PGRSC

2024 PACIFIC GIS & REMOTE SENSING USER CONFERENCE

SUSTAINABLE MANAGEMENT FOR COASTAL AREAS THROUGH REMOTE SENSING AND GIS

25 – 29 Nov. 2024 | Japan USP-ICT Theatre

USP Laucala Campus | Suva | Fiji

CONFERENCE PROCEEDINGS

Version 1.4 – 2024-11-23

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Integrating GPS-enabled Technologies and Workflows into Fishery Surveys

by Bradley Eichelberger | CNMI Division of Fish and Wildlife

Abstract ID: 41
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic: Maritime Environment

The CNMI Division of Fish and Wildlife monitors the health and condition of fisheries in the Northern Mariana Islands. Biologists estimate reef fish abundance using a combination of underwater point count surveys, shoreline fisherman surveys, and fish market catch records. We recently integrated the use of GPS-enabled dive watches to increase spatial accuracy of data collection while in-water and utilized open source GIS data collection software to collect survey location data while on the research vessel. Lastly, we implemented the use of rugged GPS tablets to assist in shoreline and fish market surveys and build workflows to synchronize the data back to databases. Collecting fisheries data in more efficient manners allows CNMI Division of Fish and Wildlife to more effectively manage its marine natural resources.

Predictive Models v. U.S. Constitution: The Secret Sauce

by Alan Clinton | County of Kauai Planning Department

Abstract ID: 42
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic: Mapping

Scientists and Modelers are generating a wealth of studies and projections on natural hazard impacts which are seemingly being ignored. Can planners and policymakers use this information beyond just broad policy positions and instead use these studies to physically regulate an area’s built environment? Are there legal issues utilizing scientific projections to determine the extent of property rights? How should models be organized and prepared for more rapid adoption into law? The purpose of this session is to explore how modeled projections can be utilized to draft and implement built environment regulations and the pairing of visualizations and tools required to achieve these goals. The ongoing development of the County of Kaua'i Coastal Zone Management Program offers a unique narrative that highlights novel policy and technical approaches with the goal of safeguarding dynamic and sensitive landscapes.

Assessing Forest Biomass Changes in Pench Tiger Reserve, Maharashtra, India with Remote Sensing and Machine Learning Approaches

by Sayanta Ghosh | Afrin Zaidi | Pranjul Chauhan | Aniruddh Soni | Jitendra Vir Sharma | The Energy and Resources Institute (TERI) | The Energy and Resources Institute (TERI) | The Energy and Resources Institute (TERI) | The Energy and Resources Institute (TERI) | The Energy and Resources Institute (TERI)

Abstract ID: 43
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic: Forestry

Temporal change in forest cover, the largest terrestrial ecosystem on Earth, influences the climate at local, regional, and global scales through physical, chemical, and biological processes. Forests sequester and store more carbon dioxide than any other terrestrial ecosystem, acting as a "natural brake" in climate variation. This study assesses the spatio-temporal variation in forest biomass by combining field-based, remote sensing, and machine learning approaches. We developed Fractional Vegetation Cover (FVC) layers using the Linear Spectral Unmixing (LSU) Algorithm on cloud-free multi-temporal LANDSAT data for Pench Tiger Reserve (PTR), Maharashtra, India, from 2001 to 2022. A Linear Regression Model (LRM) was developed between field-based forest biomass and FVC, using data from 112 sampling plots of 0.1 ha across 1084.35 sq. km. area of PTR, covering three forest strata: Very Dense Forest (VDF), Moderate Dense Forest (MDF), and Open Forest (OF). The LRM showed strong positive correlations with R^2 values of 0.79 for VDF, 0.76 for MDF, and 0.77 for OF. The predicted biomass demonstrated a strong positive correlation with observed biomass (Correlation Factor 0.87).

Results indicate that in VDF, carbon stock decreased from the year 2001 (5.62 million tonnes) to the year 2017 (3.06 million tonnes) before increasing to 3.28 million tonnes in the year 2022. Overall carbon stock also decreased from the year 2001 (14.15 million tonnes) to 2017 (9.99 million tonnes) before rising to 11.62 million tonnes during the year 2022. Temporal FVC variation showed similar trends in forest cover under VDF strata, significantly impacting the carbon stock increase from the year 2017 onwards. Comparative analysis of FVC models based on various vegetation indices (NDVI, NDMI, MSAVI, and EVI) highlighted that the NDVI-based FVC model had the highest correlation with field-based forest biomass (R^2=0.77, $p<0.005$). A degradation matrix developed using temporal FVC layers delineated degradation patches and analysed forest degradation trends. The outcomes of this study will aid policymakers in devising development plans to regulate land-use and forest cover dynamics, enhancing carbon sequestration rates and maintaining global climate balance.

Keywords: FVC, Forest Biomass, Linear Spectral Unmixing, Carbon Stock, NDVI, Linear Regression Model

Case studies in marine habitat mapping using QField and earth observations for MACBLUE and RBBP through Digital Earth Pacific (DEP)

by Nicholas Metherall | Maivunijale Waqa | Shyam Lodhia | University of the South Pacific | SPC | GIZ

Abstract ID: 44
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic: Maritime Environment

Many coastal marine habitats are under considerable stress as a result of anthropogenic impacts and climatic factors. Having baselines and ongoing monitoring is crucial in conservation and management of these ecosystems. In expanding beyond terrestrial land cover mapping, marine coastal ecosystem mapping comes with a range of additional challenges. These include variability in water quality, depths, dynamic estuarine zones, tides, sun glint and a range of other factors.

Through field data collection using QField and machine learning approaches that leverage petabytes of earth observations data, Digital Earth Pacific (DEP) has been able to make progress in a number of projects that aim to map coastal marine habitats. These include the Managing Blue Carbon Ecosystems (MACBLUE) and Resilient Boundaries for the Blue Pacific (RBBP) projects where we have developed coastal habitat maps for Fiji, Solomon Islands, Vanuatu, PNG and Tuvalu. To do this we used QField to gather field data points to support DEP machine learning approaches to mapping coastal habitats. We used tidal corrections including median low-tide and median high-tide images, benthic non benthic binary masks to analyse intertidal and subtidal zones. We also considered the impacts of dynamic coastal and estuarine zones. The result includes a focus on seagrass habitats, coral reefs and other benthic habitats.

