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DEPARTMENT OF
SCIENCE & TECHNOLOGY

सत्यमेव जयते

भारतीय सर्वेक्षण विभाग
Survey of India

Report
on
National Workshop on Strengthening of Geospatial Ecosystem 2025

"Geospatial Mission: An Enabler of Viksit Bharat"

SURVEY OF INDIA

Department of Science & Technology
Government of India

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Table List of Abbreviations

AGI	Association of Geospatial Industries
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
API	Application Programming Interface
BIS	Bureau of Indian Standards
CORS	Continuously Operating Reference Stations
DEM	Digital Elevation Model
DORIS	Doppler Orbitography and Radio positioning Integrated by Satellite
GDPDC	Geospatial Data Promotion and Development Committee
GAM	Geodetic Asset Maps
GAR	Geodetic Asset Registers
GDI	Geospatial Data Interface
GeoAI	Geospatial Artificial Intelligence
Geo-ICT	Geospatial Information and Communication Technology
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
IHO	International Hydrographic Organization
GRF	Geodetic Reference Frame
INCOIS	Indian National Centre for Ocean Information Services
IoT	Internet of Things
ISO	International Organization for Standardization
ISRO	Indian Space Research Organisation
ITRF	International Terrestrial Reference Frame
LiDAR	Light Detection and Ranging
MoES	Ministry of Earth Sciences
NAKSHA	National geospatial Knowledge-based land Survey of urban Habitations
NGRF	National Geodetic Reference Frame

NHRF	National Horizontal Reference Frame
NIGST	National Institute of Geo-Informatics Science and Technology
NGDR	National Geospatial Data Registry
UGI	Unified Geospatial Interface
NGM	National Geospatial Mission
NUIS	National Urban Information System
NVRF	National Vertical Reference Frame
OGC	Open Geospatial Consortium
ORI	Orthorectified Imagery
OSM	Open Series Maps
PNT	Positioning, Navigation and Timing
SLR	Satellite Laser Ranging
SVAMITVA	Survey of Villages and Mapping with Improvised Technology in Village Areas
UAV	Unmanned Aerial Vehicle
UN-GGCE	United Nations Global Geodetic Centre of Excellence
VLBI	Very Long Baseline Interferometry

1. Introduction

The Survey of India, Department of Science &Technology, hosted the **National Workshop on Strengthening of Geospatial Ecosystem, "Geospatial Mission: An Enabler of Viksit Bharat"** on 17 December 2025 at Yashobhoomi, Sector 25, Dwarka, New Delhi.

The National Workshop brought together policymakers, administrators, academicians' technologists, industry leaders, and international experts to deliberate on current development in geo-spatial sector after the National Geospatial Policy 2022 and discussed the challenges& innovations shaping India's geospatial future. Various Central Government Ministries/Departments, nodal agencies of fundamental data themes, State government representatives, Industry and academia, were invited to be part of this National Event. More than 480 delegates (Central govt. 200, State govt. 120; Industry 100; Academia 48) from these agencies participated in-person and more than 200 plus delegates attended the conference in virtual mode.

The aim of the Workshop was to provide a platform for discussion among various stakeholders of Geospatial sector from both Public and Private Sectors. The workshop aimed towards enhancing the cooperation and coordination between state government agencies and central government agencies for creation of foundational Geospatial infrastructure and data for the country to meet the needs of various Ministries, Departments and State Governments.

The event focussed on the modernization of the National Geodetic Reference Frame as the backbone for precise positioning and national-scale applications, alongside strengthening geospatial data generation through high-quality Orthorectified imagery, digital elevation models. A strong focus was placed on the role of standards in harmonising geospatial data to ensure interoperability, seamless data exchange, and integration across government, industry, researchers and academia, supported by national initiatives such as NGDR, UGI, and BIS-led standardisation efforts.

The workshop also addressed the need to keep pace with rapid technological advancements including GeoAI, digital twins, advanced 3D mapping, and real-time analytics, highlighting capacity building, research collaboration, and innovation as key enablers. To achieve the aim of the National Workshop and address the topics, the programme was divided in four sessions that underscored geospatial infrastructure as a critical national asset and a key enabler for governance, infrastructure development, sustainability, and the vision of Viksit Bharat 2047.

2. Background

Geospatial information has evolved into the bedrock of modern governance, supporting essential sectors such as smart infrastructure, precision agriculture, land administration, and disaster management. As India transitions toward a digital and knowledge-driven economy, the need to unify fragmented datasets and eliminate "silos" between government, industry, and academia has become paramount. The workshop was designed to address core challenges, including data accessibility, interoperability, and the duplication of efforts among various agencies.

Policy Evolution and Liberalization

The workshop comes at a transformative period for the sector, following a decade of significant policy shifts:

i. **Historical Context:** Pre-2000, geospatial data was highly restricted and security-centric. The National Map Policy 2005 made the first attempt to formalize access by defining Open Series Maps (OSM).
ii. **The Liberalization Milestone:** In February 2021, India introduced a historic liberalization of geospatial data guidelines, allowing the private sector to collect and process data without prior approvals.
iii. **National Geospatial Policy (NGP) 2022:** This citizen-centric policy established a 15-year vision to make India a global leader in the domain by 2035. It identified 14 National Fundamental Geospatial Data Themes—such as Elevation, Orthoimagery, and Transport Networks—assigning nodal ministries to each to ensure authoritative data generation.

The National Geospatial Mission (NGM)

Announced by the Hon'ble Union Finance Minister in the 2025-26 Budget Speech, the National Geospatial Mission is a transformative program intended to build the nation's digital spatial backbone. Under the leadership of the Survey of India, the Mission focuses on five core components:

i. **Modernizing the National Geodetic Reference Frame (NGRF)** to ensure global and regional level integration with precision.
ii. **Strengthening Mapping Infrastructure** through high-resolution ORI, DEM using aerial/UAV imagery, LiDAR and satellite imagery.
iii. **Establishing Geo-ICT Infrastructure** via a unified national geospatial web portal and API based services.
iv. **Training and Capacity Building** for skilling manpower at various level form field to supervisory/managerial roles.
v. **Indigenous Technology Development** to align with the vision of Atmanirbhar Bharat.

By fostering collaboration, standardizing data frameworks, and promoting indigenous innovations the workshop aims to unlock the full potential of geospatial intelligence, supporting India's journey toward a $30 trillion economy by 2047 and the vision of a Viksit Bharat.

3. Inaugural Session

The National Workshop on Strengthening of the Geospatial Ecosystem -2025 marked an important milestone in advancing India's geospatial vision in alignment with the proposed National Geospatial Mission. The inaugural session set the strategic context for the workshop by underlining the critical role of geospatial infrastructure as an enabler for Viksit Bharat, supporting governance, economic growth, national security, and technology-led development.

Inauguration of the Session by the lighting of the lamp by the *Guest of Honour, Prof. Abhay Karandikar, Hon'ble Secretary, DST, along with Shri Srikant Sastri, Chairman, GDPDC, Shri Hitesh Kumar S. Makwana, IAS, Surveyor General of India, Vice Admiral Lochan Singh Pathania, Chief Hydrographer and Shri Shailesh Kumar Sinha, Additional Surveyor General, Survey of India (From Right to Left)*

Dr. Jitendra Singh, Hon'ble Union Minister of State (Independent Charge) for Science & Technology, highlighted the landmark geospatial liberalisation reforms of 2021, followed by the National Geospatial Policy, 2022, stating that these measures have democratised access to high-accuracy geospatial data, spurred innovation, strengthened industry participation and significantly expanded the use of geospatial technologies across domains. Building on this momentum, he said, the National Geospatial Mission has been launched as a transformative, whole-of-government initiative to create a modern, accurate and accessible national geospatial infrastructure aligned with the vision of Viksit Bharat 2047.

The Hon’ble Minister emphasised that national priorities such as smart cities, road and rail infrastructure, precision agriculture, logistics optimisation, natural resource management, disaster risk reduction, climate action, and next-generation defence preparedness will increasingly depend on reliable, interoperable, and robust geospatial data. Commending the Survey of India, he noted that as the country’s oldest and most trusted mapping organisation, it has played a pivotal role in strengthening India’s geospatial ecosystem and supporting nation-building through technological modernisation and institutional leadership.

Shri Hitesh Kumar S. Makwana, IAS, Surveyor General of India, addressed and welcomed dignitaries, senior officials from Central and State Governments, representatives from industry, academia, international experts, and other stakeholders. In his welcome address, the Surveyor General highlighted the modernization of India’s National Geodetic Reference Frame as a core priority of Survey of India. He informed that over 1,100 Continuously Operating Reference Stations (CORS) have been established across the country and efforts are underway to integrate CORS set up by States and research institutions to create a common national reference frame. More than 15,000 users across government and private sectors are already using CORS services, while increasing adoption and sectoral usage remains a key focus area.

Survey of India’s role as the national mapping agency and key initiatives undertaken in recent years were outlined. Several important initiatives undertaken by Survey of India were also highlighted, including the preparation of State- and District-wise Geodetic Asset Registers (GAR) and Geodetic Asset Maps (GAM),state maps in regional languages and the creation of a Digital Data Register to enable wider discovery and reuse of geospatial datasets. He emphasized that Survey of India has transitioned from a closed data regime to a more open and collaborative approach, aligning with the National Geospatial Policy, 2022.Key national programmes such as SVAMITVA, NAKSHA, AMRUT), National Hydrology Project, and National Urban Information System (NUIS) were highlighted as examples where Survey of India is playing a critical role. Also, ongoing efforts in standard development, including the constitution of thematic working groups and coordination with BIS and State Governments to ensure nationwide harmonization were also highlighted.

