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MORALITY BEFORE KNOWLEDGE

The use of satellite imagery in supporting non-military operations: a geospatial intelligence perspective

Rika Kariyani[1]*, Asep Adang Supriyadi[1]
[1] *Sensing Technology, Faculty of Science and Technology, Republic of Indonesia Defense University, Bogor, West Java, 16810, Indonesia*
*Correspondence: rika.kariani@tp.idu.ac.id

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ABSTRACT

Background: Satellite imagery technology, initially developed for military purposes, has expanded into a critical tool in non-military applications, including environmental monitoring, disaster mitigation, infrastructure development, and humanitarian aid. This shift highlights the evolving role of satellite technology from military functions to addressing sustainability and global well-being challenges. **Methods**: A literature review approach was employed to examine the use of satellite imagery in non-military settings. Peer-reviewed articles were identified, selected, and analyzed from databases such as Google Scholar and ScienceDirect. The focus was on articles discussing applications in environmental monitoring, disaster management, infrastructure planning, and humanitarian assistance. Relevant literature was categorized and synthesized to identify emerging trends and implications of satellite imagery technology. **Findings**: Satellite imagery has proven to be invaluable in providing essential geospatial data for non-military purposes. It facilitates monitoring of environmental changes, supports infrastructure planning and evaluation, enhances disaster mitigation through risk analysis, and improves coordination of humanitarian aid during emergencies. The integration of platforms like Google Earth Engine and artificial intelligence significantly increases its utility, especially in object detection, climate change monitoring, and disaster impact assessments. **Conclusion**: Satellite imagery has evolved into an indispensable tool for a wide range of non-military applications, offering sustainable and efficient solutions to global challenges. It significantly enhances environmental monitoring, infrastructure development, disaster response, and humanitarian operations. The study emphasizes the need for continued innovation in satellite technology and interdisciplinary collaboration to meet future global sustainability goals. **Novelty/Originality of this article**: This study provides a comprehensive analysis of satellite imagery's growing role in non-military applications, emphasizing its potential in addressing global challenges. By synthesizing insights across multiple fields, the research highlights the transformative power of satellite technology in supporting sustainable development and disaster resilience.

KEYWORDS: geospatial intelligence; remote sensing; satellite imagery.

1. Introduction

Timely and accurate information is the key to overcoming various developing problems. Satellite imagery is the technology that has been used and proven to be correct in providing important information. Satellite imagery is not only used as a tool for military purposes but has also become a valuable asset in supporting non-military operations in various fields, ranging from environmental monitoring to humanitarian assistance. Humanity uses almost unthinkable amounts of energy to power the way of life in the modern era (Nishijima et al., 2013). The geopotential intelligence perspective plays an important role in translating satellite imagery data into useful information that can be

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applied in various operational contexts. In the mission implementation process, non-military operations support system equipment will be disrupted and destroyed in various ways (Qi et al., 2020).

The use of satellite imagery in the context of non-military operations can open insights, more effective solutions, and more targeted actions in facing current and future global challenges. The COVID-19 pandemic is an example of a global challenge that has occurred. The spread of COVID-19 emphasizes the importance of identifying when there is a new pandemic pattern by implementing risk control measures for a country in providing the health services the community needs. Artificial intelligence is changing the way information technology solutions are implemented and operated (Döllner, 2020). Analysis from social media can be used for earth observation as well as satellite acquisition to see potential new areas of human gathering (Atek et al., 2022). Emphasizes ongoing research and development in cartography and encourages interdisciplinary collaboration for a better understanding of the world (Habib & Okayli, 2023).

2. Methods

The research method employed was a literature review aimed at examining the transformation of satellite imagery from a predominantly military tool to a critical asset in various non-military domains, including environmental monitoring, disaster mitigation, infrastructure development, and humanitarian assistance. The initial step involved defining the research objectives, which concentrated on the technological evolution of satellite imagery and its diverse non-military applications. Subsequently, inclusion criteria were established to focus on peer-reviewed scientific articles and publications pertinent to the topic, while exclusion criteria were applied to filter out unreliable sources. A comprehensive search strategy was implemented using academic databases, utilizing relevant keywords such as "satellite imagery applications" and "environmental monitoring." Data collection involved meticulously recording significant information from the selected literature, ensuring that only high-quality and relevant sources were included in the analysis.

