ITU Journal

Future and evolving technologies

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Volume 6, Issue 1, March 2025

ISSN: 2616-8375

ITU Journal
Future and evolving technologies

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SUGGESTED CITATION:

ITU Journal on Future and Evolving Technologies, Volume 6, Issue 1, March 2025

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Exploring GeoAI for Good: A journey through webinars, workshops and global challenges

Recognizing the significant interest generated by the GeoAI initiatives at AI for Good, the ITU Journal on Future and Evolving Technologies (ITU J-FET) has dedicated a special issue to showcase and amplify the innovative approaches and insights that have emerged from these initiatives.

This overview aims to provide readers of this special issue with some context of the origins of the GeoAI initiatives at AI for Good, offering a comprehensive account of the activities organized to date and highlighting the current focus of these endeavours.

Introduction

Geospatial Artificial Intelligence (GeoAI) presents unique challenges due to the complexity, scale and variability of spatial data. Unlike traditional AI tasks, geospatial problems often involve irregularly-distributed data, spatial dependencies and multiscale patterns that require specialized processing techniques. One key challenge is the heterogeneous nature of geospatial data, which comes from various sources such as satellite imagery, sensor networks and ground data collection. These datasets often have different resolutions, formats and levels of accuracy, making integration and preprocessing difficult. Another key feature of geospatial data is spatial autocorrelation and non-stationarity; data points in proximity tend to be more similar, violating the assumption of independent and identically-distributed data used in many Machine Learning (ML) models. This requires models that can capture spatial relationships and adapt to varying patterns across different regions.

Within ITU, a harmonized approach to geospatial technologies began in 2019 with the establishment of an intersectoral group on geospatial issues. In the same year, ITU signed a Letter of Intent with the World Geospatial Industry Council and started to participate in the work of the UN Geospatial Network, a thematic network established by the Committee of Experts on Global Geospatial Information Management (UN GGIM). ITU also started to work in the context of the UN Open GIS Initiative, which established a GeoAI Working Group in September 2020 and established solid cooperation with the UN-GGIM Academic Network, with the Chair, Prof. Maria Brovelli who over the years played a leadership role in organizing the ITU GeoAI activities, including the GeoAI Discovery series, the GeoAI Challenges and the GeoAI Education line of work.

The *GeoAI Discovery series*[1], was conceived at the ITU AI for Good as a crucial platform for spreading knowledge and providing training on the use of GeoAI to advance the Sustainable Development Goals (SDGs). Through a cohesive narrative connecting technology, education and practical applications, the series of webinars and practical workshops continue to explore the transformative potential of GeoAI across diverse domains, fostering innovation and promoting data-driven solutions to global challenges.

The *ITU GeoAI Challenge*[2] is a competition aimed at providing solutions for collaboratively addressing real-world geospatial problems by applying GeoAI solutions. Through this platform, participants attempt to address the challenges around SDGs using real-world data.

Participants also acquire hands-on experience in AI/ML and compete for prizes, recognition and certificates.

1 https://aiforgood.itu.int/eventcat/discovery-geoai/
2 https://aiforgood.itu.int/about-us/geoai-challenge/

The GeoAI Discovery series (2021–2023)

The ITU GeoAI for Good journey began in 2021 with a two-session[3, 4] hands-on workshop on satellite data analysis and ML classification using QGIS. Held between April and May, this event introduced participants to the intricacies of satellite image processing. With tools like the Semi-Automatic Classification Plugin and dzetsaka classification tool, Gorica Bratic and Maria Brovelli taught the attendees how to retrieve, process and classify satellite imagery while evaluating the performance of ML algorithms. The workshop emphasized the power of open-source tools to democratize geospatial data analysis. It was highly appreciated both during the live session (around 1500 attendees) and afterwards (with almost 9000 replays to date on YouTube). This positive reception encouraged us to launch the GeoAI Discovery series.

In parallel, the WGIC organized the session *Geospatial AI/ML Applications and Policies – A Global Perspective*[5], led by Barbara Ryan, to launch a WGIC report exploring the role of AI/ML in geospatial technology, key global policy issues and the shortage of specialized AI talent. The report provided insights into GeoAI trends, legal frameworks in 12 countries and the EU, and policy recommendations for ethical AI governance, industry cooperation and adaptive regulations to foster innovation and trust.