The inaugural session also had a Special Address by Shri Srikant Sastri, Chairman, Geospatial Data Promotion and Development Committee (GDPDC). He highlighted the central role of geospatial technology in India’s economic growth and governance, underscoring the need for indigenous, reliable, and interoperable geospatial infrastructure to achieve Viksit Bharat, stating ‘Geospatial Bharat - Viksit Bharat’. Drawing on successful pilot programmes under Operation Dronagiri, particularly the Varanasi agriculture use case, demonstrated how integrated geospatial data and public-private collaboration can deliver tangible gains in productivity and farmer incomes, reinforcing the case for a national-scale, standards-based geospatial platform.

Vice Admiral Lochan Singh Pathania, Chief Hydrographer, underscored the close linkage between hydrography and geospatial sciences, highlighting the role of hydrographer’s in navigational charting and the wide applications of hydrographic data in shipping, tourism, and exploration. International cooperation, overseas deployments, and large-scale training initiatives were emphasized, while expressing that the workshop will identify key challenges and generate new ideas, presenting opportunities for future development and collaboration.

The inaugural session concluded with the Keynote Address by Prof. Abhay Karandikar, Secretary, Department of Science and Technology (DST). He emphasized the need for a robust governance framework, strong standards, interoperability, and research-led innovation to support the next phase of geospatial growth. He highlighted DST's support for geospatial R&D, start-ups, technology innovation hubs, and capacity building, and reaffirmed the Government's commitment to making the geospatial ecosystem future-ready, inclusive, and globally competitive.

On the occasion, the Survey of India Coffee Table Book was launched by Dr. Jitendra Singh, Hon'ble Union Minister of State (Independent Charge) for Science & Technology, showcasing Survey of India legacy, technological evolution, and contribution to India's growth journey.

A Survey of India documentary chronicling the journey and evolution of survey of India, was also launched on the occasion.

Inauguration of the Coffee Table Book of Survey of India (SOI) by Dr. Jitendra Singh, Hon'ble Minister of State (I/C), Ministry of Science & Technology (virtually) along with the distinguished dignitaries on the dais, Prof. Abhay Karandikar, Hon'ble Secretary, DST (Centre), Vice Admiral Lochan Singh Pathania, Shri Srikant Sastri, Shri Hitesh Kumar S. Makwana, IAS and Shri Shailesh Kumar Sinha (from right to left)

The inaugural session set a strong foundation for the workshop by clearly articulating the strategic importance of geospatial data, the role of Survey of India as the national mapping authority, and the need for coordinated action across government, industry, academia, and international partners to realize the objectives of the geospatial policy, National Geospatial Mission and Viksit Bharat 2047.

4. Technical Sessions

Session 1: Modernization and Strengthening of National Geodetic Reference Frame

Objective:

- To highlight the urgent need for redefining and modernizing the NHRF and NVRF in alignment with global best practices (ITRF-2020, IHRF).
- To highlight the necessity of using NHRF & NVRF for consistent, accurate, and unified coordinate reference system for the entire country.
- To demonstrate how a strengthened NGRF enables high-precision applications in urban planning, land governance, hydrology, flood modelling, coastal monitoring, and national infrastructure design.
- To foster collaboration among government, academia, industry, and international agencies for strengthening India's geodetic capabilities in alignment with global best practices.
- To reinforce alignment with the National Geospatial Policy 2022 and the larger vision of building an accurate, integrated, and future-ready geospatial ecosystem for Viksit Bharat.

Overview:

The session on "Modernization and Strengthening of the National Geodetic Reference Frame" focused on outlining the scope for strengthening the foundational reference framework required for precise positioning and mapping in India, with emphasis on the redefinition and strengthening of both the National Horizontal Reference Frame (NHRF) and the National Vertical Reference Frame (NVRF). The session was intended to highlight the existing Continuously Operating Reference Stations (CORS) infrastructure and the need for densification of the network, along with the integration of advanced space geodetic techniques such as VLBI, DORIS, and SLR. In addition, the session proposed to address the development of a high-accuracy Geoid Model using gravity and levelling data, as well as the modernization of tidal observatories to support robust sea-level monitoring, while highlighting the relevance of these initiatives for ensuring uniformity in mapping, long-term Earth surface monitoring, and the enhancement of Positioning, Navigation and Timing (PNT) services across sectors such as agriculture and infrastructure development.

Chair	**Sh. Alok Prem Nagar, Additional Secretary, Ministry of Panchayati Raj**
Speaker	Prof. Onkar Dikshit, Coordinator, National Centre for Geodesy, IIT Kanpur
Speaker	Cdr. Prashant Kumar Srivastava, Scientist-G/Advisor, Ministry of Earth Sciences (MoES)
Speaker	Sh. G Varun Kumar, Additional Surveyor General, The National Institute of Geo-Informatics Science and Technology (NIGST)
Speaker	Dr. Balakrishnan Nair T.M Director, INCOIS
Speaker	Sh. Sajid Malik, Chairman & Managing Director, Genesys International Corporation
Distinguished International Speaker	Mr. Olivier Casabianca, Vice President, Trimble Advanced Positioning

Speaker's address/Discussion Summary:

The session on **Modernization and Strengthening of the National Geodetic Reference Frame** highlighted critical role of a modern and dynamic geodetic reference framework as a foundational national infrastructure supporting governance, infrastructure, disaster resilience, research, the blue economy, and emerging applications such as digital twins and autonomous navigation. It traced the evolution of India's geodetic system from the Great Trigonometrical Survey to GPS-based Ground Control Points and the current CORS network, noting that 1,145CORS stations, initially driven by the SVAMITVA programme, now provide a robust horizontal reference framework enabling real-time, centimetre-level positioning accuracy.

A key focus of the session was on the transition from static to dynamic reference frames, recognizing that India lies on a tectonically active plate moving approximately 5 cm per year. The proposed approach involves implementing both plate-fixed and dynamic reference frames, aligned with the International Terrestrial Reference Frame (ITRF 2020)**,** while accounting for intra-plate deformation, seismic activity, and long-term geophysical changes. Advanced space geodetic techniques such as VLBI, DORIS, and Satellite Laser Ranging (SLR) were identified as critical components for strengthening the national horizontal framework and ensuring global interoperability.

On the vertical reference side, the session highlighted the limitations of the 1909 mean sea level–based datum for modern applications and emphasized the need for a high-accuracy national geoid model using gravimetric, GNSS, levelling, and satellite data. The discussions underscored the importance of modernizing tidal observatories, gravity networks, and co-located GNSS–tide gauge stations to enable reliable sea-level monitoring, coastal vulnerability assessment, and climate change analysis.

The session also highlighted cross-sectoral applications of the modernized reference frame. From the Ministry of Panchayati Raj, the SVAMITVA experience illustrated how CORS-enabled surveying significantly reduced time and cost, improved land record accuracy, enhanced property tax revenues, and enabled integration with social welfare datasets at the Gram Panchayat level. It was emphasized that wider adoption by State departments remains a critical gap, requiring awareness-building and demonstrable use cases.

From an oceanographic and blue economy perspective, it was highlighted that precise geodetic control is foundational for tsunami early warning systems, storm surge modelling, coastal inundation mapping, and marine spatial planning. A dynamic national reference frame was positioned as essential for separating sea-level rise from vertical land motion, especially along India's extensive and tectonically sensitive coastline.

Industry inputs demonstrated how high-precision geodetic infrastructure is already enabling digital twins, urban flood modelling, infrastructure planning, and ADAS-level navigation mapping for highways and expressways. It was emphasized that the economic and social benefits generated from these applications significantly outweigh the cost of geodetic infrastructure, provided the CORS network is adequately densified, reliably operated, and properly maintained.

Academic perspectives highlighted the need for indigenous capability development, including GNSS processing, NavIC integration, quality assessment of CORS stations, epoch-based reference frame realization, and long-term sustainability of the framework. The importance of capacity building, R&D, and continuous adjustment of the reference frame was strongly emphasized. International experience reinforced that India's efforts align with global best practices adopted by countries such as the USA, Canada, and Australia, and that industry readiness, standards compliance, and phased transition strategies are essential to minimize disruption to surveyors and users.

The chair concluded the session with a strong emphasis on usage, maintenance, and sustainability. The launch of Geodetic Asset Registers and Maps was highlighted as a progressive step towards sustainability, transparency and long-term stewardship.

Announcement of United Nations Global Geodetic Centre of Excellence (UN-GGCE) Multilateral MoU:

The session marked a significant milestone with Survey of India's participation in the United Nations Global Geodetic Centre of Excellence (UN-GGCE) Multilateral MoU**,** reinforcing India's commitment to the global geodetic supply chain and international collaboration.

Announcement of the United Nations Global Geodetic Centre of Excellence (UN-GGCE) Multilateral Memorandum of Understanding (MMoU)

Session Takeaways:

1. Geodetic Reference Frame as National Infrastructure

i. The geodetic reference frame is a foundational national asset, comparable to roads, power grids, and digital identity systems, and is essential for precision governance, infrastructure development, and economic growth.

ii. Accurate positioning underpins applications across land records, disaster management, agriculture, transportation, urban planning, blue economy, and national security.

iii. Development of dynamic reference systems alongside static

iv. India must move decisively from static coordinate assumptions to dynamic, time-dependent reference frames that reflect tectonic motion and Earth system dynamics.

2. **Strengthening the CORS Network**
    i. The existing CORS network represents a major achievement, but **further densification (**25–30 km spacing) is essential for universal usability across sectors.
    ii. Awareness and adoption among State departments and private industry remain limited and must be actively addressed through targeted outreach and use-case demonstration.
3. **Modernization of Vertical Reference Framework**
    i. The legacy mean sea level datum is inadequate for modern needs; transition to geoid-based, geopotential height systems is essential.
    ii. Integration of gravity data, GNSS, levelling, and modernized tidal observatories is critical for climate resilience and coastal risk management.
4. **Sectoral Impact and Societal Value**
    i. SVAMITVA demonstrated tangible benefits in rural governance, land tenure security, revenue enhancement, and service delivery.
    ii. Oceanography, disaster warning systems, and blue economy applications depend critically on accurate vertical and horizontal referencing.
    iii. Urban digital twins, flood modelling, infrastructure alignment, and autonomous navigation require centimeter-level accuracy at scale.
5. **Industry Enablement and Economic Returns**
    i. Private sector applications are already generating significant economic and safety benefits, including high-definition mapping and ADAS-enabled navigation.
    ii. Maximizing return on public investment requires ensuring data accessibility, reliability, and long-term operational stability of the geodetic infrastructure.

