ISSN: 2581-4613

ISSUE 3 SEPTEMBER 2023

GIS RESOURCES

GEOSPATIAL TECHNOLOGIES FOR CLIMATE CHANGE MITIGATION



Flood Hazard Web GIS Application in Japan Developed using TatukGIS National Land Cover Monitoring System: Helping Nepal Manage Its Candscapes For Climate Action

Geospatial Technologies in Agriculture: A Vital Tool for Climate Change Mitigation

RIEGL WAVEFORM LIDAR FOR FORESTRY

A BROAD SENSOR PORTFOLIO SERVING ALL LEVELS OF FORESTRY SURVEY



Terrestrial Laser Scanning with the RIEGL VZ-i Series unrivalled level of detail

INTERGEO

9 OCT. 10-12

- single tree, stem and branch segmentation
- convex hull of crown
- crown volume, tree metrics, tree height, crown coverage



UAV-based Laser Scanning with the RIEGL VUX-120, VUX-240, VUX-1 & miniVUX-Series unrivalled views and flexibility

- segmented point clouds for display of single trees
- volume models for biomass measurements
- 3D piped model of tree stem



П

Airborne Laser Scanning with the RIEGL VQ-480 II, VQ-580 II-S, VQ-1260, VQ-1460 & VQ-1560 Series unrivalled area efficiency

- growth monitoring by vegetation masks, canopy models, crown coverage, etc.
- underwood and deadfall visualization and calculation



Explore the full portfolio of proven RIEGL LIDAR Sensors and Systems at www.riegl.com



Canada |

Scan this QR code

o get detailed

formation of

Japan

RIEGL LIDAR in Forestry.

Australia |

Table of Contents

Columns



27

Editor's Note

News Digest



Geo Events

Articles

06

Geospatial Technologies To Prepare For Climate Change Mitigation

10

Geospatial Technologies in Agriculture: A Vital Tool for Climate Change Mitigation

15

Flood Hazard Web GIS Application in Japan Developed using TatukGIS SDK

19

National Land Cover Monitoring System: Helping Nepal Manage Its Landscapes For Climate Action

23

Navigating the Future: The Power of Satellite-based GNSS Augmentation



Executives

Editor Ashok Prim Director (Retd), Survey of India India

Associate Editor

Dr. Venkata Ravibabu Mandla Ph.D IIT Roorkee, Australian Endeavour Awardee Associate Professor, CGARD, NIRD&PR, Hyderabad, India Email: mvravibabu.nird@gov.in

Advisory Board

Dr. Ch Ramesh Naidu Ph.D JNTU - Hyderabad Professor, Dept. of Civil Engineering, GVPCOE(A), Visakhapatnam, India Email: rameshnaidu@gvpce.ac.in

Dr. Rajitha K Ph.D IIT Kharagpur Assistant Professor, Dept. of Civil Engineering, BITS-Pilani, Hyderabad, India Email: rajitha@hyderabad.bits-pilani.ac.in

Dr. Gourkishore Tripathy Ph.D IIT Bombay Independent Consultant Email: gktripathy@gisresources.com

Dr. T. Ranga Vittal, Ph.D (Geology) Independent GIS Consultant Email: rangavittal@gmail.com

M. D. Cariappa Survey and Field Data Collection Expert (Including UAV and LiDAR Mapping) Alumni Course 500.73, IIS&M, Survey of India, Hyderabad, India Email: kcariappa@gmail.com

Venkat Kondepati, PMP, ITIL, Msc. Geography Independent Consultant Calgary, AB, Canada Email: vkondepati@gisresources.com

Regd. Office

GIS Resources B-24, Jawahar Vihar, Malik Mau Aima, Rae Bareli, Uttar Pradesh, India - 229010 Phone: +91 852 304 7671 Email: support@gisresources.com Website: www.gisresources.com

Advertising and Marketing Queries Email: support@gisresources.com

Disclaimer

GIS Resources is an initiative of Spatial Media and Services Enterprises with the purpose that everyone can enrich their knowledge and develop competitiveness. All views in this issue are those of the authors and don't necessarily subscribe to the views of the GIS Resources.











Editor's Note

By Ashok Prim

s the global community grapples with the devastating impacts of climate change, geospatial technologies have emerged as a beacon of hope. These advanced tools, including geographic information systems (GIS), remote sensing, and global positioning systems (GPS), offer unparalleled capabilities in helping us build climate resilience.

One of the primary contributions of geospatial technologies is their ability to monitor environmental changes with remarkable precision. Satellites equipped with remote sensing instruments can track changes in temperature, land use, and sea levels. This data is invaluable for understanding the impacts of climate change and formulating effective mitigation measures.

Additionally, GIS technology plays a vital role in land-use planning and sustainable development. By overlaying data on climate vulnerabilities and population density, governments and organizations can make informed decisions about where to build infrastructure, reducing exposure to climate-related risks.

The G20 has recognized the importance of harnessing geospatial technologies for climate change mitigation. In the G20 Climate Declaration, member nations commit to leveraging these technologies to monitor and manage the impacts of climate change. By sharing data and best practices, G20 nations can collaborate on innovative solutions to reduce greenhouse gas emissions and adapt to changing environmental conditions.

Geospatial technologies are at the forefront of climate change mitigation efforts. They empower us to make informed decisions, identify emission hotspots, and monitor environmental changes in real-time. With the commitment of the G20 nations, we can amplify the impact of these technologies and steer our planet toward a sustainable and resilient future.



Geospatial Technologies To Prepare For Climate Change Mitigation

By Sam Himsworth GIS Developer Fathom o effectively address the challenges posed by climate change, it is vital that we understand and monitor its impact. Only by doing this can we successfully manage and mitigate it. Spurred on by increasing regulations companies are being held accountable for their climate exposure and impact, and supported by a rise of digital adoption across industries, geospatial technologies are now more important than ever in the climate change discourse.

Earlier this year, it appears the UK Government came to a similar conclusion and responded with the launch of a new UK Geospatial Strategy 2030. The purpose of the strategy is for the UK to capitalize on the increased demand for geospatial technologies such as AI, satellite imaging, and real-time data to "boost location-powered innovation" and drive economic growth. The strategy, entitled *'Unlocking the power of location'* was created by the independent committee responsible for setting the UK's geospatial strategy and outlines how nine different industries - across finance, transportation, public health, and housing - could benefit from location data. Climate change is a regular theme throughout the report, both exposing where climate risks exist and helping deliver a low-carbon transition.

It's great to see those outside of the geospatial industry start to wise up about its potential to help tackle climate change. Already it's having a fantastic impact in the realm of flooding.

Preparing for climate change in the US

Under climate change, flooding in the US is expected to worsen, leading to infrastructure damage and the displacement of numerous people from their homes. Indeed, in the next three decades alone, research entitled 'Inequitable patterns of US flood risk in the Anthropocene' suggests that greater rainfall and sea levels rising could increase the annual cost of flood damages for the country up to \$40.6 bn an \$8 bn rise.

As a result, government authorities and land planners are looking for solutions to this problem - and nature-based solutions are a strong favorite thanks to their environmental sustainability. Floodplains, in their natural form, are a prime example of how flooding can be tackled. A single acre of wetlands can hold approximately 1 million gallons of water. But unfortunately, floodplains are increasingly being converted into farmland or claimed by urbanization and built upon.

In 2019, environmental non-profit The Nature Conservancy (TNC) launched an interactive Floodplain Prioritization Tool. The Tool is a free, online interactive web map; an increasingly popular medium for spatial data showcase. The web map was created to help government authorities, planners and landowners to identify floodplain sites along the Mississippi River Basin in the US, across all 24 states it flows through. Each watershed on the map contains comprehensive attribute data within the boundary polygons, allowing for visual filtering and detailed analysis. This gives a panoramic view of the region, providing a broader picture on the challenges and opportunities in different localities. Once identified using this location data, these decision makers would be able to prioritize specific sites for protection or

restoration. With tens of millions of floodplain acres across the Basin having already been developed on prior, the Floodplain Prioritization Tool is facing an uphill battle.

To create the Tool, TNC required detailed maps of floodplain characteristics and flood risk, in order to inform conservation decisions. FEMA's existing flood maps were the initial port of call, but these were deemed too patchy and an underestimation of the flooding rivers across the US, and so more detailed data was sought. TNC was also looking for data that was reliable and consistent across a large scale, to allow decision makers to identify the most valuable sites and to allocate resources across the vast expanses of the Mississippi River Basin accordingly.

To do this, The Nature Conservancy used a bespoke large scale flood model that was built using Fathom's US Flood Map. It provided the detail, scale and reliability that the TNC was looking for, in addition to offering a more realistic picture of how floods physically spread when compared against alternative large-scale models.

The Floodplain Prioritization Tool has already been put to good use. One example can be found in the Missouri Lower Meramec River, which benefits from amazing biodiversity including almost 300 aquatic or aquatic-dependent species, many of which are rare, sensitive or protected. 31 of these species have even been identified as having global significance, with a number of them not found anywhere else on Earth. Here, the Floodplain Prioritization Tool is helping to inform a collaborative floodplain management plan that is being led by the US Army Corps of Engineers Silver Jackets program.

As part of the partnership, Fathom and The Nature Conservancy also collaborated on a scientific paper, which was published in Nature Sustainability in 2019. The paper examined the cost-benefit ratios of acquiring floodplain land relative to future flood damages in the US. It found that for every \$1 invested into conserving large 100-year floodplains, the US could save at least \$5 in the long term by avoiding future flood damage. This highlights the potential economic benefits of climate mitigation using geospatial technologies.

Responding To Climate Disasters in Zimbabwe

In low-income countries, flooding can severely impact access



Figure 1: The Floodplain Prioritization Tool's coverage. Source: Freshwater Network – Mississippi River Basin Floodplain Tool | Mississippi River Basin.

INDUSTRY

to food. The effect is felt across the supply chain, from destroying crops and food stores, to obstructing supply routes, to killing livestock. And as food becomes more scarce, its price can skyrocket.