The inaugural GeoAI Discovery series event *What it will take for AI to work with geospatial data*[6], in February 2022, brought together key figures in the GeoAI ecosystem. Nadine Alameh, Maria Brovelli and Barbara Ryan, alongside ITU geospatial focal point Andrea Manara, outlined the objectives and relevance of the series. The event set the stage, emphasizing the global impact of GeoAI in addressing pressing challenges like agriculture and climate change.

In February 2022, the panel *Where Ethics and Geospatial AI meet*[7], moderated by Barbara Ryan, explored how industry can lead ethical discussions, examining best practices, data governance and privacy considerations in GeoAI. The panel discussed outcomes from the WGIC Policy and Trends report on GeoAI, which highlighted the growing importance of ethical AI governance in the geospatial industry to build trust among customers, policymakers and citizens.

In March 2022, the two-sessions[8, 9] workshop *Analyzing the Amazon Deforestation with Machine Learning and the Google Earth Engine* spotlighted the application of AI to environmental monitoring. The workshops, taught by Vasil Yordanov and Maria Brovelli, utilized Google Earth Engine to analyze deforestation in the Amazon. Participants explored multispectral imagery, computed indices like NDVI, and applied ML to quantify forest loss. The event underscored the role of GeoAI in fostering sustainability and ecological preservation.

In April 2022, the webinar on *Climate action and GeoAI: Innovative applications for climate change mitigation and adaptation*[10], moderated by WGIC, demonstrated use cases on integrating AI/ML with geospatial and Earth Observation (EO) data, driving insights to provide meaningful and effective solutions for climate action.

In June 2022 three GeoAI Discovery events were organized.

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3 https://aiforgood.itu.int/event/workshop-satellite-data-analysis-and-machine-learning-classification-with-qgis-part-1/
4 https://aiforgood.itu.int/event/workshop-satellite-data-analysis-and-machine-learning-classification-with-qgis-part-2/
5 https://aiforgood.itu.int/event/geospatial-ai-ml-applications-and-policies-a-global-perspective/
6 https://aiforgood.itu.int/event/what-it-will-take-for-ai-to-work-with-geospatial-data/
7 https://aiforgood.itu.int/event/where-ethics-and-geospatial-ai-meet/
8 https://aiforgood.itu.int/event/analyzing-the-amazon-rainforest-with-machine-learning-and-the-google-earth-engine-geoai-discovery-series-episode-3-1/
9 https://aiforgood.itu.int/event/analyzing-the-amazon-rainforest-with-machine-learning-and-the-google-earth-engine-geoai-discovery-series-episode-3-2/
10 https://aiforgood.itu.int/event/climate-action-and-geoai-innovative-applications-for-climate-change-mitigation-and-adaptation/

The webinar *Spatial Digital Twins and AI: Racing into the Future*[11], moderated by WGIC, discussed how advancements in technology and lower sensor costs have accelerated the adoption of spatial digital twins, requiring precise spatial data for accurate alignment with the physical world. The speakers explored how AI/ML and automation enhance digital twin scalability, enabling real-time data updates and insights for broader applications.

The webinar *GeoAI and Health*[12], moderated by Nadine Alameh, explored how geospatial data engineering and AI-driven models can help tackle public health challenges. Experts from academia, government and industry, including the health technology start-up HSR.*health*, discussed how leveraging vast amounts of social determinants of health data with AI can provide actionable insights. The panel highlighted how GeoAI reveals the "where" of health data, enabling better decision-making for effective health solutions.

Another pivotal moment came in June 2022 with the keynote *The Future of GeoAI for Good with Google Earth Engine*[13]. Rebecca Moore, Director of Google Earth, discussed how the platform's massive geospatial datasets and analytical capabilities empower researchers worldwide. This session highlighted the potential of GeoAI to drive meaningful action in conservation and climate resilience.