Following the data collection, the literature was systematically categorized based on key themes, including the latest technologies and applications related to disaster mitigation. The synthesized findings revealed notable trends and implications of satellite imagery in non-military contexts. These results were compiled into a comprehensive report that encompassed an introduction, methodology, key findings, discussion, and conclusions, complete with properly formatted references and citations. The process also included a brainstorming phase to aid in the study's design, highlighting the multifaceted applications of satellite imagery. Ultimately, the literature review underscored the growing significance of satellite technology in addressing critical challenges beyond military use, contributing valuable insights to the fields of environmental and humanitarian efforts. The following brainstorming was used in designing this study (Fig. 1).

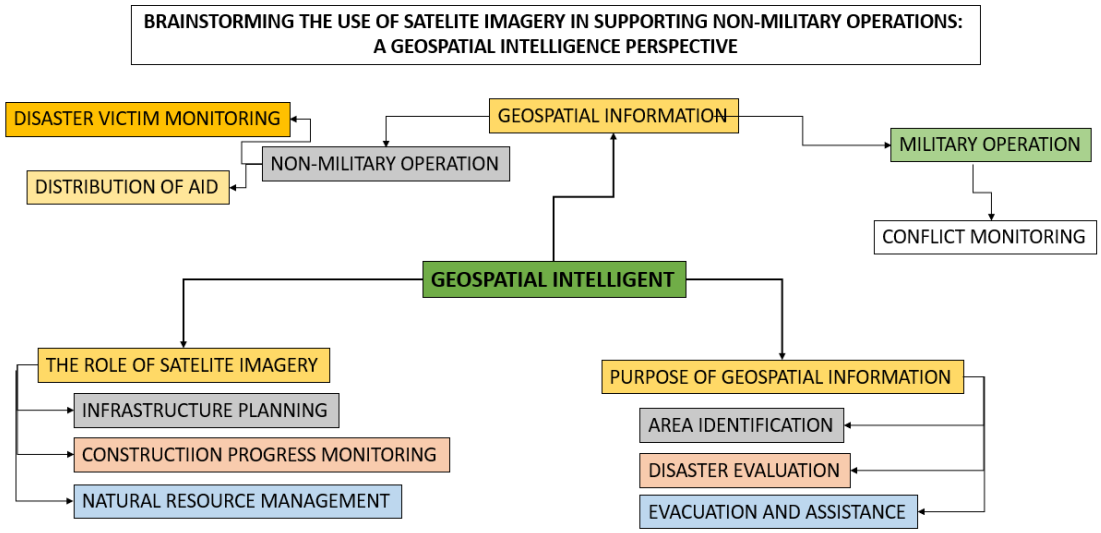

Fig. 1 Brainstroming

3. Results and Discussion

The use of satellite imagery to support various things in the contemporary era, including environmental monitoring, natural disaster mitigation, infrastructure development, and humanitarian activities. The resolution of satellite imagery is so high that it is increasingly being used to visualize the impact of an event in real-time (Bennett et al., 2022a). By careful analysis of satellite imagery, environmental experts can map periodic patterns of change, identify zones that are vulnerable to environmental degradation, and plan effective conservation measures. Utilization of satellite imagery and drones can be used as tools for monitoring crops and estimating crop yields. Things that can be observed include optimizing resources and tactics for using machine power, including irrigation systems so that conservation and increased productivity can be observed (Arya, 2021). Accurate monitoring of deforested land is a necessity in environmental management and optimal use of land resources. Cover crops can affect soil water content, soil systems, and planting systems (Raimondi et al., 2023).High-resolution satellite imagery is useful for identifying resources on the ground (He et al., 2023). However, Manual monitoring of grasslands over large areas is often impossible due to time and financial constraints (Ara et al., 2021).

Satellite imagery plays an important role in monitoring and responding quickly to disaster threats. Experts can map areas that are vulnerable to disasters, monitor changes in the earth's surface that may be early signs of disaster, and provide important information to agencies related to disaster management to plan evacuation and distribution of aid. Weather analysis and forecasting, and geostationary satellites have the advantage because images can be obtained more frequently (Higuchi, 2021). Worsening forest fires caused by climate change pose enormous risks to ecological systems, infrastructure, and human welfare. In the context of sustainable development goals, especially those related to climate action, prioritizing assessment and management, as well as the intensity of forest fires which can be extensive, is the most important thing (Spiller et al., 2023). However, the limited availability of high-resolution monitoring systems for drought phenomena which are influenced by weather anomalies hampers policy decision-making (Polpanich et al., 2022).