The UN World Food Programme (WFP) is the world's largest humanitarian organization. Their ethos is to use food assistance to save lives, while also bringing stability and prosperity. WFP contracted Floodbase, an organization who specialize in responding to climate disasters, to supply emergency flood analytics to countries affected by food insecurity. Floodbase integrates satellite observations with various types of geospatial data, including hydrological and meteorological data and models, to enable flood policy decision-making. In particular, WFP was looking for reliable data to understand where catastrophic floods are occurring in real-time, and where they are predicted to happen in the future.

Using this spatial data, WFP rapidly delivers food and capital to at-risk communities in emergency situations, supporting their short-term needs as well as helping them repair assets such as water harvesting systems in order to ensure longerterm food security.

Floodbase has used Fathom data to help Zimbabwe achieve better food security since 2021. The company provides WFP Zimbabwe with emergency maps of forecasted events, to help provide an accurate understanding of how flooding impacts communities, agriculture and important assets. The data is used by country planners, first responders, governments and disaster managers to strengthen their decision making and protect vulnerable communities in the country from flooding and climate shocks.

Nearly two-thirds of Zimbabwe's population live below the poverty line. The country ranks 108th of 119 countries on the IFPRI's 2017 Global Hunger Index. In short, climate shocks intensify food shortages that are already severe.

In 2022, Tropical Storm Ana hit Zimbabwe and the flood maps proved critical in helping shape the country's first response across two particularly vulnerable regions, Chidodo and Mushumbi Pools. The intelligence also provided vital insights for the key decision makers into further prospective flood locations. Thanks to Fathom's Global Flood Map being adopted by Floodbase, WFP Zimbabwe was able to understand the country's risk to infrequent yet severe flood maps, and planning decisions have been made to protect the most at-risk communities from future flood events.

Future Flooding In the UK

At the start of 2023, a new academic research paper was published, led by hydrology expert Professor Paul Bates.



It delved into the creation of a new UK flood model that simulates pluvial (rainfall), fluvial (river) and coastal flood risks against the UK Climate Projections 2018 climate simulations using a number of (geo)spatial datasets, GIS layers and machine learning. The model contains a greater level of detail and nuance to previous work, and represents the best understanding of the UK's evolving flood risk landscape.

A number of key findings from the report include:

- Average annual flood losses to properties and businesses can be restricted to a 4% rise above historic levels, but only if all countries meet their COP26 and net zero emission reduction pledges in full.
- If targets are missed, the annual cost of flooding in the UK could grow by 13-23% in the next century, depending on the climate scenario.
- Most places that are at risk of future flooding are at risk in the present day. Therefore, the best thing we can do to strengthen flood management under climate change is to address the areas already at risk.
- The assessments of flood hazard and risk currently being used in the UK are not subject to peer review and therefore it's impossible to validate their accuracy.

When released, the results of the paper received international coverage across over 300 media publications, from national

sites such as Sky News, BBC and CNBC, to industry magazines including New Civil Engineer and Business Live. Needless to say, it was a fantastic advertisement to the value of geospatial layers in analyzing and visualizing the flood risk of the UK.

What's Standing in the Way?

In April 2023, the Executive Office of the President and the President's Council of Advisors on Science and Technology sent a report to the United States President entitled 'Extreme Weather Risk in a Changing Climate: Enhancing Prediction and Protecting Communities'.

The purpose of the report was to highlight the risks of extreme weather to communities and the US federal government. It focussed on where advances have already been made, and where more focus is needed, and proposed a national adaptation plan that could help protect lives, livelihoods, and property.

Geospatial products underpinned the report's findings. One example is the Wildfire Hazard Potential Map; a raster geospatial product that informs evaluations of wildfire hazards and prioritization of fuel management across large landscapes, which was used to report on current wildfire risks that the US is experiencing. Two of the reports key recommendations also centered around the development of nationwide geospatial products:

Recommendation 1: Action should be taken to better quantify and disseminate current and future risks of climaterelated extreme weather. This would include a central data portal, where modeling products would be available for use. Guidance on products and their reliability would also form part of the portal.

Recommendation 2: A more collaborative ecosystem would improve public and private sector tools that monitor and evaluate extreme weather risk. An interagency group should be designated to inventory and release federal data pertaining to weather-hazard models.

Both of these recommendations arose from the suggestion that the data needed to create weather-hazard models is currently inadequate to provide the reliability and skill needed to address climate change. I would recommend giving the report a read and looking through the list of areas outlined in calls for further data research. As a user of geospatial datasets, I sincerely hope these recommendations are followed. Only with more accurate data can we continue to demonstrate the valuable role geospatial technologies can play in helping monitor, manage and mitigate climate change.

Conclusion

"The power of location will continue to underpin solutions to our biggest challenges including climate change," explains Sir Bernard Silverman, Chair of the UK's Geospatial Commission. I couldn't agree more. Governments and industries alike are recognizing the increasing importance of geospatial technologies in addressing major societal challenges, such as climate change. As shown, GIS and geospatial data is being used effectively to facilitate small and large scale management of many climate related issues such as food security, flood prevention and extreme weather. Contextualizing this data using enabling technologies, such as GIS, provides a greater understanding of the overarching issues and patterns, helping to identify higher risk areas and optimize responses. In turn, geospatial information brings many potential social, environmental and economic benefits through valuable locational insights.

To progress, it is clear that more high quality, validated, spatial data needs to be available globally, aligned with the views of the likes of the UK's Geospatial Commission and the Executive Office of the President. Greater availability and guality of data translates into more informed policy decisions for mitigating the negative effects of climate change. To achieve this goal, collaboration and cooperation is needed, whether that be within or between industries and governing bodies. More nations committing to investment into similar geospatial strategies can only result in advantages, for their citizens and geospatial ecosystems alike. Data sharing and innovation is important in the creation and maintenance of consistent data sources. This will be vital to many different industries and regions of the globe, empowering global geospatial applications, services and ecosystems when moving forward with our collective mission to combat adverse effects of climate change.



Figure 2: Simulation of a 1-in-100 year undefended fluvial flood in Oxford (UK), in 2070.



Geospatial Technologies in Agriculture: A Vital Tool for Climate Change Mitigation

By Vera Petryk Chief Marketing Officer EOS Data Analytics

he confluence of technology and agriculture has long been a catalyst for revolutionary advancements, driving increased yields, sustainable practices, and resilient ecosystems. Yet, as the global community faces the pressing challenges of climate change, the intersection of these two domains takes on even greater significance. Geospatial technologies, including tools like Geographic Information Systems (GIS), satellite imagery, and remote sensing, have emerged as powerful allies in this endeavor. They offer agricultural stakeholders a precise, data-driven lens through which they can monitor, analyze, and adapt to our planet's everchanging climate. This article embarks on an exploration of how these sophisticated technologies are shaping the future of agriculture, transforming it into a formidable frontline defense against the growing threats of climate change.

The Consequences of Climate Change

Climate change, a consequence of increasing atmospheric concentrations of greenhouse gasses, has begun to leave indelible marks on our planet. Its manifestations are multifaceted and global in scope. Sea levels are rising, irregular and extreme weather patterns are becoming the new norm, threatening biodiversity, human health, and the very safety of many communities. Erratic meteorological events also result in reduced agricultural yields, posing substantial challenges to food security. Fragile ecosystems, such as coral reefs and polar regions, face existential threats, leading to potential collapses that would reverberate throughout the global food chain. Moreover, freshwater sources are depleting or becoming contaminated, leaving many regions parched and others flooded.

Yet, amidst these looming challenges, there remains a glimmer of hope. The ever-evolving realm of sustainable solutions offers pathways to adapt to and mitigate the effects of climate change. One such avenue, which could significantly pivot the trajectory of our future, is sustainable agriculture. This practice not only addresses food security concerns but also aids in reducing the carbon footprint of farming activities, preserving natural resources, and bolstering local economies. As we transition to the next section, we will explore how geospatial data is helping to make all of this possible.

Geospatial Data as a Tool in Addressing Climate Change

In the multifaceted battle against climate change, the insights drawn from geospatial data are proving invaluable. At its core, geospatial data allows scientists, policymakers, and stakeholders to understand the earth's changing patterns with unprecedented precision. Through tools like Geographic Information Systems (GIS) and satellite technology, we can not only monitor but also predict environmental changes, fostering proactive rather than reactive interventions.

Companies like EOS Data Analytics (EOSDA) are at the forefront of integrating GIS and satellite technologies to combat the adverse effects of climate change. EOSDA recognizes the critical role of sustainable solutions in shaping the future of our planet. The company is deeply committed to ensuring that the Earth remains habitable for future generations.

EOSDA's services span a multitude of sectors, but one of their standout contributions lies in agriculture. By utilizing geospatial data, EOSDA aids farmers worldwide helping them make informed decisions regarding crop health, irrigation needs, and pest infestations. Such precision agriculture practices not only

Remote Sensing Technologies in a Fight Against Climate Change

At the fusion of technology and environmental science lies the transformative power of GIS, a major force reshaping our approach to climate change mitigation and adaptation. These technologies, both terrestrial and satellite-based, offer the detailed view of our planet, revealing patterns, anomalies, and possibilities that were once hidden from the human eye.

One of the primary strengths of GIS lies in its ability to synthesize vast quantities of diverse data. Combining atmospheric readings, soil moisture levels, vegetation indices, and more, GIS paints a comprehensive picture of current environmental conditions. This dynamic portrait aids policymakers and stakeholders in crafting informed strategies, ensuring interventions are both timely and efficacious.

Satellite-based GIS, in particular, offers unparalleled global coverage, capturing real-time data on atmospheric gas concentrations, deforestation rates, glacial retreats, ocean temperature anomalies, and more. This perspective is essential for tracking large-scale environmental changes, allowing us to evaluate the effectiveness of global climate agreements and national policies.