In July 2022, the event *Deep Earth Query: Information Discovery from Big Earth Observation Data Archives*[14] tackled the challenges of managing and utilizing the massive archives of EO data generated by satellites like ESA's Sentinel. Begum Demir presented innovative solutions, including a deep hashing network for efficient data indexing and retrieval. The session highlighted the intersection of AI and big data in unlocking insights from EO.

In September 2022, the webinar *GeoAI and the digital transformation of agriculture, water and food systems*[15] explored how the integration of AI and geospatial IT, including remote sensing and GIS, is transforming agriculture by improving productivity, profitability and sustainability. The speakers discussed how agro-informatics has evolved from precision to smart agriculture, leveraging ML, deep learning and reinforcement learning for optimal crop management.

The series also addressed biodiversity through the November 2022 workshop *Machine Learning Supporting Ecology*[16]. Devis Tuia showcased how AI-powered tools, such as camera traps and drone data, are revolutionizing animal population monitoring and behaviour analysis. The event called attention to the urgent need for technological integration in combating the biodiversity crisis.

In April 2023, the session *Synergy Between Geography and Mapping with the Nation's Energy Mission*[17] explored the contributions of geographical sciences to the U.S. Department of Energy's national priorities. Budhu Bhaduri delved into the applications of high-performance computing and geospatial technologies in addressing climate change, energy sustainability and urban dynamics, demonstrating the far-reaching implications of GeoAI.

The importance of education in advancing GeoAI was emphasized in the June 2023 webinar *GeoAI Education*[18]. Organized by the UN-GGIM Academic Network, this event featured experts like Songnian Li, Ali Mansurian and Lokendra Chauhan, who discussed the gaps in GeoAI training and the need for innovative curricula. The session aimed to equip educators and stakeholders with the tools to cultivate a new generation of GeoAI practitioners.

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11 https://aiforgood.itu.int/event/spatial-digital-twins-and-ai-racing-into-the-future/
12 https://aiforgood.itu.int/event/geoai-and-health/
13 https://aiforgood.itu.int/event/geoai-for-good-with-google-earth-engine/
14 https://aiforgood.itu.int/event/deep-earth-query-information-discovery-from-big-earth-observation-data-archives/
15 https://aiforgood.itu.int/event/geoai-and-the-digital-transformation-of-agriculture-water-and-food-systems/
16 https://aiforgood.itu.int/event/machine-learning-supporting-ecology/
17 https://aiforgood.itu.int/event/synergy-between-geography-and-mapping-with-the-nations-energy-mission/
18 https://aiforgood.itu.int/event/geoai-education/

GeoAI and education workshops at the AI for Good Global Summit

Meanwhile, the UN-GGIM Academic Network was studying if the importance of GeoAI was increasing in the education sector and among UN-GGIM member states. To this aim two surveys were prepared and submitted. The surveys gathered responses from 70 universities and 169 member states, revealing a strong demand for capacity building in GeoAI. Academic institutions emphasized the necessity of integrating GeoAI into undergraduate, graduate and PhD programmes, while member states underscored the importance of developing GeoAI capabilities for public sector applications. Survey results also indicated a high priority for topics such as ethics in GeoAI, the use of open geospatial data, open learning techniques and the importance of teaching how to evaluate AI model performance.

Building on these findings, GeoAI Education was the central theme for the Geospatial community at the AI For Good Summit in July 2023, where a dedicated side event focused on this topic. Experts and stakeholders discussed the urgent need to establish a standardized syllabus and a comprehensive body of knowledge. This momentum continued at the UN-GGIM Thirteenth Session in August 2023, further reinforcing the necessity of structured GeoAI training frameworks.

In response, four international working groups were formed to develop specialized educational tracks. The first track focuses on developers who possess strong computational skills but lack expertise in geomatics; this syllabus introduces fundamental geospatial concepts before advancing into specialized GeoAI applications. The second track caters for geomatics professionals seeking to build foundational AI competencies, equipping them with essential ML techniques before delving into GeoAI-specific methodologies. A third track was designed for decision-makers with limited technical proficiency, ensuring they acquire a conceptual understanding of GeoAI's potential applications and implications. Lastly, the foundational element across all tracks is the comprehensive Body of Knowledge in GeoAI, which serves to establish a common lexicon and framework, promoting interdisciplinary collaboration and standardizing best practices in data acquisition, processing and AI integration.