In this presentation we seek to shed light on methods you can reproduce, and lessons learned about what worked well and what did not through rigorous trial and error approaches. We draw on case studies from Fiji, Solomon Islands, Vanuatu, PNG and Tuvalu. Some of the results are able to show greater accuracy at a local level than the global models including the Allen Coral Atlas. Yet more improvements can continue to be made in future.

Mineral Resource Extraction Detection (MRED) using machine learning approaches to detect mineral extraction and potential impacts on qoliqoli marine ecosystems in Fiji (Digital Earth Pacific)

by Nicholas Metherall | Alex Leith | Kishan Kumar | University of the South Pacific | Auspatious | SPC

Abstract ID: 45
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic: Land Environment

Digital Earth Pacific approaches to detect mineral extraction and potential impacts on *qoliqoli* marine ecosystems in Fiji

***Nicholas Metherall*[1,2,5], *Alex Leith*[3,5], *Kishan Kumar*[4]**

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According to the Baseline Assessment of Development Minerals in Fiji, the environmental impacts of development mineral extraction have been extensive (2018). Within the assessment, thirty-six of 105 surveyed community members (34%) reported negative impacts of mining on their *qoliqoli* (village managed fisheries) following establishment of river extraction operations.

Monitoring the impacts of mineral extraction on increased sediment loading downstream in marine ecosystems is challenging given the dynamic nature of rapidly changing water quality. Furthermore, there are additional challenges in disaggregating the influences of mining from rainfall-runoff dynamics and other sources of turbidity and sediment transport.

This study first seeks to detect mineral extraction activities using Digital Earth Pacific

(DEP). The DEP algorithms use random forest classification of mineral extraction activities with change detection to identify areas impacted by recent mineral extraction activities between two points in time.

To assess the associated impacts of these mineral extraction activities on marine ecosystems, the study combines remote sensing of both terrestrial and marine environments. In future further sediment transport modelling can be run over marine ecosystems. The results yield estimates of potential impacts of sediment transport from mining on *qoliqoli* marine ecosystems in Fiji.

Pro and Contra of the New Indonesian National Capital

by Fahmi Amhar | The Indonesian National Research & Innovation Agency

Abstract ID: 46
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic: Human landscape

Indonesia has decided to establish a new capital city on the island of Kalimantan to replace Jakarta.

Developing an exclusive city segment for those who can afford it, as seen with projects similar to several new cities around Jakarta, is straightforward and can be termed as level-1 development. Creating an inclusive city for diverse residents, requiring input from local governments, academics, and communities, is more challenging—this is level-2. Building a national capital that accommodates diversity and aspires to be a smart, green city represents a different, more complex challenge—level-3. Moving a capital across islands with vastly different conditions is unprecedented in Indonesia. Thus, even though the National Capital Law has been passed, the debate continues. Within less than a month, the law was challenged in the Constitutional Court.

The research question can be **What are the challenges and requirements for developing a new national capital that accommodates diversity and sustainability, compared to traditional urban development and inclusive city planning in Indonesia?** This question addresses the complexities of developing a new national capital, considering different levels of urban development and the unique challenges posed by relocating a capital across islands with diverse conditions.

The research combine literature review, case studies, qualitative interviews, remote sensing methods, and GIS simulation modeling to analyze the challenges and requirements for developing an inclusive and sustainable new national capital.

Jakarta is highly disaster-prone, situated on the ring of fire with active volcanoes, an earthquake-prone fault line, unresolved flooding, and land subsidence, earning it the "sinking city" label. Java, despite being just 7% of Indonesia's land area, houses 55% of its population, leading to severe urbanization issues. The new capital in East Kalimantan is seen as a solution, centrally located near Samarinda and Balikpapan with existing infrastructure. However, the National Capital Bill was passed quickly, with limited public involvement, raising concerns about its long-term impact.

What about the contra arguments? Two disaster-related issues are often overlooked: numerous passive faults that, while not earthquake-prone, are susceptible to landslides, and poorly absorbing clayey soil that causes floods during rains and groundwater scarcity

during droughts, with frequent smog from wildfires. From a defense perspective, the new capital’s location near Indonesia's Archipelagic Sea Lanes poses security risks, requiring different military deployments. Additionally, construction costs may overrun due to simplistic assumptions, and transition costs for relocating officials and adapting the public could lead to dissatisfaction and potential disintegration sentiments.

Proponents of the new capital argue that future business processes will rely more on technology, as we've seen with remote work and online cabinet meetings. However, the new capital may overlook the potential of advanced 4.0 technologies. Instead, a focus on "Cloud Governance" or the "Indonesia Metaverse" could be more relevant.

The president could work from Bogor or Bali, while ministers and parliament members could work remotely from their districts, avoiding traffic and natural disasters. Virtual meetings would be secure and productive, supported by blockchain technology to ensure trust and transparency. This approach would make the new capital project more cost-effective, avoiding excessive state spending and national debt, and reducing the risk of becoming a white elephant or being influenced by foreign or oligarchic interests.

A Partnership for Rapid Aerial and Streetview Data Collection and Utilization in Tuvalu

by Frank Pichel | PLACE

Abstract ID: 47
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic: Mapping

In September 2023, the Government of Tuvalu, represented by the Department of Lands and Surveys (L&S), entered into a Memorandum of Understanding with the ThisIsPlaceFoundation (PLACE) to advance the collection of geo-referenced aerial and street-level imagery across the country. The agreement was further supported by the Pacific Community (SPC), through its Digital Earth Pacific program. This initiative, involving Unmanned Aerial Vehicle (UAV) captured images (PLACE Aerial) and geo-referenced street camera imagery (PLACE Ground), is vital for Tuvalu's land management, land use planning, climate mitigation, environmental stewardship, and the creation of a Digital Twin—a virtual model that replicates the physical environment. Additionally, this data is available to members of the PLACE Community, facilitating broader applications and collaborations.

Following the agreement, SPC, the Lands and Surveys Department of Tuvalu, and PLACE collaborated to finalize a comprehensive work plan detailing data collection, training, and the development of data products. This culminated in field data collection in 2024.