For infrastructure development, satellite imagery provides the data necessary for planning, monitoring, and evaluating infrastructure projects. A problem that can arise in settlements is ensuring access to housing and infrastructure for a growing population. Another important aspect is the environmental sustainability of the settlement boundaries (Nelin et al., 2023).With satellite imagery, planners can map potential locations for

infrastructure development, monitor project progress, and measure the environmental impact of the project. Data regarding damage to buildings in conflict zones relies on eyewitness reports or manual detection, making data difficult, incomplete, and potentially biased. This lack of data results in information being restricted to the media, making humanitarian aid efforts, human rights monitoring, reconstruction initiatives, and academic studies of violent conflict difficult to track (Mueller et al., 2021). Satellite imagery is also used for military purposes of intelligence, but is now spreading to every armed conflict. The role of satellite imagery in influencing the course of armed conflict will continue to grow as research advances to make direct analysis (Sticher et al., 2023a).

Satellite imagery can provide specific and broad access to geospatial data in the context of environmental monitoring to detect and classify objects from satellite imagery which is very important for many applications (Tehsin et al., 2023). Google Earth Engine (GEE) is a free web-based spatial analysis platform that only requires a web and internet connection to access programmatically. Google Earth Engine is used to analyze data from regularly updated multi-petabyte catalogs of satellite imagery (e.g. MODIS, Landsat, Sentinel) and other geospatial datasets (Crego et al., 2022). The existence of big data and earth observation technology can play an important role in facilitating the monitoring of sustainable development in urban areas (Han et al., 2022). From year to year, global climate changes occur which cover various areas, such as states and access to natural resources, residential infrastructure, and so on.(Alimbekova & Walker, 2022). Observing weather, especially to monitor the growth of cumulus clouds globally, makes it easier to analyze environmental and climate changes. This cloud growth is closely related to the formation of energy and water cycles, and global ecosystems at various scales seen from the influence of solar radiation and rainfall. Satellite imagery is an important data source for accurate cloud detection and segmentation which is important for climate and environmental monitoring (Shi & Zuo, 2022). Monitoring the melting of ice during the summer, by paying attention to cloud growth and snow accumulation, is one of the benefits of satellite imagery of the earth's surface (Brun et al., 2015). By tracking changes over time, satellite imagery allows the identification of long-term trends and seasonal changes in an ecosystem. Flood modeling and mapping typically require estimating flood frequency, modeling the distribution of pollutants in seawater, and inundation mapping, which require specific data sets that are often not available to developing countries due to financial, logistical, technical, and organizational challenges. (Ekeu-wei & Blackburn, 2018). Satellite imagery is very useful in measuring the impact of human activities on ecosystems quite accurately. The risk of forest fires has increased globally over recent years due to several factors. For example, a quick and efficient response to forest fires is critical to reducing the damage to humans and wildlife (James et al., 2023). Currently, plastic pollution in aquatic ecosystems has been identified as an increasing global water pollution threat, resulting in a negative impact on water quality, and as a result, impacting the health of humans, aquatic animals, and wildlife. Therefore, this presents a global environmental disaster that requires immediate attention (Mukonza & Chiang, 2022).

Effective conservation action planning is very possible. The area used for mineral extraction is a key indicator in understanding and mitigating environmental impacts caused by the natural resource management sector. To date, mineral product data from the natural resource management sector worldwide does not report areas used for mining activities (Maus et al., 2020). The use of satellite imagery in environmental monitoring provides great benefits for understanding environmental dynamics and conservation efforts. By utilizing this technology effectively, stakeholders can plan timely, efficient, and sustainable actions to maintain environmental sustainability. For decades, scientists and conservationists have advocated for the creation of protected areas that preserve ecosystems and biodiversity as primary goals, and benefit local populations (Vidal et al., 2014). The integration of artificial intelligence and satellite remote sensing in land cover change detection is important in scientific discovery and research (Gu & Zeng, 2024). The availability of big data and earth observation technology plays an important role in facilitating sustainable monitoring of urban development (Han et al., 2022). Deforestation is often caused by human activities

such as illegal logging, agricultural expansion, and infrastructure development. From year to year, global climate changes occur which cover various areas, such as states and access to natural resources, residential infrastructure, and so on. Climate change has different consequences for agriculture and livestock, rainfall which can affect crop yields and animal feed (Alimbekova & Walker, 2022). Satellite imagery has reached a consensus that spring phenology for vegetation in urban areas occurs earlier than in rural areas (Tian et al., 2020). Changes in vegetation cover are one of the main indicators used to monitor environmental quality. It accurately looks at changes in hydrology, climate, and human activity, especially in arid and semi-arid regions (Almalki et al., 2022). Mangrove forests consist of plant species such as halophilic fungi and shrubs with certain morphological, physiological, and reproductive characteristics that enable them to survive on the surface between terrestrial, estuarine, and marine ecosystems near the coast in tropical and sub-tropical areas throughout the world (Villate Daza et al., 2020).

