Classification: A Machine Learning Instance Segmentation Approach to Multimodal Species-Classification Dataset Creation and Algorithms Development

Selorm Komla Darkey

University of Exeter, United Kingdom

Tree inventories are essential for monitoring, management, and planning in both forest and urban ecosystems. Despite the significant ecological and social benefits of urban trees, most species classification studies have focused on forested environments. In the United Kingdom (U.K), existing tree mapping efforts are either limited to generalized canopy cover or rely on small-scale, manually collected inventories, restricting their scalability.

This study investigates the feasibility of large-scale urban tree species classification across the UK using Earth observation data and machine learning (ML) approaches. Google Satellite Imagery, High-resolution PlanetScope and multispectral Sentinel-2 imagery were used to detect and delineate individual tree crowns, as well as create novel classification datasets.

Tree detection and crown delineation were performed using Mask Region-Based Convolutional Neural Networks (Mask R-CNN) with a ResNet-50 backbone and Feature Pyramid Network and benchmarked against a single-shot You Only Look Once (YOLOv11) segmentation architecture, achieving an overall accuracy of approximately 80% in tree crown segmentation tasks. A key contribution of this work is the creation of a novel, multi-modal, multi-temporal satellite-derived urban tree species dataset for the UK to support scalable, reproducible urban tree species mapping efforts.

By integrating satellite data with Artificial Intelligence techniques, this work demonstrates a pathway toward improved urban tree species mapping at national scale. The results highlight the potential of this approach to support urban planning, biodiversity monitoring, and climate resilience initiatives, while advancing remote sensing applications in complex urban environments.

Keywords: Earth observation, Remote Sensing, Tree species classification, GeoAI, Urban climate resilience

Technical Session „Data sharing and Collaborative Geoinformation Portals”

Implementation on Geospatial-based Policies to Improve the Quality of Excellent Human Resources Toward Golden Vision of Indonesia 2045

Winhard Tampubolon

National Coordinating Agency for Surveys and Mapping, Bogor, Indonesia

In the era of Brittle, Anxious, Non-linear, Incomprehensible (BANI) characterized by global geopolitical and geoeconomic uncertainty, Indonesia has potential opportunities in human capital as the fourth largest population in the world that align with 8 % economic growth targets. This study identifies that the current national policy governance is still influenced by sectoral egos and trapped within bureaucratic silos, with internal root problems including insufficient Human Resources (HR) quality in various fields, talent gaps, and the lack of technology in policy-making process. Implications in National Resilience perspective indicate risks of demographic degradation, the natural resource curse, as well as imbalance development among regions if the gaps in national policy governance are not able to address them.

Finally, as a proposed solution, a strengthening strategy is needed through a collaborative mechanism between systems that integrates the Geoportal, human resource transformation, acceleration of downstreaming various high-value-added commodities, technology utilization, as well as standardization of regional development supported by data based on the Integrated Geospatial Information Framework (IGIF). Authorized Decision Support System through the implementation of Geospatial-Based Policy will be able to improve the quality of excellent human resources in order to maximize the demographic bonus toward Golden Vision of Indonesia 2045.

Keywords: System of Systems, Geospatial, Human capital, Geo-economy

Empowering Local Government through Digital Twin for Urban Decision Making: Integrating UAV and Terrestrial Laser Scanning Data in Rajshahi City, Bangladesh

Md Zahid Hasan Siddiquee

Institute of Water Modelling, Dhaka, Bangladesh

Divisional cities in Bangladesh, including Rajshahi, face critical governance gaps in urban infrastructure planning such as slow decision-making, lack of transparency, and minimal stakeholder participation. This study develops a high-resolution digital twin of Rajshahi's core urban area by integrating Unmanned Aerial Vehicle (UAV) photogrammetry and Terrestrial Laser Scanning (TLS) data, specifically designed to empower local government decision-making. Data acquisition combined aerial imagery and ground-based laser scanning, followed by point cloud fusion and web-based deployment on a participatory platform. The fused model achieved centimeter-level accuracy sufficient for infrastructure planning. The digital twin reduced infrastructure planning query times by over 95%, replacing multi-day field visits with sub-hour desktop analysis. Controlled experiments with city corporation planning officers demonstrated dramatic improvements in efficiency. Stakeholder transparency rating increased substantially from paper maps to the digital twin. Crucially, citizens were able to submit annotations directly on the 3D model, and multiple citizen suggestions were incorporated into revised infrastructure plans within one week – demonstrating that digital twins can move beyond visualization to genuine participatory governance. This replicable UAV+TLS workflow offers a practical template for secondary cities in the Global South to transition from static maps to dynamic, participatory digital twins – not as a futuristic luxury, but as a practical, affordable governance tool. Total implementation cost represented a minimal one-time investment relative to annual city infrastructure budgets. The term "empowerment" is operationalized through three mechanisms: speed (query response from days to minutes), autonomy (municipal staff perform measurements without external GIS experts), and legitimacy (citizens access the same data as officials, reducing disputes). Current limitations include the static temporal resolution of the twin, which reflects conditions only at the time of survey. Future work will integrate IoT sensors for real-time monitoring and automated change detection using deep learning on quarterly UAV surveys. This work aligns with AGSE 2026 themes of geoinformation capture and collaborative data portals, offering a proven pathway for data-driven, participatory urban governance in the Global South.