The data collection effort, focused on capturing the entire Fongafale and Fatato islands. The team conducted six UAV flights at 1,000 feet, covering the islands including the near shore. The UAV captured high-resolution imagery with a ground sample distance (GSD) of 4.7 cm, resulting in 1,135 JPEG images position to within 12 due in large part to the Ground Control Points captured by the surveyors from SPC and the the Lands & Surveys Department.

Concurrently, PLACE Ground data collection was carried out using a truck, motorcycles and via backpack. The PLACE Ground effort mapped a total of 72 linear kilometres of roads and paths, including 100% of the primary and secondary roads (16.5 km) captured using a Mosaic 360 Camera mounted on the Lands & Survey vehicle. Additionally, 55.2 km of paths and secondary roads were documented using a GoProMax 360-degree camera mounted on a moped.

The project culminated in the delivery of an orthomosaic, a digital surface model (DSM), and a 3D model of the entire captured area. This presentation will delve into the data collection process, highlight the resultant data, and explore the various applications of the aerial and street-level imagery to date. These applications are expected to significantly enhance Tuvalu's capacity for informed decision-making and planning in the face of environmental and developmental challenges.

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Advanced Macroalgae Index for Improved Algal Bloom Detection in Aquatic Ecosystems

by Majid Nazeer | Mohammad M. M. Alsahli | The Hong Kong Polytechnic University | Kuwait University

Abstract ID: 48
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic: Remote Sensing data and software

Algae overgrowth poses a significant threat to aquatic ecosystems, a problem that has become more frequent in recent decades due to increased human activities near the coasts and inland water bodies. To protect and sustain these ecosystems, it is crucial to understand how the aquatic environment fosters algae growth through comprehensive monitoring. We introduce a novel Three-band Macroalgae Index (TMI) that utilizes the green, red, and near-infrared bands of the Landsat-8 Operational Land Imager (OLI) as a reliable remote sensing tool for detecting and monitoring algal overgrowth in aquatic environments. The TMI has been tested under various water quality conditions across different aquatic settings. These conditions can vary between images of the same study area due to factors such as atmospheric aerosols, the refraction of water-leaving radiance based on sun and view angles, and sun glint influenced by waves and currents. Six study areas were chosen for their diverse water quality, including the hypersaline Great Salt Lake, the moderately eutrophic Lake St. Claire, and the open ocean waters of the English Channel. A comparative analysis between the TMI and nine existing algal bloom indices demonstrated the superior performance of TMI (90%–100%) in alignment with OC2-based-TSI classifications. The existing indices showed inconsistent performance across different environmental and water quality conditions, likely due to factors such as the uncertainty of shortwave infrared band retrievals in turbid waters and their dependence on specific geographical locations or sensors. The TMI addresses these issues, making it a viable alternative for detecting algal blooms in various water types, as it employs wavebands commonly available on many remote sensing systems.

Vanuatu Climate Futures Portal – Road Inundation Mapping Tool

by Raviky Talae | Sunny Kamuta Seuseu | Van-KIRAP Project Infrastructure Sector Coordinator | Van-KIRAP Project Manager SPREP

Abstract ID: 49
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic: Mapping

Vanuatu, an archipelago in the South Pacific, is extremely vulnerable to the impacts of climate change, particularly sea-level rise, storm surges, and extreme rainfall events. These phenomena pose significant threats to the country's road infrastructure, which is crucial for transportation, trade, and community connectivity. To address these challenges, the Vanuatu Klaemet Infomesen blong redy, adapt mo protect (VanKIRAP) project developed the Vanuatu Climate Futures Portal and a Road Inundation Mapping Tool, a cutting-edge resource designed to support climate-resilient infrastructure planning and management.

The Road Inundation Mapping Tool uses advanced Geographic Information Systems (GIS) and climate modeling techniques to visualize the potential impacts of climate-induced inundation on Vanuatu's road network. By integrating local topographical data, sea-level rise projections, and extreme weather event scenarios, this tool provides detailed maps that highlight sections of roads at risk of inundation under different climate futures. Users can explore multiple climate scenarios, ranging from moderate to extreme, allowing for comprehensive risk assessments and informed decision-making.

Key features of the tool include interactive maps and downloadable data sets that enable users to focus on specific areas or parameters of interest. Planners, engineers, and policymakers can utilize this tool to identify vulnerable road segments, prioritize infrastructure investments, and develop adaptive strategies to mitigate future risks. The Road Inundation Mapping Tool also supports disaster preparedness by helping authorities plan evacuation routes and emergency response strategies in areas prone to flooding.

This tool exemplifies the power of combining scientific data with user-friendly technology to address real-world challenges. It is part of Vanuatu's broader effort to enhance climate resilience across sectors and ensure that infrastructure development aligns with long-term sustainability goals. By proactively mapping inundation risks, the tool empowers decision-makers to build more resilient road networks that can withstand the increasing frequency and intensity of climate-related events.

Overall, the Road Inundation Mapping Tool is a vital resource for safeguarding Vanuatu's infrastructure against the growing threats posed by climate change. It offers a practical solution for integrating climate risk assessments into infrastructure planning, ensuring that Vanuatu's roads remain functional and accessible even in the face of rising seas and

extreme weather.

Topographic and Bathymetric LiDAR in the Coastal Zones

by Andy Burrell | Landpro Limited

Abstract ID: 50
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic:

Monitoring both above and below the water surface in the coastal zones is a critical part of understanding change in the intertidal regions most susceptible to environment conditions caused by a changing climate.

Combined topographic and bathymetric LiDAR is an advanced measurement technique well suited to this otherwise difficult, active area to measure at scale.

The presentation discusses LiDAR technology and in more detail the challenges associated with acquisition and processing of ALB (Aerial LiDAR Bathymetry), as well as the benefits of applying it in the Pacific regions.

We will look at the sensor technology, the acquisition challenges, advanced processing workflows and how these deliverables can be used to map these coastal zones effectively.

This presentation will be a good overview of the technology, methodology, deliverables and insights offered in this critical yet difficult to map area surrounding all land masses.

Using examples from the Landpro owned Riegl VQ880GII in New Zealand and the Optec CZMIL SuperNova in Kiribati.