Furthermore, predictive modeling, an advanced feature of many GIS platforms, helps societies anticipate and prepare for future climate-related scenarios. From envisioning the inundation patterns of coastal cities due to sea-level rise to predicting agricultural yields in an era of changing precipitation patterns, GIS technologies offer a roadmap to a range of potential futures. Armed with this data, communities can implement adaptive measures, from constructing climateresilient infrastructure to transitioning to crops better suited to anticipated conditions.

On a more micro level, GIS technologies can assist local

bolster yields but also promote sustainable agriculture methods that are less taxing on the environment.

In the expansive realm of climate change mitigation, the integration of geospatial data is not just a luxury; it's a necessity. Companies like EOSDA are paving the way, demonstrating how innovative remote sensing technologies can be seamlessly melded with environmental stewardship to craft a brighter, more sustainable future.



Figure 1: Deforestation detection in the forests of Tasmania, Australia using EOSDA Forest Monitoring software. Source: EOS Data Analytics.

communities in harnessing renewable energy more efficiently. By mapping solar irradiance or wind patterns, regions can strategically place solar panels and wind turbines, optimizing energy generation and reducing reliance on fossil fuels.

Moving on, we'll discuss the negative impact of climate change on agriculture and different groups of people, followed by the actual cases that show how remote technologies prove effective in solving these issues.

Climate Change and Agriculture

Agriculture has always been closely tied to the rhythms and patterns of the Earth's climate. With the majority of global agricultural practices being rainfed, even minor fluctuations in weather patterns can have profound consequences. As the issue of climate change keeps growing, the agriculture sector finds itself on the front lines, tackling challenges that threaten not just individual farms, but food security on a global scale.

How Agriculture Suffers from Climate Change

Changes in climate and weather patterns have a direct impact on every process in farming. Altered precipitation patterns, for instance, lead to both extended droughts and destructive floods, directly affecting crop yields. Rising temperatures result in heat stress, uneven crop growth, shorten growing seasons, and shift traditional agricultural zones, compelling farmers to adapt rapidly, sometimes even transitioning to entirely new crops. These temperature changes also modify the habitats of pests and diseases, introducing new threats to regions previously untouched by them.

However, the implications of climate change on food security extend beyond just the volume of production. Indeed, while reduced yields pose significant threats, the nutritional quality of many staple crops also stands compromised under increased temperatures. This decline in nutritional value means that even if food is available, its nourishing potential may be diminished, making communities more vulnerable to malnutrition. Therefore, the very economics of food production is altered. Reduced yields, coupled with increased susceptibility to pests and diseases, can drive up production costs. As a result, consumers might witness heightened food prices in the market, rendering essential commodities out of reach for many, further exacerbating food security issues. Luckily, today's technologies, especially remote sensing, offer a diverse set of possibilities for the food production industry to keep up with the changes.

How Remote Sensing Technologies Help Mitigate the Effects of Climate Change in Agriculture

At its core, remote sensing offers a holistic view of farmlands. This aerial perspective delivers detailed imagery that can unveil patterns and anomalies often invisible to the ground observer. Aspects such as crop health, soil moisture levels, irrigation discrepancies, and even pest and disease infestations can be detected with remarkable accuracy.

This technology's temporal advantage is also noteworthy. Through consistent monitoring, remote sensing allows for the tracking of changes over time, be it the growth progression of crops or the gradual impact of a changing climate on agricultural regions. Such continuous data streams empower farmers and agricultural planners to make informed decisions rapidly, optimizing resources and intervening proactively when issues arise.

Moreover, the precision of remote sensing technologies aids in tailoring agricultural strategies to the unique needs of individual plots. By zoning farmlands based on soil health, water needs, or crop type, farmers can implement Variable Rate Application (VRA) of inputs such as fertilizers or pesticides, thereby reducing costs, minimizing environmental impact, and boosting yields.

Over the past half-century, the agricultural sector has seen a dramatic increase in fertilizer use, resulting in bountiful yields. Yet, this intensified farming came with significant environmental trade-offs: soil degradation, water contamination, and an uptick in greenhouse gas emissions due to an increase in machinery and fertilizer applications.

The solution could well lie in the implementation of sustainable agriculture practices. Projections indicate that if 15-25% of global farms adopt smart farming techniques by 2030, we could witness a yield boost of 10-15%. These numbers underscore a compelling case for the agriculture industry to pivot from resource-intensive methods to more sustainable, precision-based practices.

One way to reap the benefits of precision agriculture is to use farm software like EOSDA Crop Monitoring.



Figure 2: Field zoning in EOSDA Crop Monitoring for variable rate fertilizer application. Source: EOS Data Analytics.

Delving into its capabilities, key features stand out:

- Soil Moisture Monitoring: Using the Normalized Difference Moisture Index (NDMI), this functionality measures moisture levels across soil, roots, and foliage, pinpointing areas of water stress and optimizing irrigation strategies.
- Zoning for Variable Rate Application (VRA): This innovative feature enables targeted application of fertilizers, pesticides, and herbicides. By doing so, it not only maximizes crop health but also curtails the environmental issues of water pollution and soil exhaustion.
- Vegetation Indices: Equipping farmers with data-driven insights, these indices offer a comprehensive view of both current crop conditions and historical field productivity, facilitating decisions that align with environmental sustainability and business profitability.

Climate Change and Indigenous People

Indigenous communities, stewards of approximately 20% of the Earth's surface and protectors of 80% of its biodiversity, occupy a unique and important role in the unfolding narrative of climate change. Often residing in ecosystems ranging from tropical forests to arctic tundras, these communities are the first to witness and experience the direct consequences of a

shifting climate. Yet, their profound connection to the land, centuries-old wisdom, and sustainable practices also position them as vital allies in the global effort to address the climate crisis.

How Indigenous People Suffer from Climate Change

Indigenous peoples, despite having the smallest carbon footprints, are among the most affected by climate change. Rising sea levels threaten coastal and island communities, while changing weather patterns disrupt traditional farming, fishing, and herding practices. In the Arctic, melting ice caps and permafrost endanger the livelihoods and cultural practices of the Inuit and other indigenous groups. Such disruptions have cascading effects, leading to food insecurity, displacement, and economic hardships.

Climate change isn't just an environmental challenge for indigenous communities. It's a profound cultural and spiritual crisis. Many indigenous traditions, rituals, and ceremonies are closely tied to specific places, species, or seasonal events. The loss of a sacred site to rising seas or the disappearance of a totemic animal due to changing habitats deeply wounds the cultural sphere of these communities.

While indigenous communities are among the most vulnerable to climate impacts, their traditional knowledge offers a rich repository of adaptive strategies and mitigation techniques. From forest management practices that sequester carbon to age-old agricultural methods that enrich the soil, indigenous wisdom can complement modern science in crafting holistic solutions.

Historically, indigenous voices have been marginalized in global climate dialogues. However, recent years have seen a growing recognition of their rights and contributions. Instruments like the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) emphasize the importance of their participation in climate-related decisions, particularly when it concerns their lands and territories.

Numerous studies have shown that lands owned by indigenous communities often boast better conservation outcomes than even protected areas. Recognizing and reinforcing indigenous land rights, therefore, is not just an issue of justice but also a



Figure 3: Monitoring field's vegetation using NDVI index map in EOSDA Crop Monitoring. Source: EOS Data Analytics.



Figure 4: Graphs of annual surface and root zone soil moisture and their correlation with NDVI index value. Source: EOS Data Analytics.

pragmatic strategy in the global effort to conserve biodiversity and combat climate change.

In essence, the relationship between climate change and indigenous peoples highlights a broader truth: the climate crisis isn't just an environmental or economic challenge. It's deeply intertwined with issues of rights, identity, culture, and equity. Luckily, modern technology can also be used to help indigenous communities in tackling their climate-related struggles. Let's see an example.

How Remote Sensing Technologies Help Indigenous People Resist Climate Change: Mapping Project in Chad

In developing countries such as Chad, communities heavily reliant on pastoralism and subsistence farming find themselves increasingly vulnerable to the extreme weather events caused by climate change. This vulnerability is due to the potential shortages or deterioration of natural resources. The complexities of this situation are evident in Chad's Mayo-Kebbi Est region, where an enduring conflict has developed between nomadic pastoralists and local farmers. At the heart of this conflict is a struggle for the fair use of land and freshwater resources, which have been further strained by the consequences of climate change. On the land front, unpredictable rainy seasons have resulted in droughts, compelling farmers to seek more fertile grounds and pastoralists to look for new pastures. This has led to disputes as pastoralists' routes cross cultivated lands, and farmers, in turn, establish plots that hinder the traditional routes of pastoralists.

Water scarcity has further intensified these tensions. As traditional water points dry up due to reduced rainfall, pastoralists find themselves seeking new water sources in proximity to villages, inadvertently encroaching on areas that local farmers consider their own. The situation becomes even more convoluted when government and military representatives enter the fray, often privatizing land and denying access to both pastoralists and local farmers. This project aimed to harmonize the conflicting interests by creating a shared understanding and agreement on the use of the region's limited natural resources. To do that, a participatory resources mapping was conducted. EOSDA obtained satellite imagery of the area with EOSDA LandViewer and created a printable map layout with annotated natural and artificial objects to make it ready for mapping by locals.

Participatory mapping uniquely involved local communities in creating maps tailored to their needs, facilitated by external entities such as NGOs or tech companies. This approach has not only addressed immediate conflicts but also fostered a sense of ownership and collaboration among participants.

The success and potential of this approach became evident when leaders from 116 communities, spanning 23 villages, came together to work on this project — a number that far exceeded the initial expectations. With the completion of this project, a 2D map, complemented by a written agreement, has guided these communities in their shared use of resources, offering a blueprint for conflict resolution. This document, which was eagerly anticipated, stands as a testament to what can be achieved when technology meets tradition.

In an era where the consequences of climate change spare no one, the integration of geospatial technologies in farming is what bears hope. Advanced tools, coupled with the benefits of sustainable agriculture, provide an unparalleled advantage in the fight against the unpredictable and often devastating effects of a changing climate. By leveraging the precision and efficiency offered by GIS technologies, we can foster agricultural practices that not only ensure food security but also contribute to the healing and restoration of our planet. All-in-all, geospatial innovations remind us that even in the face of daunting challenges, we possess the tools to change the situation for the better.