Keywords: Digital Twin, UAV, Terrestrial Laser Scanning (TLS), Geospatial Technology, Local Government, Stakeholder Participation, Urban Infrastructure, Participatory Governance

Design and Development of an Integrated Geospatial Intelligence Platform for Climate Vulnerability Mapping and Community-Based Risk Reporting in Northern Ghana

Abdul-Karim W. Fuseini
Stuttgart University of Applied Sciences, Germany

The increasing frequency and intensity of climate-related hazards across northern Ghana have intensified the operational challenges faced by non-governmental organisations (NGOs) and civil society organisations (CSOs) engaged in climate adaptation, disaster risk reduction, and resilience programming. A persistent problem confronting these organisations is the difficulty of accurately identifying vulnerable populations, understanding the multidimensional nature of vulnerability, and spatially prioritising interventions at community, district, and regional scales. Although vulnerability across the Northern, Savannah, North East, Upper East, and Upper West Regions is shaped by complex interactions between climatic exposure, environmental degradation, poverty, food insecurity, weak infrastructure, and dependence on rain-fed agriculture, many organisations continue to rely on fragmented assessments, isolated technical datasets, anecdotal evidence, and externally produced reports that are often insufficient for evidence-based operational decision-making. At the same time, globally available Earth observation datasets, including CHIRPS precipitation products, Sentinel-1 flood composites, MODIS-derived vegetation and thermal indices, and ESA WorldCover land classifications, possess significant potential for climate risk analysis and vulnerability monitoring. However, these datasets remain technically inaccessible to many frontline practitioners due to limited Geographic Information Systems (GIS) and remote sensing expertise, fragmented analytical workflows, and the absence of simplified decision-support environments capable of translating complex environmental data into actionable operational intelligence. This disconnect between data availability and practical usability continues to constrain early warning preparedness, adaptation planning, resource allocation, and the effective targeting of vulnerable communities across northern Ghana.

This paper presents ClimateRiskAnalytics, a prototype open-architecture geospatial intelligence platform developed to bridge this operational and technical gap. The platform integrates and contextualises multi-source environmental and socio-economic datasets within a unified browser-based analytical environment designed specifically for NGOs, CSOs, and local development practitioners with limited specialist GIS competency. The system generates actionable climate risk intelligence at community, district, regional, and cross-regional scales, enabling users to identify vulnerability hotspots, monitor environmental stress indicators, and support evidence-based adaptation planning and disaster risk reduction interventions. In addition, the platform incorporates a participatory community incident reporting module through which frontline NGO staff and trained local correspondents can submit geo-tagged hazard observations and local impact reports that complement and validate remotely sensed analytics.

A prototype field assessment is planned across all five regions of northern Ghana, with stakeholder engagement activities scheduled in Tamale, Damongo, Nalerigu, Bolgatanga, and Wa in early October. The study contributes to ongoing discussions on climate services accessibility, geospatial democratisation, and the operational integration of Earth observation technologies into local adaptation planning within the broader Sahel-Sudan transition zone.

Keywords: climate risk analytics, geospatial intelligence, climate adaptation, vulnerability mapping, Earth observation, NGO decision-support systems, flood-drought risk, community resilience

Colouring Ghana: A Collaborative Open Geoinformation Portal for Building-Stock Data to Support Climate Resilience in Ghana

George Agyenim Amankwah, Jefferson-Aaron Ayerbi Totimeh, Da-Costa Boakye Mensah Asare, Charles Gameti, Ambrose Kannor and Samuel Ato Andam-Akorful

Department of Geomatic Engineering, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

Rapid urbanisation and growing climate-related hazards in Ghana demand effective planning responses. This requires more than basic spatial data: planners, researchers, municipal authorities, and communities also need granular building-level information on use, materials, age, condition, and other attributes that may influence vulnerability. Such information remains limited in many existing datasets. This contribution examines the early implementation of Colouring Ghana, a collaborative open geoinformation portal for building-stock data. Part of the international Colouring Cities Research Programme and led in Ghana by Kwame Nkrumah University of Science and Technology, the platform uses volunteered geographic information (VGI) to support the collection of building attributes organised within a standardised twelve-category schema. Contributed attribute data are released under the Open Database Licence (ODbL), and many entries can be added using local knowledge rather than specialist technical skills. Piloted in Ghana's Oforikrom Municipality using 21,200 Overture Maps building footprints, the platform's most-populated contributor-entered fields currently cover roughly 6,100-6,800 footprints, representing about 29-32% field-level coverage of the pilot building stock. For climate-resilience applications, the most relevant populated fields relate to land use, construction, and building conditions. The pilot demonstrates that open footprints provide a workable base layer for locally contributed building-stock attributes, while highlighting data completeness as a central challenge in VGI-based data production. Colouring Ghana provides a standardised geoinformation layer designed for integration with hazard, climate, socio-economic, and planning datasets. Drawing on the attributes captured to date, the platform can support building-level vulnerability assessment, adaptation planning, urban change monitoring, and disaster risk reduction. More broadly, the case illustrates how collaborative open geoinformation portals can strengthen building-stock knowledge, support open data sharing, and inform resilient built-environment governance in Ghana.

Keywords: Collaborative geoinformation portal, Open building data, Volunteered geographic information (VGI), Building-stock geoinformation, Climate resilience

Estimation of Above-Ground Biomass Using GEDI LiDAR and Sentinel- Data in Tropical Rainforests

Hetti Arachchige Nalani

Faculty of Geomatics, Sabaragamuwa University of Sri Lanka

Accurate estimation of above-ground biomass (AGB) is essential for understanding carbon dynamics and supporting climate change mitigation strategies in tropical forest ecosystems. This study aims to estimate AGB in the Sinharaja Forest Reserve, a tropical wet evergreen forest of significant extent and a designated World Heritage Site, which functions as one of the largest carbon sinks in the country. However, a comprehensive carbon stock assessment of this forest has not yet been conducted.

Therefore, the objective of this study is to estimate the total carbon stock of the Sinharaja forest by integrating spaceborne LiDAR data from the Global Ecosystem Dynamics Investigation (GEDI) mission with multispectral imagery from Sentinel-2 and terrain variables derived from a digital elevation model. GEDI Level-4A data, which provide footprint-level above-ground biomass density (AGBD), are used as reference samples after applying appropriate quality and uncertainty filtering. Sentinel-2 Level-2A imagery is processed to derive key vegetation indices, including the Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), and red-edge-based indices that are sensitive to canopy structure. In addition, terrain variables such as elevation and slope are incorporated to account for environmental variability influencing biomass distribution.