Spatial climate & hydrology insights: Tools to reduce uncertainty and empower decision-making

by Hannah Marley | NIWA

Abstract ID: 51
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic:

Understanding the spatial and temporal variability of weather, climate, and hydrological processes is key to effectively managing water resources and mitigating risks related to extreme weather events (e.g. tropical cyclones), droughts, and flooding. This is particularly the case in the Pacific Islands, where communities are highly vulnerable to such risks. Ongoing efforts throughout the Pacific are being made to strengthen and expand the observational climate and hydrology networks and to enhance the collection of data through improved station density and collaborative work with the World Meteorological Organization (WMO) and National Meteorological and Hydrological Services. However, there remains a significant challenge in accessing and integrating this data into tools that can provide spatial and temporal insights for management and mitigation. The lack of robust, user-friendly platforms to bring together and communicate this information hinders effective decision-making and limits the ability to fully leverage the observational networks that are being expanded in the Pacific Region. Here we present the development of innovative tools that use spatial climate and hydrology data to bridge this gap. By showcasing examples of dashboards developed for end-users, we will demonstrate how these tools are meeting the critical needs of decision-makers, ultimately reducing uncertainty around weather and climate events and hydrological processes. We will discuss how these tools use station data to capture spatial variability and produce a range of real-time observations and forecasts, significantly enhancing accessibility and usability. This presentation highlights the need for continued improvement of our spatial observational networks, enhancement of data quality, and refinement of the tools built upon them, ensuring that stakeholders have the necessary resources to navigate an increasingly variable climate.

Biggest Bang for Your Buck: Using NASA Earth Observations to maximize island-ocean ecosystem benefits following invasive mammal eradication

by Elke Windschitl | Miroslav Honzák | David Will | Bradley J Cosentino | Joseph O Sexton | Geoffrey Roberts | Harrison McKenzie-McHarg | John W Wilson | Min Feng | Alison Thieme | Neha Hunka | Island Conservation, Santa Cruz, CA, USA | Center for Biodiversity Outcomes, Arizona State University, Tempe, AZ, USA | Island Conservation, Santa Cruz, CA, USA | Hobart and William Smith Colleges, Geneva, NY, USA | terraPulse Inc., Gaithersburg, MD, USA | FLINTpro Corp., Fort Collins, CO, USA | FLINTpro Corp., Fort Collins, CO, USA | terraPulse Inc., Gaithersburg, MD, USA | terraPulse Inc., Gaithersburg, MD, USA | terraPulse Inc., Gaithersburg, MD, USA | Department of Geosciences, University of Maryland, College Park, MD, USA

Abstract ID: 52
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic:

Invasive mammal eradication on islands is a proven conservation intervention to prevent extinction of threatened species. However, there is growing evidence that removal of invasive mammals may also serve as an effective nature-based solution for vegetation recovery and climate resilience. To quantify this on a global scale, we developed a globally consistent and scalable approach for long-term monitoring of forest extent, forest carbon, and vegetation productivity covering 1,078 islands, 1.9 million hectares, and 17 ecoregions. We used time-serial satellite estimates of tree cover and the Normalized Difference Vegetation Index (NDVI) over a 36-year period (1984 – 2020) to record annual baselines and changes in forest area and vegetation productivity. The analysis revealed significant and sustained positive trends in all the indices on islands with eradication. The magnitude and potential biological relevance of these effects was highly variable across ecoregions, but the overall sustained effects provide strong evidence of a positive ecosystem response to invasive mammal removal. We elaborate the analysis to investigate spatially explicit trend changes within islands and how ecological factors moderate those changes. We present a case study demonstrating how this remote sensing approach can model ecosystem change and inform management decisions to strategically enhance island restoration.

"How to map data from geospatial APIs (as a non coder)"

by Matt Smith | Rover Mapping (GIS and Data Consultancy)

Abstract ID: 53
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic:

Background

The 2020s have seen major advancements in the opportunities and requirements for GIS data processing. Flat file and file geodatabase sharing have evolved to include cloud - based live GeoJSON and REST APIs (application programming interfaces). These data sources are increasingly available to organisations as open creative commons data.

Originally only understood by those with data management or programming experience, generative AI software has transformed the way for non coder GIS professionals to gain access to these data sources.

Focussing on the Australian context, this presentation provides an overview of useful open datasets provided by Australian government organisations including the ACT Government and New South Wales Rural Fire Service.

Rover Mapping envisage similar data feeds and APIs to be increasingly available to other pacific organisations in the future. This presentation aims to provide an overview of these data formats and technical options for processing each API data type. Concise python code snippets will be displayed during the presentation for both ESRI ArcGIS and QGIS which can easily be generated online to incorporate these datasets into an enterprise GIS environment.

Objectives

By sharing code snippets and advice (as well as warnings) on using AI tools to generate GIS workflows, this presentation aims to extend the knowledge of conference attendees on the power of cloud based data sources in solving 21st century geospatial problems. Examples provided in this presentation will be presented both for the benefit of ESRI ArcGIS and QGIS users.

Conclusions

From displaying road segments impacted from high traffic congestion to neighbourhood suffering from planned and unplanned bushfires, geospatial APIs allow for enterprise GIS environments to be enriched widely understood python code. As IOT devices and cloud technology further advances, geospatial APIs will become an increasingly common option of

communicating what is happening across the Pacific region.

A Usable Encryption Solution for File-Based Geospatial Data within a Database File System

by Pankaj Sharma | University of Fiji

Abstract ID: 54
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic:

Developing a security solution for spatial files within today's enterprise Geographical Information System (GIS) that is also usable presents a multifaceted challenge. These files exist in "data silos" of different file server types, resulting in limited collaboration and increased vulnerability. While cloud-based data storage offers many benefits, the associated security concerns have limited its uptake in GIS, making it crucial to explore comparable alternative security solutions that can be deployed on-premise and are also usable. This paper introduces a reasonably usable security solution for spatial files within collaborative enterprise GIS. We explore a Database File System (DBFS) as a potential repository to consolidate and manage spatial files based on its enterprise document management capabilities and security features inherited from the underlying legacy DBMS. These files are protected using the Advanced Encryption Standard (AES) algorithm with practical encryption times of 8 MB per second. The final part focuses on an automated encryption solution with schemes for single- and multi-user files that is compatible with various GIS programs and protocol services. Usability testing is carried out to assess the solution's usability and focuses on effectiveness, efficiency, and user satisfaction, with the results demonstrating its usability based on the minimal changes it makes to how users work in a collaborative enterprise GIS environment. The solution furnishes a viable means for consolidating and protecting spatial files with various formats at the storage layer within enterprise GIS.