6. **Indigenous Capability, Standards, and Capacity Building**
    i. Emphasis on improved indigenous capability in GNSS processing, NavIC integration, space geodesy, and reference frame realization.
    ii. Alignment with OGC and BIS standards is essential to ensure seamless adoption across software platforms and minimize transition risks.

7. **CORS network densification and sustained maintenance** are critical to enable centimetre-level real-time positioning, reduce survey costs, and supplement legacy workflows.

8. India's participation in the **UN Global Geodetic Centre of Excellence MOU** reinforces its commitment to global geodesy and opens pathways for international collaboration and leadership

The session on "Modernization and Strengthening of the National Geodetic Reference Frame" chaired by Sh. Alok Prem Nagar (Center), Additional Secretary, Ministry of Panchayati Raj, along with the speakers on the dais Mr. Olivier Casabianca, Sh. Sajid Malik, Dr. Balakrishnan Nair T. M., Sh. G. Varun Kumar, Cdr. P. K. Srivastava, and Prof. Onkar Dikshit (from right to left).

Session 2: Strengthening of Geospatial Data and Mapping Infrastructure

Objective:

- To highlight the national requirement for authoritative ORI and DEM datasets covering all terrains, including challenging and high priority urban regions.
- To discuss the urgent requirement of a structured Geo-ICT framework for the efficient acquisition, processing, dissemination, and seamless integration of these large-scale geospatial datasets.
- To outline approaches for digitizing, standardizing, and integrating Survey of India's as well as other Ministries/ Organizations extensive legacy records within modern geospatial workflows.
- To emphasize the importance of interoperable, standardized, and high accuracy geospatial frameworks for governance, planning, and infrastructure development.
- To explore how strengthened mapping infrastructure supports land records modernization, disaster management, environmental conservation, and urban development.
- To encourage collaboration among government, industry, and academia to accelerate nationwide mapping and modernization efforts.

Overview:

The session on "Strengthening of Geospatial Data and Mapping Infrastructure" set the context for deliberations on enhancing the availability, quality, and usability of foundational geospatial datasets to support national development priorities. This session addressed the critical need for high-quality foundational geospatial data with a focus on the generation of Orthorectified Imagery (ORI) and Digital Elevation Models (DEM) for the entire country. The session was intended to outline the approach for nationwide mapping using different acquisition technologies suited to varied terrain types, with particular emphasis on urban areas. It also proposed to cover the comprehensive re-engineering and digitization of Survey of India's extensive legacy geospatial records to enable standardization, seamless integration, and improved usability across government systems and facilitating modernization of land records, urban planning, disaster management, and infrastructure project design.

Chair	**Sh. Srikant Sastri, Chairman, GDPDC**
Speaker	Sh. S. V. Singh, Additional Surveyor General, Survey of India
Speaker	Dr. Manabendra Saharia, Associate Professor, IIT Delhi
Speaker	Dr. Prakash Chauhan, Director, NRSC
Speaker	Mr. Rohan Verma, Director, MapmyIndia and MD Mappls DT
Speaker	Sh. Seeram SambasivaRao, IAS, Special Secretary (E & IT) and Director, Survey and Land Records, Government of Kerala.(***Virtual Mode)***
Distinguished International Speaker	Dr. Yury Filippov, Head of Department of the National Spatial Data System Centre for Information, (***Virtual Mode)***

Speakers address/Discussion Summary:

The session on Geospatial Data and Mapping Infrastructure focused on strengthening India's foundational geospatial capabilities as a critical enabler for economic development, technology sovereignty, and data-driven governance. The Chair emphasized that a common national geodetic reference framework is indispensable for interoperability, comparing it to a shared time standard without which coordination would be impossible. Building on the previous session on geodetic reference systems, this session examined how foundational geospatial data, technology platforms, applications, interoperability, and stakeholder collaboration together form the backbone of India's geospatial ecosystem.

The session outlined five key thematic areas: identification of foundational datasets; technology infrastructure for managing large-scale data; development of applications for economic and societal benefit; interoperability across datasets and systems; and collaboration among government, industry, academia, and international partners.

The session discussed Kerala's Digital Survey Mission as a scalable best-practice for land governance, demonstrating the digitisation of legacy land records through integrated IT systems, unique parcel IDs, citizen participation, and CORS-enabled surveying. It also showcased Survey of India's work under the National Hydrology Project, which enabled large-scale generation of high-resolution LiDAR-based DEMs, GIS-ready geodatabases, geoid models, bathymetric data, and operational CORS networks, marking a shift from map-based outputs to structured geospatial datasets with strong capacity building across institutions.

From an industry perspective, it was emphasized that Orthorectified Imagery (ORI) and DEMs should be treated as national digital infrastructure, comparable to roads or power grids. The importance of adopting terrain-specific acquisition strategies, ensuring frequent updates for urban areas, and preventing post-collection fragmentation was strongly underlined. The session stressed that interoperability is not limited to file formats, but includes APIs, services, coordinate reference consistency, versioning, lineage, and the ability to stream and analyse data rather than merely download it. User experience was identified as a critical success factor, particularly for government users who are not GIS specialists.

The academic perspective highlighted the need for geospatial sovereignty beyond data ownership, extending to ownership of scientific models and decision-making systems. While India has made strong progress in data acquisition, reliance on proprietary and commercial models especially in hydrology and hazard modelling, was identified as a strategic vulnerability. The session showcased indigenous, GPU-based flood modelling and digital twin development, demonstrating significant gains in accuracy and computational efficiency and underscoring the importance of open standards and open-source technologies for long-term sustainability.

Interoperability challenges arising from diverse data sources like satellites, aerial platforms, drones, LiDAR, radar, and ground sensors, were discussed, with emphasis on OGC-compliant standards and strong geodetic foundations as enablers of integration. The need to safeguard

India's sovereign satellite data capabilities, particularly for high-resolution imagery, was highlighted to avoid over-dependence on foreign sources during the transition to greater private sector participation.

An international perspective from the Russian Federation illustrated the implementation of a National Spatial Data System that integrates geodetic networks, official maps, real estate data, and value-added services into a single, web-based platform. The system's focus on openness, standardized services, frequent updates, and ease of use demonstrated how geospatial platforms can bridge the gap between data availability and real-world usage by government, businesses, and citizens. The speaker emphasized that innovation should prioritize sharing experiences and best practices, rather than distinctions between national and international software ecosystems.

The chair concluded the session by reinforcing that geospatial data and mapping infrastructure are no longer technical back-office functions, but constitute national decision-making infrastructure requiring sustained investment, strong institutional stewardship, interoperability by design, and close collaboration across stakeholders.

Session Takeaways:

1. **Foundational Importance of Geospatial Infrastructure**
   i. A unified geodetic reference framework is essential for ensuring that geospatial datasets, maps, and applications can interoperate seamlessly across sectors and jurisdictions.
   ii. Foundational datasets such as ORI, DEMs, geodatabases, and CORS networks must be treated as long-term national infrastructure assets.
   iii. Scalable land governance reform and advanced geospatial applications are achievable through high-quality surveys, GIS-ready data generation, robust CORS infrastructure, and strong institutional coordination.
2. **Interoperability and Data Sovereignty**
   i. Interoperability must extend beyond data formats to include APIs, consistent reference frameworks, versioning, and platform-based access to avoid fragmentation after data collection.
   ii. Long-term geospatial sovereignty depends not only on data ownership but also on indigenous control over models, analytical workflows, and decision systems, supported through open-source innovation.
3. **Need for Sustained Satellite and Sensor Capabilities**
   i. Ensuring continuity of high-resolution satellite data from independent sources is essential to avoid data gaps during the transition to increased private sector participation. Public investment must continue in space-based, aerial, and ground-based observation systems.
4. **Value of International Experience and Collaboration**
   i. International examples demonstrated that integrating data, standards, services, and people into a single national platform can significantly reduce the gap between data availability and actual usage.

ii. Knowledge exchange and sharing of best practices are more valuable than rigid distinctions between domestic and international software ecosystems.

Sh. Srikant Sastri, Chairman, GDPDC(Center) led the session on "Strengthening of Geospatial Data and Mapping Infrastructure," with speakers on the dais: Mr. Rohan Verma, Dr. Prakash Chauhan, Sh. S. V. Singh, and Dr. Manabendra Saharia (from right to left).

Sh. Seeram Sambasiva Rao, IAS, Special Secretary (E & IT) and Director, Survey and Land Records, Government of Kerala and distinguished international speaker Dr. Yury Filippov, Head of Department, National Spatial Data System Centre for Information joined Virtually.

Session 3: Role of Standards in harmonizing geospatial frameworks

Objective

- To highlight the importance of unified geospatial standards for ensuring interoperability, data consistency, and quality across national datasets.
- To understand the role of standards in harmonizing legacy and newly generated data, aligning with frameworks such as NHRF, NSRF, NGDR, and UGI.
- To understand the role of standards in harmonizing legacy and newly generated data, aligning with frameworks such as NHRF, NSRF, NGDR, and UGI.
- To encourage research and innovation in academia for advancing standard-driven geospatial technologies and methodologies.
- To support evidence-based governance by integrating standardized geospatial data into planning, monitoring, and service delivery workflows.
- To align standardization efforts with the National Geospatial Policy 2022 and the broader vision of Viksit Bharat.