A machine learning approach is employed to model the relationship between GEDI-derived AGBD and the predictor variables extracted from Sentinel-2 and terrain data. The trained model is then applied to generate a continuous spatial distribution map of AGB across the study area. Model performance is evaluated using independent validation data derived from a subset of GEDI observations. The results demonstrate that integrating LiDAR-based structural information with optical and terrain data significantly improves the accuracy of biomass estimation in dense tropical forests. This study highlights the effectiveness of multi-source remote sensing data fusion for large-scale biomass mapping and provides a scalable framework for carbon stock assessment in similar forest ecosystems.

Keywords: Above ground Biomass, Sentinel-2, GEDI LiDAR, Machine Learning

Comparative Spatial Modeling of Flood Susceptibility in the Tana River Basin Using Random Forest and Autoencoder–Multilayer Perceptron Artificial Neural Networks

Jay Makorani and Charles Gaya

Jomo Kenyatta University of Agriculture and Technology , Nairobi, Kenya

Floods are among the most devastating natural disasters worldwide, often causing severe damage to ecosystems and human infrastructure. Interestingly, many flood-prone regions also have high potential for agricultural productivity. When properly managed, floods can thus support agricultural development. A key aspect of effective flood management is the accurate prediction of vulner-able areas, enabling the implementation of strategies to reduce flood damage while leveraging potential benefits. Traditional flood susceptibility assessments have often relied on expert judgment, which may lack accuracy. This study adopts a data-driven approach, focusing on Kenya's Tana River Basin – an area frequently affected by floods. It compares the predictive capabilities of two models: Random Forest (RF), a machine learning algorithm, and Autoencoder Multilayer Perceptron, a deep learning (Artificial Neural Networks) model. Both models considered nine factors influencing flooding (predictor variables). P-values generated by Ordinary Least Squares regression were used to deter-mine the association between flood occurrences and these predictor variables. Based on this analysis, two variables were excluded due to their lack of strong correlation with flood events. The models were trained on 9,964 data points and tested on 598,597. Model performance was evaluated using Accuracy and Area Under the ROC Curve (AUC). Random Forest outperformed Autoencod-er-MLP, achieving 95% accuracy and AUC scores of 97% (training) and 92% (prediction), compared to Autoencoder-MLP's 86% accuracy and AUCs of 88% (training) and 83% (prediction).

Keywords: Flood Susceptibility, Autoencoder Multilayer Perceptron, Artificial Neural Networks

Overcoming Camera Calibration Limitations in HD Mapping via Deep Learning-Based Unposed 3D Reconstruction

Caleb Masinde

Motor Ai. Berlin, Germany

The continuous and accurate extraction of roadside assets, such as traffic signs, is vital for maintaining High-Definition (HD) maps used in autonomous navigation and municipal infrastructure management. Traditional 3D reconstruction and mapping approaches heavily rely on calibrated stereo vision systems or classical Structure-from-Motion (SfM) techniques. While effective in controlled environments, these conventional methods face significant limitations when processing crowdsourced or standard dashcam imagery, primarily because they require precise prior knowledge of the camera's internal (focal length, optical center, distortion) and external (position, orientation) orientation parameters. When these parameters are unknown, uncalibrated, or dynamic, classical feature-matching and depth estimation pipelines often fail or produce compounding localization errors.

To address these challenges, this project proposes a workflow for traffic sign extraction and map updating using uncalibrated monocular dashcam imagery. The methodology integrates a state-of-the-art 2D object detection model with Dust3r (Dense Unconstrained Stereo 3D Reconstruction). Unlike classical SfM or traditional stereo algorithms, Dust3r directly regresses dense 3D point maps from unposed and uncalibrated image sequences without requiring known camera intrinsics or extrinsics. Traffic signs are first identified via bounding boxes in the 2D image space and then projected into the Dust3r-generated 3D coordinate system to extract precise relative measurements.

To resolve the inherent scale ambiguity of monocular reconstruction, the pipeline leverages semantic anchors—specifically, the standardized regulatory dimensions of roadside infrastructure, such as the known heights of traffic sign poles. By calculating the scale factor between these known physical priors and the arbitrary units of the Dust3r output, the system achieves precise metric scaling. By combining this scaled local geometry with rough GPS and heading data, the pipeline successfully translates relative 3D object positions into global geographic coordinates. This approach presents a robust, scalable, and highly cost-effective framework for continuously updating GIS databases and HD maps using standard, commercially available dashcams.

Keywords: High-Definition (HD) maps, Traffic signs detection, object detection, Dense Unconstrained Stereo 3D Reconstruction (Dust3r)

Spatiotemporal Dynamics of Multi-Hazard Susceptibility Under Climate Change and LULC Change Scenarios

Kashif Ullah

Zhejiang University of Technology, Zhejiang, China

Climate change and environmental changes are projected to increase the susceptibility of mountainous regions to natural hazards. This study investigates the future impacts of land use and land cover (LULC) change and climate change (rainfall) on multi-hazards (landslides, floods, and debris flows) at a regional scale in the eastern Hindukush, Pakistan. Future rainfall data from CMIP6 models under three climate change scenarios (SSP1-2.6, SSP2-4.5, and SSP5-8.5) and future LULC scenarios were used to project multi-hazard susceptibility for the 2040s, 2070s, and 2100 using a deep learning CNN.

Our findings indicate a projected increase in rainfall over time, especially in the 2070s and 2100s under the selected SSPs. Concurrently, built-up areas are expected to expand while forest cover shows a long-term decline. Analyzing the combined effects of future rainfall and LULC changes reveals an overall increase in multi-hazard susceptibility in the long term (2070 and 2100) across all three SSP scenarios. The most significant changes, compared to the baseline period, are expected in 2070 under SSP1-2.6 and SSP5-8.5. The second most significant changes are projected for 2100. In contrast, the near future (2040s) shows a decrease in overall multi-hazard susceptibility relative to the baseline, except for: (i) landslides and debris flows under SSP5-8.5, and (ii) floods and debris flows under SSP1-2.6, which show increases.