However, amidst these challenges, innovative solutions are emerging. One such endeavor is the participatory mapping project by Hindou Oumarou Ibrahim, a member of the Mbororo pastoralist people and founder and president of the Association for Indigenous Women and Peoples of Chad (AFPAT), with support from EOS Data Analytics.



Figure 5: The area covered by the participatory map created using satellite data from EOSDA LandViewer. Source: EOS Data Analytics.



Flood Hazard Web GIS Application in Japan Developed using TatukGIS SDK

By Herman Moyers TatukGIS & Hamamoto Takashi Tsukasa Consulting Co.

igashihiroshima City, in Hiroshima Prefecture, Japan, recently implemented a flood hazard and disaster prevention-related web GIS application developed using the TatukGIS Developer Kernel (DK) for ASP.NET edition which is designed to mitigate the flood risks posed by hundreds of agricultural irrigation reservoirs. The web mapping application enables anyone in the vicinity of a reservoir to understand in advance the flooding impact if the reservoir fails - such as due to heavy rainfall during a typhoon or an earthquake. Citizens can easily understand if their home, property, or business is at risk, how much time following a reservoir collapse before flood water reaches their location (i.e., time available to evacuate), projected depth of the inundation presented as color gradients, and optimal evacuation path to higher ground and emergency shelter.

The territory of Higashihiroshima City contains 1,821 priority-level agricultural reservoirs, more than any other city in the Hiroshima Prefecture, and approximately 2,200 smaller irrigation ponds. The entirety of Japan contains 31,600 priority-level agricultural reservoirs, many constructed hundreds of years ago, prior to the Edo period (1603-1868). Simultaneous monitoring of so many locations during and following periods of heavy Typhoon rainfall or a seismic event is very difficult, particularly considering that priority is given to monitoring and mitigating risks associated with river flooding and landslides. According to the Higashihiroshima Agriculture and Forestry Division, 48 agricultural reservoirs in Hiroshima Prefecture (many in the territory of Fukuyama City) collapsed in 2018, sometimes

INDUSTRY

resulting in deaths. It is hoped this application will help citizens become more aware in advance of the risk posed by nearby reservoirs and be better prepared.

A simulated flood presentation is available for each reservoir in Higashihiroshima City using unfavorable assumptions that the reservoir is full and the collapse is instantaneous. When a flood scenario is called by an online user, depth gradients of the inundation are rendered on the map using vector polygons. As an example (see the following image), a sudden collapse of the Senzoku Reservoir located in Saijo Town ward is projected to result in flood water reaching National Highway 375, approximately 2 kilometers to the west, after approximately 15 minutes. Sections along the highway would become flooded to a depth of 2 to 3 meters.

Any flood presentation on a map area defined by the online user can be downloaded as a full map resolution PDF image file, such as for use in reports or for citizens to print out to study and have handy at the time of a disaster.

The Higashihiroshima City reservoir flood hazard web mapping application was developed by Tsukasa Consulting Co. in Japan using the DK for ASP.NET edition with Microsoft Visual Studio and ASP.NET Web Forms. DK support for the WMTS (Web Map Tile Service) protocol and a built-in Leaflet library are used to incorporate into the project two map layers from remote servers, an aerial image layer from the Japan Geographic Survey Institute WTMS and an OpenStreetMap layer from the Geospatial Information Authority of Japan. Locally held vector map layers are in the SHP file format and/or TatukGIS SQL native structure format running on SQLite database. DK functionality reprojects layers on-the-fly to the map presentation coordinate system. The DK provides the north arrow, scale, and print-to-PDF features. The web application runs on Windows' Internet Information Services (IIS) 11.

Relying on its many years of experience developing GIS solutions using TatukGIS SDK products, Tsukasa Consulting developed this application to completion on a tight timeline to have it in operation for the 2023 typhoon season. The short timeline was because Tsukasa received the request to perform the project only after Higashihiroshima City was unable to agree on terms with its traditional GIS solution provider. The most important advantage of the TatukGIS platform for this project was it enabled rapid development of the web GIS application to an advanced level for on-time deployment on a reasonable budget, while not requiring any expensive, top-shelf, dedicated server hardware.



Figure 1: Online flood scenario triggered by potential collapse of the Senzoku Reservoir.



Figure 2: Flood scenario with map features including north arrow, scale, and key information, prepared by the online user for download as a PDF image file.

Other features of the TatukGIS Developer Kernel appreciated for this project include support for Japanese language characters (the DK supports language characters for all languages), ready support for any imaginable coordinate system, ability to easily incorporate available map layers streamed via the web from remote servers, and the operating performance (i.e., speed) of the software.

"TatukGIS software works so efficiently that developed applications can run terrifically even on older or less expensive computing hardware."

Tsukasa Consulting

The TatukGIS DK for ASP.NET edition supports both ASP.NET Core and Web Forms technologies for web GIS development. Tsukasa Consulting chose to use the Web Forms framework for the Flood Hazard application because this was the safer strategy considering the tight project timeline and Tsukasa's previous familiarity with Web Forms. Now Tsukasa is working on porting the application to ASP.NET Core for an improved online user experience. Another advantage of upgrading to ASP.NET Core is this will enable hosting the application on Linux, macOS, and Windows servers. (ASP.NET Web Forms is bound to just Windows.)

Tsukasa Consulting also now evaluates the possibility of using TatukGIS support for hydrology-related functionality to offer its Japanese customers better flood risk simulation and preparedness possibilities.

TatukGIS Hydrology Toolset

The TatukGIS Hydrology Toolset provides a set of hydrology modeling and analysis features most often used in the development of water resource-related applications. From raw Digital Elevation Model source data, Hydrology Toolset functionality calculates the slopes, water flow directions, flow accumulations, basins, watersheds, and a topologically correct model of the steam order. The Toolset can convert calculated stream topology into vector polylines and basins/watersheds into vector polygon areas, which can be used for sophisticated, networked flood simulation scenarios.

The hydrology modeling functionality is just one of roughly 750 classes comprising the DK library's comprehensive API.

Tsukasa Consulting

Tsukasa Consulting, located in Osaka, Japan, began using TatukGIS SDK products for its GIS development work more than 10 years ago. It has used the DK for Delphi edition with VCL and FMX frameworks to develop several custom desktop, client-server, and mobile GIS applications for Japanese government customers.

These applications run mostly on Windows or MacOS desktop computers or iOS iPad devices. Tsukasa's applications developed using the DK include a cadastral-urban planning-related mapping application used by Japanese municipal governments on Mac computers and iPads, a field survey iPad mapping application used by municipal governments, and a mapping the application used for the massive radioactive decontamination work performed in regions affected by the Fukushima Daiichi nuclear power plant accident. More recently Tsukasa Consulting turned to the DK for ASP.NET edition for web GIS development projects. In partnership with a U.S.-based partner (also a TatukGIS customer), Tsukasa used the DK for ASP.NET to develop a sophisticated web server application offering spatial presentation and analysis of extensive U.S. Federal economic and demographic statistical data sourced from the U.S. Census Bureau, U.S. Bureau of Labor Statistics, U.S. Bureau of Economic Analysis, and other sources. It can be said that Tsukasa Consulting is an ambassador of TatukGIS technology in Japan.

TatukGIS Development Libraries

TatukGIS Developer Kernel (DK) is a set of established software development libraries providing a comprehensive API for custom geospatial development. The DK platform is file format and database engine agnostic and orientated to industry standards. Native support for more than 70 geospatial industry formats is compiled into the DK library and dozens more formats are supported via external drivers. Support is available for advanced spatial database layer formats. Each format is supported to the fullest extent possible, limited only by lack of sufficient publicly available documentation for some proprietary formats.

With TatukGIS software, there is no proprietary or internal data format, which allows customers the freedom to use whatever data formats and storage works best for them.

Figure 3: Water flow directions calculated from a DEM layer.

The TatukGIS DK can represent an interesting economic opportunity for developers migrating from other GIS vendors or technology. The DK is licensed free of deployment royalties or run-time fees, the only cost being the perdeveloper license fee. As a true SDK, DK-developed applications can be creatively customized in ways that can stand out from products based on a different technology. DKdeveloped applications tend to be highly efficient and, therefore, do not demand costly dedicated or state-of-the-art hardware. All considered, these economic advantages offer the potential to significantly reduce the all-in cost of application development to deployment, offering developers greater independence and flexibility on pricing strategy.

Another advantage of the DK library is its availability as multiple product editions, each edition designed for a different development platform, e.g., .NET, ASP.NET, Delphi, Java, Python, and even ActiveX. On all these platforms, the DK runs natively. This means, for example, a DK application developed in Java is a fully native Java bytecode .jar file, so not just a wrapper. DK editions for all platforms share essentially the same API and development logic. Migrating, for example, from Java to .NET is much easier than anyone might expect because the whole experience, logic, algorithms, etc., can be reused in .NET. Using Delphi, migrating an application between operating systems, or deploying an application to multiple operating systems, is even easier. In most cases, porting a DK Delphi FMX Framework developed Windows desktop GIS application to iOS or Android is a matter of just recompiling the same app for all platforms. iOS and Android mobile GIS applications, using efficient on-device data storage, can run also in off-line mode and provide functionality comparable to a normal desktop application.

The same DK API is available also on the TatukGIS end-user product, the desktop TatukGIS Editor. The Editor's built-in Python scripting environment exposes the entire DK API, making it a perfect tool for prototyping or even constructing full-fledged applications, but with the advantage that development starts at the level of a well-designed and tested, general-purpose desktop GIS application.

Tsukasa Consulting's experience with the DK offers an excellent example. In earlier years it worked mostly with the DK for Delphi edition with FMX to develop GIS applications for Windows and macOS desktop computers and iOS (iPad) devices. As evidenced by the Flood Hazard application, in more recent years Tsukasa leveraged the knowledge gained with the DK for Delphi to create web applications using the DK for ASP.NET edition. The DK can be very interesting for companies using more than one development language/platform, or that appreciate having the flexibility to potentially migrate in an efficient manner at some time in the future to a different language or platform, as technologies evolve.

TatukGIS's strategy for supporting technologies is, in most cases, a long-term commitment. When valuable for customers, TatukGIS is known to continue supporting legacy technologies. Continuing support for ActiveX benefits developers forced to continue using older development technologies that ActiveX supports. Though TatukGIS supports the more modern ASP.NET Core (MVC) Framework for web GIS development, it also still supports ASP.NET Web Forms which is limited to .NET Framework (i.e., not available on ASP.NET Core). Tsukasa Consulting's success with the Flood Hazard web GIS application is proof that ASP.NET Web Forms, in some cases, remains a valuable option for creating web GIS sites in a fast and intuitive way. The built-in DK functionality is vast, with roughly 750 classes providing support for vector and raster data editing, viewing, printing, querying, analyzing, exporting, data classification, statistics, routing, geocoding, on-the-fly layer coordinate system conversion, raster algebra, Fresnel zones, viewshed analysis, grid analysis, interpolation, heat maps, Kriging, triangulation, hydrology calculations, extensive symbology, 3D visualization, and much more.

More information about Reservoir Hazard Map and Disaster Prevention resources is available on the Higashihiroshima City website at:

https://www.city.higashihiroshima.lg.jp/bosai/10/36731.html



Figure 4: Topologically correct stream flows converted from raster to vector polylines and watersheds and basins from raster to vector polygons.



National Land Cover Monitoring System: Helping Nepal Manage Its Landscapes For Climate Action

By Sajana Maharjan Remote Sensing and Geo-information Analyst ICIMOD

and cover maps represent spatial information on different types of physical coverage of the Earth's surface, including cropland, forests, grassland, lakes, and water bodies. They help us understand our landscapes and the changes they undergo over time. By using land cover maps, we can draw fascinating insights for navigating urban growth, identifying areas for conservation efforts, conducting food security planning and assessments, and managing our natural resources. Accurate land cover data provide critical base data for studies that use carbon stock, climate, hydrological, species distribution, and dynamic vegetation models. Findings from such models using land cover data help policymakers decide on further landscape management and planning. Crucially, data from Nepal's National Land Cover Monitoring System (NLCMS) were used to set the targets for the Second Nationally Determined Contribution (NDC) submission to the United Nations Framework Convention on Climate Change (UNFCCC) in line with the Paris Agreement. These data are fundamental to recognizing and achieving long-term goals related to Nepal's climate action plans. Nepal's Long-term Strategy for Net-zero Emissions also relies on land cover information - including forest, other wooded land, and land cover change information - based on NLCMS data.

Background

Historically, Nepal has seen several land cover mapping studies at multiple levels and scales. These studies were often one-off project-specific interventions that used different methodologies and did not prioritize temporal consistency. While most results from the mapping studies are publicly available, they are not comparable as they do not use a consistent method or classification scheme and use different scales; some studies have a regional focus, and very few studies capture the entire national landscape. This hindered any assessment of land cover dynamics and their practical applications in Nepal. Nepal's NLCMS offers to change this.

The National Land Cover Monitoring System

Using publicly available satellite imagery, the NLCMS uses a robust methodology to provide annual land cover data for the entire country. The system capitalizes on the cloud computing capabilities of the Google Earth Engine (GEE) platform, an online platform that catalogs, processes, and stores Petabytes (one petabyte is equal to 1,000 Terabytes) of publicly accessible satellite imagery. GEE allows the scientific analysis and visualization of large data series of satellite imagery.

Collaborative Development of the NLCMS

SERVIR-Hindu Kush Himalaya, a joint initiative of the United States Agency for International Development (USAID), the National Aeronautics and Space Administration (NASA), and the International Centre for Integrated Mountain Development (ICIMOD) collaborated with Nepal's Forest Research and Training Centre (FRTC), the nationally mandated agency for forest cover data, to develop an operational NLCMS for Nepal. Together, we organized multiple stakeholder consultations with government, nongovernmental, and research institutions to understand and identify land cover needs for Nepal. These consultations helped us determine and agree upon the different land cover classes for the country.

The NLCMS is a customized offshoot of ICIMOD's Regional Land Cover Monitoring System (RLCMS), which provides spatially seamless and temporally consistent annual land cover information and maps for the Hindu Kush Himalayan (HKH) region. We collaborated with the Asian Disaster Preparedness Center (ADPC), the Global Land Analysis and Discovery (GLAD) group at the University of Maryland (UMD), the United States Forest Services (USFS), SilvaCarbon, and multiple partners in ICIMOD's regional member countries to develop the system.

Customisation and Stakeholder Engagement

The beauty of the NLCMS lies in its customization ability, high flexibility, and capacity to meet the diverse needs of multiple stakeholders. Countries follow different definitions of forests, particularly the threshold for crown cover percentage. The primary focus was on co-developing NLCMS through stakeholder engagement and partnerships, which has multiple benefits. This approach helps build partners' confidence in the data generated and the system, whilst the ICIMOD team strengthens their knowledge of the methodology and technical aspects of the system. FRTC played a crucial role in generating land cover maps, including identifying land cover classes for the country, data collection, classification, accuracy assessment, and field validation. This led to greater uptake of the system by FRTC. This experience has helped FRTC to continue producing land cover maps regularly.

During the development of the system, we focused on flexibility, the adoption of a consistent and transparent methodology, the use of open-source remote sensing data, explicit quantification of uncertainty in the results, and knowledge transfer to key stakeholders.

Methodology

Data Sources and Pre-Processing

We used the Land Cover Classification System and associated tools of the Food and Agriculture Organization of the United Nations (FAO) to determine land cover typology. On the GEE platform, we chose Landsat satellite imagery to generate land cover data, using data from the historical archive which is freely available to download from several data portals. This extensive historical library provides valuable data to understand land cover changes and trends which allowed us to develop annual land cover maps for Nepal from 2000 onwards.

We collected reference data using the Collect Earth Online (CEO) software tool that allows viewing and interpreting high-resolution satellite imagery. CEO leverages opensource satellite data and enable users to analyze satellite images to classify them into different land cover types. We used this data to train models and accurately assess the generated land cover maps.



Figure 1: Flowchart of workflow.

We pre-processed Landsat satellite images to account for solar illumination and other topographic and atmospheric effects. We then prepared annual composites for each year (2000–2019), consolidating all satellite imagery available for a particular year. Each composite layer also consists of covariate layers such as normalized difference vegetation index (NDVI), snow and built-up index, and the different image bands. We could not prepare annual land cover composites for 2012 as Landsat satellite images are not available for that year.

To generate land cover primitives, we used the Random Forest algorithm (a commonly used machine learning classification algorithm that uses outputs of several decision trees to improve prediction). Primitives are probability layers, i.e. each pixel in a primitive denotes the probability of representing a particular biophysical feature. Nine land cover data layers - bare rock, bare soil, cropland, built-up, tree, water, snow, grassland, and riverbed - are included here. We then carried out temporal smoothing to minimize data noise and make the data temporally consistent.

We incorporated additional layers such as tree height and tree canopy cover from the GLAD group at UMD, ICIMOD's in-house data on glaciers and glacial lakes, built-up layers from the open street map, and global nightlight data in the assemblage to produce an annual land cover map for the entire country. We used a decision tree classifier to accommodate this step, carried out accuracy assessments for 2019, and conducted field validation with FRTC. The flowchart depicting the overall methodology is included in Figure 1.

Outreach and Results

FRTC launched the NLCMS for

Nepal on Earth Day, April 2022. Data generated by the NLCMS are available for download from ICIMOD's Regional Database System (Figure 3). A detailed look into the technical aspects of the system development is available in an open-access technical report published by the FRTC.

NLCMS results show that forests make up a majority of Nepal's land cover, followed by cropland and grassland. From 2000 to 2019, forests increased in the country by 1.7%. In the same period, cropland decreased by 2.1% and built-up areas increased by 0.36%.

Nepal's Ministry of Forests and Environment (MoFE) and the

Other land cover types (snow, bare rock, other wooded land, glacier, riverbed, built-up, water body, and bare soil) comprise approximately 20% of the country's total land cover. The overall accuracy of the land cover data generated for the 2019 map is 84.80%. Figure 4 shows land cover information for Nepal's Terai region.

Several pieces of literature have mentioned that, although remote sensing is an efficient and effective tool for monitoring mountain environments, the complex topography in high mountain areas still poses challenges. The rugged topography, resulting from steep slopes, rough surfaces, shadows, and the presence of rocks and bare soil, affects the illumination of the surface, which results in energy redistribution. This leads to radiance differences received by passive sensors for the same land cover class on different slopes and aspects. Even though Nepal has a rugged and complex topography, we achieved promising results. This is because we accounted for atmospheric and topographic corrections and developed composites, consolidating all the images available for a particular year together with several covariates.

Use Cases and Impact

The national land cover data are being used for a range of uses across different departments in Nepal. As mentioned above, Nepal's MoFE has used NLCMS data to set the targets for the Second NDC submission to the UNFCCC in line with the Paris Agreement. Importantly, details of Nepal's second NDC were featured by the UN as an 'NDC of note' specifying the country had made "strong advances in using data and evidence for setting clear short and medium-term emissions targets."



The FRTC has used the data to map forest degradation in the

Figure 2: NLCMS application to access data at different levels; there are options to generate land cover maps and graphs at province level and physiographic region of Nepal.

Terai Arc Landscape. The information is being used to meet an agreement with the World Bank's Forest Carbon Partnership Facility (FCPF). REDD+ ('reducing emissions from deforestation and forest degradation in developing countries') is the voluntary climate change mitigation framework developed by the United Nations Framework Convention on Climate Change, UNFCCC. The REDD+ Implementation Centre in Nepal under the MoFE has finalized its activity data using NLCMS data for national and international reporting, ultimately contributing to climate change mitigation action.

Using NLCMS data, the Government of Nepal is also setting the reference level for three provinces to meet a carbon trading agreement with the Lowering Emissions by Accelerating Forest Finance (LEAF) Coalition. In addition, projects such as 'Building a Resilient Churia Region in Nepal (BRCRN)' are using NLCMS data to set baseline conditions for 26 river systems in the Churia region and will be used further for monitoring.

Students and universities are also using the data in their research activities. To date, data downloads have reached 1453 times by 815 unique users.

Limitations and Way Forward

NLCMS is an operational system being developed to address the demand and bridge the data gap in Nepal. It has used state-of-the-art methods whilst keeping the option for flexibility to adopt evolving technologies and address the needs of stakeholders. The physiographic zones from the Middle Mountains to the High Himalayas have a smaller and more fragmented land cover. In this context, there is a high chance of loss of information on land cover in these zones, as the system uses Landsat images and a minimum mapping unit of 0.5 hectares. Sample-based area and uncertainty analysis need to be undertaken to quantify uncertainty and avoid biased estimates of area and changes. Furthermore, research is ongoing to augment the existing NLCMS products through the use of Sentinel-1 Cband radar data in collaboration with the applied science team under the NASA program. The aim is to continue using NLCMS and associated geospatial technologies to generate high-quality landscape data, ensuring that Nepal's future NDCs remain data-driven, and supplying the necessary data for Nepal's Long-term Strategy for Net-zero Emissions. Ultimately, NLCMS is a vital tool for climate action to cut emissions and adapt to climate impacts.

2000	2005	
2010	2015	
2019	Waterbody Glader Snow Forest Riverbed Built-up	Cropland Bare soil Bare rock Grassland Other wooded land

Figure 3: Demonstration of land cover in the southern part of the country for the years 2000, 2005, 2010, 2015, and 2019. We can see deforestation and how built-up is sprawling between 2000 and 2019.





Navigating the Future: The Power of Satellite-based GNSS Augmentation

By Aashi Mishra Sr. Content Writer Research Nester GNSS augmentation system is a technology that improves the performance of Global Navigation Satellite Systems (GNSS) like GPS (Global Positioning System) GLONASS and Galileo. These systems rely on satellite signals to determine the location, speed, and time information of objects on Earth. However, GNSS signals can be affected by factors such as atmospheric conditions signal blockages, and multipath interference. To enhance the accuracy, availability, and reliability of these signals GNSS augmentation systems provide information.

The market for satellite-based GNSS Augmentation

Systems has emerged as a rapidly growing sector within the broader GNSS ecosystem. According to a market report by research nester it is estimated that by the end of 2035, the global revenue for satellite-based GNSS augmentation systems will reach around USD 30 billion with an annual growth rate (CAGR) of 7% during the period from 2023, to 2035. In this article, we explore the dynamics, trends, and potential of this sector dedicated to Satellite-Based GNSS Augmentation Systems.

How Does a Satellite-based GNSS Augmentation System Work?

A GNSS augmentation system that relies on satellite functions by utilizing a network of ground-based reference stations. These stations monitor GPS signals from satellites and transmit correction data to a central control station. The control station processes this data and calculates the required adjustments, which are then transmitted to geostationary satellites. These satellites in turn broadcast the

INDUSTRY

corrected signals back, to Earth enabling precise positioning.

The Wide Area Augmentation System (WAAS) in North America is an instance of a satellite based GNSS augmentation system. It relies on three satellites and a network of more, than 25 reference stations to ensure aircraft navigation with sub meter accuracy. Pilots can effectively navigate through weather conditions by utilizing both GPS and WAAS signals.

Benefits of a Satellite-based GNSS Augmentation System

Satellite-based GNSS augmentation systems offer a range of advantages, including enhanced accuracy, availability, and reliability. By incorporating satellites and ground-based stations to supplement the signals from GPS and other GNSS constellations these systems can provide extremely precise positioning information even in challenging environments like bustling city streets or dense forests.

To illustrate, the aviation industry utilizes satellite-based GNSS augmentation systems to refine approach and landing procedures thereby reducing the risk of accidents and improving efficiency. Similarly, in navigation, these systems aid ships in navigating narrow channels while avoiding collisions with other vessels. Moreover, in landbased applications such as surveying and mapping satellitebased GNSS augmentation systems can furnish accurate location data for construction projects as well, for environmental monitoring purposes.

Types of GNSS Augmentation Systems

- 1. SBAS (Satellite-Based Augmentation Systems): SBAS is a system that utilizes satellites to transmit correction messages aiming to enhance the precision of GNSS signals. Notable examples of systems are the Wide Area Augmentation System (WAAS) in the United States the European Geostationary Navigation Overlay Service (EGNOS) and Japan's Multi-functional Satellite Augmentation System (MSAS). These systems offer measures, for different types of errors including ionospheric delays and satellite clock errors.
- 2. **GBAS (Ground-Based Augmentation Systems)**: GBAS uses reference stations on the ground to send real-time correction data to airplanes improving the precision of satellite navigation, for aviation purposes. GBAS is frequently utilized in aircraft landing approaches and plays a vital role in guaranteeing safe and accurate landings particularly when faced with challenging weather conditions.
- 3. **DGNSS (Differential GNSS)**: DGNSS is a method where a reference station, which has a predetermined position calculates the variation between its known location and the position determined through GNSS signals. This variation, referred to as correction data is



Figure 1: How does a Satellite-based GNSS Augmentation System works.

then shared with users nearby so that they can adjust their GNSS measurements accordingly. This technique finds application in fields such, as surveying, precision agriculture and maritime use cases.

Applications of Satellite-based GNSS Augmentation Systems

Satellite-based systems that augment Global Navigation Satellite Systems (GNSS) find applications in fields, including aviation, maritime, and land-based navigation. In the aviation sector, these systems play a role, in enabling precise approach and landing procedures while also facilitating navigation during flights. For instance, pilots rely on the Wide Area Augmentation System (WAAS) to ensure safe navigation throughout their journey. In navigation, GNSS augmentation systems provide ships with precise positioning information to navigate safely and avoid potential collisions. Similarly, in land-based navigation, these systems are extensively utilized for surveying purposes, mapping activities, and geolocation services.

Precision agriculture greatly benefits from the utilization of satellite-based GNSS augmentation systems. These systems offer farmers the ability to accurately apply fertilizers, pesticides, and water to their crops resulting in increased yields and decreased expenses. Another example is in emergency situations, where first responders can rely on GNSS augmentation systems to swiftly locate individuals requiring assistance. These satellite-based systems have become a part of our society enhancing transportation, communication, and navigation for improved safety and efficiency.

Research Nester

Industry Trends and Innovations

Global Navigation Satellite Systems (GNSS) that rely on satellites have completely transformed the way we navigate and determine our positions. To make accuracy dependability and coverage even better Augmentation Systems for Satellite Based GNSS have emerged as contributors, in the field of navigation technology.

- Multi-Constellation and Multi-Frequency Integration -An important trend in GNSS augmentation is the incorporation of signals from constellations like GPS, Galileo, BeiDou, and GLONASS as well as multiple frequency bands such, as L1, L2, and L5. This integration boosts the reliability of navigation solutions by offering a range of signals to work with minimizing the impact of signal blockages and interruptions. This trend also leads to precision and availability ensuring that navigation systems perform well even in difficult conditions.
- Real-time Data Fusion and Sensor Integration -Combining real-time GNSS data with sensor inputs like inertial sensors, barometers, and cameras is known as real-time data fusion. This integration significantly improves the accuracy of positioning solutions in urban environments with tall buildings and limited satellite visibility. By incorporating Inertial Measurement Units (IMUs) which provide information, on acceleration and rotation navigation solutions can be enhanced when there is a loss of signal.

- Precise Point Positioning (PPP) PPP is a method that allows for accurate positioning using GNSS signals even without relying on a reference station in close proximity. This approach is becoming increasingly popular in fields where centimeter-level precision is crucial, like surveying and geodesy. PPP takes advantage of corrections from networks of reference stations and predictions of satellite orbits making it well-suited for applications, in remote and dynamic environments.
- Integration with Emerging Technologies The potential of integrating GNSS augmentation systems with emerging technologies, like 5G and the Internet of Things (IoT) is enormous. These technologies offer sources of data to improve signal reliability and broaden the range of applications. For instance, in areas, 5G networks can help with accurate positioning while IoT devices can provide real-time environmental data to enhance navigation precision.
- Quantum GNSS Augmentation Quantum technology is leaving its mark in the field of GNSS augmentation. The use of quantum sensors allows for measurements of environmental factors that impact GNSS signals like atmospheric pressure and temperature. Incorporating quantum sensors into augmentation systems can result in improved correction accuracy thereby enhancing navigation precision further.



Figure 2: Types of GNSS Augmentation Systems.

Challenges and Limitations of Satellite-based GNSS Augmentation Systems

One of the hurdles faced by satellite-based GNSS augmentation systems involves dealing with signal interference. This issue can arise due to factors, such as atmospheric conditions obstructions like buildings, and signal reflections. To tackle this challenge certain systems employ antennas and advanced algorithms to filter out unwanted signals and enhance accuracy.

Maintenance also poses a concern for satellite-based GNSS augmentation systems. Regular upkeep and repairs for both satellites and ground stations can be quite demanding and expensive, in remote areas. To address this challenge, some systems are designed with redundancy and backup capabilities. This ensures that if one component fails the system can continue to operate.

Despite these challenges, satellite-based GNSS augmentation systems have demonstrated their value in various industries. By acknowledging and overcoming these obstacles we can broaden the capabilities of these systems in the future.

Future of Satellite-based GNSS Augmentation Systems

The advancements in technology are constantly pushing the boundaries. One exciting possibility on the horizon is the integration of intelligence (AI) into these systems, which could greatly enhance their accuracy and dependability. By analyzing amounts of real-time data AI has the potential to detect and rectify errors in GNSS signals resulting in even more precise navigation and positioning capabilities. Another area where satellite-based GNSS augmentation systems could flourish is in vehicles. As we witness the rise of self-driving cars there will be an increasing demand for accurate and reliable positioning information. These augmentation systems could play a role, in providing such information ensuring that autonomous vehicles operate safely and efficiently on our roads.

Conclusion

The sector of Satellite-Based GNSS Augmentation Systems shows promise for technological progress and business development. These systems have a range of applications in aviation, agriculture, maritime navigation, and other industries. They offer the potential to enhance accuracy, reliability, and safety across sectors. As industries increasingly seek solutions this sector is primed for growth through innovation and strategic partnerships. Moving forward entails overcoming challenges and capitalizing on opportunities to pave the way for navigation experiences in the future.

Source: https://www.researchnester.com/reports/satellitebased-gnss-augmentation-system-market/3882



Subscribe to GIS Resources Magazine To Never Miss an Edition!



BUSINESS

<

June 16 - September 15, 2023

Locana Extends OpenStreetMap Support

Locana has recently announced it is now a member of OpenStreetMap US, a nonprofit organization that helps support and grow the OpenStreetMap (OSM) project. For more than a decade, Locana's team of experts has been actively involved in building OSM by enriching data sets, making map information more detailed and accurate. testing new methodologies for generating location intelligence from OSM data, and contributing in other ways to the OSM community. Locana has also been a pioneer in demonstrating the value of OSM data by using it in innovative applications.

German Start-up Rasdaman GmbH and Airbus Defence and Space Team Up on Datacubes

German Start-up Rasdaman GmbH and Airbus Defence and Space announce a collaboration towards the next generation of Earth Observation exploitation services. centred around spatio-temporal datacubes, to pave the way for a dynamic version of the CopDEM for analytics in the cloud. Airbus Defence and Space produces a time-series of high-quality EO products, such as its **Copernicus Digital Elevation Model** (CopDEM). Recognizing the opportunities coming with datacubes, Airbus Defence and Space is collaborating with Rasdaman GmbH on leveraging them. Combining the leads in satellite data and datacube technology unleashes a whole new avenue of opportunities.

BAE's \$5.6 Billion Purchase of Ball Aerospace Consolidates Military GPS

Recent \$5.6 billion purchase of Ball Corp.'s aerospace division by Britain-based BAE Systems combines two major space and defense companies, it also consolidates two major military GPS players. The purchase, in an all-cash deal, is BAE Systems' largest acquisition in its history. They are getting a Colorado-based space and defense company, Ball Aerospace, that earned about \$1.98 in revenue in 2022.

Turbulent Approval for Autonomous Vehicles in San Francisco

Recently California Public Utilities Commission (CPUC) last week granted GM Cruise and Waymo permission to use roads in San Francisco at all hours and offer paid service much like Uber and Lyft. Previously, the companies had to operate in the city during the night. These included such entities as trade unions, law enforcement, disability groups, residents and others. The groups and residents are concerned that AVs are blocking roads and causing traffic jams that have blocked emergency vehicles.

Côte d'Ivoire is Launching its First Satellite for Earth Observation

Côte d'Ivoire has announced plans to launch its first satellite within the next two years. A team of scientists in the fields of astrophysics and geology tell The Conversation Africa about the potential benefits of this development and how the country plans to realise its space industry ambitions. YAM-SAT-CI 01 will be a nanosatellite for the observation of the Earth. A nanosatellite is a small satellite, weighing from 1kg to 10kg. It will be equipped with a camera which can provide images of the coast, forests, natural parks and urban areas of the country.

World's First High-orbit Synthetic Aperture Radar Satellite Enters Orbit

China's L-SAR4 01 satellite, the world's first high-orbit synthetic aperture radar (SAR) satellite, has entered its operational orbit, the China National Space Administration (CNSA) said on August 21, 2023. The satellite is now in sound condition, with the SAR antenna successfully deployed, and will carry out inorbit testing in the follow-up tasks, said the CNSA. The satellite precisely entered the preset orbit after four orbital maneuvers. said Meng Lingjie, deputy chief designer of engineering at CNSA's Earth Observation System and Data Center. The satellite can also meet the needs of earthquake monitoring, land and resource surveying, and be applied in industries such as marine, water conservancy, meteorology, agriculture, environmental protection and forestry.

Accord announces volume production of new line of GNSS receiver IC's with GlobalFoundries

Accord Software and Systems Pvt. Ltd, a leading provider of Global Navigation Satellite Systems (GNSS) solutions, has recently announced the volume production of Accord's new line of GNSS receiver IC's, the AST-500 "Kaveri" series manufactured with GlobalFoundries (GF). GF is a leading semiconductor manufacturer with locations throughout the world offering a wide range of differentiated process technologies that enable high-performance products across multiple domains and applications.

Deloitte's SpaceTech Report Estimates GNSS Will Grow To \$547 Billion

Deloitte's SpaceTech report, says that GNSS, valued at more than \$220 billion in 2021, is projected to reach \$547 billion by 2031. The report said that as AI improves the capabilities of robotics and autonomous vehicles, associated devices will continue to use GNSS sensors as new use cases arise. However, the report says that LEO alone could see an eightfold increase in today's economic value by 2035 with the right investment and incentivization.

USGIF Welcomes NVIDIA to Its Highest Membership Level

The United States Geospatial Intelligence Foundation (USGIF) is pleased to welcome NVIDIA to its highest membership level, Strategic Partner. NVIDIA will join more than two dozen other member companies at this level in advancing geospatial intelligence to help address challenges in a variety of fields.

Point One Expands Footprint in Europe With Septentrio

Point One Navigation, based in San Francisco, and its European partner Septentrio have made its GNSS locating services available throughout the continent. For Septentrio receivers that are compatible, Point One Navigation is offering access to their Polaris RTK network and Sensor Fusion. Markets with fierce rivalry, such as industrial autonomy, precision agriculture, logistics, and autonomous vehicles, are being pursued by the corporations in Europe.

Hexagon Equips the World's First Fully Autonomous Road Trains

Hexagon has recently announced a landmark agreement with leading diversified mining company Mineral Resources (MinRes) to provide an autonomous haulage solution for a fleet of 120 fully autonomous road trains in Australia, which will transform safety, productivity and sustainability in the region. The world-first, fully autonomous road trains are a full-site, truck-agnostic solution. The addition of unmanned and autonomous systems will form an essential part of the supply chain for the MinRes Onslow Iron project in Western Australia's Pilbara region.

HERE data Chosen by Majority of Automakers for their EU Intelligent Speed Assistance Solution

The European Union's (EU) Intelligent Speed Assistance (ISA) regulation has been in effect since July 2022, and an overwhelming majority of automakers have selected the HERE ISA Map for their solutions to comply with the regulation. ISA is an in-vehicle system that leverages speed limit data to inform, warn and discourage drivers from exceeding the statutory limit on any given EU roadway.

Fathom Revolutionizes Flood Risk Intelligence With New US Flood Map

Fathom, a global leader in water risk intelligence, has released a new US Flood Map; a cutting-edge tool that provides the most comprehensive climate-driven flood risk information for the US. Responding to the inconsistent and incomplete coverage of existing datasets, the US Flood Map leverages the latest observation, terrain and climate information to present a consistent view of flood risk for all major flood perils, climate scenarios and time horizons. Thanks to its team of scientists, Fathom's US Flood Map offers the most advanced hazard and risk information for the country, at 10m resolution. Fathom's US Flood Map empowers engineers, climatologists, GIS professionals and asset owners and operators to make swifter, more informed decisions for their projects at pace and with confidence, using this comprehensive resource.

Successful Integration of the *RIEGL* VQ-840-G Topo-Bathymetric Laser Scanner into the Schiebel CAMCOPTER® S-100 UAS

RIEGL Laser Measurement Systems GmbH and SCHIEBEL has successfully completed the integration of a high-end laser scanning system, the RIEGL VO-840-G topo-bathymetric LiDAR sensor, on the Schiebel CAMCOPTER® S-100 Unmanned Air System (UAS). Operating a high-end laser scanning system remotely on an Unmanned Air Vehicle (UAV) requires a tailored solution going beyond what is currently available off-the-shelf. In order to maintain the broad operating range of the UAS, it is imperative to keep the weight of the sensor payload low. In addition, the effective execution of the survey mission requires full remote control of the payload instruments and real-time feedback to the operator via a data link.

Hexagon Releases Cloud Solution for Utilities and Telecoms Geospatial Asset Management

Utilities and telecommunications companies looking to modernize asset management can benefit from HxGN Networks in the cloud, a software-as-aservice (SaaS) offering from Hexagon's Safety, Infrastructure & Geospatial division. HxGN Networks in the cloud is the only fully managed, SaaS geospatial asset management solution for utilities and communications. In addition to providing all features and functions of the on-premises HxGN Networks suite, the cloud-based solution includes hosted IT infrastructure as well as preventive and corrective maintenance services, which allow companies to reduce capital expenditures.

Google Might Make \$100 Million by Selling Map Data to Renewable Energy Firms

According to CNBC, Google hopes to generate \$100 million by licensing mapping data to renewable energy providers. According to a document seen by CNBC, the company will sell access to APIs containing solar and energy information such as air quality. As reported by CNBC, the mapping data would be integrated into new products by renewable energy businesses. According to CNBC, the company's total income in its first year is estimated to be between \$90 million and \$100 million.

Cesium Supports NVIDIA's Earth-2 Initiative

Cesium was featured in a recent keynote given by NVIDIA founder and CEO Jensen Huang on climate research at the Berlin Summit for the Earth Virtualization Engines (EVE) initiative. EVE strives to provide high-fidelity actionable climate information at local granularity, globally, via a scalable digital infrastructure to catalyze a change in the broader ecosystem of climate data and services and deliver a just, equitable, and scientifically grounded basis for action.