MapSafe: A complete tool for achieving geospatialdata sovereignty

by Dr Pankaj Sharma | University of Fiji

Abstract ID: 55
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic:

Sensitive geographic data are invaluable assets for the people to whom they belong and their disclosure should be decided by the sovereign data owner (SDO). Due to several high-profile data breaches and business models that commercialize user data, the need for new approaches to geoprivacy and data sovereignty has grown. We propose MapSafe, a client web application that first obfuscates datasets using donut masking or hexagonal binning, separately, and thereafter implements a multi-level encryption scheme that permits SDOs to share the final encrypted volume containing the geospatial information when they choose and at a level of detail which they are comfortable. The authenticity verification of the volume is facilitated by storing the hash value corresponding to the encrypted volume immutably on the Blockchain as a public record. Our approach places geoprivacy under data guardians'' control, and its integration capabilities promote its adoption in existing and future geospatial web systems.

A cloud-based solution for trustless indigenous data sovereignty: Protecting Māori biodiversity management data in Aotearoa New Zealand

by Dr Pankaj Sharma | University of Fiji

Abstract ID: 56
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic:

Indigenous peoples should be able to govern data about themselves, their territories, resources, and ways of life, collected by themselves or others. However, the progressive use of cloud computing for the geoweb raises data security and privacy concerns. We propose a complete and trustless approach for indigenous geospatial data sovereignty on the cloud by furnishing security functions at the core—the web browser. Geomasking permits sharing an anonymized dataset with less privileged users, while the original is protected and shared with sovereign data owners via public-key encryption. The encrypted dataset's hash value is notarized on the blockchain for the verification of its authenticity when on the cloud. The application was designed for the protection of Biodiversity Management Areas stewarded by the Māori people in Aotearoa New Zealand. It enables diversified functions of geospatial data protection compared with previous works focusing on the cloud by solving data-sharing problems without relying on a third party.

Disaster Intelligence Capacity Building in Pacific Island Countries

by Markus Bucy and Brent Hoade | J2 Geospatial Intelligence Services

Abstract ID: 57
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic:

As sea levels rise and disaster events become more frequent and intense, the need for localised disaster intelligence across Oceania is becoming increasingly important. The geographic isolation of many Pacific Islands further highlights the importance of having homegrown capabilities to respond effectively.

This abstract proposes that Pacific Island Countries would benefit from adopting a model similar to that of Disaster Relief Australia (DRA), which repurposes veterans to deliver a disaster intelligence capability. This approach has two main advantages. First, it creates an agile, capable, and low-cost local team of pilots and analysts who would provide proactive and reactive disaster intelligence. These teams would have the ability to capture and collect aerial imagery and use Geographic Information Systems (GIS), and other data resources, to deliver actionable geospatial intelligence in austere and remote environments. Secondly, giving veterans the opportunity to repurpose their skills in service to their local community assists with their reintegration back into civilian society.
DRA is a charity that retrains veterans and emergency services personnel for disaster relief. Veterans' skills make them well-suited for the challenging environments often encountered in disaster zones. In addition to other services, DRA has developed an effective disaster intelligence capability, which has been greatly enhanced through its social enterprise, J2 Geospatial Intelligence Services (J2). J2 is becoming a lead agency for the provision of localised post-disaster aerial imagery and mapping data, utilising defence-oriented Intelligence Surveillance and Reconnaissance (ISR) expertise together with experience gained over the course of three thousand+ post and pre-disaster flights across Australia and the Asia-Pacific.

This capability can be established locally and very cost-effectively by deploying small, expert teams to train selected veterans and other civilians from the community. These training teams offer skills, frameworks, and ongoing support to newly established indigenous teams of pilots and analysts to create a sustainable, local disaster intelligence capability. Training is focused on the utilization of low-cost, highly capable off-the-shelf drone technologies and affordable software platforms to minimize infrastructure costs.

In the immediate wake of a disaster event, multiple, trained, small teams of two to three people can rapidly deploy to undertake aerial mapping and assessment of impacted properties and locations. The goal being to build a sovereign, rapid-response disaster capability that provides critical information year-round.

Proactively, before a disaster event, coastlines and communities can also be mapped and assessed to determine hazards and risks that support mitigation and resilience building priorities.
By combining data from drones, traditional aircraft, satellites, and other sources, teams of analysts review, and process layered information-sets into valuable geospatial intelligence for use by decision makers both before and after disaster events.

The sustained ability to deliver timely and actionable intelligence will assist national, regional and local emergency management agencies, as well as communities, in making informed decisions across the disaster cycle.

Navigating Utilities Asset Management with QGIS, QField, X5 Mobile PRO, and Starlink Mini: A Pasifika Wayfinder's Journey

by Edwin Liava'a | N/A

Abstract ID: 58
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic:

Abstract:

This presentation explores the use of Free and Open Source Software for Geospatial applications (FOSS4G) in utilities asset management and disaster risk resilience in the Pacific Islands, focusing on an ADB Renewable Energy Development Project in the Federated States of Micronesia.

We demonstrate how QGIS and QField have revolutionized our approach to mapping critical infrastructure, modelling hazard impacts, and conducting field surveys. These tools enable comprehensive geospatial analysis and efficient data collection, even in remote areas.

The adoption of FOSS4G aligns with principles of democratization and community empowerment, particularly crucial in the Pacific Island context. It offers an accessible path for building local technical capacity without the constraints of proprietary software.

We introduce the GNSS X5 Mobile PRO as an affordable option for sub-meter accuracy data collection. This ultra portable GNSS receiver, weighing only 45 grams, offers centimeter-level positioning using all major satellite constellations. It supports PPK, RTK, and NTRIP modes, making it versatile for various surveying needs. The X5 Mobile PRO's compatibility with smartphones and its ability to work within a 10km radius (in RTK mode) or up to 70km (in NTRIP mode) make it an excellent choice for Pacific Islands utilities seeking cost-effective, high-precision mapping solutions.