These findings hold considerable promise for guiding future multi-risk mapping initiatives in mountainous regions worldwide. The multi-hazard susceptibility analysis helps pinpoint areas where cost-effective engineering and nature-based solutions can be most efficiently applied in high-risk zones, thereby enhancing community resilience and adaptability to natural hazards. However, several limitations should be acknowledged for future research. This study assessed climate change based exclusively on rainfall, omitting other critical factors such as temperature, whose long-term effects are substantial in exacerbating multi-hazard risk in the study region. Future work should thoroughly investigate the potential impact of rising temperatures on glacier melt and the consequent changes in multi-hazard patterns.

Keywords: Multi-hazard susceptibility, Climate change, Convolutional Neural Networks (CNNs)

Comparative Study of Vegetation Indices for Assessing Agricultural Land of Gezira Scheme, Sudan, 2000

Mohamed Salih Dafalla

University of Khartoum, Sudan

Monitoring of vegetation cover is crucial for estimating crops production, drought, and desertification and range management. This study aimed to investigate efficacy of three remotely sensed based vegetation indices for mapping land and vegetation cover in the Gezira scheme, the oldest and largest irrigated agricultural scheme in the Sudan. A subset of scene was produced from a LandSat satellite image (173/50) that was freely downloaded from Global Land Cover Facility in 2000. Visual interpretation technique was used to recognize different vegetation patterns in the scheme. Data transformation was performed to produce ratio vegetation index (RVI), normalized difference vegetation index (NDVI) and soil adjusted vegetation index (SAVI). Synthesized images of RVI, NDVI and SAVI were classified to vegetated and non-vegetated areas based on the index thresholds. Concurrently, the NDVI and SAVI imaged were classified into four classes dense vegetation, sparse vegetation, soil and water or wet soil. Frequency analysis was used to test efficiency of the different vegetation indices. The results indicated that vegetated areas covered the 2877 Km2, 3231 Km2 and 5986 Km2 by use of NDVI, SAVI and RVI, respectively. On the other hand, non-vegetated area covered 8347 km2, 7910 km2 and 5238 km2 by use of NDVI, SAVI and RVI, respectively. Based on NDVI and SAVI, respectively, the areas covered by dense vegetation were 216 Km2 and 894 Km2, sparse vegetation were 2661 Km2 and 2336 Km2, soil were 7345 Km2 and 7645 Km2 and water or wet soil were 1002 km2 and265 Km2. Result indicated that NDVI and SAVI were strongly correlated (r=0.85) and negative correlation between SAVI and RVI (r= -0.87). Frequency analysis showed that overall accuracy of classification was 90% for RVI, 92% for NDVI and 88% for SAVI. The study concluded that indices were powerful and can be used for assessing land covers. The study recommended that NDVI and SAVI should be used in assessing agricultural land in the Gezira scheme. High spatial and temporal resolutions images are highly recommended for efficient assessment and monitoring of agricultural land in the Gezira Scheme.

Keywords: Sudan, Gezira Scheme, NDVI, SAVI, Vegetation Cover

Expansion of Human Footprint and Its Spatial Linkages to Human–Wildlife Conflict: A study from Malyattoor Landscape, Kerala, India

Sooraj N P[1], Arun S[1], Arjun C P[2], Vishnu M[3], Aleesha Fathima S L[3], Sajeev C Rajan[3] and Jaishanker R[3]

[1]Kerala University of Digital Sciences, Innovation and Technology
[2]Malayattoor Forest Division, Kerala. Forests and Wildlife Department
[3]Kerala University of Digital Sciences, Innovation and Technology (Digital University Kerala)

Human–wildlife conflict has emerged as a critical conservation and social issue worldwide, as people and wild animals increasingly overlap in space and compete for resources. Habitat loss and fragmentation, the expansion of agriculture and settlements into natural areas, the depletion of natural prey or forage, and poor waste management are among the key drivers of this conflict. This study examines the spatiotemporal dynamics of human footprint expansion and its association with human-wildlife conflict in the Malayattoor Landscape in Kerala. Multi-temporal land use/land cover mapping was carried out using Landsat and Sentinel-2 imagery over 25 years from 2000 to 2025. The analytical framework constructs a distance-decay gradient of the human footprint from existing settlement centres toward the protected area boundaries. These gradients capture how anthropogenic land cover has not merely expanded in area but also penetrated toward forest boundaries over time. The LULC transitions derived from this gradient are overlaid with georeferenced human-wildlife conflict records and quantitatively analysed to test whether zones of accelerating human footprint expansion correspond to elevated conflict intensity. A human-pressure surface is also generated, representing the distribution of anthropogenic pressure across the study area. The findings aim to provide spatially explicit, quantitative evidence for prioritising conflict mitigation and forest fringe management in the Malayattoor Landscape.