Overview:

The session on “Role of Standards in Harmonizing Geospatial Frameworks” was designed to examine the importance of geospatial standards in advancing the objectives of the National Geospatial Mission, with a focus on the need for standardized data frameworks and schemas to enable interoperability, system integration, and seamless data exchange across government departments, private industry, academia, and civil society. The session was intended to address approaches for harmonising and standardising both legacy and newly generated geospatial datasets originating from diverse producers and formats, with particular emphasis on ensuring alignment with the redefined National Horizontal Reference Frame (NHRF) and facilitating the operationalisation of the National Geospatial Data Registry (NGDR) and the Unified Geospatial Interface (UGI). It was also envisaged that the session would highlight the importance of defining and adhering to quality standards and accuracy benchmarks for foundational geospatial data products, such as Orthorectified Imagery (ORI) and Digital Elevation Models (DEMs), which are critical for applications including land records modernisation, urban planning, and other governance and development use cases.

Chair	**Dr. Debapriya Dutta, Chairman, LITD-22, Bureau of Indian Standards (BIS)**
Speaker	Dr. Rajendra Gaikwad,Scientist, Space Application Centre, Ahmedabad(*Virtual Mode)*
Speaker	Sh. Sandeep Shrivastava, Additional Surveyor General, Survey of India
Speaker	Sh. Nikhil Kumar, President, Association of Geospatial Industries (AGI)
Speaker	Sh. Sanjay Sinha, Sr consultant, Office of CS, Govt of Andhra Pradesh
Speaker	Cmde. Mathew G Abraham, National Hydrographic Office
Distinguished InternationalS peaker	Dr. Zaffar Sadiq Mohamed-Ghouse, Director of Advisory & Innovation, Woolpert &Vice Chair, Board of Director, OGC (*Virtual Mode*)

Speakers address/Discussion Summary:

The session on "Role of Standards in Harmonizing Geospatial Frameworks" focused on the critical importance of standards as an enabling backbone for India's evolving geospatial ecosystem, particularly in the context of the National Geospatial Policy 2022, Digital India, PM GatiShakti, and the forthcoming National Geospatial Mission.

The session highlighted that despite significant progress in geospatial data generation, long-standing challenges continue to persist, including fragmented datasets, incompatible schemas, lack of interoperability, inconsistent metadata, and duplication of effort across ministries and states. It was emphasized that while data availability has improved, the absence of operational, enforceable standards limits integration, reuse, and value realization.

Global standards developed under ISO TC-211 and OGC were discussed as foundational enablers, covering metadata (ISO 19115), data quality (ISO 19157), APIs (ISO 19168), geodetic reference systems (ISO 19111/19161), and web services (WMS, WFS, CSW).

Key Indian initiatives were highlighted, including:

i. Development and promulgation of BIS geospatial standards under LITD-22, with over 16 standards already in force and several under development for soil, geology, forests, LiDAR, and NavIC receivers.

ii. Survey of India's leadership in operationalising standards through Geospatial Data Interface (GDI) under PM GatiShakti, demonstrating how ISO-OGC compliant layers enabled expressway alignment decisions within 48 hours while avoiding ecological and heritage impacts.

iii. Establishment of thematic working groups within Survey of India for fundamental data themes of geodetic reference frame, elevation, Orthorectified imagery, functional area (administrative boundary), Geographical Names, and database harmonization.

iv. Ongoing development of National Geospatial Data Registry (NGDR) and Unified Geospatial Interface (UGI) as standard-based discovery and access platforms.

The importance of metadata as the first interface between users and data was discussed in detail, tracing India's journey from NNRMS standards (1998) to NSDI Metadata Standard (2009), subsequent BIS standards, and the latest revisions aligned with ISO 19115. Metadata was emphasized as essential for data discovery, assessment of fitness for use, FAIR principles (Findable, Accessible, Interoperable, Reusable), and automated data exchange.

State-level experience demonstrated how standards and integration improve governance outcomes. Andhra Pradesh's Real-Time Governance System (RTGS) and centralized Data Lake and Data Lens platform showcased how standardized dashboards replace ad-hoc PPTs, enable drill-down analytics across departments, and convert raw data into actionable intelligence for service delivery, disaster response, education access, health monitoring, and welfare targeting.

The marine and hydrographic perspective highlighted the urgent need to integrate land and sea datasets using globally accepted standards. Transition from legacy S-57 formats to the modern IHO S-100 framework, aligned with ISO and OGC standards, was discussed as critical for interoperability, safety, coastal management, blue economy, and future autonomous navigation. Integration of hydrographic data into NGDR was identified as a major opportunity.

From an industry perspective, the session emphasized that India is entering a phase of large-scale data creation across 14 fundamental themes, digital twins, subsurface and bathymetric mapping. Without strong semantic and syntactic standards, this will lead to clutter rather than clarity. Industry stressed the need for:

i. Common reference frames
ii. API-driven, cloud-native, REST-based architectures
iii. Spatial-temporal asset catalogues
iv. Platform-level interoperability rather than siloed portals

International experience and global vision highlighted the transition from traditional SDIs to interconnected geospatial ecosystems, driven by standards, semantic clarity, data sovereignty, decentralization, and user-centric access. Global best practices under UN-GGIM and OGC demonstrated how national mapping agencies act as custodians of foundational data while enabling federation across ministries, private sector, and communities.

The Chair concluded the session by emphasizing that standards must move from documents to operational systems, supported by testbeds, compliance mechanisms, validation tools, capacity building, and continuous research. Standards were positioned not as constraints, but as enablers of innovation, trust, scalability, and economic value.

Session Takeaways:

1. **Standards are the backbone of a federated geospatial ecosystem**
   i. Fragmentation, incompatibility, and duplication of geospatial data continue to be major challenges.
   ii. Internationally harmonised and nationally adopted standards (ISO, OGC, BIS) are essential to enable interoperability, data sharing, and reuse across ministries, States, industry, academia, and international partners.
   iii. Standards must move beyond documents to become operational within platforms, workflows, and day-to-day governance systems.
2. **Shift from portal-based data access to API-driven geospatial ecosystems**
   i. Traditional SDI portals with static downloads are insufficient for real-time governance and decision-making.
   ii. A federated, API-based ecosystem with shared semantics, national registers, and cloud-native workflows is required.
   iii. Initiatives such as the Unified Geospatial Interface (UGI), National Geospatial Data Registry (NGDR), and GatiShakti GDI demonstrate the value of standards-enabled integration.
3. **Metadata, registers, and semantic consistency are critical enablers**
   i. Metadata is the first interface between data producers and users and is central to discoverability, trust, and reuse.
   ii. Common schemas, UML-based data models, and standardised metadata structures (e.g., ISO 19115, IS 16439) are necessary to ensure consistency across datasets.
   i. The absence of national registers for parcels, buildings, addresses, and assets remains a structural gap that limits integration.

4. **Standards must be tied to national missions and real use cases**
   i. Standards are most effective when anchored to flagship programmes such as SVAMITVA, PM GatiShakti, AMRUT, NAKSHA, and National Geospatial Mission.
   ii. Demonstrated use cases such as expressway alignment through GDI, drone-based rural surveys, real-time governance dashboards, and marine ENC modernisation—build confidence and adoption.
5. **Marine, land, and inland water geospatial integration is essential**
   i. India's geospatial focus must expand beyond land to include offshore, coastal, and inland waters. Hydrographic standards (IHO S-100) aligned with ISO and OGC provide a strong model for interoperability and quality assurance.
   ii. Integration of land, sea & air datasets is critical for coastal zone management, disaster resilience, ports, blue economy, and climate adaptation.
6. **Quality, accuracy, and reference frameworks cannot be compromised**
   i. Poor-quality or inconsistent foundational data leads to significant downstream inefficiencies and rework.
   ii. Standards for positional accuracy, data quality, lineage, and uncertainty are as important as formats and APIs.
7. **Capacity building and institutional readiness are as important as technology**
   i. There is a significant gap in trained manpower for surveying, feature extraction, data modelling, and standards implementation, especially at State and field levels.
   ii. Adoption of standards requires structured skilling programmes across government, industry, and academia.
   iii. Academia must engage more deeply with real-world datasets and operational challenges, beyond laboratory research.
8. **Industry, States, and international collaboration are key accelerators**
   i. Industry requires predictable, open, and standards-compliant frameworks to innovate and scale solutions.
   ii. State-level experiences (e.g., real-time governance platforms, data lakes, standardised dashboards) highlight the importance of two-way data sharing and value creation.
   iii. Continued alignment with global practices through ISO, OGC, IHO, and UN-GGIM strengthens India's global standing and market access.
9. **Next steps for the National Geospatial Mission**
   i. Establish testbeds and pilot projects to operationalised standards across sectors. Develop compliance, validation, and conformance mechanisms linked to platforms and funding.
   ii. Invest in continuous research and evolution of standards to keep pace with emerging technologies such as AI, digital twins, IoT, and real-time analytics.

Dr. Debapriya Dutta, Chairman, LITD-22, BIS, led the session on "Role of Standards in Harmonizing Geospatial Frameworks," with speakers: Sh. Nikhil Kumar, Cmde. Mathew G. Abraham, Sh. Sandeep Shrivastava and Sh. Sanjay Sinha (from right to left)

Dr. Zaffar Sadiq Mohamed-Ghouse, Director of Advisory & Innovation, Woolpert &Vice Chair, Board of Director, OGC and Dr. Rajendra Gaikwad, Scientist, Space Application Centre, Ahmedabad address (Virtually)

Session 4: Keeping pace with technological advancements in Geospatial fields

Objective:

- To reflect on the evolving landscape of geospatial technologies and their growing influence on governance, innovation, and development.
- To explore how emerging tools and approaches can transform traditional methods of data generation, analysis, and decision making.
- To foster dialogue among government, industry, and academia on developing a forward-looking, technology-driven geospatial ecosystem.
- To encourage the exchange of ideas, experiences, and best practices that can inspire collaboration and innovation across sectors.
- To deliberate on strengthening institutional capacities, human resource skills, and technical infrastructure to keep pace with rapid technological advancements.
- To envision the role of technology as a catalyst for building a resilient, inclusive, and future-ready geospatial framework aligned with national priorities.