Apart from deforestation, satellite imagery is also useful for mapping changes in land cover, such as urbanization, agriculture, and other land use changes. Satellite imagery can be used to monitor and predict gross weight production and water evaporation in living tissue (Celis et al., 2024). Forest destruction is known to cause natural disasters in the form of floods, landslides in the rainy season, droughts in the dry season, climate change, and global warming. The high rate of forest destruction is caused by various factors, one of which is weak law enforcement in illegal logging efforts (Mujetahid et al., 2023). Mapping Antarctica with satellite imagery is also important for monitoring the polar environment (Zeng et al., 2023). The conversion of natural land cover to human-dominated land use systems has a significant impact on the environment. Global mapping and monitoring of extensive human-dominated land use via satellite provides an empirical basis for assessing land use (Hansen et al., 2022). Land degradation often occurs due to unsustainable agricultural practices, mining, and inappropriate land use. To identify water bodies from satellite images automatically is one of the most difficult tasks in the realm of remote sensing. Detailed and precise urban green space maps provide important data on the sustainability of urban development (Chen et al., 2021). In recent years, several image processors have been developed for multispectral processing to analyze land availability, water prediction, object detection, climate change, and others (Afaq & Manocha, 2021). Information obtained from satellite imagery not only helps in monitoring current environmental conditions but also plays an important role in sustainable decision-making.

For a long time, satellite imagery was used for military and intelligence purposes, but today its use extends to every aspect of armed conflict (Sticher et al., 2023b). Improving the technical and research methodology of hazard and disaster identification is crucial in disaster management. Object detection is an important step in satellite image-based applications such as agriculture, urban planning, and defense applications (Chollet, 2017). Artificial intelligence applications such as tracking and mapping, geospatial analysis, remote sensing techniques, robotics, drone technology, machine learning, telecommunications and network services, accident and hotspot analysis, smart cities planning, transportation planning, and environmental impact analysis, are components of social change technology, which has had a significant impact on research on societal responses to hazards and disasters (Abid et al., 2021). Humanitarian aid coordination has always been difficult due to a lack of data needed for management and planning (Jenerowicz et al., 2019). Remote sensing technology has experienced a significant increase in popularity over the last two decades and has become an integral part of our lives (Avtar et al., 2021). Very high-resolution satellite imagery was once a rare commodity, with satellite pass-over frequencies being rare in certain areas (Voigt et al., 2014). Very high-resolution satellite imagery is increasingly being used to visualize the impact of armed conflict in near real-time (Bennett et al., 2022b). This helps in identifying areas that require immediate intervention, planning evacuation routes, and coordinating humanitarian aid efforts more effectively. For example, in situations of armed conflict, satellite imagery can spot military movements or weapons buildups that could signal an escalation of conflict, allowing for a quicker response from authorities or international organizations. Satellite imagery also plays an important role in

managing refugees, providing accurate data about the location, size, and condition of refugee camps so that it can be used by decision-makers to anticipate the magnitude of potential disasters and provide rapid responses to threatened residences (Bhatt et al., 2017). Extensive mining operations, deforestation, and soil erosion coupled with population growth can harm forest resources (Pyngrope et al., 2021). Urban flooding is a major natural disaster that poses a serious threat to the urban environment (Peng et al., 2019). In situations of natural disaster or conflict, access to affected areas is often limited and dangerous. From satellite imagery, it is possible to map the condition of roads, bridges, and other crucial infrastructure when delivering aid. In general, poor road conditions, especially cracked roads, disrupt the community in the form of inconvenience for road users, serious damage to vehicles, and accidents (Yi & bin Ahmad, 2023). Mapping the distribution of poverty in developing countries is critical for humanitarian organizations and policymakers to formulate targeted programs and aid (Tingzon et al., 2019). The use of satellite imagery in support of non-military operations not only provides benefits in terms of rapid response to crises but also in improving understanding and long-term planning. Agricultural land changes every year, making agricultural water estimates difficult to use, considering agricultural methods of use identification and mapping land (Zhong et al., 2009). By developing geospatial analysis technology and methodology, the benefits of satellite imagery can continue to be improved to support sustainable development goals for humanity in the future.