Complementing this, we discuss the potential of Starlink Mini for enhancing data connectivity in remote locations. This compact satellite internet solution, measuring just 11.4 x 9.8 inches, provides up to 100 Mbps download speeds with low latency. Its portability, affordability (estimated cost around $599), and easy setup make it an ideal companion for field data collection and transmission in areas with limited or no traditional internet connectivity.

By combining FOSS4G tools with affordable, high-precision hardware like the X5 Mobile PRO and innovative connectivity solutions like Starlink Mini, we're charting a course towards more resilient and self-reliant Pacific Island communities in the face of climate change and natural disasters.

Building Climate Resilience with Open Source GIS: Samoa’s Land Transport Authority Asset Management System

by Tooa Brown | Samoa GIS & RS User Group

Abstract ID: 59
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic:

As climate change brings more extreme weather, managing and protecting infrastructure is essential, especially for island nations like Samoa. This presentation explores the upgrade of Samoa’s Asset Management System (SAMS) for Samoa’s Land Transport Authority (LTA), funded by the Samoa Climate Resilient Transport Project. Built with open-source GIS tools, such as QGIS and PostgreSQL, this system helps LTA monitor roads, bridges, and other assets to make better decisions for climate and disaster resilience. We’ll discuss how the SAMS uses geospatial data to identify risks, prioritize repairs, and prepare for extreme weather events. By using open-source technology, this system provides a cost-effective way to support safer, stronger infrastructure in the Pacific. This presentation will show how GIS can be a powerful tool for creating resilient transportation systems and protecting communities from climate risks.

NASA’s Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission: shedding new light on the ocean and the atmosphere above

by Lachlan McKinna | Jeremy Werdell | GO2Q/NASA GSFC | NASA GSFC

Abstract ID: 60
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic:

In February of 2024, NASA launched the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission. PACE is a strategic climate continuity activity that will extend key heritage ocean color, cloud, and aerosol data records, and enable new insight into oceanographic and atmospheric responses to Earth's changing climate. The primary instrument, the Ocean Color Instrument (OCI), is a global imaging spectrometer with a ground pixel resolution of 1km x 1km (at nadir). The OCI spans the ultraviolet (UV), visible (VIS) and near-infrared (NIR) region in 2.5 nm steps and includes seven discrete shortwave infrared bands from 940 to 2260 nm. This leap in technology will enable improved understanding of aquatic ecosystems and biogeochemistry, as well as provide new information on phytoplankton community composition, harmful algal blooms, and near-shore water quality monitoring (e.g., coral reefs). PACE OCI data will also continue many land, aerosol, and cloud capabilities from MODIS and VIIRS, which in combination with its ocean measurements, will enable improved assessment of aerosol impacts on ocean biology and chemistry. The PACE OCI payload is complemented by two multi-angle polarimeters, the Spectro-polarimeter for Planetary Exploration (SPEXone) and the Hyper-Angular Rainbow Polarimeter 2 (HARP2). SPEXOne spans the UV-VIS-NIR region while HARP2 has four discrete spectral channels (441, 549, 669, 873 nm). Data collected by SPEXone and HARP2 will significantly improve aerosol and hydrosol characterizations (e.g., volcanic ash, smoke, dust). The PACE instrument suite will revolutionize studies of global biogeochemistry, carbon cycles, hydrosols/aerosols, and clouds in the ocean-atmosphere system. In this presentation, I will provide an overview of the PACE mission’s science objectives, sensor payload, distributed data products, and the field validation activities. I will also discuss how current PACE data products and those under development may be of interest to the PGRSC community. A highlight will be a series of images captured by PACE showcasing the mission’s unique capabilities.

Recent Spatio-Temporal Alterations in Coastal Areas of Funafuti, Tuvalu

by Sree Juwel Kumar Chowdhury | Chan-Su Yang | Marine Security and Safety Research Center, Korea Institute of Ocean Science & Technology, Busan, Korea; Department of Convergence Study on the Ocean Science and Technology, Ocean Science and Technology School, Korea Maritime & Ocean University, Busan, Korea | Marine Security and Safety Research Center, Korea Institute of Ocean Science & Technology, Busan, Korea; Department of Convergence Study on the Ocean Science and Technology, Ocean Science and Technology School, Korea Maritime & Ocean University, Busan, Korea; Marine Technology and Convergence Engineering, University of Science & Technology, Daejeon, Korea

Abstract ID: 61
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic:

Island countries are more vulnerable due to the alterations of their coastal areas caused by natural and human intervention. Thus, it is crucial to monitor the coastal changes over time. Therefore, in this study, Funafuti atoll is selected as the study area, which is composed of small, separated islets with distinct features. The purpose of this study is to evaluate the recent coastal changes of Funafuti through using Sentinel-2 satellite images. To extract the coastline, a semi-automatic method based on segmentation and thresholding is applied to the normalized difference vegetation index and normalized difference water index calculated image. Adaptive thresholding is adopted for separating the land-water area due to the distinct characteristics of each islet. Moreover, sea level information at the image acquisition time is used to assess the position of the extracted coastline. The study depicts that the length of coastline is approximately 0.27% decreased and approximately 3.52% vegetation area is decreased. Most of the alterations happened in the eastern part of Funafuti, which were caused by human intervention as well as tropical cyclones. As each of the islets of Funafuti is small and shows different morphological features, it is challenging to extract the coastline by following a specific method, and therefore, future study will be focused on improving the applied coastline extraction approach through adding more criteria about the coastal feature.

Application of Optical Satellites for Wave Monitoring

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Abstract ID: 62
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic:

Monitoring and modelling of wave action is significant to comprehend the sediment transport and coastal erosion or accretion. Generally, global ocean model like ERA5 is used for analyzing the wave properties that include wave height, wavelength, and direction adjacent to the coast. However, this information is inadequate to evaluate the wave circumstance in the vicinity of a small island, as the bathymetry information is not considered. Therefore, this study proposed a method to retrieve the wave properties that include wavelength and wave direction from the optical satellite images. Sentinel-2 and Landsat-8/9 images are used for extracting the wave properties, which are then compared with the ERA5 wave data. The study result showed that there is a correlation between the satellite estimated wavelength and wave direction and ERA5 wave information as they are closely aligned. The findings will be valuable for analyzing wave conditions around the small islands during extreme events such as typhoons and cyclones, in conjunction with ERA5 wave data.