Overview:

The session on **"**Keeping Pace with Technological Advancements in Geospatial Fields" was designed to outline the scope of discussions on the rapidly evolving geospatial technologies, including GeoAI, Digital Twins, Quantum computing -NavIC, and advanced 3D mapping, and their transformative potential across sectors such as urban planning, navigation, disaster management, and smart infrastructure development. The session was intended to chart a comprehensive roadmap for advancing cutting-edge geospatial technologies, strengthening academia–industry collaboration, and supporting leading research institutions and innovation hubs. It aimed to align stakeholders on actionable strategies for accelerating technology development, knowledge exchange, and commercialization, with the objective of positioning India as a global leader in geospatial innovation. The session also proposed to highlight the importance of international collaboration, including the role of a dedicated unit within Survey of India, to enhance global engagement and improve international market visibility for the Indian geospatial industry.

Chair	**Sh. Abhishek Singh, IAS, Director General, NIC**
Speaker	Sh. Roshan Srivastava, Associate Professor, IIT Tirupati
Speaker	Sh. S. K. Sinha, Addl SG, SoI
Speaker	Sh. Kunal Satyarthi, Joint Secretary, DOLR
Speaker	Sh. Alok Prem Nagar, JS, MoPR
Speaker	Sh. Agendra Kumar, MD , ESRI India
Distinguished International Speaker	Mr. David Henderson, Chief Geospatial Officer, Ordnance Survey (***Virtual Mode)***

Speakers address/Discussion Summary:

Session on 'Keeping pace with technological advancements in Geospatial fields' focused on how rapid technological advancements, particularly in AI, GeoAI, Digital Twins, advanced remote sensing, and real-time geospatial platforms, are fundamentally reshaping the geospatial ecosystem and its role in national development.

The Chair set the context by highlighting the rapid acceleration of AI, Generative AI, Agentic AI, and their disproportionate impact on the geospatial sector due to the convergence of large-scale satellite, sensor, and administrative datasets, cloud-GPU compute, and multi-source analytics. AI's strategic relevance was emphasized for India in terms of economic value creation, employment, public service delivery, and data-driven governance, enabled by India's robust Digital Public Infrastructure (DPI) and policy ecosystem under the India AI Mission. A Geospatial AI Stack was formulated, comprising data layers, compute infrastructure, analytics, geospatial foundation models, and application layers, with examples such as flood risk assessment, infrastructure planning, and disaster response. NIC initiatives such as Bharat Maps, One Map, and API-based integration across ministries were highlighted as foundational enablers.

Geospatial data is recognized as critical national infrastructure under the National Geospatial Policy. Drawing from UN-GGIM future trends, technology maturity frameworks need to be adopted and IoT, ML, CORS, drones, and cloud computing were identified as mature technologies ready for institutionalization, while emerging areas like quantum computing warrant research investments. Distinction between 3D models and true digital twins, the importance of big data processing frameworks, and the urgent need for a spatial Digital Public Infrastructure (DPI) were emphasized. Key gaps highlighted included data modelling, standards, authoritative custodianship, governance, versioning, and temporal validity across the geospatial value chain.

The evolution and impact of the SVAMITVA Scheme, highlighting Survey of India's role in drone surveys and CORS expansion was presented. Platforms such as Gram Manchitra, built on Bharat Maps and LGD codes, were showcased for practical village-level applications including infrastructure planning, rooftop solar potential assessment (linked with PM Surya Ghar Yojana), sanitation accessibility, and property tax assessment. Adoption across multiple states and ongoing hackathons with IITs to extract further value from SVAMITVA datasets were noted.

The international perspective from the ordnance survey, UK, emphasised that geospatial data is now mainstream, and foundational to national data infrastructure. Global themes of "Reinventing the Map", interoperability, AI-enabled automation, skills transition, collaboration, and digital twins were emphasised. Challenges highlighted positional accuracy, legacy data alignment, uncertainty in communication, and the need to position authoritative location data as the backbone of integrated national data ecosystems.

Industry vision highlighted the need for sovereign, secure, open-standard geospatial infrastructure, integrating GeoAI, ML, agentic AI, reality mapping, LiDAR, drones, and 3D GIS for living digital twins. ESRI's India-specific offerings, including 800+ authoritative datasets, 100+ AI models, on-premise base maps, navigation datasets, and real-time data ingestion technologies to support government use cases.

The persistent disconnect between advanced geospatial technologies and ground-level land administration emphasising challenges in integrating modern imagery with legal cadastral maps, fragmented datasets across registries and utilities, lack of common identifiers, and acute shortages of trained surveyors and feature extraction professionals was discussed. There is aneed for AI-assisted linkage of legacy MIS datasets, field-level capacity building, and stronger engagement of academia with real-world land governance challenges.

The chair concluded the session by emphasising the need for spatial decision-makers, robust PNT and CORS infrastructure, and institutional platforms for digital twins and NavIC-based applications. Promotion of advanced geospatial technology by establishing of innovation hubs like IIT Tirupati Technology Innovation Hub, geospatial intelligence labs, national digital tool libraries, hackathons, start-up incubation, and capacity-building initiatives, inviting collaboration through open and federated geospatial ecosystems, was emphasized.

Session Takeaways

1. **Geospatial + AI as National Infrastructure**
   i. Geospatial data, combined with AI and advanced compute, is now a core national digital infrastructure enabling data-driven governance, infrastructure planning, disaster management, and economic growth.
   ii. Building indigenous geospatial foundation models aligned with India AI Mission is critical for scalable and sovereign solutions.
2. **Need for Integrated and Interoperable Platforms**
   i. True interoperability requires APIs, common reference frameworks, metadata standards, versioning, and platform-based access, not just standardized data formats.
   ii. A unified national geospatial backbone integrating SoI, NIC, ISRO, BISAG, and sectoral platforms was emphasized.
   iii. The focus must shift from mere data collection to actionable applications, dashboards, decision-support systems, and real-time analytics for ministries and local governments.
   iv. Use cases such as SVAMITVA, Bharat Maps, PARIVESH, and Gram Manchitra demonstrate this transition.
3. **Modern Technologies Require Phased Adoption**
   i. Mature technologies (AI/DL/ML, IoT, Data Cubes, Ubiquitous Connectivity) are ready for institutionalization and implementation on scale. Government can invest in Technologies like Quantum Computing/Positioning which promise high value but whose trajectories are still uncertain. In technologies edge computing, intelligent mobility Digital Twins, Immersive Visualization, whose trajectory of growth is predictable but yet to mature, Govt. should encourage Pilots before institutionalization.
   ii. Technology roadmaps recommended above were in should align with global trends identified by UN-GGIM.

4. Legacy Data Integration is a Critical Bottleneck

i. Integrating historical cadastral maps, land records, registration data, and municipal MIS with high-resolution geospatial data remains a major challenge.

ii. Legal-authoritative linkage between legacy records and modern spatial datasets is essential.

5. Capacity Building and Skill Gaps

i. Acute shortages exist in trained surveyors, GIS analysts, and feature extraction professionals, especially at state and local levels.

ii. Academia, industry & government collaboration is vital to build a skilled geospatial workforce beyond elite institutions.

Sh. Abhishek Singh, Director General, NIC, led the session on "Keeping Pace with Technological Advancements in Geospatial Fields" (virtual mode), with speakers on the dais: Sh. Agendra Kumar, Sh. Alok Prem Nagar, Sh. S. K. Sinha, Sh. Kunal Satyarthi, and Sh. Roshan Srivastava (from right to left)

5. Exhibition of Products and Services

On the occasion of National workshop various government and private organization showcased their products and services. Survey of India showcased the multilingual state maps, Geodetic Asset Register (GAR) and Geodetic Asset Maps (GAM), 3D Mapping, CORS technology among other SOI products. SoI distributed the GAR & GAM, State maps to the visitors.

Private organizations showcased their software, hardware and services being offered for geo-spatial work.

Details of organisations and Industry partners showcased during exhibition are as follows.

Government Organisations	Industry partners
Survey of India	Aarvee engineering Consultants Ltd
Department of Land Resources	ESRI India
National Mission for Clean Ganga	Hexagon India
Ministry of Panchayati Raj (MoPR)	IIC Technologies
	LTIMindtree Ltd
	RMSI Pvt Ltd.

Exhibition corner


SURVEY OF INDIA
SURVEY OF INDIA


AARVEE ENGINEERING CONSULTANTS LTD.
ESRI INDIA
DEM and GIS ready data set

6. National Workshop Outcomes

1. **Strategic Alignment with National Vision:** The workshop clearly positioned the geospatial ecosystem as a core enabler of *Viksit Bharat 2047*, reinforcing its role in governance, economic growth, infrastructure planning, climate resilience, and citizen-centric service delivery.
2. **Validation of National Geospatial Mission Goals:** The discussions reinforced the importance of the National Geospatial Mission and its alignment with the vision of Viksit Bharat 2047.
3. **Shift from Data Creation to Decision Support:** Deliberations highlighted a clear transition from standalone data generation towards application-driven, decision-support systems, including AI-enabled analytics, geospatial foundation models, and agentic GIS for policymaking.
4. **Success of Mission-Mode Initiatives:** Successful national initiatives such as SVAMITVA, Operation Dronagiri, PM Gati Shakti, Bharat Maps, One Maps, Gram Manchitra, and PARIVESH demonstrated how standardized and interoperable geospatial data can deliver measurable outcomes on the ground.
5. **Standards and interoperability identified as top priority:**
   i. Acknowledgement of the need for common standards, metadata, and semantic alignment, and that standards are as critical as physical infrastructure for scaling geospatial solutions.
   ii. Metadata, semantic models and API/OGC compliance are necessary for national scale integration.
6. **Recognition of Interoperability Challenges:** Persistent challenges related to fragmented datasets, legacy systems, inconsistent schemas, absence of national registers (land parcels, buildings, addresses), and limited API-based data exchange.
7. **Growing Importance of Indigenous Capability:** Strong emphasis was placed on developing indigenous geospatial models, workflows, and platforms to ensure long-term data sovereignty and reduce dependency on proprietary global systems.
8. **Expanded Stakeholder Collaboration:** The workshop strengthened collaboration across central ministries, state governments, industry, academia, and international organizations, creating momentum for a federated and participatory geospatial ecosystem.
9. **Increased Stakeholder Alignment:** The workshop successfully brought together a wide array of stakeholders, including policymakers, industry leaders, and technologists, fostering a unified vision for India’s geospatial future.