4. Conclusions

Satellite imagery has evolved from just a military tool to become an important asset in a variety of non-military operations supporting environmental monitoring, disaster mitigation, infrastructure development, and humanitarian assistance. Satellite imagery provides broad access to geospatial data in the context of environmental monitoring. With the ability of satellite imagery to map environmental changes globally and on significant time scales, stakeholders can identify patterns of change, measure the impact of human activities on ecosystems, and plan effective conservation actions. This technology offers high resolution and real-time capabilities, enabling careful and detailed analysis that is essential for experts to identify environmental problems, plan conservation measures, and respond more effectively to natural disasters.

The use of satellite imagery also facilitates the collection of accurate geospatial data and is crucial for detecting, classifying objects, and monitoring environmental changes. Platforms such as Google Earth Engine enable broad access to satellite imagery data, supporting monitoring of sustainable development in various fields. Satellite imagery plays an important role in climate change analysis, dealing with deforestation, monitoring agriculture, and dealing with pollution. In addition, the integration of artificial intelligence with satellite imagery further expands the scope of applications of this technology, from object detection to smart city planning and disaster response. In the context of armed conflict and emergencies, satellite imagery provides real-time information that is vital for aid and evacuation coordination. Overall, The use of satellite imagery in non-military operations offers effective and efficient solutions to various global challenges, supporting sustainable development, environmental conservation, and improving people's quality of life. Research and development of this technology continue to encourage interdisciplinary collaboration and expand its applications for a better future.

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References
Al-Aizari, AR, Al-Masnay, YA, Aydda, A., Zhang, J., Ullah, K., Islam, ARMT, Habib, T., Kaku, DU, Nizeyimana, JC, Al-Shaibah, B. , Khalil, Y. M., AL-Hameedi, W. M. M., & Liu, X. (2022). Assessment Analysis of Flood Susceptibility in Tropical Desert Area: A Case Study of Yemen. *Remote Sensing, 14*(16). https://doi.org/10.3390/rs14164050

Abid, SK, Sulaiman, N., Chan, S.W., Nazir, U., Abid, M., Han, H., Ariza-Montes, A., & Vega-Muñoz, A. (2021). Toward an integrated disaster management approach: How artificial intelligence can improve disaster management. *Sustainability (Switzerland), 13*(22), 1–17. https://doi.org/10.3390/su132212560

Afaq, Y., & Manocha, A. (2021). Happiness Index Determination by Analyzing Satellite Images for Urbanization. *Applied Artificial Intelligence, 35*(15), 1466–1489. https://doi.org/10.1080/08839514.2021.1982533

Alimbekova, N. A., & Walker, N. (2022). Kyrgyz Open Data Cube of Satellite Images and Environmental Products as a Tool for Pasture Monitoring. *International Journal of Geoinformatics, 18*(1), 81–85. https://doi.org/10.52939/ijg.v18i1.2113

Almalki, R., Khaki, M., Saco, P. M., & Rodriguez, J. F. (2022). Monitoring and Mapping Vegetation Cover Changes in Arid and Semi-arid Areas Using Remote Sensing Technology: A Review. *Remote Sensing, 14*(20). https://doi.org/10.3390/rs14205143

Ara, I., Harrison, M.T., Whitehead, J., Waldner, F., Bridle, K., Gilfedder, L., Marques Da Silva, J., Marques, F., & Rawnsley, R. (2021). Modeling seasonal pasture growth and botanical composition at the paddock scale with satellite imagery. *In Silico Plants, 3*(1), 1–15. https://doi.org/10.1093/insilicoplants/diaa013

Arya, C. (2021). IoT Based Precision Farming and Agriculture - Aspects and Technologies. *Mathematical Statistics and Engineering Applications, 70*(2), 1426–1433. https://doi.org/10.17762/msea.v70i2.2335

Atek, S., Pesaresi, C., Eugeni, M., De Vito, C., Cardinale, V., Mecella, M., Rescio, A., Petronzio, L., Vincenzi, A., Pistillo, P. , Bianchini, F., Giusto, G., Pasquali, G., & Gaudenzi, P. (2022). A Geospatial Artificial Intelligence and satellite-based earth observation cognitive system

in response to COVID-19. *Acta Astronautica, 197*(March), 323–335. https://doi.org/10.1016/j.actaastro.2022.05.013

Avtar, R., Kouser, A., Kumar, A., Singh, D., Misra, P., Gupta, A., Yunus, A.P., Kumar, P., Johnson, B.A., Dasgupta, R., Sahu, N., & Rimba, AB (2021). Remote sensing for international peace and security: Its role and implications. *Remote Sensing, 13*(3). https://doi.org/10.3390/rs13030439