Keywords: Geoinformatics, LULC Change, Human Footprint, forest fragmentation, human-wildlife conflict

Integrating Presence-only and Abundance Data to Predict African Baobab Distribution: A Bayesian Data Fusion Framework

Akoeugnigan Idelphonse Sode[1], Adandé Belarmain Fandohan[2], Elias Teixeira Krainski[3], Achille Ephrem Assogbadjo[4] and Romain Glèlè Kakaï[1]

[1] Laboratoire de Biomathématiques et d'Estimations Forestières, Université d'Abomey-Calavi, Benin
[2] School of Tropical Forestry, National University of Agriculture (UNA), Benin
[3] King Abdullah University of Science and Technology (KAUST), Saudi Arabia
[4] Laboratoire d’Écologie Appliquée, Faculté des Sciences Agronomiques, Université d’Abomey-Calavi, Benin

Species distribution models (SDMs) are vital tools in ecology and conservation. The integration of increasingly available citizen science data with planned survey data offers a significant opportunity to improve estimates of species distributions. While integrated SDMs often combine presence-only and abundance data, the link between the two data types is still not well understood. This study proposes a Bayesian spatial fusion modelling framework to jointly analyse presence-only and abundance data for the African baobab in Benin. The aim was to understand and map the spatial variation in the species’ distribution. We briefly reviewed process-based models for count and point process data. We explored various data fusion strategies using Integrated Nested Laplace Approximations (INLA) and Stochastic Partial Differential Equations (SPDE) for fast Bayesian computation. The results revealed a heterogeneous baobab distribution across Benin, characterised by a spatial autocorrelation range of 34.4 km (95% Bayesian credible interval, BCI = 27.59 - 42.52). Key drivers of this distribution include environmental factors such as annual temperature, rainfall of the driest month, soil texture (silt/clay fractions), and slope. A spatial fusion model incorporating shared latent components and common covariates' effects demonstrated the highest performance level, surpassing alternative fusion approaches. The model achieved the highest mean composite scores for the Area Under the ROC Curve (AUC) (0.85 ± 0.02), accuracy (0.77 ± 0.02), and True Skill Statistics (TSS) (0.66 ± 0.05). The shared component model effectively captures the dependence structure between the data types and enhances prediction precision by leveraging information across datasets. This research underscores the potential of spatial fusion modelling for integrating disparate data sources, providing a robust framework to advance SDM inference in data-limited contexts and address broader, complex spatial regression problems.

Keywords: INLA, Log-Gaussian Cox process, geospatial data fusion, shared latent component, sustainable agroforestry, Adansonia digitata

Assessment of Satellite-Based Methodologies for Estimating Turbidity in Surface Water Bodies

Metzi Aguilar, Oscar Valencia, David Morán, Erick Ramos, Rafael Alas and Guillermo Cortés

Universidad Centroamericana José Simeón Cañas, San Salvador, El Salvador

Lake Güija, in El Salvador, is part of a strategically important hydrological system due to its connection to the Ostúa River and subsequently to the Lempa River, a basin that supplies a significant proportion of the country's drinking water. This interconnectivity implies that potential contamination processes occurring in the upper basin could propagate downstream, affecting both lacustrine ecosystems and human water supply systems. In this context, the research explored the feasibility of using satellite remote sensing as a complementary tool for environmental monitoring. The central premise is that optically active water parameters, such as turbidity or suspended solids, produce variations in reflectance recorded by multispectral satellite sensors, allowing their spatial behavior to be inferred through statistical models calibrated with field measurements.

Keywords: remote sensing, water bodies, turbidity, regression model, multivariate

Groundwater Potential Mapping Using Machine Learning, Multi-Criteria Decision, and Bivariate Statistical Algorithms: A Modular and Transferable Framework

Michael Aboagye Appiah, Dietrich Schröder and Adel Omran

Stuttgart University of Applied Sciences, Germany

Groundwater constitutes nearly 99% of Earth's liquid freshwater, yet conventional groundwater potential mapping remains constrained by fragmented, manual workflows that limit transferability across regions. This study develops and validates an automated, modular framework that integrates bivariate statistical analysis, multi-criteria decision-making, and machine learning within a unified geospatial system to address this limitation.

The framework was implemented in the East Gonja District of Ghana, a water-scarce region representative of environments vulnerable to climate-induced recharge variability. The system automates the full analytical workflow, including preprocessing of Digital Elevation Models, standardization of fifteen environmental, terrain, and geological conditioning factors, Frequency Ratio analysis with automated discrimination scoring, Analytic Hierarchy Process weighting guided by data-driven factor ranking, and predictive modelling using Random Forest, XGBoost, and CatBoost algorithms. A three-mode training architecture enables systematic comparison of data-driven, knowledge-driven, and hybrid modelling approaches.

Validation using 308 borehole records demonstrates strong predictive performance, with Random Forest achieving an AUC-ROC of 0.8344 and an accuracy of 77.42%, while maintaining low false positive rates. The hybrid integration approach combines machine learning outputs with AHP-derived weights to generate five-class groundwater potential maps that support differentiated planning and resource allocation.

The framework significantly reduces processing time from weeks to hours while maintaining analytical consistency. It provides a scalable and transferable decision-support tool for groundwater assessment, contributing to climate-resilient water resource management in data-limited regions.>>

Keywords: groundwater potential mapping, machine learning, multi-criteria decision-making, geospatial analysis, climate resilience, water resource management

Global Landscape Water Requirement Satisfaction Index for Drought Monitoring over Diverse Landscapes and Land Cover Types

Stefanie Kagone[1], Gabriel Senay[2], Gabriel Parrish[3] and Michael Budde[2]

[1]ASRC Federal Data Solutions, Sioux Falls, USA
[2] U.S. Geological Survey EROS Center, Sioux Falls, USA
[3] Kellogg Brown & Root, Houston, USA

Climate variability is amplifying global drought-related food insecurity, making timely, accessible geospatial information to guide decision-making in vulnerable regions. The Famine Early Warning Systems Network (FEWS NET) integrates climate, vegetation, and hydrologic indicators into openly shared geospatial data products that enhance evidence-based early warning of drought impacts to global food production. The newly developed Landscape Water Requirement Satisfaction Index (L-WRSI) delivers global 1-km, 10-day updates that combine precipitation, soil moisture conditions, and atmospheric water demand to assess water adequacy using the ratio between vegetation's ideal evaporative demand and its actual evaporative use. Enabled by a new NDVI-based (Normalized Difference Vegetation Index) phenology approach to identify vegetation growing stages, L-WRSI supports landscape-wide, non-crop specific monitoring across all land cover types, strengthening drought surveillance and environmental hazard assessment. As part of FEWS NET's long-standing mission, these products highlight the essential role of transparent data sharing and collaborative geoinformation portals, such as the one maintained by U.S. Geological Survey and FEWS NET, in strengthening global resilience, supporting food security, and applying geoinformation to the growing challenges posed by climate variability.