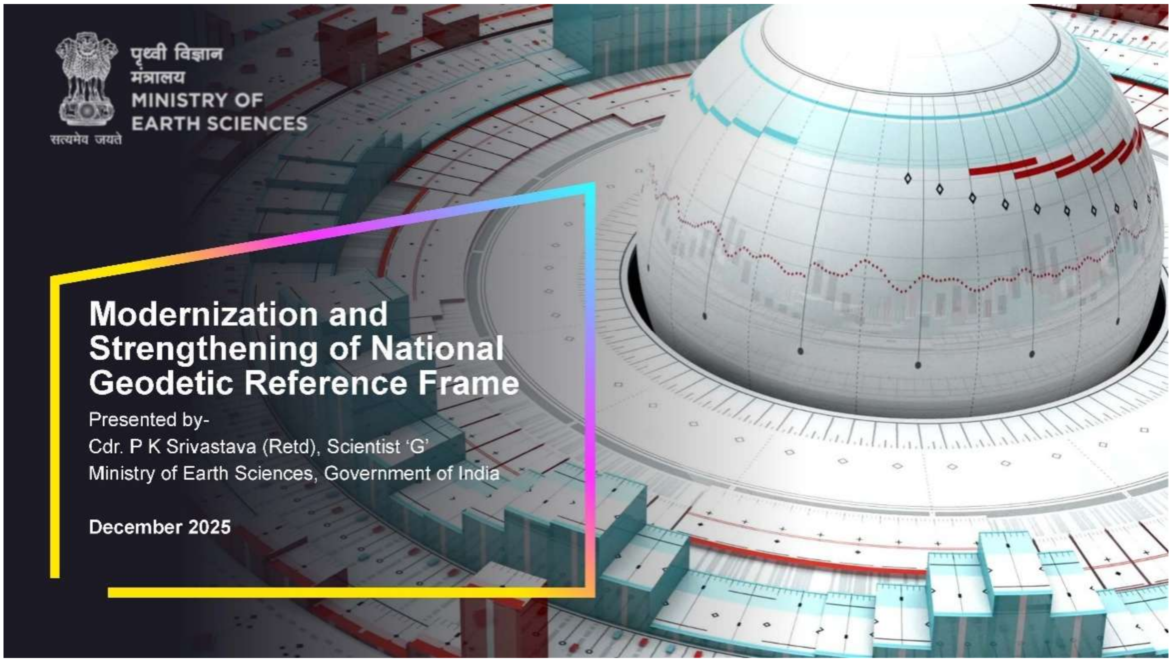
7. Key Recommendations

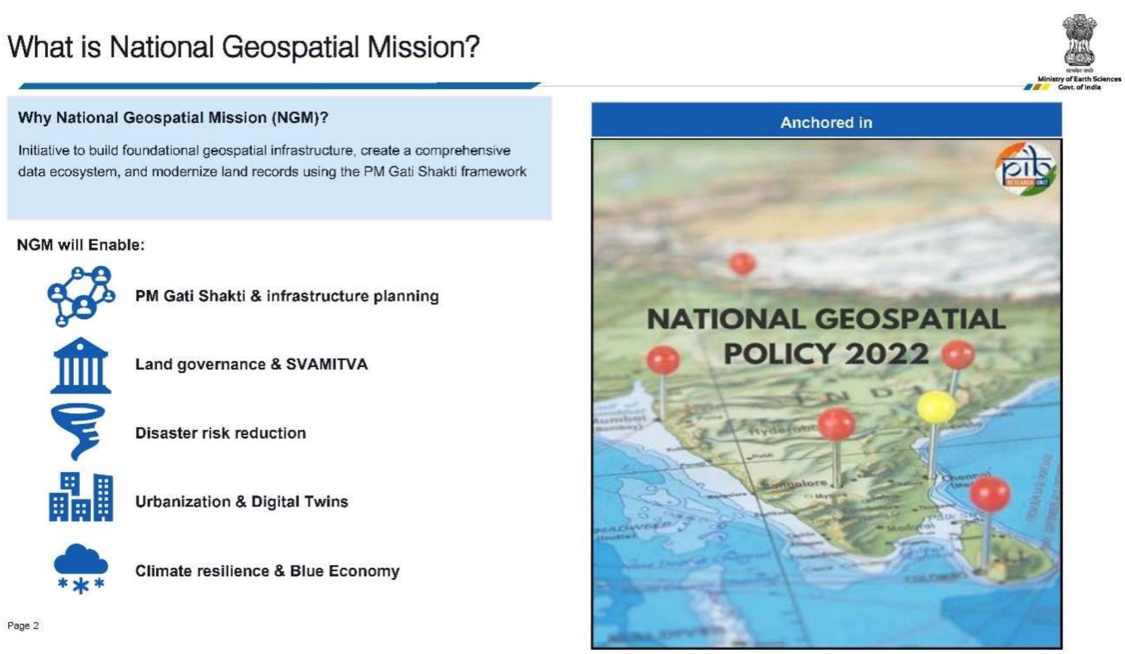
1. **Strengthening of Geodetic reference infrastructure:**
   i. **Network Densification:** Expanding the existing CORS infrastructure to ensure comprehensive, high-precision coverage across all terrains.
   ii. **Operational Excellence:** Implementing long-term sustainable maintenance strategies to guarantee zero downtime and eliminate service delivery lags**.**
   iii. **User-Centric Framework:** Enhancing the end-user experience through modernized service interfaces and a robust, transparent grievance redressal mechanism.
2. **Operationalised National Geospatial Standards:** Move beyond standards as documents by embedding BIS, ISO, and OGC-aligned standards into national missions, platforms, procurement norms, and project workflows. Need to finalize and publish the revised metadata & core standards (high priority).
   i. Issue the updated ISO/IS/NSDI-aligned metadata (ISO 19115 / BIS 16439 revisions) as the national baseline.
   ii. Expedite operationalisation of LiDAR, ORI, Elevation and Geodetic reference frame standards since the National Geospatial Mission will produce newer datasets
   iii. Provide concise implementer's guide and sample XML/JSON templates for common datasets.
3. **Establish Geospatial Test Beds and Sandboxes:** Create sectoral and state-level test beds to pilot standards, validate interoperability, assess data quality, and refine implementation frameworks before national scale-up.
   i. Set up 2–3 multi-theme testbeds for standards, APIs and validation.
   ii. Use these as living labs for performance, quality check and interoperability testing.
4. **Develop National Spatial Registers:** Prioritise creation of authoritative, continuously updated national registers for parcels, buildings, roads, addresses, and geodetic references to serve as common foundational layers.
5. **Strengthen API-Driven Federated Architecture:** Transition from static portal-based data sharing to cloud-native, API-first, federated geospatial ecosystems enabling real-time access, machine-to-machine integration, and scalable analytics.
6. **Invest in Geospatial AI and Foundation Models:** Accelerate development of indigenous geospatial foundation models under the India AI Mission, leveraging satellite imagery, sensors, and administrative data for multi-sector applications.
7. **Enhance Capacity Building and Skilling:** Launch structured capacity-building programmes for central ministries, states, ULBs, academia, and industry to build expertise in standards, metadata, AI, digital twins, and spatial analytics. Certification of vocational training programme through NCVET skill council.
8. **Encourage Modular procurements:**
   i. Encourage modular procurement (data as service, model as service).
   ii. Model technical specifications for geo-spatial tender formulation in collaboration with stakeholders.

iii. Encourage industry adoption of rover/CORS workflows

9. **Institutionalise Compliance and Quality Assurance:** Introduce standard conformance testing, certification mechanisms, and periodic audits to ensure consistent adoption of geospatial standards across departments.
10. **Promote Research and Academia & Government Collaboration:** Encourage applied research, hackathons, and real-world pilots through IITs, universities, and innovation hubs to bridge the gap between labs and governance needs.
11. **Ensure Ethical, Secure, and Responsible Use:** Embed principles of data privacy, security, ethical AI, and responsible data sharing within geospatial policies and system designs.
12. **Strengthen Role of Survey of India as Anchor Institution:** Reinforce Survey of India's role as the custodian of national geodetic reference frameworks, authoritative base datasets, and standard harmonisation across sectors.

Annexure’s
Session - 1

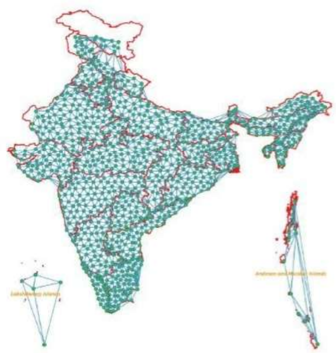

पृथ्वी विज्ञान मंत्रालय
MINISTRY OF EARTH SCIENCES
सत्यमेव जयते
Modernization and Strengthening of National Geodetic Reference Frame
Presented by-
Cdr. P K Srivastava (Retd), Scientist 'G'
Ministry of Earth Sciences, Government of India
December 2025


What is National Geospatial Mission?
Ministry of Earth Sciences
Govt. of India
Why National Geospatial Mission (NGM)?
Initiative to build foundational geospatial infrastructure, create a comprehensive data ecosystem, and modernize land records using the PM Gati Shakti framework
NGM will Enable:
PM Gati Shakti & infrastructure planning
Land governance & SVAMITVA
Disaster risk reduction
Urbanization & Digital Twins
Climate resilience & Blue Economy
Page 2
Anchored in
NATIONAL GEOSPATIAL POLICY 2022

Geodetic infrastructure in India

Ministry of Earth Sciences
Govt. of India

India is making significant strides in strengthening its geodetic capabilities through five key pillars: horizontal and vertical datums, gravimetric networks, tidal observation systems, and geomagnetic studies.