Bennett, M.M., Van Den Hoek, J., Zhao, B., & Prishchepov, A.V. (2022a). Improving Satellite Monitoring of Armed Conflicts. *Earth's Future, 10*(9). https://doi.org/10.1029/2022EF002904

Bennett, M. M., Van Den Hoek, J., Zhao, B., & Prishchepov, A. V. (2022b). Improving Satellite Monitoring of Armed Conflicts. *Earth's Future, 10*(9). https://doi.org/10.1029/2022EF002904

Bhatt, C.M., Rao, G.S., Diwakar, P.G., & Dadhwal, V.K. (2017). Development of flood inundation extent libraries over a range of potential flood levels: a practical framework for quick flood response. *Geomatics, Natural Hazards and Risk, 8*(2), 384–401. https://doi.org/10.1080/19475705.2016.1220025

Brun, F., Dumont, M., Wagnon, P., Berthier, E., Azam, M.F., Shea, J.M., Sirguey, P., Rabatel, A., & Ramanathan, A. (2015). Seasonal changes in surface albedo of Himalayan glaciers from MODIS data and links with the annual mass balance. *Cryosphere, 9*(1), 341–355. https://doi.org/10.5194/tc-9-341-2015

Celis, J., Xiao, X., White, P. M., Cabral, O. M. R., & Freitas, H. C. (2024). Improved Modeling of Gross Primary Production and Transpiration of Sugarcane Plantations with Time-Series Landsat and Sentinel-2 Images. *Remote Sensing, 16*(1). https://doi.org/10.3390/rs16010046

Chen, Y., Weng, Q., Tang, L., Liu, Q., Zhang, X., & Bilal, M. (2021). Automatic mapping of urban green spaces using a geospatial neural network. *GIScience and Remote Sensing, 58*(4), 624–642. https://doi.org/10.1080/15481603.2021.1933367

Chollett, F. (2017). Machine learning분야 소개 및 주요 방법론 학습 기본machine learning알고리즘에 대한 이해 및 응용 관련 최신 연구 동향 습득. *Machine Learning, 45*(13), 40–48. https://books.google.ca/books?id=EoYBngEACAAJ&dq=mitchell+machine+learning+1997&hl=en&sa=X&ved=0ahUKEwiomdqfj8TkAhWGslkKHRCbAtoQ6AEIKjAA

Crego, R.D., Stabach, J.A., & Connette, G. (2022). Implementation of species distribution models in Google Earth Engine. *Diversity and Distributions, 28*(5), 904–916. https://doi.org/10.1111/ddi.13491

Döllner, J. (2020). Geospatial Artificial Intelligence: Potentials of Machine Learning for 3D Point Clouds and Geospatial Digital Twins. *PFG - Journal of Photogrammetry, Remote Sensing and Geoinformation Science, 88*(1), 15–24. https://doi.org/10.1007/s41064-020-00102-3

Ekeu-wei, I. T., & Blackburn, G. A. (2018). Applications of open-access remotely sensed data for flood modeling and mapping in developing regions. *In Hydrology* (*Vol. 5*, Issue 3). https://doi.org/10.3390/hydrology5030039

Gu, Z., & Zeng, M. (2024). The Use of Artificial Intelligence and Satellite Remote Sensing in Land Cover Change Detection: Review and Perspectives. *Sustainability (Switzerland), 16*(1). https://doi.org/10.3390/su16010274

Habib, M., & Okayli, M. (2023). An Overview of Modern Cartographic Trends Aligned with the ICA's Perspective. *Revue Internationale de Géomatique*, 1–16. https://doi.org/10.32604/rig.2023.043399

Han, L., Lu, L., Lu, J., Liu, X., Zhang, S., Luo, K., He, D., Wang, P., Guo, H., & Li, Q. (2022). Assessing Spatiotemporal Changes of SDG Indicators at the Neighborhood Level in Guilin, China: A Geospatial Big Data Approach. *Remote Sensing, 14*(19). https://doi.org/10.3390/rs14194985

Hansen, MC, Potapov, PV, Pickens, A.H., Tyukavina, A., Hernandez-Serna, A., Zalles, V., Turubanova, S., Kommareddy, I., Stehman, SV, Song, XP, & Kommareddy, A. (2022).