These efforts culminated in the 2024 AI For Good Summit on May 30, 2024, where the progress of the four working groups was showcased under the theme *Navigating GeoAI: Plotting the Course for Future Education.* This event highlighted the advancements made in structuring GeoAI education and its practical applications for societal benefit. Furthermore, the UN-GGIM Academic Network, in collaboration with other UN-GGIM thematic networks, has continued to expand the discourse around GeoAI, fostering a unified approach to research, capacity building and policy integration. Within a geodata-driven AI paradigm, ML models derive insights from vast datasets, necessitating rigorous methodologies for data collection, cleansing and validation. The expertise of geospatial professionals is crucial in ensuring that input data adheres to high standards, mitigating biases and inaccuracies that could propagate through AI-driven analyses. In parallel, model-driven AI approaches incorporate domain-specific mathematical and physical models, requiring the fusion of traditional geomatics principles with advanced AI techniques to enhance predictive accuracy and applicability.

Establishing a robust educational framework and a shared body of knowledge in GeoAI is pivotal for fostering innovation, streamlining policy development and enabling informed decision-making.

The GeoAI Discovery series (2024-present)

The educational aspect continued to be pivotal for the series, as it was highlighted for instance in the organization of a roundtable discussion in February 2024 on the *Handbook of Geospatial Artificial Intelligence*[19] by Di Zhu, Song Gao, Wenwen Li, Yingjie Hu and Samantha Arundel.

Since 2024, the team shifted the focus towards organizing more hands-on workshops, and also towards the rapidly evolving field of geospatial foundation models. These are advanced AI models trained on extensive EO data to analyse and predict a wide range of topics without requiring the vast amount of training needed for traditional models. They are highly versatile, capable of processing and analysing large volumes of data with high precision and they excel at generalizing knowledge, where they can apply insights from one task to another, reducing the need for extensive retraining. Geospatial foundation models represent a significant advancement in GeoAI, offering a powerful tool to address complex global challenges.

In March 2024, the series organized a webinar on *Geospatial Frontiers: Navigating the Future with Generative AI and Foundation Models*[20] by Blagoj Delipetrev. As models like ChatGPT, Gemini and Llama were taking the Internet by storm, the presentation helped the audience to get a fundamental understanding of foundation models and their practical applications in the geospatial sector. It was followed by an invigorating talk in April 2024 on *Foundation Models for Science: A Paradigm Shift in AI*[21] by Rahul Ramachandran, Sujit Roy and Paolo Fraccaro from the NASA-IBM collaboration. Foundation models like Prithvi, unlike traditional models trained on specific tasks, have become a game changer in geospatial analysis to excel in numerous scientific tasks including flood modelling, weather predictions and more.

The series continued in June 2024 with *Leveraging LLMs for Advanced Spatial Decision Support: The Case of SATGPT*[22]. Hamid Mehmood introduced SATGPT, a cutting-edge decision support system integrating LLMs with EO data. Designed for disaster management, SATGPT demonstrated how LLMs could dynamically generate geospatial analyses, such as flood mapping, through a user-friendly interface. The session also unveiled an accompanying course on geospatial data analysis with ChatGPT and Google Earth Engine, underscoring the commitment to accessible and impactful education.

Continuing with the exploration of the use of GeoAI solutions for disaster management, in September 2024 the series included a webinar and demo of practical tools with *Unlocking the Power of GeoAI for Humanitarian Use Cases*[23] by Michael Gould, Rami Alouta and Lisa Tanh. The session highlighted the transformative potential of GeoAI in humanitarian efforts, showcasing practical applications such as rapid, automated damage assessments and mapping informal settlements. By leveraging advanced geospatial analysis, humanitarian organizations can enhance decision-making.