Schematic representation of location of CORS Stations

Activity	Description
Horizontal Datum & Reference Frame	Establishing a consistent global/geodetic control framework using GNSS and ITRF standards.
Vertical Datum	Defining a stable reference surface for elevation and sea level monitoring across India.
Gravity Measurement	Measuring Earth's gravity field to support geoid modeling and surface deformations.
Tidal Observation	Monitoring sea levels to support coastal safety, navigation, and inundation studies.
Geomagnetic Survey	Measuring Earth's magnetic field variations for navigation, geophysical, and scientific purposes.
Geodetic Astronomy	Using space geodesy techniques (VLBI, SLR) to accurately determine Earth's orientation and positions.
GNSS and CORS Network	Distributed network of GNSS stations providing real-time position data for mapping and engineering works.
Data Modernization & Coordination	Upgrading and standardizing geodetic data collection, storage, and sharing with global systems.

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Where NGRF fits in National Geospatial Mission

Ministry of Earth Sciences
Govt. of India

Core Components of NGM

A. Modernization & Strengthening of National Geodetic Reference Frame

A.1 National Horizontal Reference Frame (NHRF)

A.2 National Vertical Reference Frame (NVRF)

B. Geospatial Data & Mapping Infrastructure

C. Geo-ICT Infrastructure

D. Training & Capacity Building

E. Technology Development

The Geodetic Reference Frame is the first brick.

- Ortho-imagery, DEMs, Digital Twins, land records—**all depend on NGRF**
- If the reference frame is inconsistent, *everything built on top inherits that error*

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Why Modernization of NGRF is Urgent?

Ministry of Earth Sciences Govt. of India

Limitations of Legacy Reference Systems

- NHRF referenced to International Terrestrial Reference Frame (ITRF)2008, (epoch 2005) shows 30–80 cm drift
- Static, passive Ground Control Points inadequate for real-time Global Navigation Satellite System (GNSS) & Real-Time Kinematic (RTK) services
- Vertical datum based on 1909 Mean Sea Level (MSL) assumptions no longer scientifically valid
- Absence of national high-accuracy geoid limits GNSS-based heighting
- Horizontal & vertical frames not fully integrated
- Active tectonics & subsidence demand 4D, time-dependent reference frames
- Modern applications require Continuously Operating Reference Station (CORS) + space geodetic techniques

Page 5

Why NGRF Matters For Viksit Bharat

Ministry of Earth Sciences Govt. of India

VIKSIT INDIA
BOLD VISION. BRIGHTER FUTURE.
2047

- Precision engineering & mega infrastructure projects
- Flood, storm surge & inundation modelling
- Long-term monitoring of:
  - Crustal deformation
  - Seismic strain
  - Climate change signals
- Precision agriculture & PNT-enabled services
- Digital Twins requiring cm-level spatial fidelity
- River interlinking & water resource management
- Coastal subsidence & sea-level rise monitoring

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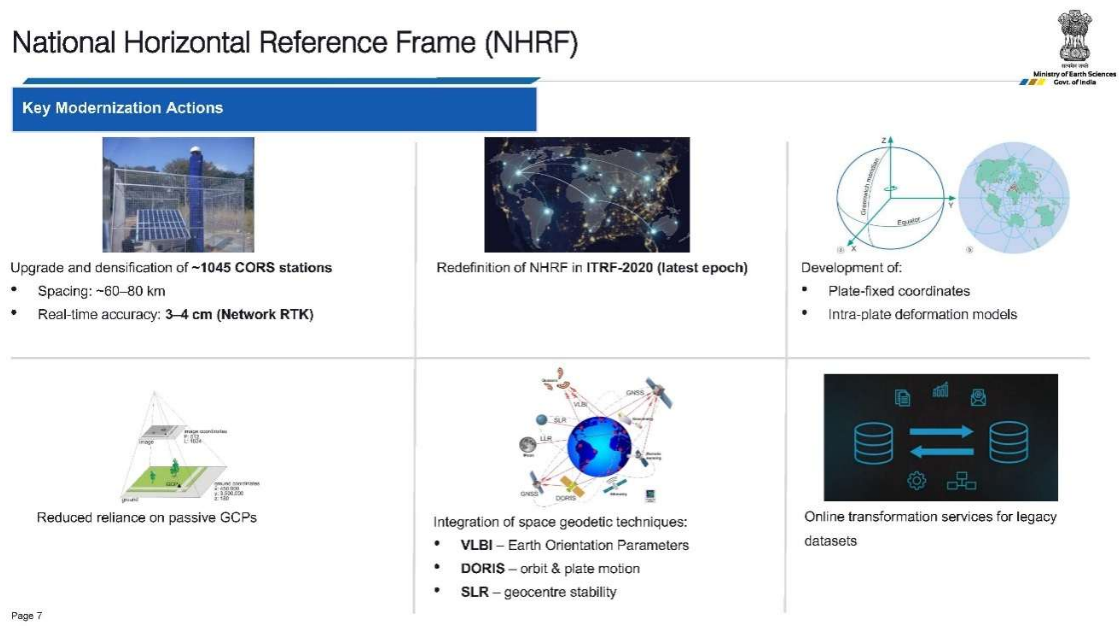
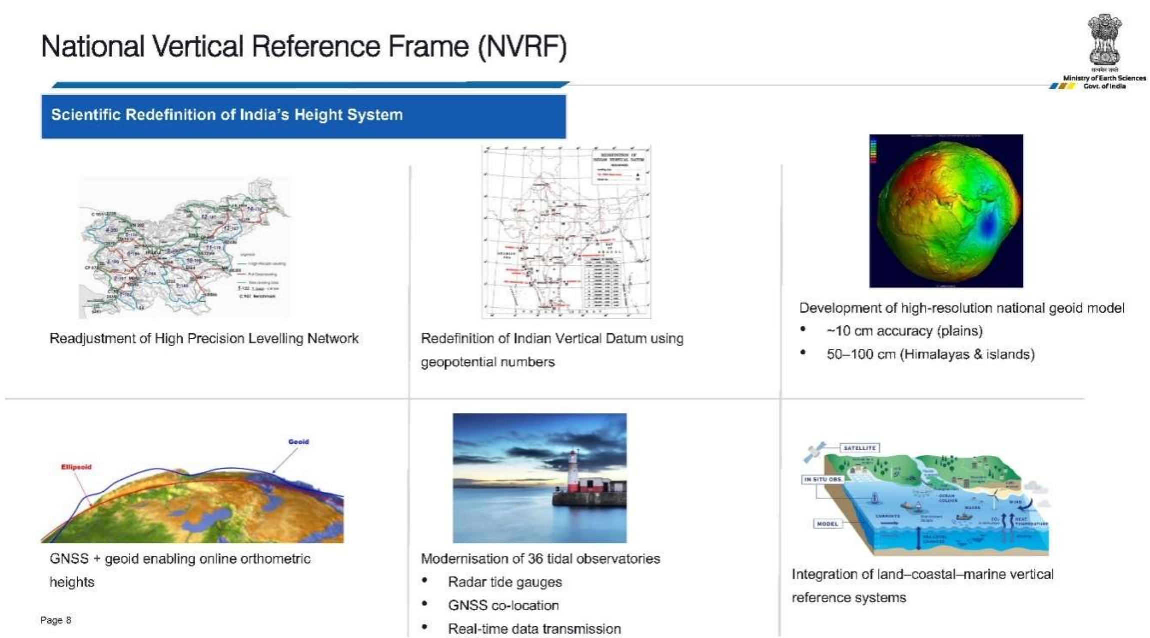

National Horizontal Reference Frame (NHRF)
Ministry of Earth Sciences
Govt. of India
Key Modernization Actions
Upgrade and densification of ~1045 CORS stations
• Spacing: ~60–80 km
• Real-time accuracy: 3–4 cm (Network RTK)
Redefinition of NHRF in ITRF-2020 (latest epoch)
Development of:
• Plate-fixed coordinates
• Intra-plate deformation models
Reduced reliance on passive GCPs
Integration of space geodetic techniques:
• VLBI – Earth Orientation Parameters
• DORIS – orbit & plate motion
• SLR – geocentre stability
Online transformation services for legacy datasets
Page 7


National Vertical Reference Frame (NVRF)
Ministry of Earth Sciences
Govt. of India
Scientific Redefinition of India's Height System
Readjustment of High Precision Levelling Network
Redefinition of Indian Vertical Datum using geopotential numbers
Development of high-resolution national geoid model
• ~10 cm accuracy (plains)
• 50–100 cm (Himalayas & islands)
Ellipsoid
Geoid
GNSS + geoid enabling online orthometric heights
Modernisation of 36 tidal observatories
• Radar tide gauges
• GNSS co-location
• Real-time data transmission
SATELLITE
IN SITU OBS.
MODEL
Integration of land–coastal–marine vertical reference systems
Page 8

Major Applications using CORS Network

Ministry of Earth Sciences
Govt. of India

Infrastructure and Construction

Large-scale projects like high-speed rail (NCRTC), irrigation, dams, smart cities, railroads, canals, and drainage planning gain from CORS for precise surveying, mapping, and monitoring without base station setups. It supports revenue map updates under SVAMITVA and state boundary management

Agriculture and Mining

Precision agriculture uses CORS for auto-navigation and machine control, optimizing yields and resource use. Mining benefits from accurate asset management, land use change detection, and operational efficiency.

Transport and Aviation

Transport sectors, including roads and railways, leverage CORS for engineering construction and real-time positioning. Civil aviation improves with enhanced navigation and safety through centimeter-level data.

Disaster and Scientific Sectors

Disaster management and emergency response utilize CORS for rapid data collection and ground truthing. Scientific fields like meteorology, seismology, hydrology, plate tectonics, and space weather studies access consistent reference data for research.