Global land use extent and dispersion within natural land cover using Landsat data. *Environmental Research Letters, 17*(3). https://doi.org/10.1088/1748-9326/ac46ec

He, C., Liu, Y., Wang, D., Liu, S., Yu, L., & Ren, Y. (2023). Automatic Extraction of Bare Soil Land from High-Resolution Remote Sensing Images Based on Semantic Segmentation with Deep Learning. *Remote Sensing, 15*(6). https://doi.org/10.3390/rs15061646

Higuchi, A. (2021). Toward more integrated uses of geostationary satellite data for disaster management and risk mitigation. *Remote Sensing, 13*(8). https://doi.org/10.3390/rs13081553

James, GL, Ansaf, RB, Al Samahi, SS, Parker, RD, Cutler, JM, Gachette, RV, & Ansaf, BI (2023). An Efficient Wildfire Detection System for AI-Embedded Applications Using Satellite Imagery. *Fire, 6*(4), 1–13. https://doi.org/10.3390/fire6040169

Jenerowicz, M., Wawrzaszek, A., Drzewiecki, W., Krupinski, M., & Aleksandrowicz, S. (2019). Multifractality in Humanitarian Applications: A Case Study of Internally Displaced Persons/Refugee Camps. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 12*(11), 4438–4445. https://doi.org/10.1109/JSTARS.2019.2950970

Maus, V., Giljum, S., Gutschlhofer, J., da Silva, D.M., Probst, M., Gass, S.L.B., Luckeneder, S., Lieber, M., & McCallum, I. (2020). A global-scale data set of mining areas. *Scientific Data, 7*(1), 1–13. https://doi.org/10.1038/s41597-020-00624-w

Mueller, H., Groeger, A., Hersh, J., Matranga, A., & Serrat, J. (2021). Monitoring war destruction from space using machine learning. *Proceedings of the National Academy of Sciences of the United States of America*, 118(23). https://doi.org/10.1073/pnas.2025400118

Mujetahid, A., Nursaputra, M., & Soma, AS (2023). Monitoring Illegal Logging Using Google Earth Engine in South Sulawesi Tropical Forest, Indonesia. *Forests, 14*(3). https://doi.org/10.3390/f14030652

Mukonza, S.S., & Chiang, J.-L. (2022). Satellite sensors as an emerging technique for monitoring macro- and microplastics in aquatic ecosystems. *Water Emerging Contaminants & Nanoplastics, 1*(4), 17. https://doi.org/10.20517/wecn.2022.12

Nelin, Ye., Kasianov, V., & Shterndok, E. (2023). Research on the Directions of Monitoring the Use of Real Estate in Settlements. *Municipal Economy of Cities, 6*(180), 118–122. https://doi.org/10.33042/2522-1809-2023-6-180-118-122

Nishijima, S., Eckroad, S., Marian, A., Choi, K., Kim, W.S., Terai, M., Deng, Z., Zheng, J., Wang, J., Umemoto, K., Du, J., Febvre, P., Keenan, S., Mukhanov, O., Cooley, L.D., Foley, C.P., Hassenzahl, W.V., & Izumi, M. (2013). Superconductivity and the environment: A Roadmap. *Superconductor Science and Technology, 26*(11). https://doi.org/10.1088/0953-2048/26/11/113001

Peng, B., Meng, Z., Huang, Q., & Wang, C. (2019). Patch similarity convolutional neural network for urban flood extent mapping using bi-temporal satellite multispectral imagery. *Remote Sensing, 11*(21). https://doi.org/10.3390/rs11212492

Polpanich, O.U., Bhatpuria, D., Santos Santos, T.F., & Krittasudthacheewa, C. (2022). Leveraging Multi-Source Data and Digital Technology to Support the Monitoring of Localized Water Changes in the Mekong Region. *Sustainability (Switzerland), 14*(3). https://doi.org/10.3390/su14031739

Pyngrope, O.R., Kumar, M., Pebam, R., Singh, S.K., Kundu, A., & Lal, D. (2021). Investigating forest fragmentation through earth observation datasets and metric analysis in the tropical rainforest area. *SN Applied Sciences, 3*(7). https://doi.org/10.1007/s42452-021-04683-5

Qi, O., Zhang, L., Shi, W., & Wang, Y. (2020). Analysis of the Survivability of Equipment Support System of Non-War Military Operations Based on Operational Efficiency. *Journal of Physics: Conference Series, 1649*(1). https://doi.org/10.1088/1742-6596/1649/1/012040

Raimondi, G., Maucieri, C., Borin, M., Pancorbo, J. L., Cabrera, M., & Quemada, M. (2023). Satellite imagery and modeling contribute to understanding cover crop effects on

nitrogen dynamics and water availability. *Agronomy for Sustainable Development, 43*(5), 1–19. https://doi.org/10.1007/s13593-023-00922-8