Keywords: >>Drought monitoring, Remote sensing, Evapotranspiration, L-WRSI, Food security, FEWS NET

Data Preparation for GIS using FME Form software

Hardy Lehmkühler

Stuttgart University of Applied Sciences, Germany

This workshop provides a hands-on approach to spatial data preprocessing which is addressed differently than by standard GIS preprocessing.

The general concept of data management software poses data readers, writers and processing tools. For spatial data the FME Form software (FME=Feature Manipulation Engine) is well established and will be used in the workshop.

At the beginning the software will be introduced by solving the standard task to generate GIS features from CAD input. The large and well-sorted catalogue of processing tools for e.g. attribute, geometry, text or list handling will be shown and partially tested. Then, further standard processing tasks can be chosen to explore in examples like node-link detection, partial geometry management, connecting real-time data or plain reorganisation of feature classes.

Geometry as one part of a features characteristics will be noticed as being represented in terms of a comprehensive geometry model.

During the workshop the handling of features with increasing value but also increasing amount of linked information will also be noticed. Such can also be limited to efficiently reach the desired output.

Workflows created here can be executed e.g. once as single data transformation job. They can also be repeatedly invoked at certain times or triggered by special events. This kind of scheduling with FME Flow software will be explained as well in a final discussion.

Keywords: *Spatial data management software, Extract Transform Load principle, FME flow software*

An Introduction to Programming in QGIS Using PyQGIS and Jupyter Notebook

Dietrich Schröder

Stuttgart University of Applied Sciences, Germany

This workshop provides a structured entry point into the automation and customization of GIS workflows. Participants will be introduced to the core principles of scripting within QGIS through the PyQGIS API, enabling them to move beyond manual operations toward reproducible and scalable spatial analyses.

The workshop begins with a concise overview of the QGIS Python environment, including the architecture of PyQGIS and its integration within the QGIS interface. Participants will learn how to access spatial data programmatically, manipulate vector and raster layers, and perform common geoprocessing tasks using Python. Emphasis is placed on understanding the underlying data structures and methods that govern spatial operations in QGIS.

Building on this foundation, the workshop incorporates Jupyter Notebooks as an interactive development environment. This approach allows participants to combine code, documentation, and visualization in a single, reproducible workflow. Through guided exercises, attendees will develop scripts that automate routine GIS tasks, explore spatial datasets, and visualize results dynamically.

By the end of the session, participants will have acquired practical skills for integrating PyQGIS into their analytical workflows, as well as a conceptual understanding of how to leverage Jupyter Notebooks for transparent and reproducible geospatial analysis. The workshop is designed for beginners with basic familiarity in GIS and Python, and aims to bridge the gap between graphical user interfaces and programmatic spatial data processing.

Keywords: *PyQGIS, QGIS automation, Jupyter Notebooks, Geospatial data analysis*

Assessing smartphone sensor data for mobile data capturing and mapping

Paul Rawiel
Stuttgart University of Applied Sciences, Germany

Smartphones are widely distributed devices with many different sensors on board that can be used for a huge variety of applications that are related climate monitoring, efficient transport, mobile mapping and many more. To build so called apps on android smartphones for applications in the above-mentioned areas, it is essential to know about the different sensors that come with the device, how to access the data measured by these sensors, how to process that data and how to visualize the results.

The workshop offers a hands-on experience to make a first step into the programming of apps for android devices based on the programming language java and the development environment Android Studio.

Participants will learn how to program an app using the Android Studio and install it on an Android Smartphone. As an example, a compass will be programmed using the magnetic field sensor and the accelerometer of the smartphone.

Participants should bring an android smartphone and a cable to connect it to the computer.

Keywords: *Android Studio, Java Programming, Smartphone Sensors, App Programming*

The European Masterportal: A Contribution for an Open Source Stack for Geospatial Infrastructure

Franz-Josef Behr[1], Shakti Galaut[2] and Jens Nienaber[3]
[1]Stuttgart University of Applied Sciences, [2]City of Solingen, [3]Data Port, Hamburg, Germany

The Masterportal, a comprehensive solution for the client-side presentation of geodata, has been under development since late 2014 using OpenLayers and vue.js (https://www.masterportal.org/). The Masterportal is open-source software and is released under the MIT licence. It processes geodata and services via standardised interfaces (https://www.masterportal.org/features/features). Add-ons allow the functionality of the Masterportal to be extended as required without the need to modify the core (https://github.com/terrestris/masterportal-addons/tree/main). The Masterportal is successfully used by many public administrations at federal, state and local levels, as well as by data centres and municipal utility companies throughout Germany and in other European countries. In the municipal sector, cities such as Munich and Vienna are notable examples. It is continuously being further developed by an open-source community and a strong alliance of implementation partners and is on its way to becoming an OSGeo project (https://www.osgeo.org/projects/masterportal/). The annual costs for a public institution joining the Masterportal implementation partnership are based on the municipality's population, an approach that exemplifies a potential funding model for open-source developments: The software solution is developed by the administration for the administration. Even small local authorities can easily and cost-effectively integrate it into their online presence. It allows for the centralised maintenance of a wide variety of geoportals with minimal staffing requirements.

In the Free and Hanseatic City of Hamburg, for example, it is used whenever web-based map applications are required – either as a standalone application or as part of an e-government solution. The Masterportal is also used in other cities and districts, including cities such as Munich, Stuttgart and Vienna (https://www.masterportal.org/referenzen/referenzen). The software supports localisation of the user interface (https://bitbucket.org/geowerkstatt-hamburg/masterportal/src/dev/locales/). Minor updates are released monthly, whilst a version with Long-Term Support (LTS) is published annually.