The series continues in 2025 with a two-part series of hands-on workshops, kick-starting the year with *Mastering remote sensing image segmentation with AI: A hands-on* workshop *with the Segment Anything Model*[24] by Qiusheng Wu. This workshop empowers geospatial professionals with advanced AI tools for precise image segmentation, enhancing their ability to analyse and interpret satellite and aerial imagery. By mastering these techniques, participants can significantly improve their geospatial data workflows, which is the dawn of a new geospatial era. The second part of the series focused on

[19] https://aiforgood.itu.int/event/geoai-solutions-for-sustainable-development-the-handbook-of-geospatial-artificial-intelligence-geoai/
[20] https://aiforgood.itu.int/event/geospatial-frontiers-navigating-the-future-with-generative-ai-and-foundational-models/
[21] https://aiforgood.itu.int/event/foundation-models-for-science-a-paradigm-shift-in-ai/
[22] https://aiforgood.itu.int/event/leveraging-llms-for-advanced-spatial-decision-support-the-case-of-satgpt/
[23] https://aiforgood.itu.int/event/unlocking-the-power-of-geospatial-artificial-intelligence-geoai-for-humanitarian-use-cases/
[24] https://aiforgood.itu.int/event/mastering-remote-sensing-image-segmentation-with-ai-a-hands-on-workshop-with-the-segment-anything-model/

Modeling population dynamics with AI: A hands-on workshop with the Population Dynamics Foundation Model (PDFM)[25] where participants were introduced to the untapped potential of PDFM with a real-world case study on predicting housing prices in the US.

Do not miss future workshops, including the *Workshop: Earth Observation Foundation models with Prithvi-EO-2.0 and TerraTorch*[26], organized by NASA and IBM, on 19 March 2025, where Paolo Fraccaro will explain how to utilize the powerful Prithvi-EO-2.0 foundation model with TerraTorch to perform flexible geospatial tasks. The workshop will cover three use cases of image classification (land cover mapping using satellite imagery), segmentation (extracting and delineating geographical features with precision) and regression (predicting environmental variables from satellite data).

Our diverse audience can look forward to the continuation of the series, with a focus on foundation models and education throughout the rest of the year.

The GeoAI Challenges

In June 2022, the first edition of the *GeoAI Challenge*[27] was launched, with three problem statements:

- *School mapping with big data*[28]: Curated by UNICEF, this problem statement aimed to enhance existing algorithms to map schools using satellite imagery and to develop new ways to explain the results and biases driven by the algorithms.
- *Cropland mapping with satellite imagery*[29]: Curated by FAO and the UN Open GIS Initiative GeoAI working group, this problem statement aimed to develop an accurate, cost-effective classification model for cropland extent and crop intensity maps in the selected regions using machine learning and artificial intelligence techniques.
- *Location Mention Recognition (LMR) from social media crisis-related text*[30]: Curated by Qatar Computing Research Institute and Qatar University this problem statement is aimed to encourage the development of systems for Location Mention Recognition (LMR) from microblogs during emergencies.

In December 2022, the best teams from the 2022 GeoAI competitions on *Crop mapping*[31] and *Location mention recognition*[32] showcased their solutions in dedicated webinars and were awarded prizes and received certificates to recognize their outstanding performance.

This first competition was hosted in the ITU infrastructure, for the composition of teams and submissions of solutions. ITU provided a state-of-the-art, free-of-charge computing platform to participants of the challenge who do not have adequate access to computing in their respective institutions. The computing platform provided participants with access to free GPUs and CPUs, hosted a Jupyter notebook server, Python kernel and pre-installed ML packages, e.g. PyTorch and TensorFlow.

During the AI for Good summit in July 2023, the second edition of the ITU GeoAI Challenge was announced. This competition run on the Zindi platform[33] which provided an automated leaderboard allowing participants to see in real time how their submitted solutions ranked in the competition.