Shi, G., & Zuo, B. (2022). CloudRCNN: A Framework Based on Deep Neural Networks for Semantic Segmentation of Satellite Cloud Images. *Applied Sciences (Switzerland), 12*(11). https://doi.org/10.3390/app12115370

Spiller, D., Carbone, A., Amici, S., Thangavel, K., Sabatini, R., & Laneve, G. (2023). Wildfire Detection Using Convolutional Neural Networks and PRISMA Hyperspectral Imagery: A Spatial-Spectral Analysis. *Remote Sensing, 15*(19), 1–22. https://doi.org/10.3390/rs15194855

Sticher, V., Wegner, J.D., & Pfeifle, B. (2023a). Toward the remote monitoring of armed conflicts. *PNAS Nexus, 2*(6), 1–12. https://doi.org/10.1093/pnasnexus/pgad181

Sticher, V., Wegner, J.D., & Pfeifle, B. (2023b). Toward the remote monitoring of armed conflicts. *PNAS Nexus, 2*(6), 1–12. https://doi.org/10.1093/pnasnexus/pgad181

Tehsin, S., Kausar, S., Jameel, A., Humayun, M., & Almofarreh, D. K. (2023). Satellite Image Categorization Using Scalable Deep Learning. *Applied Sciences (Switzerland), 13*(8). https://doi.org/10.3390/app13085108

Tian, J., Zhu, X., Wu, J., Shen, M., & Chen, J. (2020). Coarse-resolution satellite images overestimate urbanization effects on spring vegetation phenology. *Remote Sensing, 12*(1). https://doi.org/10.3390/RS12010117

Tingzon, I., Orden, A., Go, K.T., Sy, S., Sekara, V., Weber, I., Fatehkia, M., García-Herranz, M., & Kim, D. (2019). MAPPING POVERTY in the PHILIPPINES USING MACHINE LEARNING, SATELLITE IMAGERY, and CROWD-SOURCED GEOSPATIAL INFORMATION. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives, 42*(4/W19), 425–431. https://doi.org/10.5194/isprs-archives-XLII-4-W19-425-2019

Vidal, O., López-García, J., & Rendón-Salinas, E. (2014). Trends in Deforestation and Forest Degradation after a Decade of Monitoring in the Monarch Butterfly Biosphere Reserve in Mexico. *Conservation Biology, 28*(1), 177–186. https://doi.org/10.1111/cobi.12138

Villate Daza, D.A., Moreno, H.S., Portz, L., Manzolli, R.P., Bolívar-Anillo, H.J., & Anfuso, G. (2020). Mangrove forests evolution and threats in the Caribbean Sea of Colombia. *Water (Switzerland), 12*(4). https://doi.org/10.3390/W12041113

Voigt, S., Schoepfer, E., Fourie, C., & Mager, A. (2014). Towards semi-automated satellite mapping for humanitarian situational awareness. *Proceedings of the 4th IEEE Global Humanitarian Technology Conference, GHTC 2014*, 412–416. https://doi.org/10.1109/GHTC.2014.6970315

Yi, T. J., & bin Ahmad, A. (2023). Quality Assessments of Unmanned Aerial Vehicle (Uav) and Terrestrial Laser Scanning (Tls) Methods in Road Cracks Mapping. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives, 48*(4/W6-2022), 183–193. https://doi.org/10.5194/isprs-archives-XLVIII-4-W6-2022-183-2023

Zeng, T., Shi, L., Huang, L., Zhang, Y., Zhu, H., & Yang, X. (2023). A Color Matching Method for Mosaic HY-1 Satellite Images in Antarctica. *Remote Sensing, 15*(18), 1–20. https://doi.org/10.3390/rs15184399

Zhong, L., Hawkins, T., Holland, K., Gong, P., & Biging, G. (2009). Satellite imagery can support water planning in the Central Valley. *California Agriculture, 63*(4), 220–224. https://doi.org/10.3733/ca.v063n04p220

Biographies of Author(s)

Rika Kariyani, Sensing Technology, Faculty of Science and Technology, Republic of Indonesia Defense University

- Email: rika.kariani@tp.idu.ac.id
- ORCID:
- Web of Science ResearcherID:
- Scopus Author ID:
- Homepage:

Asep Adang Suriyadi, Sensing Technology, Faculty of Science and Technology, Republic of Indonesia Defense University

- Email: aadangsupriyadi@gmail.com
- ORCID: https://orcid.org/0000-0003-1103-6669
- Web of Science ResearcherID:
- Scopus Author ID: 57201546735
- Homepage: