ASSOCIATION OF GEOSPATIAL INDUSTRIES

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From the President's Desk

Global issues like climate change, inconsistent supply chains, and limited access to information and financing have resulted in major changes to the world's food systems. The solution lies in targeted technological solutions through the digitalization of agriculture. Constant digital advancements can also improve the monitoring, management, and allocation of resources in agricultural systems.

Geospatial solutions have an integral role to play as part of the roadmap to a transformative adaptation in agriculture. The collection and analysis of real-time and predictive data will help millions of farmers in India, and the geospatial sector must animate these promising directions.

Globally, farmers are successfully managing their agricultural productivity and making crop predictions using Geospatial tools and other cutting-edge technologies. Additionally, they are employing it to visually analyze agricultural environments, land resources, and workflows to ascertain how to maximize profit while protecting soil fertility.

The time-series study of agricultural crops and soil factors has gotten simpler and quicker because of the accessibility of open-source satellite imagery. Geospatial technology is also transforming global logistics and supply chain management. This helps track products, maintain visibility, recommend optimum and alternate routes, and manage inventories better, benefitting the agriculture supply chain as well.

Using precision agriculture techniques, producers can choose how best to allocate resources for both small- and large-scale farms. The integrated strategy involves the use of drones, LiDAR, SAR data, and other instruments for mapping and tracking every aspect of agricultural productivity.

Despite the pandemic, agriculture was one of the only sectors to have clocked positive growth, thanks to the resilience offered by technological interventions. The Association of Geospatial Industries, which has served as the voice of the Indian geospatial industry for the past 13 years, applauds such noteworthy advancements in digital agriculture in India.

As a thought leader encouraging the greater application of geospatial information in the nation, we are pleased to see the consistent penetration of geospatial technologies in the agriculture sector. We present this year-end issue of our newsletter along the same lines, as a thorough analysis of the value and potential of geospatial technologies in Indian agriculture.

I hope this Edition comes across as insightful and enjoyable. Stay tuned for more insights, stories, and analyses from AGI in the coming months.

Enjoy Reading!

Pramod Kaushik
President, AGI

In this Issue

A digital ecosystem will boost scalability, inclusivity, community involvement, reliability, correctness, and updates while retaining cost and time effectiveness

Technology is essential to good governance, as are the innovations it supports, notes **Mr. Sonmoni Borah, IAS, Joint Secretary, Department of Land Resources, Ministry of Rural Development**

Please tell us about the land administration system in India and how The Digital India Land Records Modernization Programme (DILRMP) and its initiatives lend to ease of land governance in our country.

Historically, India inherited different land systems and different practices of land records management system with asymmetrical practices, un-surveyed records, and measurement units in the States. Some States in the North-eastern Region have land systems based on customary laws and even have land governing systems administered by traditional village chiefs.

This widespread asymmetric standardization and record-keeping have caused issues such as multiplicity, inconsistency, inaccuracy, or even a complete lack of data, which trickled down to other sectors of governance, planning, and development. Therefore, the diversity in land governance and land records system required a major programmatic intervention to ensure computerization and digitization to make the system transparent and robust for delivery of various schematic benefits of the Government Schemes and Programmes.

The oldest cadastral maps in India are more than 100 years old and were first created using a distinct spatial reference frame. For cross-checks and resurvey operations, the current physical reference sites or survey monuments that represent the previous spatial reference frames used for preparing the maps are difficult to locate as it was as old as the cadastral maps were prepared. The previous survey records and auxiliary traverse records are also not easily accessible. This makes it difficult to geo-reference existing records without resurveying.

THE PREVIOUS SURVEY RECORDS AND AUXILIARY TRAVERSE RECORDS ARE ALSO NOT EASILY ACCESSIBLE. THIS MAKES IT DIFFICULT TO GEO-REFERENCE EXISTING RECORDS WITHOUT RESURVEYING.

The Government of India strongly felt the need for comprehensive land records modernization in the country to solve these challenges. This was possible only with the help of a unified, reliable, and real-time land records information and management system, which we have established with the flagship Digital India Land Records Modernization Programme (DILRMP) as a Central sector Scheme from 2016 with 100 % financial support to States/ UTs in the permissible components and activities.

With the help of cutting-edge hybrid survey methodologies, including the use of High-Resolution Satellite Images (HRSI) followed by Ground Truthing / Survey using Differential GPS (DGPS) and Electronic Total Station (ETS), the DILRMP has started converting old land records into a new digital format with geo-referencing.

As we celebrate Azaadi Ka Amrit Kaal, substantial progress has been achieved under the different components of the scheme e.g., computerization of record of rights (RoR) has been completed in 620,363 villages (94.45 %) out of a total of 6,56,792 villages, out of 5,255 Sub-Registrar Offices in the country, 4,905 (93.34 %) have been computerized and out of 16,664,385 Maps / FMBs in the country, 11,738,345 Maps /FMBs (68.26%) have been digitized.

We can connect the entire country, except one or two States, and all of the land records are now almost

entirely digital and accessible on a single platform. So, we're aiming to integrate all of India's land records database onto a single platform uniformly.

What opportunities is the DILRMP initiative opening for different stakeholders?

The Department of Land Resources, Ministry of Rural Development, Government of India, has envisaged the Digital India Land Records Programme (DILRMP) as a significant system and reform endeavour for India's land administration and governance. The program was revamped as part of the "Digital India" flagship initiative by the Government of India, to capitalize on the similarities found in the field of land records across States/UTs for state-specific yet comprehensive solutions.

The major components of DILRMP include:

- Computerization of land records
- Digitization of Cadastral Maps/ FMBs and their linkage with RoR
- Computerization of registration
- Survey/resurvey and updating of the survey and settlement records
- Modern record rooms and/or land management centres at the Tehsil level
- Training & capacity building, IEC, and Evaluation Studies
- Consent-based linkage of Aadhaar with Record of Rights
- Computerization of Revenue Courts

THE PROGRAM WAS REVAMPED AS PART OF THE "DIGITAL INDIA" FLAGSHIP INITIATIVE BY THE GOVERNMENT OF INDIA, TO CAPITALIZE ON THE SIMILARITIES FOUND IN THE FIELD OF LAND RECORDS ACROSS STATES/ UTS FOR STATE-SPECIFIC YET COMPREHENSIVE SOLUTIONS.

Further, Department has also taken several innovative initiatives to empower citizens, facilitate ease of living for the people and Ease of Doing Business for the prospectors. These initiatives inter alia include:

(i) **Integrated Land Information Management System (ILIMS)** to integrate the information related to land including linkage with banks to facilitate credit facility to land owners,

(ii) **E-Registration or the National Generic Document Registration System (NGDRS)** that provides an option to the prospectors to submit documents online for registration and take online appointment which ultimately results in reducing the compliance burden on account of reduced time, cost, processes and physical visits, etc, apart from taking benefit and advantage of other inbuilt modules in the system

(iii) Similarly, **Bhu-Aadhar or Unique Land Parcel Identification Number (ULPIN)** was conceptualized and now being adopted by 24 States /UTs. In this system, a 14-digit – Alpha-numeric unique ID is assigned a land parcel based on the vertices of the coordinate of the land parcel. The system is of International Standard and meets Electronic Commerce Code Management Association (ECCMA) and Open Geo-Spatial Consortium (OGC) standards,

(iv) Another initiative of the Department in the pipeline is to facilitate States /UTs to have **land records in all 22 languages** mentioned in the Constitution of India to remove the linguistic barrier. This is being done in association with C-DAC and pilot field tests are underway in 8 States/ UT and ready to be rolled out now; and

(v) **Inter-linking of the e-Court System of the Civil Courts with land record database** and registration has also taken off in collaboration with Department of Justice, e-Court Committee of Hon'ble Supreme Court, State Governments and NIC.

Remote sensing, satellite imagery, surveying and mapping, positioning technology, hybrid aerial photography with ground truthing, and GIS are all used in the DILRMP. The result is precise, up-to-date data, which will play a significant role in reducing land conflicts, increasing accountability and transparency in land governance, improving survey and resurvey accuracy, saving cost and time, and streamlining workflows.

To sum up, it may be concluded that all the activities of the Department under the broad aegis of DILRMP are directed towards Aatmanirbhar Bharat through enhancing Citizen-centric activities and empowerment, transparency, creating engagement and awareness, making information available online on real time basis, ease of living of the people, and Ease of Doing Business for the entrepreneurs.

Several stages of the DILRMP have already been completed in various States and Union Territories. Looking at these completed projects, what are the major implementation challenges remaining to be addressed from a technological perspective?

One must accept the complexity of the situation in the country when it comes to land records, registries, and revenue administration. The complete picture has to be studied, including related technicalities, current institutional arrangements, potential policy outcomes, and—most crucially—stakeholder responsibility.

Since DILRMP involves a lot of technicalities, particularly in survey/ resurvey and numerous stakeholders, it has already been challenging to effectively translate execution plans into concrete ground operations. The multi-pronged DILRMP implementation requires the timely addition of critical resources, such as the people or material resources crucial to the execution.

Given that India is home to 1.4 billion people, this is the world's largest modernization and digitization of land records programme and government effort. Despite the mammoth challenges, the Central Government through DILRMP and the active support of States/ UTs have already produced almost 12 million digitized cadastral maps and about 310 million records of rights.

DESPITE THE MAMMOTH CHALLENGES, THE CENTRAL GOVERNMENT THROUGH DILRMP AND THE ACTIVE SUPPORT OF STATES/ UTS HAVE ALREADY PRODUCED ALMOST 12 MILLION DIGITIZED CADASTRAL MAPS AND ABOUT 310 MILLION RECORDS OF RIGHTS.

Currently, an attempt is to have geo-coordinates of each land parcel. For India, the geo-referencing of the land parcel and assigning Bhu-Aadhar or ULPIN will be a game-changer not only in land administration but also a mega solution in governance itself. The whole government approach and these initiatives will ensure minimum Government and maximum Governance.

How are interconnectivity and transparent data sharing between grassroots functionaries being ensured through the Integrated Land Information Management System (ILIMS) and the National Generic Document Registration System (NGDRS)?

The National Generic Document Registration System (NGDRS) or E-Registration was introduced as a pilot initiative under the DILRMP to have a uniform registration system and property management in the country and to promote ease of doing business in the country. Under this system, property registration services are being made accessible online throughout the nation.

The E-Registration through the NGDRS system has helped to streamline the entire process, from stamp duty payment to online appointment scheduling at the sub-registrar office. For all types of transactions, including the sale, purchase, and transfer of land, other deeds and documents, the NGDRS represents a significant transition from the current manual registration system to an online system.

The approach is also encouraging offices located in remote locations to adopt technology, digitize documents, and reduce manual involvement to decrease inaccuracies in land records.

People will directly benefit from the NGDRS through a reduction in land and property disputes, check on fraudulent transactions, SMS and email-enabled alerts related to property transactions, and external system integrations like e-Sign, e-KYC, PAN verification, payment gateways, and so on.

Thanks to its interoperability, the NGDRS is also instrumental in the creation of an Integrated Land Information Management System (ILIMS). The ILIMS project intends to improve real-time land information, optimize resources, and support policy and planning. Information on land parcel ownership, land usage, taxation, geographic boundary, property valuation, encumbrances, etc. is all included in the ILIMS. State-specific needs may also be added to the ILIMS by various States if they see fit and as long as they are relevant.

How is the Unique Land Parcel Identification Number (ULPIN) bringing standardization to land statistics and accounting in the country?

The main goal of the ULPIN or Bhu-Aadhar project is to create a unique ID for each land parcel and update current land records based on the mirror concept, where cadastral records reflect the ground reality. The 14-digit Unique Land Parcel Identification Number (ULPIN), which is based on the geo-reference coordinates of vertices of an international standard and complies with ECCMA and OGC standards is a unique ID for each land parcel.

ULPIN is referred to as the " Aadhaar for land" or "Bhu-Aadhar" since it can be used to instantly identify each parcel of property that has been surveyed.

The direct benefits include stopping land fraud, particularly in rural India's hinterlands where land records are out-of-date and sometimes challenged. Citizens can instantly access historical land records through a small window. Such standardization will also simplify the process of buying land.

It is easier to ensure the uniqueness of land-related transactions and land records and link property transactions digitally. Besides, communication over land titles has become simpler between ministries, investment companies, and all users. Once a parcel of land acquires its ULPIN, officials have access to the information pertaining to it, allowing them to obtain correct data for planning, development, and citizen services.

Put simply, the ULPIN is bringing effective integration and interoperability across departments through standardization at the data and application level.

Would you please throw some light on the MATRIBHOOMI portal? How it can be used as a solution for mega-governance?

The MATRIBHOOMI portal will act as a single repository for all cadastral maps and land parcel data as well as a single reliable source for the cadastral base layer. It is envisaged to offer citizen-centric services as part of an Integrated National Geo-portal of India for Governance.

For all cadastral maps gathered via APIs and stored by various States in their own data centres, the portal will also serve as a National Archive and Atlas of Land Records. State-level data can be updated on real-time basis on the portal with information on ownership changes, court orders, sales and purchases, and inheritances via means of APIs, this portal will be the mirror of databases of land records which are available in various States/UTs. From the geo-portal, the base layer can be utilized for overlaying, integrating, or providing as a service in other applications for value-added services to various Ministries/ Departments/ State Governments/ UT Governments/ other stakeholders. This is set to transform land administration in the country on the concept of the whole of the Government approach and principles of "Minimum Government, Maximum Governance".

In your opinion, what are the key pillars of efficient and effective land information management in India? What should be the contribution of Government and industry respectively to this vision?

Efficient and effective land information management in India is the key to sustainable development and harnessing the potential of the economy for the government and all sectors and stakeholders including the individual owner of the land. Likewise, it is the backbone for targeted citizen services for the inhabitants, making it very critical to evaluate what we need to do right.

A digital ecosystem will boost scalability, inclusivity, community involvement and citizen engagement, reliability, correctness, and updates while retaining cost and time effectiveness. For this we need decision-makers, business owners, researchers, and field personnel to collaborate over a single, stable ecosystem, that can be continuously improved upon making the citizens self-reliant.

I believe we have already come a long way in creating that, with the DILRMP and its sub-initiatives. Today, both inside and outside of government, we recognize that technology is essential to good governance, as are the innovations it supports. Since the GoI has already delivered the Geospatial Guidelines, I hope that academia, industry, and other stakeholders will work together to popularize and further innovate on the technology.

The Government and industry must collaborate for on-ground implementation of surveys/ resurveys and planned augmentation of infrastructure like the CORS network for better, faster outcomes. Stakeholders at different levels, including the Centre, State, and private organizations, need to be trained in Geospatial technology capabilities. Again, the industry and industry bodies working in the geospatial field have a key role to play here.

Mainstreaming digital technologies into the agriculture value chain needs the participation of multiple stakeholders

The benefits of new technologies are yet to reach the farmers, notes **Dr. C S Murthy, Director, Mahalanobis National Crop Forecast Centre (MNCFC)**

How does MNCFC use Remote Sensing and SAR data for crop assessments? Can they be used for all crops? If yes/no, why?

Satellite data of moderate spatial resolutions of both optical and microwave sensors are being analysed extensively at MNCFC for crop mapping, crop health monitoring and crop risk assessment. Analysis of microwave data acquired by Synthetic Aperture Radar (SAR) covers different crops. For many years, crop mapping with SAR data is being carried out for selected crops such as paddy and jute. This data is now being extended to other crops like soybean, maize and red gram since the results are promising. SAR-based indices are being used for crop condition assessment for all crops by way of extracting these indices using the crop maps generated with optical indices. Thus, synergistic use of SAR and optical remote sensing data is followed at MNCFC.

How are crop models used for yield prediction? Have you developed your own crop models at MNCFC?

There are three widely followed models for generating yield estimates namely (a) Semi-physical, (b) Crop simulation, (c) Machine Learning / Deep Learning. These crop models produce pre-harvest crop yield estimates, right now for major crops.

Semi-physical models are based on the biochemical process of plants involving light absorption for photosynthesis, radiation use efficiency, stress factors, accumulated biomass and grain yield. It is recognized as a better approach than simple empirical modelling. Its strength lies in adopting a process-based framework with limited parameterization. Critical elements of this model: (a) precise information on crop variety, planting, and harvest dates, (b) empirical derivation of FAPAR with NDVI and (c) derivation of water stress and temperature stress factors.

IN RECENT YEARS, AI MODELS ARE BEING INCREASINGLY USED FOR CROP YIELD ESTIMATION. SATELLITE-DERIVED VEGETATION INDICES, METEOROLOGICAL DATA, HYDROLOGICAL VARIABLES, AND EDAPHIC FACTORS ARE USED AS INPUTS IN THESE MODELS.

Crop growth models simulate the plant processes to estimate various bio-physical parameters and final crop yield. These models need intensive parameterization starting from genetic coefficients of crop variety under cultivation, crop sowing time, crop management practices – fertilizer applications, irrigation supplies, pest/ disease occurrence etc. When applied over larger geographies, these models tend to perform poorly due to limited parameterization and inadequate representation of varied crop-growing environments

Artificial Intelligence (AI) has gained importance in solving the non-linear relationships between variables. AI includes Machine Learning and Deep Learning models, such as the random forest (RF), Support Vector Machine (SVM), and different variants of neural network models (NN). In recent years, AI models are being increasingly used for crop yield estimation. Satellite-derived vegetation indices, meteorological data, hydrological variables, and edaphic factors are used as inputs in these models. Good quality data for training and validation is a prerequisite for the successful implementation of these models.

At MNCFC, crop yield estimation models are being implemented in collaboration with SAC and IMD under FASAL project. Under crop insurance, pilot studies on crop yield estimation at the insurance unit level are being carried out through the AgriTech industry.

MNCFC is planning to initiate many collaborative studies with both academics and the industry to improve crop yield estimation in the country.

Apart from crop yield forecasts, MNCFC also has projects centred on drought assessment (NADAMS) and crop insurance (KISAN). Please throw light on the use of Geospatial technologies in these projects.

Monitoring and assessment of drought conditions and timely dissemination of information to stakeholders constitute the most vital part of the drought management system. Under the current drought monitoring project called NADAMS, several drought indicators such as rainfall deviations, rainy-days deviations, Moisture Adequacy Index, soil moisture index, and crop condition anomalies based NDVI, LSWI are generated at the sub-district level and provided to states, by MNCFC. These indices along with crop sown area data are used by States for declaring drought as per the guidelines of the National Drought Manual 2016.

Further, MNCFC generates several indices using weather and satellite datasets from the beginning of the season to support Crop Weather Watch review meetings of the Ministry. Our endeavour is to strengthen the crop monitoring system with all possible geospatial information products. These products are provided to all states taking part in Crop Weather Watch meetings. In Kharif 2022, the drought conditions prevailing in eastern India comprising parts of Uttar Pradesh, Jharkhand, Bihar, and West Bengal were closely tracked by MNCFC helping the Ministry and States with technology-based inputs.

What role can Multi-sensor (SAR & Multispectral/Hyperspectral) and Multi-resolution data integration play in agricultural analysis?

The synergistic use of multiple spectral indices is always beneficial for monitoring crops. Every spectral index has some strengths and limitations. Combined use of non-overlapping spectral indices leads to enhanced information content on crop status. In the early part of the season, NDVI is less sensitive because vegetation cover is not significant.

LSWI is more sensitive to surface wetness/dryness and hence it plays a better role than NDVI in the early part of the crop season. Similarly, SAR backscatter data shows higher sensitivity to surface dryness and wetness and hence can be used for drought detection early in the season. During the crop growing stage, backscatter, and optical indices like NDVI and LSWI together capture both surficial and structural parameters of the crop. Biophysical parameters like LAI, FAPAR available at coarse resolution needs to be integrated with moderate resolution spectral indices to improve crop surveillance systems. Hyperspectral data provides the unique information content on crops and operational models using such datasets are yet to be evolved.

Are you using Data Science and Machine Learning for predictive analytics? If yes, please elaborate.

Remote sensing data of moderate resolutions around 10m is available free once in 5-10 days, thereby reducing the cost of surveillance over large areas. Similarly, mobile technology has tremendously improved the field data collection system by producing real-time crop status and crop management data.

ML/DL models are well-proven for analysing large streams of data from multiple sources – satellites, weather stations, Mobile Apps etc in agriculture. These models are efficient to investigate the associations, establish relationships, and perform predictions on crop health and risk occurrence.

MNCFC is currently working towards realising crop mapping and crop yield estimation using ML/DL models for major crops in the country. Smartphone-based crop surveillance using AI-based photo analytics is another important area for developing farmer advisory systems to be realised in the country. MNCFC has initiated collaborative efforts in this direction.

Lastly, what are some areas where MNCFC would like to explore partnerships/solutions from the Indian Geospatial industry?

There are enormous opportunities for developing and mainstreaming geospatial solutions in the agriculture value chain in the country. Spatial analytics, data mining, data engineering, evidence-based tools, etc., could churn many useful information products. The benefits of these new technologies are yet to reach the farmers.

Many farmer-centric services such as weather advisory, pest/management and market advisory could be improved to a larger extent by bringing new forms of knowledge and tools through digitalisation and datafication. There is scope for developing new business models with these technologies to boost the country's agricultural economy.

Therefore, the potential areas for collaborative efforts with the geospatial industry include (a) farmer-centric advisory services on weather and pest/disease management and market intelligence, (b) innovative crop insurance products for crop risk management and (c) strengthening crop estimation surveys and crop surveillance systems.

Mainstreaming digital technologies into the agriculture value chain needs the participation of multiple stakeholders - farmers, input suppliers, traders, and administrators, researchers representing private sectors, governments, and non-profit organizations. The benefits of technology are effectively reaped only when the institutional mechanism is in place.

Mainstreaming digital technologies into the agriculture value chain needs the participation of multiple stakeholders

The benefits of new technologies are yet to reach the farmers, notes **Shailender Kumar, Senior Vice President & Regional Managing Director, Oracle India, NetSuite - JAPAC**

Geospatial cloud computing is still in its infancy in India. Where is the gap? If bridged, how could this boost digitization across sectors?

Some of the main geospatial cloud computing challenges are:

- Lack of integration of spatial data into business processes: GIS systems are usually dedicated, specialized systems that are disconnected from business systems and these applications can't use the full value of geospatial information.
- Interoperability: when there are more than one GIS or mapping component at play, there arise concerns about data privacy and data residency.
- Heterogeneous data: integration analysis becomes difficult as different kinds of data are held in different files or separate data stores and each needs a specialised skill set.
- Scalability: this becomes important to effectively process every growing amounts of geospatial data for commercial applications requiring location information such as sensor data, GPS streaming data and 3D data.
- Application level integration: due to missing integration between mapping systems and business systems, organisations cannot leverage centralised location information across decision support systems.

Cloud in geospatial can support digitisation in many ways such as increase user base impact of spatial data, reduces time and costs associated with managing and displaying GIS data, foster and strengthen multi-agency collaboration and partnerships, and enhance their interactions with the public. Also, transportation agencies stand to benefit the way they conduct business, in terms of efficiency, transparency and cost effectiveness.

Oracle's Cloud Infrastructure (OCI) has been titled "the ideal platform for running heterogeneous workloads". What does this mean for the user?

OCI supports all workloads. It is a comprehensive platform of public cloud services that enables customers to build and run a wide range of applications in a scalable, secure, highly available and high-performance environment. By revolutionizing core engineering and systems designed for cloud computing, OCI enables organisations to not only solve problems they have with existing clouds, but also modernize their infrastructure. OCI services and platform caters to a wide range of requirements of heterogeneous applications, thereby enabling organization to run their legacy and modern applications on OCI. Another salient advantage of OCI is its superior economics. Oracle offers uniform pricing for OCI across all its global locations – an industry first.

Agriculture is probably one of the hardest hit by supply chain issues, including lack of traceability, slower transactions, and so on. How is Oracle changing the landscape to resilient, automated supply chains?

The global economy is facing a massive challenge and in today's interconnected world, disruptions are happening at fast pace across businesses and across sectors. Supply chains are no exception. If they fail, companies risk losing millions.

Recent events have highlighted just how interdependent we all really all, like never before. Companies need to understand how to be resilient, manage risk and respond to sudden and sharp changes in their global supply chain landscape.

As we embrace the new normal, many companies will want to evaluate alternate sourcing plans and some maybe forced to produce essential products domestically instead of relying on riskier offshore producers.

Organisations will likely look to become less lean and build more flexibility into their supply chains. They will need to securely support remote workers, for instance, and learn to engage with customers in new, often virtual ways. Oracle Cloud solutions can help companies accelerate their journey to recovery and be prepared to monitor, analyse and react to new disruptions. It is possible that global supply chains and consumer behaviour may be changed forever and we can equip companies and tools to detect these lasting trends and plan supply chains accordingly.

Despite a new era of business development and innovation for the Geospatial industry, digital infrastructure management, and scalability challenges remain very real, especially for startups and small enterprises. What is the most viable way forward for them?

One perk of being a startup that uses Oracle is the opportunity to integrate with Oracle Cloud solutions, across its entire applications and technology portfolio. When a startup builds on top of our own cloud solution, that integration complements Oracle's cloud offering, enhancing capabilities for global customers while providing the startup scale and exposure. Startups use OCI to build cloud native, scalable, high performing and highly available applications using every modern language framework and cloud service they expect from a leading cloud platform. OCI supports a broad range of application infrastructure including bare metal, VM, containers or functions, with many different runtime and managed data persistence options. A scalable system provides elasticity, the ability to automatically add and remove resources to more closely match demand at any given point in time.

FIRST, OUR PRIVATE NETWORK CONNECTIVITY CHARGES ARE 74% LESS. SECOND, ORACLE DELIVERS >3X BETTER PRICE-PERFORMANCE FOR COMPUTE COMPARED TO OTHER HYPERSCALERS, FOR GENERAL PURPOSE COMPUTE INSTANCES.

How can users leverage OCI for Precision Farming? Keeping in mind the high costs involved in Precision Farming practices, does OCI provides a cost-effective solution?

Oracle Cloud Infrastructure (OCI) is built for enterprises seeking higher performance, consistently lower costs, and easier cloud migration for their existing on-premises applications. Oracle Cloud Infrastructure is consistently less expensive than other hyperscalers for a wide range of popular cloud workloads for several reasons.

First, our private network connectivity charges are 74% less. Second, Oracle delivers >3X better price-performance for compute compared to other hyperscalers, for general purpose compute instances. Third, for HPC workloads, Oracle provides similar performance but is 44% less expensive and provides local SSDs, twice the RAM, RDMA networking, and a performance SLA. Fourth, for block storage, Oracle offers as much as 20X the IOPS of other hyperscalers, for less than half the cost.

DigiFarm, a technology platform developed by a 15th generation farmer in Norway, aims to optimize their crop production. They run a cloud-native precision agriculture platform on OCI, helping farmers and other agribusinesses determine seeded field acre boundaries. Precision agriculture and other farming tech are critical to producing enough food to support the world's growing population. According to the Institute on the Environment, crop production needs to increase between 60% and 100% to feed the extra billion people who might live on the planet by 2050. To tackle the field boundary piece of this puzzle, DigiFarm's platform uses neural networks models to automatically detect field boundaries using high-resolution satellite data. DigiFarm has been able to save 30% to 40% running Oracle Bare Metal GPUs on OCI compared to other vendors' solutions – this represents US$ 10000 to US$ 12000 every month. So far, they have helped 14000 producers in 30 countries delineate their seeded field acre boundaries with 92% accuracy.

Geospatial Technologies driving Digitalization of Agriculture

Innovations, Trends, and Future

Satej Panditrao

Agriculture is one of the most important sectors of the Indian economy. It contributes to approximately 17% of the total GDP and roughly 60% of the total population is dependent on this sector for its livelihood. To ensure continuous and sustained growth in this sector, integrated "Digital Agriculture" is being used by many companies, government bodies and organizations.

Digital Agriculture comprises using digital technologies for crop monitoring, livestock management and other processes in agriculture. Its basic aim is to increase production of the crops with sustainable development and reduce the risk of crop loss or damage.

Geospatial technologies have an integral part to play in the digitalization of agriculture, being used by different organizations across India to monitor individual agricultural fields due to their efficacy in monitoring different aspects of crop cycles as well as forecasting yield and production estimates.

Using Geospatial technologies to Improve Agricultural Processes

Different stages of crops can be seen using Remote Sensing imagery (Satellite as well as aerial and UAV) which helps users analyze the crops. Various agencies like ESA, USGS and projects like the EnMap Mission provide open-source imagery captured by SAR, multispectral, and hyperspectral satellites, which have tremendous applications in Crop health monitoring and assessment.

As far as the process of Remote Sensing based crop monitoring is concerned, the very first step is to choose the correct imagery. Correct means the imagery captured on (or near to) the date of sowing of crops. This selection of imagery is very important as the pixel values of the images depict the stage-specific reflectance or backscatter values. Preprocessing of the imagery is also important to minimize the noise.

To get the actual ground data, extensive ground surveys are required to train the models for crop-type classification. After the classification of different crops sown in the study area, the cadastral boundaries are overlaid to get the micro-level picture. Due to the extensive use of Machine and Deep Learning algorithms, the accuracy and efficacy of the outputs have increased.

As optical images are marred by clouds or haze in the rainy season, SAR plays a complementary role due to its penetration capability of the cloud. The basic hypothesis in the Remote Sensing based crop phenology assessment is that the temporal profile of backscatter values mimics the crop growth and senescence over a cropping season. So, this crop cycle can be simulated in terms of backscatter values using mathematical models (For instance, the Badhwar Rice growth model and Tor Vergata model) to get the parameters like Crop emergence date, harvesting date, peak biomass and so on.

As crop health depends on multiple factors like management practices, rainfall, Soil Moisture, fertilizers etc., continuous monitoring of the crops has become very necessary. Mobile apps, IoT based sensors are being used extensively to measure different parameters like Soil Moisture, humidity, temperature, pH, nitrogen content and so on. Temporal modelling of these parameters along with reflectance/ backscattered values gives more detailed information related to crop growth.

Geospatial technologies are also used to model crop yields. Biophysical parameters, especially biomass and their integration with biochemical parameters are of paramount importance. Various crop simulation models having agronomy parameters have been used by many researchers to forecast yield estimates. Highly complex deep learning models are currently being used with SAR data for accurate yield estimation.

Current Trends in Digital Agriculture

The creation of mobile apps, web APIs and the use of IoT-based sensors and drone imagery are the current trends. A huge amount of data is being captured, produced, and processed by different companies and organizations by using the cloud. Mobile apps are useful to generate agriculture field-level advisories for individual farmers.

Farmers upload photos of crops in the app and the robust models used in that app process these photos and shoot the results pertaining to the field. This analysis helps farmers take prompt action in case of any crop disease. Drone imagery is extensively being used to map damaged agricultural areas due to floods or any other calamity. This helps the policymakers and ministers in the agriculture department to devise efficient policies (like Pradhan Mantri Fasal Bima Yojana). Many private and nationalized banks use Remote Sensing based estimates to settle crop insurance-based claims.

A recent survey shows that banks like HDFC and insurance companies like Bajaj Allianz are leading the way in Remote Sensing-based insurance claim settlements. This trend will continue due to the availability of high-resolution imagery in the recent future, making crop health monitoring more accurate. Integration of SAR and hyperspectral (data fusion) imagery is another aspect which will be exploited by the Geospatial data scientists.

Further, it will facilitate the integration of biophysical and biochemical parameters which is the crux of remote sensing-based agricultural studies. As climate change is inevitable, climate-resilient agricultural practices will get momentum. Weather modelling, Numerical weather prediction, climate risk assessment modelling and their use in the dissemination of advisories constitutes the major work of a few companies/organizations in India, like the Indian Meteorological Department. Such developments are also necessary to investigate fraudulent practices (if any) to ensure accountability and transparency in the bureaucracy.

New Technologies and Their Role

Data Science, Machine Learning, AI, and Cloud computing are the buzzwords nowadays. These are very useful technologies, and they are indispensable when it comes to the generation of efficient Decision Support Systems. At the same time, the domain experts in Geospatial technologies are equally important. If accurate information from ground surveys is available, training and testing of the Machine and Deep Learning models become easier.

Hence, many companies are focusing on such surveys. Actual biomass measurement by using destructive testing methods is being done by many organizations like, ISRO, MNCFC and others and complex simulation models like Radiative Transfer Model, Water Cloud Model and so on are being used to forecast yield.

These models can be replaced by Deep Learning models but for such replacement, domain knowledge in Remote Sensing and agronomy is very important. To make each farmer techno-savvy and smart, capacity-building programs are being designed to ensure that the farmer explores all the possible resources available for his agriculture.

Conclusion

Digital agriculture has evolved much since its inception, and it is still growing. In India, remote sensing-based agriculture monitoring is very challenging given the diverse agro-climatic zones and agricultural practices. To ensure that small landholding farmers are getting useful insights pertaining to their cropped fields, the exploitation of Geospatial technologies is tantamount to policy making and implementation.

As far as policymaking is concerned, the government has mandated that companies and organizations working on agriculture projects use Geospatial technologies for their analyses. This has given rise to many start-ups and Technology Incubation Centers which are using huge amounts of Remote Sensing and GIS data for their projects.

In a nutshell, it can be stated that Geospatial technologies are the main drivers of Digital agriculture and in the recent future, their usage will increase exponentially.

Mitigating climate risks through Agro-Geointelligence

Geoenabled Climate Smart Agriculture for informed decisions and sustainable actions

As a food-deficient country in the 1960s, the adoption of technology and mechanization characterized the "Green Revolution" that propelled India to be one of the leading agricultural nations in the world. As India strives to sustain its food self-sufficiency in the 21st century, Indian agriculture is now faced with newer problems that are related to sustainability, efficiency, and inequality.

India's agricultural sector faces unprecedented challenges some old, some new and others that are evolving. Climate change is one such challenge that is dynamic in nature and rapidly evolving. The impacts of climate change are already being felt in Indian agriculture due to increasing temperatures and extreme weather events. These are leaving an irreversible impact on the agroecosystems.

While on the other side reducing crop yields, deteriorating nutritional quality, and lowering livestock productivity pose a threat to the nation's food security. Transboundary agrarian touchpoints spread across diverse disciplines make it a formidable task to strike the right balance for "producing more and better with less" in such circumstances and call for a smart approach that can mitigate climate risks by mapping a common ground.

Climate Smart Agriculture

Climate change impacts us globally—what happens in one location happens everywhere. These environmental crises come in many forms, from declining air quality to rising sea levels, diminishing biodiversity, and shifting populations. Conventional agricultural practices and traditional knowledge that most Indian farmers rely upon are rapidly losing relevance. The developing situation calls for a transformational change in agricultural practices that are smart and climate-friendly while being sustainable and resilient. And there is no better alternative to geospatial technologies to accomplish this.

Understanding the evolving dynamic situations becomes paramount for mitigating, preparing, and responding to these situations. And for this data, information and knowledge are critical. As digital agriculture initiatives make their way into the ecosystem, stakeholders are challenged with contextualized climate-related information and their localized impacts at right time for informed decisions. By connecting data and science in the context of space and time, the need for "agro-geointelligence" in a language understood by all, becomes paramount for informed decisions and sustainable actions.

Agro-Geointelligence for Mitigating Climate Risks

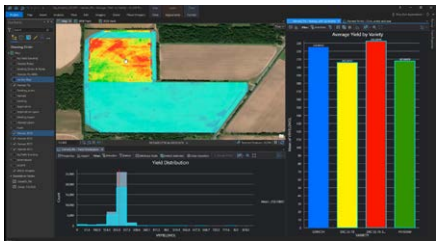
The inability of the current information systems to contextualize, embrace complexity and facilitate stakeholder convergence has been creating hurdles in addressing transboundary multi-disciplinary challenges and risks associated with climate change and global warming. And unless all the data touchpoints are brought together on a common platform for deeper contextualization and participative management and collaboration, it is a herculean task to understand the dynamics including linkages and dependencies. Given the dynamic nature and associated complexities of climate change, the need for agro-geointelligence becomes more than ever.

Bridging the Gap between Data and Science

As we transition into a digital future, decision-making at every strategic and operational step needs to be supported with evidence that is based on accurate data and backed with scientific rigour. Digital agriculture initiatives call for innovative approaches and technologies that not only address the challenges but also are self-learning (healing), able to analyze and reproduce insights and can be tailored to geographies and situations. Bridging the gap between data and science, geospatial technologies provide evidence in the form of maps, analytics, dashboards, and reports, so that their interventions and investments towards a) Anticipating risk b) Preparing to adjust c) Sharing and Learning are inclusive and sustainable.

Plan, Prepare and Respond

Contextualized agricultural intelligence will determine how governments and businesses can plan, prepare, mitigate, and respond to climate change risks. And for quickly transforming data from diverse sources into knowledge - rapid enterprise deployment, data management, mapping and visualization, analysis, and discovery become critical.



Connecting diverse data sources on a unified platform from multiple sources/systems (Centre, State, and others), stakeholders can rapidly harness actionable agro-geointelligence at different levels (Regional, national, and local) through a GIS platform for planning, operations and decision making, leveraging comprehensive, accurate, and accessible information that is tailored to their geographies.

Understanding future scenarios

Using spatial science to transform data into action, agro-geointelligence helps stakeholders to understand patterns, relationships, anomalies, and incidents in massive amounts of spatial data. Out-of-the-box spatial analytics tools, machine learning algorithms, and artificial intelligence techniques for modelling and predictive analysis arm with advanced information on the emerging situations comprehensively, thereby helping us with an accurate assessment of the likely impact of the disasters, their geographic spread, hot spots, priority areas, appropriateness, and efficacies of interventions. Spatially simulated models provide decision-makers with interactive tools for understanding the physical systems and judging how actions on the ground can affect the overall agroecosystems.

Collective problem solving

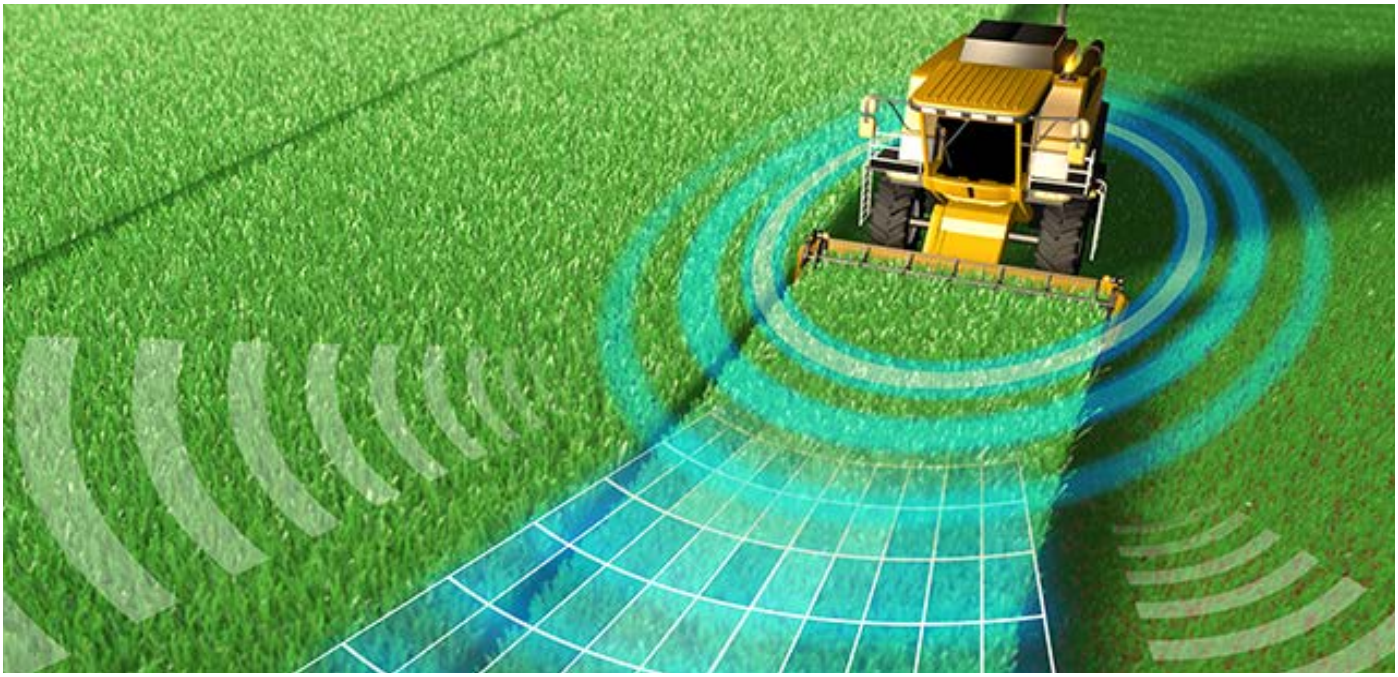
Given the dynamic nature and diversity of the processes associated with climate change, no single agency can capture all the required data touchpoints or solve the problems. Larger participation and involvement of communities becomes inevitable and so does collective problem-solving. Revolutionizing open access to authoritative information through multiple mediums, geospatial hubs foster collaboration and sharing of information and knowledge.

And for democratizing this information and expanding its participative reach to remote corners of the country, mobile GIS tools complement the geospatial infrastructure. Empowering all stakeholders equally to participate and contribute while leveraging agro-geointelligence for decision support at ground level.

Esri India's Vision for Climate-Smart Agriculture

At Esri India, our priority and focus have always been to support our customers with a commitment to science, sustainability, and positive change. For over five decades, Esri has been committed to the conservation of our planet and invested in solutions that help protect it and advocate for its care. Esri's goal is to create a sustainable future. We believe that technology and modern analytical tools help build climate action plans.

Continuing Esri India's legacy of inspiring and enabling organizations to positively impact our future through



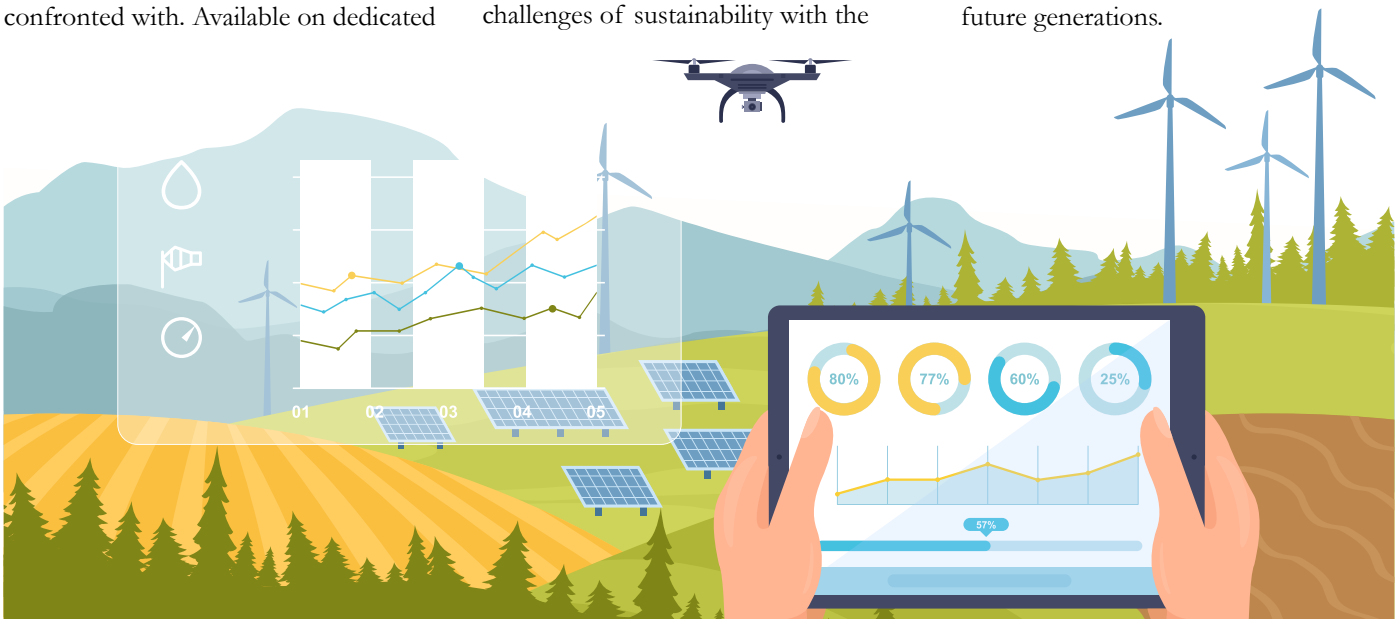
a deeper, geographic understanding of the changing world around us, Esri India conceptualized and developed made in India "Indo ArcGIS" that reflects this philosophy. Playing a central role in bringing together all the agrarian touch points in the Indian context on a unified platform through a common visual language of maps, Indo ArcGIS provides comprehensive agro-geointelligence.

By enabling the geographic approach and mapping as a fundamental language, Indo ArcGIS acts as a catalyst for creating understanding, exploring alternatives, collaborating to find solutions, and achieving consensus on complex agricultural issues we are confronted with. Available on dedicated India Cloud (Approved by MEITY and "Make in India' public procurement guidelines compliant) with Ready-to-Use solution templates, base maps and data layers, GPU-enabled cloud infrastructure enables you to harness Indo ArcGIS Pro capabilities giving you higher utilization at a lower total cost of ownership.

In Closing

In Jack Dangermond's words "As the effects of climate change accelerate and intensify, it is more important than ever for leaders to take a geographic approach to this fundamentally global issue. It is part of our mission to contribute to their ability to meet the challenges of sustainability with the best technological resources." Amid unprecedented challenges Indian agriculture faces, climate change is the cause for concern with its potential impact on food security in near future.

Climate change is here to stay and as the call for "producing more and better with less" gets louder, the time is ripe for a "digital revolution" that is characterized by geointelligence. This will set the stage for Indian agriculture to become a global leader while mitigating climate risks. Geospatial technologies will play a deciding role in how we effectively and efficiently address these and what we leave for future generations.



Agriculture 4.0: How Hexagon is Empowering and Insuring Farmers in India

Pranav Kumar, Hexagon India

India has recorded impressive achievements in agriculture in the last four decades, ever since the onset of the Green Revolution in the late sixties and is now steadily pacing towards Agriculture 4.0.

With the advancement of Digital Agriculture, apart from agricultural datasets available with government organizations, Machine control tools have become a necessity for any producer/farmer wanting to optimise operational efficiency in the field.

As the demand for food, fibre and biofuels increases, farmers are increasingly pressured to optimize their production. At the same time, challenges like land availability, labour shortages and climate change persist. Supported by Hexagon's innovative software and sensors embedded in tractors, harvesters, and implements, farmers can increase production, minimize labour requirements, reduce waste, and curtail environmental impact.

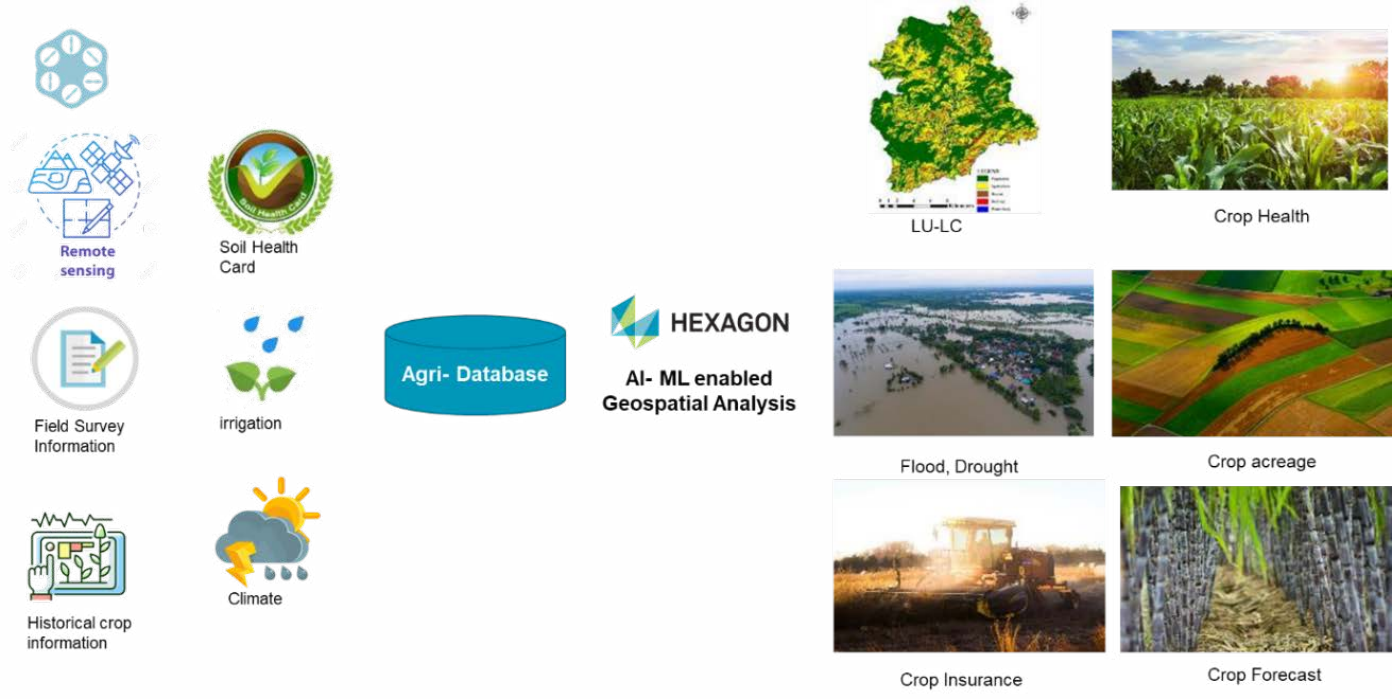
What is: Agriculture data is under-leveraged – it's not being collected or it's unstructured and not being put to work. Complex and inefficient workflows create challenges and missed opportunities. Operations are hampered by changing variables and conditions. Inputs, yields and assets (e.g., machinery) are not achieving their full potential.

What should be: A connected and automated digital agriculture ecosystem that results in vastly improved workflows, optimised yield and maximised profit.

Hexagon Pioneering a Digital Transformation in Agriculture

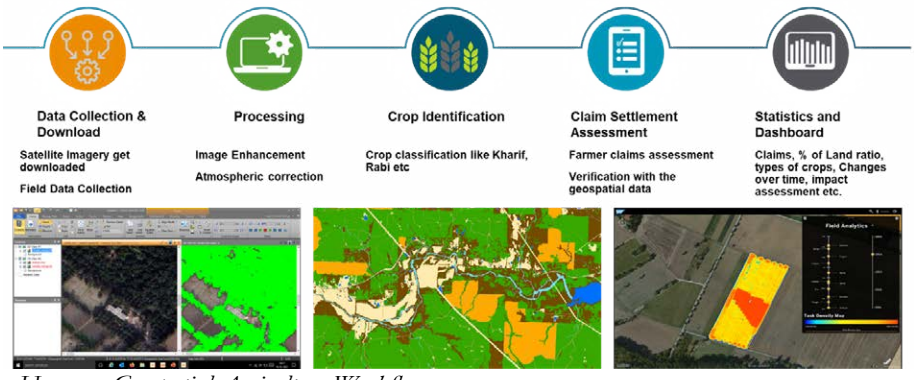
Hexagon offers data and technology-driven solutions that help farmers maximise their operations through precise positioning, planning and optimisation, machine control, monitoring, analysis and management.

Hexagon Agriculture operates as core element at each stage i.e. from planning to processing



Geospatial datasets sources to agriculture analytics output

Capabilities of all the tools and techniques, currently available for crop assessment and global experiences would be fully exploited to generate objective information products. Using **Hexagon ERDAS IMAGINE** one can estimate the yield of crops, crop damage areas due to pests or floods, presence, or absence of crops on the ground, georeferencing of village maps, attaching farmer information with each parcel, overlaying of village maps onto satellite images. Periodic Images are needed to identify different crop patterns to estimate crop acreage, crop type, and crop damage. Hexagon ERDAS APOLLO, M.App Enterprise transforms the entire process from Desktop to Web/Cloud Apps automation for real-time monitoring, analytics, and alerts in a unified dashboard.



Hexagon Geospatial Agriculture Workflow

Hexagon has the tools to process satellite and drone images like auto image georeferencing, image subset, Image Mosaic, and Image classification like NDVI, and supervised or unsupervised. Hexagon's Artificial Intelligence and Machine Learning algorithms help our esteemed users in accurately mapping the agriculture areas for crop Identification to yield, identification of planting and harvesting dates, identification of pests and disease infestation, crop condition assessment, stress detection and insurance, yield modelling and estimation, soil moisture estimation& irrigation monitoring, precision agriculture, machine control and automation, and command and control centres.

Mapping the Requirements of Indian Agriculture and Crop Insurance

The Pradhan Mantri Fasal Bima Yojana (PMFBY) aims to support production in agriculture by providing affordable crop insurance to ensure comprehensive risk cover for crops of farmers against all non-preventable natural risks from pre-sowing to the post-harvest stage, on an 'Area Approach Basis'.

The crop insurance sector needs the maximum and most timely information to minimize the risk related to crop damages. Remote sensing applications can provide this information due to the advancements in satellite imaging technology.

Hexagon's state-of-the-art software suites enable Agriculture Insurance organizations to forecast, assess the damage, monitor crop health, measure land surface wetness, etc., using pre-harvest and post-harvest satellite images of different crops. Our software-sensor suites are integral to esteemed government and private insurance customers like the Agriculture Insurance Company of India Limited (AICIL), and IFFCO TOKIO.

Farmers having hands-on experience with Hexagon's Laser Land Leveller

User Statement: Geospatial Technologies Reshaping Crop Insurance Sector

Agriculture Insurance Company of India Ltd

G Senthil Kumar, Manager, Research and Development

Economies worldwide have witnessed a surge in demand for Geospatial and space-based value-added services, technology innovation, and digitalization of systems and processes. The power of location has moved into the hands of people, along with an increasing workflow integration of Geospatial and space applications across economic sectors.

The insurance sector is no exception, and Geospatial and space infrastructure has become indispensable in environmental management, society and business workflow management alike.

Geospatial information proves to be an indispensable resource for crop insurance programs for effective risk management and strategy to combat climate uncertainties. Additionally, Remote Sensing technology has proved itself an effective tool in mitigating the concerns in Crop insurance programs vis-a-vis acreage estimation, crop loss assessment, managing ground sensing, etc.

Geospatial tools like **ERDAS IMAGINE** enable obtaining and representing geographical information for this purpose by merging distinct datasets. With their help, analysts can blend information from satellite and ground data for detailed monitoring of crops and cultivated areas. Geospatial technologies help secure near real-time data of on-ground conditions, which prove largely useful for Governments and other stakeholders.

The Agriculture Insurance Company of India Limited (AICIL) has been using Geospatial technologies extensively and effectively for over a decade to reduce overhead costs and enhance quality and performance of our projects. AICIL has been using Geospatial technologies extensively for the implementation of the National Crop Insurance Programme - PMFBY, the Restructured Weather Based Crop Insurance Scheme (RWBCIS), and the Bangla Shasya Bima.

Stepping Up the Digital Agriculture Reform: What's Next?

At Hexagon, we are keenly empowering farmers in India through our state-of-the-art software-sensor platform and innovative technologies. Farmers in India are already using Hexagon Machine control sensors for precision farming. Government organizations are leveraging Hexagon Geospatial software to empower farmers to increase their productivity and cover their risk through crop insurance. Hexagon's advanced technologies can be applied to the entire agricultural production process for improved planning, automation, monitoring and management of field operations. Which includes soil preparation, crop treatments, crop planting and harvesting and logistics operations.

In the near future, we can see a wave of digitalization sweeping the entire Agri sector in India, with innovators like Hexagon driving the Agriculture 4.0 revolution.

ENABLING AGRICULTURAL SECTOR WITH IGiS

Enabling Agriculture Sector with IGiS

As everyone knows, agriculture plays a vital role in India's economy. Despite an increasing urban population, agriculture and its related sectors remain the main source of livelihood in rural India. Sustained progress in agriculture and related activities in India has been possible due to the boosts provided by the green revolution, white revolution, yellow revolution, and blue revolution.

The Green Revolution was a series of research and technology transfer activities to improve agricultural productivity. Along with other technologies, GIS has emerged as one of the prominent technologies for the agricultural sector. GIS or geospatial technologies find direct applications in assessing and improving agricultural productivity, which has contributed to better food security. Geospatial technologies have helped agriculture in peripheral sectors like sustainable management of natural resources, protection of biodiversity, and many others.

IGiS - A product jointly developed by Scanpoint Geomatics Ltd and ISRO offers an integrated geospatial platform that integrates diverse technologies such as GIS, Image Processing, GNSS, Photogrammetry and CAD. This kind of comprehensive range of technologies on a single IGiS platform has found applications in multiple sectors, including agriculture.

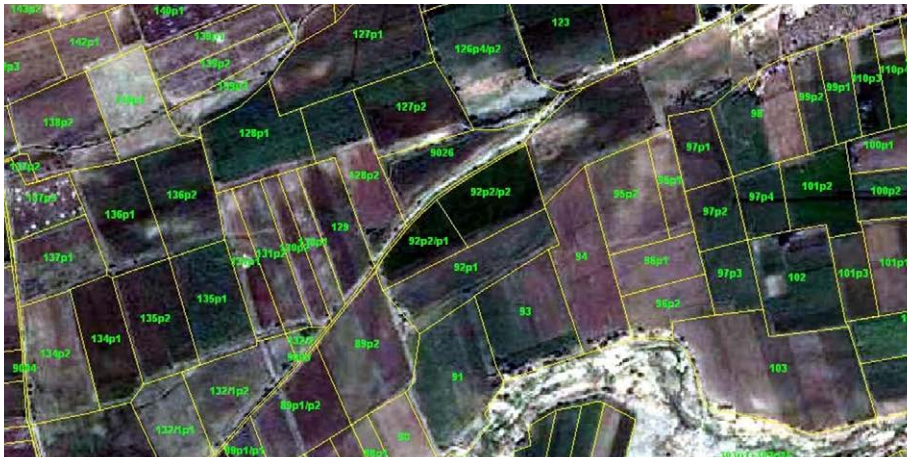
IGiS offers an end-to-end solution for agriculture as an **Agriculture Information System (AIS)**. It is used for creating Intelligent Maps which help to monitor crops, vegetation health, Soil analysis, Crop yield estimation, etc. IGiS – AIS is the GIS-based technology intervention that provides actionable insight by analysing remote sensing data captured at regular intervals throughout the crop period. This information can be disseminated to all the stakeholders through the web and or mobile for timely actions.

Significant applications of GIS in Agriculture

Crop Sown Area Estimation: Remote Sensing plays a crucial role in mapping and monitoring various crop-sown areas in different agro-climatic zones and different crop seasons such as Kharif, Rabi and Zaid. IGiS an integrated GIS software supports the ingestion of various satellite data such as Optical, SAR and Hyperspectral imageries to provide an accurate area sown under a given crop in all weather and climate conditions by integrating with plot level maps (cadastral maps).

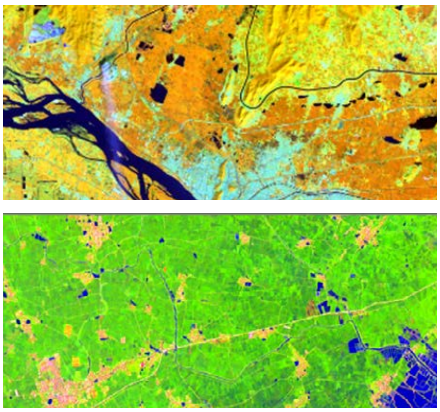
Crop Condition Assessment: Crop condition assessment is important for improvement of crop yield by continuous monitoring and timely interventions at the onset of problems. Crop condition assessment is the evaluation of the crop's health based on insect attacks, moisture deficiency, fungal and weed attacks, etc.

Remote Sensing and GIS techniques are used to visualize field data on a map for further planning or analysis activities. Remote Sensing technology supports frequent imaging using satellite/drone band combinations to identify crop conditions. IGiS enables fast and comprehensive processing of satellite or drone images to produce crop maps along with various health indices like NDVI (Normalized Difference Vegetation Index).



Plot Level Crop Sown Area

NDVI is used to assess crop health precisely. Depending on data resolution, IGiS can provide micro-level crop assessments like crop classification, sowing patterns, unhealthy crops, etc.



Band Combination of Satellite Image - Agriculture Area

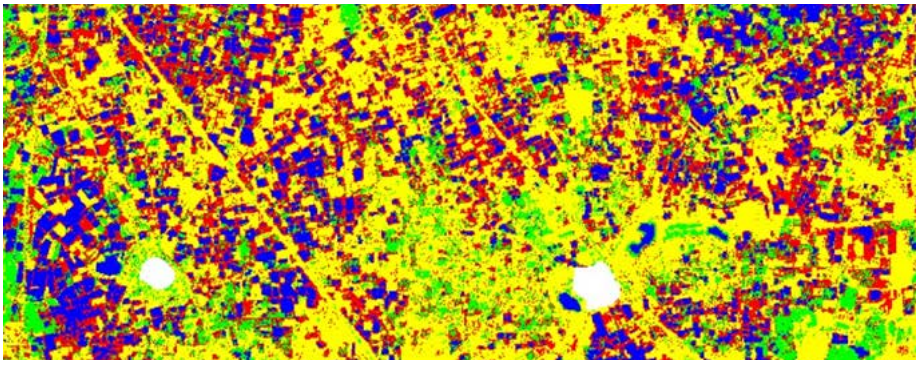
Crop Production and Yield prediction: The main objective of farming is to get a high crop yield with good quality. For that, geospatial technology plays a role in providing actionable insights for increasing crop yield by predicting the expected crop production in a particular area under specific conditions.

IGiS's analytical and powerful data management tools provide managers and farmers with a reliable solution for timely and better crop management to make the right decisions about yield estimation. This reliable solution of yield prediction can help policymakers, researchers, and various other agriculture stakeholders to ensure food security and forecast profits over a given period.

Various yield simulation techniques and algorithms like Machine learning, Deep learning, Artificial Intelligence, Neural networks and IoT (Internet of Things) can help to identify the crop type and accurate prediction of crop yield and production.

Crop Insurance and Loss Assessment: In the period of catastrophic events like hail- storming, flood, hurricane, heavy rainfall, drought etc. remote sensing technology can be used to determine exactly how much of a given crop has been damaged and the progress of the remaining crop in the farm. IGiS's Image Processing - Transformation functionalities support satellite imagery analysis and various spectral indices like NDVI, NDWI, etc. are used to monitor crop growth and health and other environmental conditions across the field, such as humidity, air temperature, surface conditions, drought, etc. IGiS can generate crop condition and distribution analytics suitable for crop insurance settlements.

Crop suitability Analysis and Land Use Planning: An integrated IGiS Suite provides an excellent platform for assessing the quality of land, selection of suitable crop sown, and agriculture applications. A Multi-criteria decision-making (MCDM) approach based on GIS is used for land use planning. Mapping different features such as soil type distribution, soil texture map, Soil pH value, soil fertility distribution, slope (S), soil texture (ST), depth to the water table, climate conditions, topography, and satellite data, allows one to identify the impact of interacting factors on crop suitability and site-specific crop management. An Integrated fuzzy logic and GIS model will be used to analyze land suitable for precision farming.



Crop Type Identification for Crop Yield Estimation

Drought Monitoring and Crop Water Requirements Analysis: Weather and drought occurrence patterns are monitored using remote sensing technology over a given area. The technology enables the decision maker with forecasting details of rainfall and so can conclude on drought situation. IGiS supports active and passive sensor images and helps to determine soil moisture content and estimate the water content in field crops. It helps in planning field-level irrigation and field management.

Smart Farming: Smart farming is based on the use of geospatial and digital data for crops being grown through the entire crop period and helps to improve the effectiveness and efficiency of crop management practices. The digital map or data access of the farm or agricultural land ultimately leads to the betterment of the crop yield, quality, and hence profit, by optimising the use of fertilizer, pesticide, and water. These digital or spatial data enable the managers or farmers to take the right decision in the right situation to optimize the agricultural processes.

Conclusion

The geospatial technologies on the IGiS platform help to provide comprehensive solutions in the agriculture sector through its interventions in crop production estimation, yield forecasting, crop condition assessment, crop insurance and crop area enhancements. IGiS makes it possible to derive and use various agriculture-related parameters like Soil Properties, Soil Moisture, Flood Impact, Agriculture encroachment, and change detection analysis.

Further advances in geospatial techniques and computing infrastructure will allow the development of a comprehensive collaborative framework amongst scientists, policymakers, researchers, extension personnel, crop consultants and other stakeholders with practical guidelines for effective management of crop yield estimations, soil fertility, cropping pattern and monitoring, drought risks, and fertilizer and weed management.

For details visit www.sgligis.com

Yearly Roundup Bulletin

Government

- The **Hon'ble Finance Minister** recognized in her Budget Speech this year the role of Geospatial technologies, AI, Drones, and Space Economy in achieving sustainable economic development in the future.
- A **Post-Budget Session** on "Transforming India through #Geospatial Knowledge and Infrastructure: Need for a National Geospatial Policy" was organized by the Office of the Principal Scientific Adviser to the Government of India and the Department of Science and Technology (DST), along with other scientific ministries and departments.
- The Union Minister for Rural Development and Panchayati Raj Shri Giriraj Singh released the **Rural Connectivity GIS Data in Public Domain,** including GIS data for 800,000+ rural facilities as points, 1 million+ habitation and 25,00,000+ km of rural roads.
- The National Rural Infrastructure Development Agency (NRIDA), the n**odal implementation agency of the PMGSY** scheme signed MoUs with three renowned GIS firms, including two AGI members Esri India and MapmyIndia. The agency also collaborated with Gati Shakti for releasing the Rural Connectivity GIS Data in Public Domain.
- The **CORS Network** was made operational in the country, with the Survey of India offering real-time and precision position services via the CORS Network for free in 6 states for three months (June-Aug 2022).
- DST launched the **Self-Certification Portal** for the Geospatial industry. The new Portal replaces multiple approvals, security clearances, licenses, and other restricting sanctions for collecting, generating, preparing, storing, publishing, and digitizing Geospatial Data and Maps within the territory of India.
- **A series of pre-events** to the 2nd United Nations World Geospatial Information Congress (2nd UN-WGIC) was organized by DST to showcase the use of Geospatial technologies in national and/or state-level flagship programmes, the Indian Geospatial industry's contribution to geo-enabling the global village, the Geospatial knowledge and innovations taking place, and the R&D capabilities with the Indian youth in taking forward technology applications.
- The **2nd UN-WGIC 2022**, convened by the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) and hosted this year by the Department of Science and Technology, Government of India, was held in Hyderabad from 10-14 October on the theme: Geo-Enabling the Global Village.
- The **Report on the "Indian Experience in Alignment with United Nations – Integrated Geospatial Information Framework"** was unveiled by Hon'ble Minister Dr. Jitendra Singh, Minister of Science and Technology, Earth Sciences and Space, Govt of India during the official opening ceremony of the 2nd UN-WGIC. It gives a glimpse of the kind of work, innovation, and benchmarks that Indian public and private sector organizations are establishing using Geospatial information, and how well they are aligned with various UN-GGIM Integrated Geospatial Information Framework (IGIF) pathways at the experience level.
- The Union Cabinet gave its nod to the **National Geospatial Policy** to boost entrepreneurship for the country's socio-economic development. The much-awaited policy also seeks to promote the use of geospatial products and services, generate useful insights from geospatial data and strengthen India's geospatial infrastructure and capabilities

- **Amazon Web Services** launched a free tool for its cloud customers, which tracks the carbon footprint of their cloud consumption – and compares it to the estimated footprint of an on-premises data centre as part of the Climate Pledge announced in 2019. AWS also launched its Innovation Pod Accelerator Programme initiative for different cohorts

- **Esri India** collaborated with the Symbiosis Institute of Geoinformatics, Pune, to empower the academic community. They launched the GeoInnovation 2022 acceleration programme for startupreneurs in partnership with AGNIi (Invest India) to help startups leverage Geospatial technology. They undertook an initiative to train 5000+ women from rural India in GIS and mobile data collection at the neighbourhood level. Esri India was certified a "Great Place to Work" for the second time in a row. They also launched Indo ArcGIS on Cloud along with Managed GIS Infrastructure Services.

- **Genesys International** received a 250-crore funding boost with the Malabar India Fund and other marquee investors joining them. They announced a strategic alliance with Esri India and a partnership with Bentley Systems for Genesys' 3D City Digital Twin Solutions for Urban India.

- **Google** launched a 3-month equity-free Google for Startups Accelerator program for Women Founders in India. The Street View feature with a 360-degree panoramic view was made available on Google Maps. Three AGI members – Google, Genesys International Corporation Ltd, and Tech Mahindra partnered for this initiative. The three companies were awarded the Innovative Partnership: Enhancing Consumer Experience Award at the Geospatial Artha Summit 2022 for adding rich content and localised features to serve Indian consumers better.

- **HERE Technologies** was recognized as the "Best Mapping Service" at the 12th India Digital Awards by the Internet and Mobile Association of India. They partnered with Zoomcar, the largest peer-to-peer (P2P) car-sharing marketplace, to reveal a city-based map of India that depicts the percentage of good, average, and bad drivers in 22 cities across the country. HERE is also powering Citility, an integrated mobility platform in India, with location services and APIs to provide vital commute information.

- **Hexagon** launched the Sixth Sense Open Innovation platform for all startups in areas such as sustainability, big data, machine learning, artificial intelligence, sensors, and robotics. Hexagon's Self-Guided Flying Laser Scanner "Leica BLK2FLY" was included in TIME's Best Inventions of 2022 list. They launched the Leica AP20 AutoPole which boosts the productivity of automated total stations to the next level through tilt compensation, automatic pole height readings, and unique target identification.

- **MapmyIndia** launched an incubation program in BITS Pilani for startups. They introduced the Mappls platform offering deep expertise in Geospatial and IoT and launched RealView 360-degree Panoramic Street View & 3D Metaverse Maps Service on the portal. MapmyIndia signed an MoU with the UP Police for improving real-time traffic safety and management. The Government of India integrated MapmyIndia Mappls APIs into ULIP to improve logistics management and delivery. Through the 'Ramayan Maps', MapmyIndia Mappls brought a unique offering that depicts the journey of the Maryada Purushottam Shri Ram – right from his birth to the establishment of the Ram Rajya. MapmyIndia also received the Innovative Marketing Campaign: Advancing Business Impact Award at the Geospatial Artha Summit 2022 in Hyderabad.

- **Maxar Technologies** acquired AI and software engineering company Wovenware to bolster machine learning and 3D data production capabilities. Through its partnership with Blackshark.ai, Maxar also extended its 3D Geospatial capabilities.

- **Oracle** tied up with India's premier communications solution provider Airtel for transforming the latter's shared services operations through automation and cloud ERP.

- **Trimble** opened their brand-new office in Chennai India. This is Trimble's biggest office space in APAC.

- **NeoGeoInfo** Technologies have expanded operations internationally with a new branch in Canada. Signed an MOU with Drone Destination for undertaking the prestigious SVAMITVA and LSM projects in the country. They inaugurated a new office in Kolkata. NeoGeoInfo also received the Award for Innovative Solutions: Advancing Value for Indian Economy at the Geospatial Artha Summit 2022.

- **Secon** launched the Real-Time Flood Forecasting & Spatial Decision Support System (RTFF & SDSS) for the Tamil Nadu government on a pilot scale to generate more localised rainfall forecasts and moderate the outflows of reservoirs in the Chennai basin.

- **TomTom** released the 11th edition of its insightful annual Traffic Index, a report detailing traffic trends seen in 404 cities in 58 countries, throughout 2021, showing how people are moving on the local and global level, in real-time and over time.

- **Avineon** announced the acquisition of Highland Mapping Inc, a provider of professional GIS services that supports local governments and other types of organizations throughout the southeastern USA.

- **Ceinsys** announced the acquisition of AllyGrow Technologies, a tech-driven multinational specializing in product design and robotics automation services. The company was able to make major headways in the US market, pitching the company's unique offerings in AEC & Manufacturing domains. On the domestic front, Ceinsys successfully developed the MY BMC BUILDING ID application which was publicly launched by the Municipal Corporation of Greater Mumbai (MCGM). The company bagged a prestigious order from Maharashtra Jeevan Pradhikaran (MJP), Mumbai for implementing state of art Asset Management software solutions in the state.

- **IIC Technologies** successfully completed the National Hydrology Project 'Provision of services for Acquisition, Processing and Delivery of DEM and Digital Orthoimagery data' for the Survey of India. They also executed a similar project for SOI under the National Mission for Clean Ganga (NMCG) initiative. In partnership with Monarch Surveyors and Engineering Consultants, IIC Technologies also successfully completed the final alignment design for the in-progress Mumbai–Pune–Hyderabad High-Speed Rail.

- **NVIDIA** held the GTC 22 putting forth the latest breakthroughs in AI, virtual collaboration, graphics, and beyond accelerating real-world results across industries.

- **CyberSWIFT Infotech** has started working with West Bengal Disaster Management & Civil Defence Department to develop eastern India's first Integrated Geospatial based Disaster Management Platform to support citizens during Disaster and Disaster Risk Reduction leveraging IT & Geospatial technologies. They have also onboarded numerous corporate clients on their land management platform.

- **Excel Geomatics** was shortlisted among the Emerging 100 Recognizing SME Businesses of India list launched by ABP Network.

- **Geospatial World** signed MoUs with the Indian Space Association, SatCom Industry Association and IIT Tirupati to collaborate in Geospatial technologies and space. The formation of the Navavishkar I-Hub Foundation at IIT Tirupati was part of their academic collaboration. They also launched two exclusive reports: The GeoBuiz Report and the Artha Report 2022. They were also the Professional Conference Organizers for the 2nd UN-WGIC 2022 in Hyderabad this year.

- **Marvel Geospatial Solutions** announced the launch of its Anti-drone system, a significant tool to counter the threat of rogue drones. The system is entirely made in India and is a network-centric detection and jammer module system. Marvel continued its global expansion in 2022 with the establishment of its Europe office in London. The company was empanelled for the nationwide SVAMITVA project and is undertaking drone surveys in Gujarat and Karnataka as part of the project.

- **Roter Group** of Companies was awarded the title of "The Best Drone Company" by the Ministry of Civil Aviation, Airports Authority of India and FICCI. Inaugurated the first drone manufacturing facility in Uttarakhand, with a capacity to produce more than 150 drones per month. The facility was inaugurated by Shri Pushkar Singh Dhami, Chief Minister, Uttarakhand. Opened new sales and services office in Noida/Delhi NCR.

- **Satpalda** signed MOU with SI Imaging Services to develop, plan, and implement collaborative remote sensing research and capacity development projects and blend SATPALDA's geospatial expertise with KOMPSAT satellite data to produce valuable products.

- **UNL** announced a strategic alliance with Genesys International to build a hyperlocal Location Technology Platform powered by a high-accuracy 3D digital map of India.

- **Excel Geomatics** proudly announced the procurement of a multitude of projects this year, including GIS-based Master Planning, DP and Zonal Planning for 6 ULBs in Bihar and a Satellite Mathematical Modeling-based Flood Plain Zoning project in Ujh River flood basin.

- **Drogo Drones** earned praise from far and wide for their usage of drones to create 3D maps of cities in India to track COVID-19 hotspots. Their solutions have already been implemented in Rajasthan, Punjab, Chhattisgarh, and Haryana so far.

- **GalaxEye** Space signed an MoU with California-based satellite software provider Antaris Inc to develop the world's first satellite containing both Synthetic Aperture Radar (SAR) and optical sensors. Deemed among the 30 most promising Indian startups of 2022 by YourStory Media. Announced their Seed Round of $3.5 million, led by Speciale Invest.

- **Garudalytics** was selected for the 2nd cohort of the Revv Up startup accelerator programme and as finalist of the Forest AI Grand Challenge by the Telangana AI Mission (T-AIM). They launched the Garudalytics Smart Mapping (GSM) platform on their first corporate anniversary. Garudalytics signed MoUs with the Lakireddy Bali Reddy College of Engineering, Andhra University, and Adikavi Nannaya University for academic, research, and skilling cooperation. They received the Award for Innovative Startups: Advancing Analytics for Impact at the Geospatial Artha Summit 2022.

- **Nebula Cloud** launched the Agisoft Metashape Professional Edition for customers in India. The photogrammetry and digital image processing software is completely hosted in India. launched Nebula Cloud Workbench for GIS Professionals in the Indian market, focused on the Geospatial industry.

- **Prakhoj** launched the Zonociti app that provides a data-driven relative ranking of localities in a city. Localities are compared on various parameters using GIS-integrated information analyses. Different stakeholders may use these rankings in different ways, the crux being well-integrated planning and decision-making at a local scale.

Association of Geospatial Industries (AGI)

- AGI celebrated its **13th Raising Day** in 2022. The new Governing Council and Office Bearers were elected for a two-year term, with Mr. Pramod Kaushik, Managing Director, Hexagon India, as the new President of AGI. The AGI Secretariat also welcomed Mr. Satej Panditrao joining as the Technical Manager.

- On 15th February 2022, AGI co-hosted an interactive session with DST to commemorate the completion of **one year of the launch of Geospatial Guidelines**, reflect upon its impact on the Geospatial industry and the users, and discuss the expectations ahead given the reformed outlook. The session was graced by the presence of Union Minister Dr. Jitendra Singh, Secretary DST Dr. S Chandrasekhar, Surveyor General and JS, DST Shri Sunil Kumar.

Interactive Session on the Completion of One Year of Launch of Geospatial Guidelines

- AGI India's flagship annual conference, the **India Geospatial Leadership Summit 2022**, was a resounding success. Themed on "Geospatial Technologies Supporting Economic Development", IGLS 2022 was hosted by AGI in hybrid mode. The event was graced by 42 speakers from all over the country, 140 delegates and 1200 online attendees, including government, private sector, and academia. AGI also gave away the 2022 Excellence Awards to various user organizations across categories.

India Geospatial Leadership Summit 2022

Policy Advocacy

- Impact discussions with the Government on Geospatial Guidelines, Drone and Remote Sensing Policies
- Voicing industry expectations out of Government initiatives like the Self-Certification Portal, CORS Network, etc.
- Sharing key announcements and analysis of Policies, Bills, and the Union Budget with the AGI member ecosystem, including the National Logistics Policy 2022.

Collaborations and Engagements

- 4 Steering Committees formed: Agriculture, Infrastructure, Urban, Water
- Report on Role of Geospatial Technologies for Urban Affairs released, endorsed by leading think tank National Institute for Urban Affairs (NIUA), and launched by Smart Cities Mission, MoHUA, Director Rahul Kapoor, and Ghaziabad Municipal Commissioner IAS Mahendra Singh Tawar, along with AGI President Pramod Kaushik and Senior Vice President Nikhil Kumar at the in-person AGI Urban Meet 2022.

Release of the Report on Role of Geospatial Technologies for Urban Affairs

- Part of Working Group on Use Case Development for Urban Sector at the Industry-Academia-Government Conclave, GISE Hub – IIT Bombay & NSDI
- Conducted Webinar with MoHUA for Geospatial industry on building use cases on India Urban Observatory data
- Conducted Meeting with DST on National Data Registry Geoportal for data monetisation, EoDB and data integration
- Industry Engagement in Promoting Ease of Doing Business

Standards Development

- Active member of the Bureau of Indian Standards giving feedback to ISO/TC211. AGI also delivered a presentation during the BIS seminar on the Standards National Action Plan (SNAP) on making the Indian Geospatial landscape future-ready in terms of comprehensive, strategic standards.
- Mutual partnership with the Open Geospatial Consortium and participation in the OGC India Forum Meeting 2022.
- Technical discussions with the Government on Spatial Data Quality Certification, NSDI, National Data Registry, etc.

Skilling and Capacity Development

- AGI conducted a training program at NIGST, Survey of India, as a follow-up to the MoU between SoI and AGI on skilling. 18 officers of SOI participated in the training program.

Training program at NIGST, Survey of India, part of the MoU between SoI and AGI on Skilling

- Task Force on Capacity Development formed under the vision and leadership of AGI's Past President Dr. Rajesh C. Mathur.
- Signed MoUs with CEPT University, CEPT Research and Development Foundation (CRDF) and School of Planning and Architecture, New Delhi.
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2nd UN-WGIC 2022

AGI actively participated in the 2nd UN-WGIC 2022. Our booth in the event exhibition showcased what we do for the Geospatial industry in India, aligned with the vision of Geo-Enabling the Global Village.

The AGI Secretariat was instrumental in the making of the IGIF Report launched at the 2nd UN-WGIC, having mobilized case studies from the Indian Geospatial industry and mapping case studies with the Nine Strategic Pathways of the UN-IGIF, along with writing, editing, and reviewing the entire report.

- AGI President Pramod Kaushik was part of the Panel for the side event on 'Indian Evolving Geospatial Ecosystem: Dialogue with Global Stakeholders' as the representative of the Geospatial industry in India.
- AGI Secretary General Sreeramam G V addressed the side event on 'Bridging Academia and Industry in Geospatial Research, Education and Training' putting forth the industrial perspective.
- AGI Director Megha Datta (She/Her) was an esteemed judge for the side event on 'Geo enabling the global village with Generation Z and Alpha' evaluating presentations by 19 urban and rural schools from across India.
- AGI organised a Special Side Event on 'Matchmaking Forum for the Indian Geospatial Industry and National Government Agencies' with participation from multiple National Mapping Agencies across the Americas, Europe, and Asia, discussing potential partnerships with AGI members.

Side Event on 'Matchmaking Forum for the Indian Geospatial Industry and National Government Agencies' organized by AGI at 2nd UN-WGIC 2022