Women in GIS

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Abstract ID: 63
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic:

This project aims to evaluate the impact of typhoid vaccination on public health through an integrative analysis of clinical, environmental, and vaccination data using Geographic Information Systems (GIS). Typhoid fever, caused by *Salmonella enterica* serotype Typhi, remains a significant health concern in many regions, particularly where sanitation and access to clean water are inadequate. Effective vaccination campaigns are crucial in reducing the incidence of this disease, and GIS mapping provides a powerful tool for visualizing the relationships between vaccination coverage, disease prevalence, and environmental factors.

Utilizing advanced GIS techniques, we analyzed elevation data to identify areas that are geographically vulnerable or advantageous for human habitation and resource allocation. By integrating digital elevation models (DEMs) and hydrological data, we mapped critical waterways that serve as lifelines for communities, providing not only drinking water but also access to transportation and economic opportunities. This analysis is vital in understanding how these geographical features impact women's lives, especially in regions where they may be responsible for water collection and management.

The sampling spots were strategically chosen based on their demographic characteristics and accessibility to resources. Population data, sourced from local census records, was layered onto our GIS maps to visualize population density and distribution patterns. This approach allowed us to pinpoint areas where women are disproportionately affected by environmental factors, such as proximity to water sources and elevation-related risks like flooding or landslides.

Through this project, we aim to highlight the challenges faced by women in these environments and advocate for their inclusion in decision-making processes related to urban planning and resource management. By bringing women's voices to the forefront, we seek to promote equitable access to resources and opportunities, ultimately contributing to sustainable community development.

In addition to mapping and data analysis, the project also incorporates qualitative research methods, including interviews and surveys with women residing in the sampled areas. This combination of quantitative and qualitative data enriches our understanding of the social dynamics at play and provides context to the GIS findings. The insights gained from these

interactions will inform our recommendations for policies and programs aimed at empowering women and improving their quality of life.

Our findings will be disseminated through a series of interactive maps and visualizations, making complex data accessible and actionable for policymakers, community leaders, and other stakeholders. By demonstrating the importance of gender-inclusive GIS modeling, we hope to inspire further research and initiatives that prioritize women's perspectives in spatial analysis.

In conclusion, this project not only advances our understanding of the spatial relationships between elevation, waterways, and population data but also emphasizes the vital contributions of women in GIS modeling. By addressing the unique challenges faced by women in various communities, we aim to foster a more inclusive approach to geographic research and application, ultimately leading to more equitable and sustainable development outcomes.

Recent Activities of UNOOSA (UN-SPIDER) in Tongatapu Island with Space-based Integrated Disaster Management Platform

by Jumpei Takami | United Nations Office for Outer Space Affairs

Abstract ID: 64
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic:

The United Nations Office for Outer Space Affairs (UNOOSA) and its department, the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER), play pivotal roles in the use of satellite-based Earth observation for disaster management and climate resilience. UNOOSA serves as the hub within the United Nations for international cooperation in space-related activities, fostering sustainable space development to benefit humanity. UN-SPIDER, established within UNOOSA, is specifically dedicated to promoting the use of space-based information for managing disasters and emergency responses. It assists countries, especially developing nations, by providing access to critical satellite data, building capacities, and supporting the integration of remote sensing technologies into disaster management frameworks.

The Tonga Preparedness Pilot Project, a collaborative initiative led by UN-SPIDER and the Committee on Earth Observation Satellites (CEOS), exemplifies the practical application of satellite data in disaster preparedness. Spearheaded by Tonga’s National Disaster Risk Management Office (NDRMO), this project harnesses satellite imagery and advanced Earth observation technologies to significantly enhance disaster resilience in Tonga. Recognizing Tonga's geographical vulnerability as a large ocean state prone to natural hazards like sea-level rise, the project emphasizes the importance of multi-stakeholder collaboration to ensure accessible and reliable remote sensing data.

The project was conceived from a UNOOSA Technical Advisory Mission in December 2023, aiming to provide Tonga with better preparedness measures and demonstrate the value of satellite Earth observation and derived products for early warning systems, known as EW4All. Through this initiative, Tonga can serve as a model for other "big ocean" states, showing how these technologies can be adapted and scaled to strengthen resilience across similar environments. By leveraging Tonga's chairmanship in the Pacific Islands Forum (PIF), the project further aims to showcase innovative applications of Earth observation to a broader audience of Pacific island nations, promoting regional cooperation in disaster preparedness.

The project addresses critical aspects of disaster resilience, such as sea-level rise simulation and land subsidence analysis, using cutting-edge technologies. For instance, by analyzing Synthetic Aperture Radar (SAR) data from ALOS-2, Sentinel-1, and CSK&CSG satellites over

Tongatapu Island, the project provides high-resolution insights into land subsidence risks. Additionally, it employs optical satellite data for drought monitoring, making use of 3-meter imagery to assess and manage drought risks effectively. To simulate sea-level rise, the project incorporates digital twin products powered by artificial intelligence (AI) and machine learning, supported by Space Data Inc., a private entity contributing to this initiative with advanced 3D modeling and simulation capabilities.

Multi-stakeholder engagement is central to the Tonga Preparedness Pilot Project. UNOOSA/UN-SPIDER plays a leading role in facilitating cooperation between various organizations, from satellite data providers to local and international stakeholders. The collaboration includes government agencies, international organizations, and the private sector, which contribute diverse expertise and resources. This approach is essential to addressing the unique challenges of remote sensing data, such as resolution, revisit frequency, and variability in observation capabilities. For example, high spatial and temporal resolution data is crucial for monitoring and assessing natural hazards like forest fires, yet data gaps often hinder comprehensive monitoring, especially over expansive ocean territories where some remote sensing technologies, such as LiDAR, are limited.

The pilot project also tackles issues of data affordability and accessibility. Ensuring that remote sensing data is affordable and available to end-users in Tonga is a core objective, as is improving the data procurement and application system to streamline the flow of satellite imagery to local stakeholders. As outlined in the project's design, this involves reducing the barriers for end-users, who often face challenges in understanding what types of satellite data can address their needs and how to analyze it effectively. By simplifying the satellite data purchase process and enhancing access to high-quality, validated imagery, the project empowers end-users to make informed decisions based on reliable data.