Industry Leaders Satellogic and SkyWatch Partner to Increase Access to Timely Earth Observation Data

Satellogic Inc. has announced at World Satellite Business Week, their partnership to bring Satellogic's highest resolution commercially available EO data to EarthCache customers. Satellogic's EO data is now available via SkyWatch's EarthCache platform. EarthCache provides an intuitive interface and robust API that enables customers to browse archive data, as well as task new satellite imagery by using a variety of criteria. SkyWatch's core mission is to make remote sensing data accessible, affordable, and standardized. Satellogic is working toward the goal of delivering daily global remaps. The company designs, manufactures, and operates its own constellation of high-resolution EO satellites.

Thales Alenia Space Signs \$334 Million G2G Contract

Thales Alenia Space has signed a \$334 million contract with the European Space Agency (ESA) to build the Galileo Second Generation (G2G) Ground Mission Segment and system engineering activities. The contract, which include Leonardo and Telespazio, call for a first version of G2G to be in operation to support the launch and Early Orbit Phase (LEOP) of the first new generation satellite. Approximately 12 satellites will be launched in the next few years that offer better flexibility, security and infrastructure than the previous generation, the company said.

Septentrio Collaborates with Xona on PULSAR GNSS Receiver

Septentrio, a leader in high-precision GNSS solutions, has been collaborating with Xona Space Systems to develop an experimental receiver which is compatible with Xona multi-frequency PULSAR™ signals. This multi-frequency receiver that supports Xona's ground breaking LEO PNT signals, will be one of the first to decode all PULSAR™ signals in parallel with other standard GNSS signals. This makes it ideal for testing Xona's upcoming LEO-PNT constellation in a simulated environment, since live signals are not yet available.

Hawkeye 360 Receives \$58 Million in Series D-1 Funding To Introduce a New Satellite Architecture and Accelerate Data Science Efforts

HawkEye 360 Inc., the world's leading defense technology company for space-based radio frequency (RF) data and analytics, has announced it has closed \$58 million in new funding. The funding will be used to develop new space systems and expand analytics that support high-value defense missions.

Spire Global Extends Contract with NASA for Earth Observation Data

Spire Global, a global provider of space-based data, analytics, and space services, announced a \$6.5 million, 12-month contract renewal with NASA's Commercial Smallsat Data Acquisition (CSDA) Programme. The contract is for \$500,000 more than the previous award of \$6 million in June 2022. Spire will continue to provide the Agency with its extensive catalogue of Earth observation data, related metadata, and ancillary information from its fully deployed satellite network.

Hawkeye 360 Working with the Pacific Islands Forum Fisheries Agency for Greater Maritime Visibility in the Pacific Islands

HawkEye 360 Inc., has announced it has been awarded a contract by the Commonwealth of Australia for a pilot program to provide greater maritime domain awareness in support of Pacific Islands Forum Fisheries Agency (FFA) efforts to detect and prevent Illegal, Unreported, and Unregulated (IUU) fishing. The contract was awarded by Australia's Department of Foreign Affairs and Trade (DFAT) for the provision of HawkEye 360's satellite RF maritime analytics and training through 2023.

Mapbox Raises \$280 Million From Softbank

Mapbox has completed a \$280 million Series E fundraising round spearheaded by SoftBank Group in order to grow its AI location services and reach into automotive industries. The additional cash, according to the company, will speed its attempts to bring AI to automobiles, particularly with new ADAS technologies for automatic driving.

Umbra and UP42 Partner Up for Land Monitoring

Umbra and UP42 announced their collaboration in a combined video released at the World Satellite Business Week conference. Umbra's industryleading highest-resolution SAR data is now available through the UP42 marketplace. Synthetic aperture radar (SAR) satellites have the unique capacity to monitor change by recording images at night, through cloud cover, smoke, and rain. Critical applications such as monitoring floating oil lid inventory, deforestation, mining, cargo ports, and changes in land use will benefit from UP42 access.

AWS and ISRO Partner to Accelerate India's Space-Tech Innovations

AWS India Private Limited has formed a strategic alliance with the Indian Space Research Organisation (ISRO). Amazon India announced this strategic relationship, expressing its goal of empowering space entrepreneurs, research institutions, and students with cutting-edge cloud technology, hence assisting in the acceleration of creative solutions in the space domain. The collaboration is intended to strengthen India's rapidly rising space sector. AWS' cloud computing educational offerings, along with ISRO's deep knowledge in space technology, are intended to inspire future generations to pursue job prospects in India's thriving space sector.

PRODUCT LAUNCH

June 16 - September 15, 2023

Septentrio Timing GNSS Module Supports Fugro AtomiChron

Hemisphere GNSS announces its nextgeneration multi-frequency, multi-GNSS A631 GNSS smart antenna. The all-new A631 is a complete redesign of the previous generation version (AtlasLink) and offers added benefits and value to an already impressive range of features and functionality. The A631 smart antenna processes and supports over 800 channels with flexible and scalable simultaneous tracking of every modern and planned GNSS constellation and signal including GPS, GLONASS, BeiDou (including Phase 3), Galileo, QZSS, IRNSS, SBAS, and Atlas® L-band. The A631 is powered by Hemisphere's recently announced nextgeneration Lyra[™] II digital ASIC, Aquila[™] wideband RF ASIC, and Cygnus™ interference mitigation technology.

Victoria Hospital Launches First Indoor Navigation Tool

Through the hospital-wide rollout of Australian digital wayfinding system, BindiMaps, Peter MacCallum Cancer Centre has become the first hospital in Victoria to offer accessible digital wayfinding for patients, employees, and visitors. The newly installed service was designed specifically to work indoors with 10 to 20 times greater accuracy than GPS can provide for indoor settings.Satellites and GPS, for example, can only pinpoint location to about 20 metres and are frequently imprecise indoors, compared to the 1-2 metre accuracy that BindiMaps provides.

GeoCue Announces Drone LiDAR and Mobile Mapping System

he new TrueView 680 LiDAR and 3D Imaging Payload attached to a heavy payload drone, touched down in the testing area collecting aerial data of the GeoCue headquarters. A drone pilot approaches the system, quickly removes the sensor from its quick release, and hands it off to a colleague. Within 15 minutes the TrueView 680 was securely locked into position on the small SUV and ready for mobile mapping duty.

New Trimble GNSS Receiver with Trimble ProPoint Delivers Survey Precision and Productivity in the Field

Trimble has recently introduced the new Trimble® R580 Global Navigation Satellite System (GNSS) receiver, the next generation in its portfolio of Trimble ProPoint® GNSS positioning engine enabled receivers. The system's survey-grade GNSS performance enables professionals in surveying, mapping and Geographic Information System (GIS), civil construction and utilities to guickly and easily capture centimeter-level positioning and boost productivity in the field. With the field-proven Trimble ProPoint GNSS engine on board, users can measure points in challenging environments, such as under tree canopy or near buildings, while Trimble EVEREST[™] Plus technology can identify and remove unwanted multipath signals for improved accuracy and data confidence.

Avenza Releases MAPublisher 11.2 for Adobe Illustrator

Avenza Systems Inc., is pleased to announce the release of MAPublisher® version 11.2 for Adobe Illustrator®. This version comes with the brand-new Vector Basemaps tool and includes additional performance enhancements and bug fixes. MAPublisher cartography software seamlessly integrates more than seventy GIS mapping tools into Adobe Illustrator to help you create beautiful maps from geospatial data.

3D Machine Control Compatibility Option from Leica Geosystems Now Available for Caterpillar NGH Excavators

Leica Geosystems, part of Hexagon, has announced the commercial availability of the Leica MC1 3D machine control system with Caterpillar factory-installed NGH sensors. The first customers of this new compatibility option have already experienced the streamlined installation process of the Leica MC1 system into Caterpillar's existing Grade 2D Assist excavator system with the support of Leica Geosystems and Caterpillar dealers. The enhanced interoperability between the Leica MC1 3D machine control solution and Caterpillar's NGH sensors offers various benefits for construction professionals and operators.

GEO EVENTS

October 15 - 18, 2023 Fall Northeast Arc Users Group (NEARC)

Omni New Haven, CT, USA https://www.northeastarc.org/springnearc.html

October 16 - 19, 2023 GIS-Pro 2023 Columbus, OH, USA https://www.urisa.org/gis-pro

Octopber 16-19, 2023 GeoSmart India 2023 Hyderabad, India https://www.geospatialworld.net/event/ geosmart-india-2023/

October 23 – 25, 2023 FOSS4G North America Baltimore, MD, USA http://www.gistc.com/en/

October 23 – 27, 2023 Texas GIS Form Austin, TX, USA https://tnris.org/texas-gis-forum/2023/

November 27 - December 1, 2023 2023 Pacific GIS & Remote Sensing User Conference Suva, Fiji https://www.pgrsc.org/

February 11 – 13, 2024 Geo Week Denver, CO, USA https://www.geo-week.com/

May 2 - 4, 2024 GISTAM 2014 Angers, France https://gistam.scitevents.org/

The Next Big Issue

Subscribe to Our Quarterly Magazine and never miss another issue again.



For enquiry, write us at support@gisresources.com

GISTAM 2024

10th International Conference on Geographical Information Systems Theory, Applications and Management

Angers, France 2 - 4 May, 2024

The International Conference on Geographical Information Systems Theory, Applications and Management aims at creating a meeting point of researchers and practitioners that address new challenges in geo-spatial data sensing, observation, representation, processing, visualization, sharing and managing, in all aspects concerning both information communication and technologies (ICT) as well as management information systems and knowledge-based systems. The conference welcomes original papers of either practical or theoretical nature, presenting research or applications, of specialized or interdisciplinary nature, addressing any aspect of geographic information systems and technologies.

Data Acquisition and Processing Remote Sensing Interaction with Spatial-Temporal Information Spatial Data Mining Managing Spatial Data Modeling, Representation and Visualization GIS and Climate Change Domain Applications

Conference Areas

REGULAR PAPER SUBMISSION: DECEMBER 13, 2023

POSITION PAPER SUBMISSION: JANUARY 25, 2024



MORE INFORMATION AT: HTTPS://GISTAM.SCITEVENTS.ORG