Specifically, the presentation or workshop will report on its use in the city of Solingen. An overview of the Masterportal software and the project is followed by an introduction to the web architecture of geoportals. This forms the basis for the subsequent installation of a complete client-server solution with a DBMS and Apache HTTP Server. The server provides the environment for the subsequent installation of the Masterportal software. The Masterportal package (https://bitbucket.org/geowerkstatt-hamburg/masterportal/downloads/examples-3.15.2-lts.zip) is downloaded, unpacked and deployed in the server's htdocs directory (see also https://terrestris.github.io/masterportal-ws/devsetup/). The Masterportal application interface is briefly introduced before the basics of the JSON-based configuration of the application interface and access to OGC web services (WMS and WFS) are demonstrated (https://terrestris.github.io/masterportal-ws/config/). Where possible, data from or for Ghana will also be accessed. Participants will thus be able to set up Masterportal instances for their own organisation or local authority. If time permits, the installation of a local server-based GeoServer instance will also be demonstrated. The configuration of GeoServer incorporating local data will be demonstrated.

Keywords: *Masterportal, Geoportal, SDI, Open Source, Open source implementation partnership, OGC standards*

Venue / Location

Country

Ghana was the first sub-Saharan African country to gain independence from colonial rule in 1957 under the leadership of Dr. Kwame Nkrumah, who became one of the most influential figures in the African independence movement. The country is located on the Gulf of Guinea in West Africa and is bordered by Côte d'Ivoire to the west, Burkina Faso to the north, and Togo to the east. Its capital city, Accra, is located in the Greater Accra Region and serves as the political, economic, and cultural centre of the country. Ghana has a population of approximately 34 million people and is home to more than 80 ethnic groups, with the Akan being the largest. This remarkable cultural diversity is reflected in the country's languages, traditions, social structures, and artistic heritage. English is the official language, while Twi, Ga, Ewe, and Dagbani are among the widely spoken Ghanaian languages. Traditional inheritance systems also differ among ethnic groups, including both matrilineal and patrilineal systems.

Ghana is well known for its rich cultural traditions, including colourful festivals, traditional music and dance, handicrafts, weaving, and the production of the famous Kente cloth. Hospitality and strong community relationships play an important role in Ghanaian society. The country also has a diverse natural environment. Along the southern coast, sandy beaches, lagoons, and coastal wetlands extend along the Atlantic Ocean. Further inland, the landscape includes a lush tropical rainforest belt, which gradually changes into forest-savanna transition zones and, further north, into the more open savanna landscapes characteristic of northern Ghana. This geographical diversity provides important habitats for a wide range of plant and animal species.

Ghana offers numerous important historical, cultural, and natural tourist attractions. Among the most notable historical sites are Cape Coast Castle and Elmina Castle, which provide important evidence of the history of the transatlantic slave trade. Kakum National Park, located in the rainforest zone, is particularly famous for its canopy walkway and its rich biodiversity. Mole National Park in northern Ghana is the country's largest national park and offers opportunities to observe wildlife, including elephants and several other animal species. Other important attractions include the Kwame Nkrumah Memorial Park in Accra, the Aburi Botanical Gardens, the scenic Boti Waterfalls, and Lake Bosomtwe, a beautiful natural lake located in the Ashanti Region. Together, these sites illustrate the exceptional combination of history, culture, biodiversity, and natural landscapes that makes Ghana an attractive destination for visitors and an important country in West Africa.

City

Kumasi is Ghana's second-largest city and the capital of the Ashanti Region. Located in the central part of the country, it is one of Ghana's most important economic, cultural, and historical centres. The city is also the spiritual and cultural heart of one of Africa's most enduring kingdoms—the Ashanti (Asante)

Kingdom. The traditions, institutions, symbols, and identity of the Asante people continue to play an important role in contemporary Ghanaian society and coexist with the country's modern democratic and administrative structures.

Kumasi remains the seat of the Asantehene, the traditional King of the Ashanti people. The current Asantehene, Otumfuo Osei Tutu II, is a highly respected traditional leader who represents the continuity of the Asante Kingdom and its cultural heritage. Although traditional authority operates alongside Ghana's modern political system, the Asantehene continues to have considerable cultural and social influence. One of the most important symbols of this heritage is the Golden Stool (Sika Dwa Kofi). According to Asante tradition, the Golden Stool represents the unity, identity, and spiritual strength of the Asante people and is regarded as the soul of the nation. It is therefore much more than a royal object and remains one of the most powerful symbols of Ghanaian cultural history.

Kumasi is also an important centre for traditional crafts and commerce. The city is particularly well known for its colourful markets, wood carving, gold jewellery, traditional textiles, and Kente weaving. The Kejetia Market, one of the largest markets in West Africa, reflects the city's importance as a regional trading centre and provides a vivid impression of everyday life in Kumasi. The Manhyia Palace and the associated Manhyia Palace Museum offer visitors an opportunity to learn more about the history of the Asante Kingdom, its rulers, and its political and cultural traditions.

Geographically, Kumasi is situated within a transitional forest zone and is surrounded by lush vegetation, which has earned the city the nickname "Garden City of West Africa." The combination of tropical greenery, gently undulating terrain, and a rapidly expanding urban environment creates a distinctive landscape. The surrounding region also contains forest reserves and areas of considerable ecological importance. Nearby Lake Bosomtwe, a naturally formed crater lake surrounded by hills and forests, is one of the region's most impressive natural attractions.

Kumasi therefore offers a remarkable combination of traditional culture, history, commerce, and natural landscapes. The city provides an excellent opportunity to experience both the heritage of the Asante Kingdom and the dynamic development of modern Ghana. Its museums, palaces, markets, craft traditions, and surrounding natural attractions make Kumasi an important destination for understanding Ghana's cultural identity and the continuing influence of traditional institutions in contemporary African society.