The Tonga Preparedness Pilot Project reflects a robust framework for improving disaster resilience through space-based data and geospatial technologies. It not only strengthens Tonga's capacity to respond to natural hazards but also serves as a pioneering model that other vulnerable regions can adopt to build sustainable disaster preparedness strategies. Through this initiative, UNOOSA and UN-SPIDER demonstrate the transformative potential of Earth observation and digital twin technologies in fostering resilient and climate-aware societies in vulnerable regions worldwide.

In recent years, the space industry has witnessed significant advancements, particularly in the development and deployment of small satellite constellations. These constellations, comprising numerous small satellites operating in coordinated orbits, have revolutionized various sectors, including telecommunications, Earth observation, and disaster management. The miniaturization of satellite technology has enabled more cost-effective and rapid deployment of satellite networks, facilitating enhanced global connectivity and real-time data acquisition. For instance, companies like Planet Labs have launched

extensive constellations to provide high-resolution Earth imaging for environmental monitoring and disaster response. This proliferation of small satellite constellations has democratized access to space-based data, allowing even smaller nations and organizations to leverage satellite technology for various applications, including disaster preparedness and climate resilience. The Tonga Preparedness Pilot Project exemplifies how such advancements can be harnessed to enhance disaster resilience in vulnerable regions.

Introduction of Synthetic Aperture Radar for Disaster Management and Forest Inventory Monitoring

by Jumpei Takami | United Nations Office for Outer Space Affairs

Abstract ID: 65
Event: 2024 Pacific Islands GIS & Remote Sensing Conference
Topic:

The use of Synthetic Aperture Radar (SAR) in disaster management has become essential for monitoring and responding to natural hazards, providing high-resolution, consistent data under nearly all weather conditions. SAR's active imaging capabilities enable it to capture data day or night, even through cloud cover, making it great insights for observing natural disasters such as earthquakes, landslides, floods, land subsidence, and droughts.

In earthquake response, SAR plays a critical role in assessing land deformation through Interferometric SAR (InSAR) and offset tracking. These techniques allow measurement of surface displacements following seismic events. For example, SAR was instrumental in analyzing the 7.3-magnitude earthquake that struck the Iran-Iraq border in November 2017. Using Sentinel-1 SAR data, researchers identified significant displacement: an 80 cm upward shift around 20 km and a 35 cm downward shift near the epicenter. Such measurements help scientists understand fault dynamics and ground response, which informs seismic risk assessments and recovery efforts. This information can also guide updates to building codes and urban planning to strengthen resilience in earthquake-prone areas.

Landslide monitoring is another critical application of SAR. Landslides pose severe risks in mountainous or sloped areas, often causing sudden and extensive damage. SAR data can detect small surface movements that may indicate an impending landslide, enabling early warnings and preventative measures. By continuously monitoring high-risk areas, SAR allows authorities to identify slight land movements that could precede a landslide, offering communities critical time to evacuate or protect infrastructure.

Flood monitoring, particularly during heavy rainfall or storm events, demonstrates the unique advantages of SAR. Floods are often accompanied by cloud cover, which obstructs optical satellite imagery. However, SAR can penetrate clouds and work even at night, capturing clear images of inundated areas and making it invaluable for flood assessment. During Cyclone Idai in 2019, Copernicus Sentinel-1 SAR data was used to map flooded regions in Mozambique despite adverse weather conditions, providing crucial information for emergency responders. SAR's ability to distinguish between flooded and non-flooded land allows for accurate flood extent mapping, guiding rescue operations and resource allocation in affected areas.

To enhance flood monitoring further, SAR data can be integrated into cloud-based platforms

like Google Earth Engine (GEE). GEE allows users to process large volumes of SAR data efficiently and estimate flood extents rapidly. By leveraging GEE, disaster management teams can access and analyze SAR imagery in near real-time depending on the satellite observation revisit frequency, generating flood maps that show the extent and impact of flooding. GEE provides tools for pre-processing SAR images and applying algorithms to delineate water bodies, enabling the quick identification of flooded areas. For instance, after a flood event, Sentinel-1 SAR data can be loaded into GEE, where image processing techniques like thresholding or water index algorithms are applied to detect changes in water coverage. This approach not only speeds up the analysis but also allows for continuous monitoring, making GEE an effective tool for coordinating emergency response and planning evacuation routes.

Land subsidence monitoring is also a vital SAR application, especially in urban or agricultural areas affected by groundwater extraction, mining, or other geophysical processes. Land subsidence can damage infrastructure, alter waterways, and increase flood risk. By applying Time-series InSAR, SAR satellites precisely detect vertical displacements over time, enabling the creation of detailed subsidence maps that reveal areas sinking gradually. This data aids urban planners and engineers in making informed decision-making regarding water management, building practices, and land use, helping to mitigate long-term impacts on communities and ecosystems.

Drought monitoring benefits from SAR's sensitivity to soil moisture, an essential factor for assessing agricultural and hydrological conditions. SAR data can detect changes in soil moisture levels, making it possible to identify drought-prone areas early. This capability is critical for agricultural planning and water resource management, as it enables authorities to implement water-saving measures, prioritize irrigation, and support affected communities. SAR's ability to monitor soil moisture over large regions provides valuable data for drought response and supports food security efforts.

In addition to its applications in disaster management, SAR technology is crucial for forest inventory monitoring, particularly in estimating forest height and biomass. Using longer wavelengths like P and L bands, SAR can penetrate forest canopies to capture detailed structural information. Forest height estimation is essential for assessing carbon storage capacity, which supports climate mitigation efforts. The European Space Agency's upcoming BIOMASS mission will deploy Tomographic SAR (TomoSAR) in P-band, enabling the creation of 3D models of forest structure globally. By accurately mapping forest height, the BIOMASS mission will improve carbon accounting and support sustainable forest management aimed at conserving biodiversity and ecosystem health.

Recent advancements, particularly with TomoSAR, have expanded SAR's potential in forest monitoring. TomoSAR creates 3D images of forest canopies, allowing scientists to analyze vertical variations in forest structure and accurately estimate tree height. In some of the

researching projects, TomoSAR data in P and L bands was used to train machine learning models for tree height estimation, with LiDAR data serving as the ground truth. The models achieved higher accuracy, demonstrating the effectiveness of TomoSAR in accurately measuring forest height across diverse forest ecosystems.