[25] https://aiforgood.itu.int/event/modeling-population-dynamics-with-ai-a-hands-on-workshop-with-the-population-dynamics-foundation-model/
[26] https://aiforgood.itu.int/event/workshop-earth-observation-foundation-models-with-prithvi-eo-2-0-and-terratorch/
[27] https://aiforgood.itu.int/event/launch-of-the-itu-geoai-challenge/
[28] https://geoaichallenge.aiforgood.itu.int/match/matchitem/62
[29] https://geoaichallenge.aiforgood.itu.int/match/matchitem/61
[30] https://geoaichallenge.aiforgood.itu.int/match/matchitem/64
[31] https://aiforgood.itu.int/event/2022-itu-geoai-location-mention-recognition-challenge-finale/
[32] https://aiforgood.itu.int/event/2022-itu-geoai-location-mention-recognition-challenge-finale/
[33] https://zindi.africa/competitions

The 2023 ITU GeoAI Challenge included five problem statements:

- *Air pollution susceptibility mapping*[34]: Curated by GEOlab at Politecnico di Milano, this problem statement aimed to implement an ML method that can accurately estimate the pollution levels of the metropolitan city of Milan.
- *Landslide susceptibility mapping*[35]: Curated by GEOlab at Politecnico di Milano, this problem statement aimed to develop ML algorithms that can analyse large datasets to identify patterns indicating a high probability of landslide occurrence and create a landslide susceptibility map.
- *Cropland mapping*[36]: Curated by United Nations Office on Drugs and Crime (UNODC) and Food and Agriculture Organization (FAO) of the United Nations, this problem statement aimed to develop an accurate, cost-effective classification model for cropland extent mapping with ML techniques in three test regions.
- *Location mention recognition*[37]: Curated by Qatar Computing Research Institute (QCRI), Qatar University (QU), and Qen Labs Inc., this problem statement aimed to automatically extracting toponyms (places or location names) from the given text.
- *Estimating soil parameters from hyperspectral images*[38]: Curated by the European Space Agency (ESA), this problem statement aimed to estimate soil parameters from hyperspectral images.

The final events, with presentations from the top three teams for each problem statement, were held in December 2023.

The 2024 ITU GeoAI Challenge included five problem statements:

- *Agricultural plastic cover mapping with satellite imagery*[39]: Curated by the FAO, this problem statement aimed to develop accurate and cost-effective classification models for agricultural plastic cover (increasingly used with the expansion of intensive and semi-intensive agricultural practices aimed at enhancing crop yield) using freely available satellite datasets.
- *Ground-level NO2 estimation challenge*[40]: Curated by the University of Padua, Interdepartmental Research Centre in Geomatics (CIRGEO), and the GEOLab at Politecnico di Milano, this problem statement aimed to develop ML models to estimate surface NO2 concentrations using only public remote sensing data as predictor variables.
- *Clandestine runways detection in the Peruvian Amazonian basin with open-source satellite*[41]: Curated by UNODC, this problem statement aimed to develop methods for automated detection of clandestine runways on open source medium resolution imagery (both optical and radar) and to compare the performance of several methods and assess how the integration of optical and SAR data increases the model accuracy. Clandestine runways, often covertly constructed in remote regions, serve as pivotal infrastructure for various illicit activities, notably illegal logging, mining and narcotics trafficking.

34 https://aiforgood.itu.int/event/2023-itu-air-pollution-susceptibility-mapping-challenge-finale/
35 https://aiforgood.itu.int/event/2023-itu-geoai-challenge-finale-landslide-susceptibility-mapping/
36 https://aiforgood.itu.int/event/2023-itu-geoai-cropland-mapping-challenge-finale/
37 https://aiforgood.itu.int/event/2023-itu-geoai-challenge-finale-location-mention-recognition/
38 https://aiforgood.itu.int/event/2023-itu-geoai-challenge-estimating-soil-parameters-from-hyperspectral-images/
39 https://zindi.africa/competitions/geoai-challenge-for-agricultural-plastic-cover-mapping-with-satellite-imagery
40 https://zindi.africa/competitions/geoai-ground-level-no2-estimation-challenge
41 https://zindi.africa/competitions/geoai-amazon-basin-secret-runway-detection-challenge

- *Vegetation mapping challenge* [42] : Curated by The National Institute of Statistics and Geography (INEGI), this problem statement aimed to propose and develop a robust and accurate ML model that can help to cleanse and improve training data, either by identifying outliers (wrong or suspicious labels), or even suggesting a more plausible label in the given test data.
- *Human Settlement Detection Challenge*[43]: Curated by INEGI, this problem statement aimed to develop a robust and accurate ML model to detect human settlements in satellite imagery.

The 2024 GeoAI competition has reached new high. The ground-level NO2 estimation problem statement gathered over 800 participants from around the world, while 372 participants submitted solutions, making it the most successful problem statement to date. Two problem statements, submitted by INEGI, were sponsored by UN-GGIM, and the winners were recognized at the Seventh High-level Forum "Accelerating Implementation: Achieving Resilience" of the United Nations Global Geospatial Information Management held in Mexico City in October 2024.

Conclusion

In summary, the ITU GeoAI events that have taken place since 2021 in AI for Good form a rich tapestry of insights, innovations and applications that showcase the transformative potential of GeoAI. By connecting experts, fostering education and highlighting real-world solutions, the GeoAI Discovery series, the GeoAI Education activities and the GeoAI Challenge have paved the way for a more equitable, sustainable and resilient future.

Acknowledgments

The authors extend their heartfelt gratitude to Reinhard Scholl for his invaluable support in organizing the GeoAI Discovery and GeoAI Challenges, Thomas Basikolo for his expert advice in the organization of the GeoAI Challenges, and Julien Smith for his technical support during the webinars. We also deeply appreciate the dedication of all ITU staff who worked tirelessly behind the scenes to make these events possible. Special thanks go to Barbara Ryan and Nadine Alameh for their role as co-curators of the GeoAI Discovery during its first year.

We want to thank UNODC for having sponsored two problem statements of interest in the 2023 and 2024 editions of the challenge and, more in general, all who contributed to organizing and presenting the webinars and challenges.

Furthermore, we wish to acknowledge the significant contributions of the UN GGIM, particularly the UN GGIM Academic Network, Geospatial Society, Private Sector Network and the UN Geospatial Network. We also extend our appreciation to the participants of the UN OpenGIS Initiative GeoAI Working Group for their invaluable input.

Maria Antonia Brovelli, Politecnico di Milano, UN GGIM Academic Network, Italy

Andrea Manara, ITU, UN Geospatial Network, Switzerland

Rohini Swaminathan, UNICEF, UN Geospatial Network, Italy

[42] https://zindi.africa/competitions/inegi-gcim-vegetation-mapping-challenge
[43] https://zindi.africa/competitions/inegi-gcim-human-settlement-detection-challenge

Special issue on "Geospatial AI to advance the United Nations Sustainable Development Goals"

Editorial

The rapid advancement of Artificial Intelligence (AI) and Machine Learning (ML) techniques, combined with the surge in geospatial data availability and massive computational power, has unveiled new avenues for addressing real-world challenges from a geospatial perspective. The integration of AI and geospatial technologies has opened a new era of Geospatial AI (GeoAI), which combines Machine Learning, Deep Learning (DL), computer vision, Natural Language Processing (NLP), remote sensing, Geographic Information Systems (GIS), Internet of Things (IoT) and big data handling to extract meaningful and actionable insights from geospatial data. Recognizing the transformative potential of this synergy, the ITU launched the GeoAI Discovery webinar series and the GeoAI Challenge in 2021 presented in the first contribution as the overview of this special issue. Now in its fourth year, this challenge stands as a beacon, motivating intellectuals globally to collaboratively tackle geospatial problems by leveraging the progress of AI/ML, with the ultimate vision of furthering progress towards achieving the United Nations Sustainable Development Goals (SDGs).