The University

The Kwame Nkrumah University of Science and Technology (KNUST) is Ghana's premier public university specialising in science, technology, engineering, and related disciplines. Located in Kumasi in the Ashanti Region, KNUST plays a major role in Ghana's higher education system and is an important centre for research, innovation, and professional training. It is the second public university established in Ghana and has grown into the largest university in the Ashanti Region. The university was established in 1952 as the Kumasi College of Technology and later became the Kwame Nkrumah University of Science and Technology in recognition of Ghana's first president, Dr. Kwame Nkrumah, and his vision of using science and technology to support national development.

The motto of the University is **"Nyansapɔ wɔsane no badwenma"**, which can be translated as **"The knot of wisdom is untied only by the wise."** The motto reflects the university's strong emphasis on knowledge, critical thinking, innovation, and the application of academic expertise to societal challenges. Over the decades, KNUST has developed into an internationally recognised institution with

a strong focus on science and technology while also providing education and research in the humanities, social sciences, health sciences, agriculture, art, and the built environment.

The university campus covers an estimated eight square miles and is characterised by considerable aesthetic and natural beauty. Its landscape consists of gently rising and falling terrain, extensive green spaces, long stretches of well-maintained lawns, and a wide variety of mature trees and tropical vegetation. Modern lecture halls, laboratories, administrative buildings, student facilities, and research centres are integrated into this green campus environment. The combination of academic infrastructure and landscaped open spaces gives KNUST a distinctive character and creates an attractive setting for studying, teaching, research, and academic exchange.

KNUST is organised into six major colleges: the **College of Agriculture and Natural Resources, College of Art and Built Environment, College of Engineering, College of Health Sciences, College of Humanities and Social Sciences, and College of Science**. These colleges bring together a broad range of academic disciplines and support interdisciplinary research and collaboration. With a student population of approximately 88,000, KNUST is a large and dynamic academic community that attracts students and researchers from Ghana and many other African and international countries.

In addition to its educational role, KNUST makes an important contribution to scientific research, technological innovation, and sustainable development in Ghana and beyond. Research activities address a wide range of topics, including agriculture and food security, engineering and infrastructure, environmental management, health, natural resources, urban development, information technology, and climate-related challenges. The university also maintains partnerships with institutions around the world, supporting international cooperation, academic exchange, and joint research projects.

With its strong academic reputation, extensive campus, diverse research activities, and close connection to the cultural and economic life of Kumasi, KNUST provides an important bridge between academic knowledge and practical development. The university is therefore an appropriate setting for international academic events and scientific exchange, bringing together researchers, students, practitioners, and alumni from different countries and disciplines.

For further information on KNUST, please visit www.knust.edu.gh.

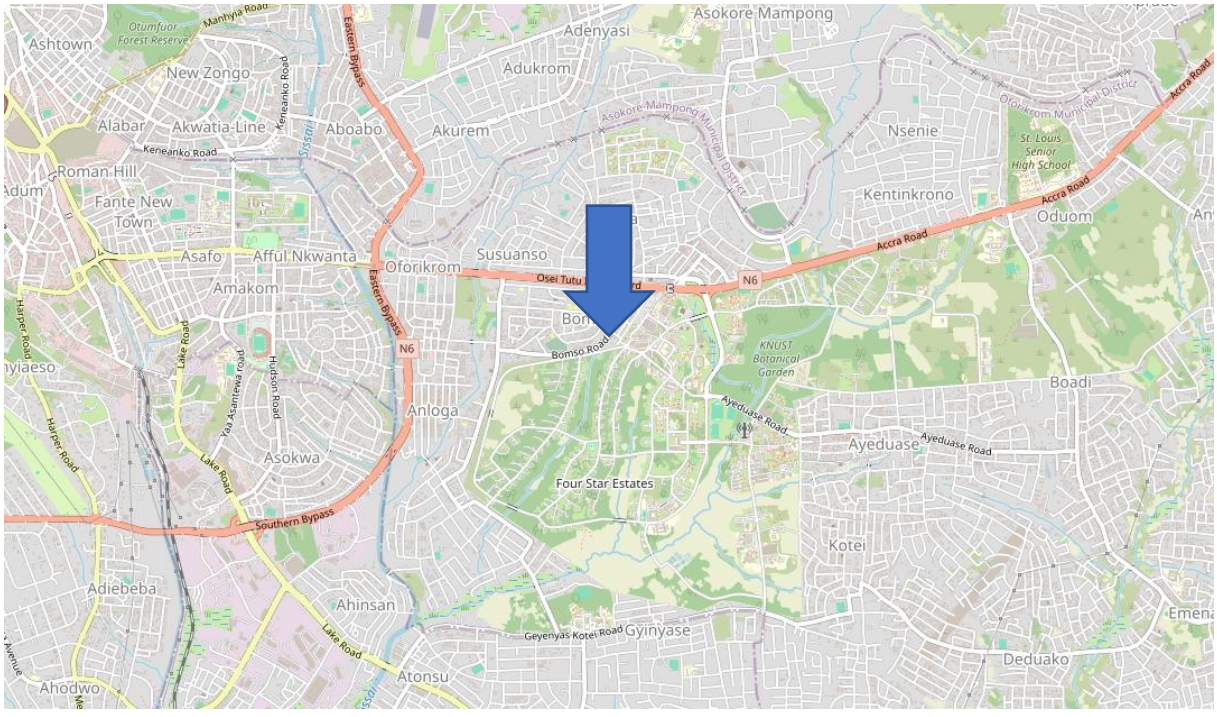

Figure 1: The location of AGSE 2026 (Source OpenStreetMap)

Figure 2: The location of AGSE 2026 at KNUST campus (Source OSM)

Having Lunch

Public transport and Parkings

Acknowledgements

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DAAD Deutscher Akademischer Austauschdiens
German Academic Exchange Service

HOCHSCHULE FÜR TECHNIK STUTTGART
University of Applied Sciences

KNUST
Kwame Nkrumah University of Science and Technology, Kumasi

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