Building on the ongoing discussions on GeoAI in the ITU Discovery track and the achievements of the GeoAI Challenge's second edition, this special issue aspires to spotlight and amplify the approaches and insights from the challenge. The special issue invited GeoAI Challenge participants, and also experts from the broad GeoAI community, to share their novel solutions, techniques and visions, with the aim of collecting state-of-the-art research efforts that address GeoAI challenges, including applications and case studies, methodologies and techniques, and education and society related issues. Topics that stand out include:

- application of AI/ML to geospatial technologies
- in-depth case studies illustrating the application of AI/ML/Deep Learning (DL) in geospatial problems
- experiences, learning and perspectives from the GeoAI Challenges
- advances in AI/ML in Earth observation
- novel GeoAI algorithms
- cutting-edge GeoAI methodologies and techniques to champion SDGs
- geospatial foundation models
- geospatial generative AI
- ethical, societal and policy ramifications of GeoAI dedicated to sustainable evolution
- GeoAI and education

All submissions have gone through a stringent peer review process, upholding the quality and pertinence of accepted narratives. The five selected papers address different aspects of supporting SDGs with global geospatial information.

Shivangi Somvanshi, Deepak Kumar and Maya Kumari in their paper "*Trends of recent data, AI/ML approaches for geospatial AI in Earth observation towards sustainable development goals*" present the latest trends in the application of AI/ML to geospatial data for Earth observation, with a focus on land cover classification, disaster prediction and climate monitoring, while emphasizing their role in

advancing the Sustainable Development Goals (SDGs). Their study concludes that "the synergy between AI/ML/DL and geospatial data in Earth observation is increasingly pivotal in driving progress toward the SDGs", as well as highlighting the importance of interdisciplinary collaborations and the inclusion of local knowledge and expertise.

Cropland maps serve as a critical determinant for supporting various Sustainable Development Goals (SDGs). The paper "*Technical achievement and summary of the Geo-AI Challenge cropland extent mapping 2023*" by Pengyu Hao, Mohammad Alasawedah, Stella Ofori-Ampofo, Julius Maina, Vita Lorenzo, Alexandre Nobajas Ganau and Zhongxin Chen presents three solutions developed during the 2023 GeoAI Challenge for cropland extent mapping. It provides a comprehensive comparison of various machine learning and deep learning algorithms for accurate and cost-effective cropland extent mapping using remote sensing data. All data and scripts are openly accessible.

In "*Leveraging large language models for flood mapping and advanced spatial decision support: A user-friendly approach with SATGPT*", Mehmood introduces SATGPT, a tool that generates code from natural language questions entered by users. The code is executed to either extract data from historical databases or to perform unsupervised image classification for flood modelling. This proof-of-concept combines LLMs with Earth Observation data, an interesting example of using AI and NLP to make advanced geospatial analysis accessible to a wider range of users, thereby supporting informed decision-making and helping to advance several SDGs. The authors suggest that 40 of the 169 SDG targets and 30 of the 232 SDG indicators could benefit from Earth Observation data analysis. For the future, there are plans to incorporate additional datasets, so that air quality monitoring and poverty mapping are also possible.

Obukhov and Brovelli present results of using Somali data for developing conflict susceptibility models in their paper titled "*Conflict susceptibility mapping methodology and data experiments*". They show that publicly available data related to socioeconomic indicators, environmental variables and other factors can be used as input for configuring their models. However, they warn that due to socio-cultural differences and the specific nature of a conflict the conditioning factors may differ from one conflict to another. Their research presents a novel contribution in applying data and geospatial science to conflict analysis in the political sciences, a social science, which is an excellent example of interdisciplinary research. Applying ML technology to conflict analysis improves our understanding of conflict scenarios, providing deeper insight into the causes and possible resolutions of a conflict, towards a peaceful environment and a justice system as aspired to by SDG16.

In their paper, "*Utilization of satellite imagery and artificial intelligence for disaster management: Approaches and case studies*", Kim and Choi show how satellites can be utilized at different stages of the disaster management cycle and identify which satellites and AI methods are best suited to the respective stages: prevention, preparedness, response and recovery. By integrating satellite technology with advanced AI methods, they present a comprehensive framework and case studies, and they offer practical recommendations for future applications.

We want to thank all contributing authors, including those whose papers were not selected for publication in this special issue. Special thanks go to the team of reviewers. Without their contributions, this special issue would not have been published. Finally, we would like to extend our thanks to the Editor-in-Chief, Prof. Ian F. Akyildiz, and the ITU Journal's team: Alessia Magliarditi, Maria Eugenia Otero and Erica Campilongo, for their assistance, guidance and patience.

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