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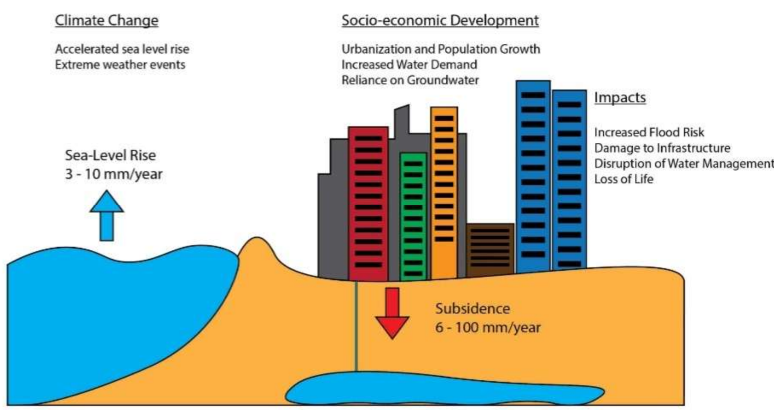
Case Study 1: Coastal Subsidence

Ministry of Earth Sciences
Govt. of India

- Deltaic regions & ports experiencing subsidence
- MSL-based heights unreliable
- Geoid-based VRF improved flood modelling
- Supports Sagarmala & Coastal resilience



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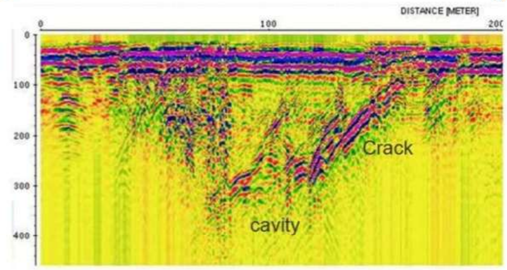
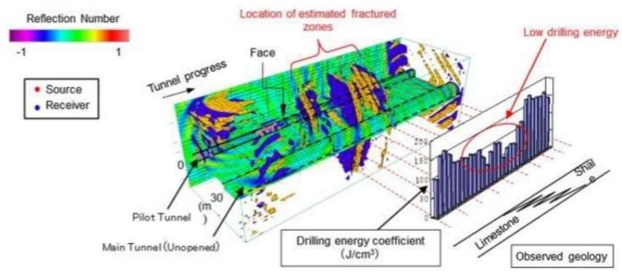
Case Study 2: Metro & Tunnel Projects

Ministry of Earth Sciences
Govt. of India

- Requires cm-level horizontal & vertical accuracy
- GNSS+ geoid based heights reduce misclosures
- Prevents alignment errors in long tunnels
- Critical for urban infrastructure safety





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Benefits of Modernization of National Geodetic Reference Frame

Ministry of Earth Sciences
Govt. of India

Centimeter-level Accuracy Nationwide
Denser CORS network improves atmospheric error modelling and delivers ~2–3 cm reliable GNSS positioning across diverse terrains

Uniform Pan-India Coverage
Eliminates gaps in remote and northeastern regions, ensuring consistent 24×7 access without dependence on local base stations.

Cost & Time Efficiency
Reduces survey costs by 50–70% and shortens survey timelines from days to hours for infrastructure and land records.

Disaster & Climate Resilience
Strengthens flood, coastal, subsidence and seismic monitoring, especially under monsoon and extreme weather conditions

Enabler of Digital & Emerging Technologies
Supports Digital Twins, UAVs, LiDAR, autonomous systems, precision agriculture and high-accuracy mapping

Scientific & Strategic Capability
Enables long-term crustal deformation, sea-level and Earth system monitoring with >99% system uptime.

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Recommendations & Way Forward

Ministry of Earth Sciences
Govt. of India

Infrastructure Recommendations

- Densify CORS to 5-10 km spacing (from 60-80 km), adding 5,000+ stations in urban/coastal areas.
- Expand levelling networks to 70,000 km with gravity ties at 500+ benchmarks, incorporating GNSS at tide gauges for NVRF redefinition.
- Integration of advanced space geodetic techniques such as VLBI, DORIS, and SLR.
- Deploy real-time data centers for VRS services and integrate Quantum-NavIC receivers for self-reliant positioning in dynamic environments.

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Policy Recommendations

- Mandating ITRF2020 adoption for NHRF/NVRF via BIS standards, including dynamic epochs and gravimetric geoid models for interoperability with global systems.
- Allocating dedicated funding for CORS densification and NavIC integration.
- Establishing inter-ministerial coordination under DST-SoI for Geo-ICT platforms linking to PM Gati Shakti, with mandatory use in infrastructure projects.

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National Workshop on Strengthening of Geospatial Ecosystem

National Centre for Geodesy IIT KANPUR

Establishing Geodetic Reference Frame for India: Issues, Concerns & a Way Forward

Prof. Onkar Dikshit
(contributions from: Prof. B. Nagarajan, Ratnesh Kushwaha, Dr. Revathi Nagarajan, Anuradha Sharma)

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22-12-2025 Modernization of National Geospatial Infrastructure 1

Introduction

- Reference frame provides **origin**, **orientation** and **scale unit** of a coordinate system.
- Significant as a starting reference point for multitude of activities.
- Forms a basis for providing precise geodetic position on earth's surface.
- Can be Global or Regional in nature:
  a. Global frame: ITRF versions, PZ-90, GTRF, etc.
  b. Regional frame: SIRGAS, EUREF, PGD2020, GDA2020, etc.

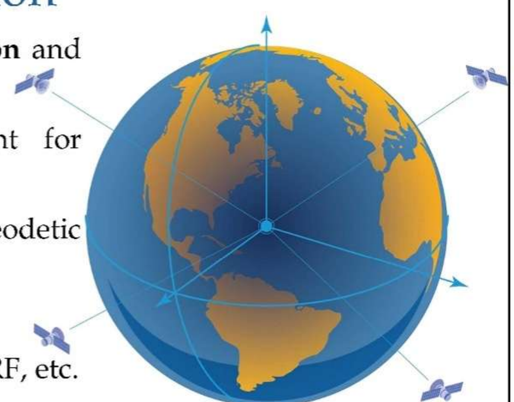

Image Source: https://geospatial.trimble.com/en/resources/blog/coordinate-systems-101-the-importance-of-geodetics-for-high-accuracy-gis-data-collection

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Current Status of Indian CORS Network

- Set up by Survey of India (SoI).
- Installation of 1042 CORS in India.
- Coordinates are provided in ITRF2008 epoch 2005.0.
- Provides two types of services:
  a. Real-time positioning services.
  b. Reference data services.

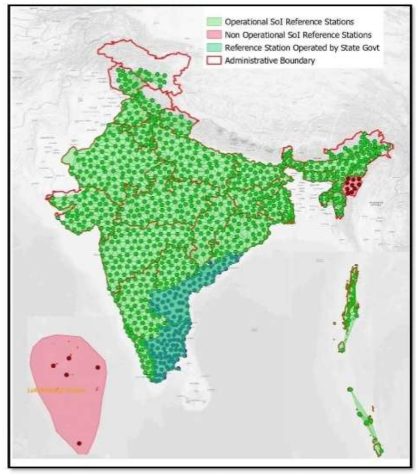

Figure: Current status of Indian CORS network

Image Source: https://cors.surveyofindia.gov.in/cors-services.php

Need of new Indian Reference Frame

- As of now, no precise geodetic reference frame for India.
- International Terrestrial Reference Frame (ITRF) can't give a true representation of region-based modelling and its applications.
- To cater for a wide range of geospatial and engineering applications.
- Aim to generate a highly precise horizontal and vertical geodetic network for India.

Right time to utilize state of the art technologies to define the new geodetic reference frame for India!

Summary of Global Developments in Regional Reference Frame

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Region	Frames	Type of Network	CORS/GCPs/IGS	Salient Features
Latin America	SIRGAS 1995 SIRGAS 2000 SIRGAS 2022	SIRGAS 2022 is a Two-tier network. One core network and national reference network Based on IGb14 at epoch 2015.0	537 stations + 128 IGS reference stations worldwide	• Constellations: GPS and GLONASS • 22 years of RINEX data • Quality check based on residual analysis of solutions • Processing: Using Bernese v5.2 and GAMIT/GLOBK software • Loosely constrained position sol.
Australia	GDA 1994 GDA 2020 ATRF 2014	GDA 2020 is a Single order network. Based on ITRF 2014 epoch 2020.0	109 Australian Fiducial Network (AFN) stations 330,000 GCPs	• GDA2020: Plate-fixed/Static Datum • Observations taken after 1994 • Processing: AUSPOS based on Bernese V5.2 • Adjustment: Indigenously developed DynaAdjust software • ATRF 2014: Dynamic Frame
Taiwan	TWD97 (1997) TWD97 (2010)	Single tier network Based on ITRF 2005 epoch 2010.0	380 CORS from 2000-2016 672 campaign GNSS stations from 2002-2015 (session of 6hr/year)	• Static reference frame • Inclusion of the surface deformation model • Processing: Bernese v5.0 • Development of a secular velocity grid model using Kriging approach

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Region	Frames	Type of Network	CORS/GCPs/IGS	Salient Features
Philippines	PGD2020	Three order geodetic network Based on ITRF2014 epoch 2020.0	55 CORS sites 66,375 GCPs 17 IGS stations	• Processing: Bernese v5.2 software • Weighted least squares adjustment • Constraining using ITRF network • Inclusion of national deformation model by estimating site velocities
Albania	ALBCORS 2019	Three order geodetic network Based on ITRF2014 epoch 2019.0	27 reference CORS sites 548 stations	• Data: 10 days, 1 second epoch interval • Processing: GNSMART Geo++ software • Coordinates transformed to ETRF89 and ETRF 2000
New Zealand	NZGD 2000	Six order network Based on ITRF 1996 epoch 1996.5	33 Zero and First order CORS sites 3366 lower order GCPs	• Data: From 1992-1998 • Processing: GAMIT software • Adjustment of lower order network by constraining zero and first order network • Incorporates deformation model

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Philippines Geodetic Network

Selected IGS Stations

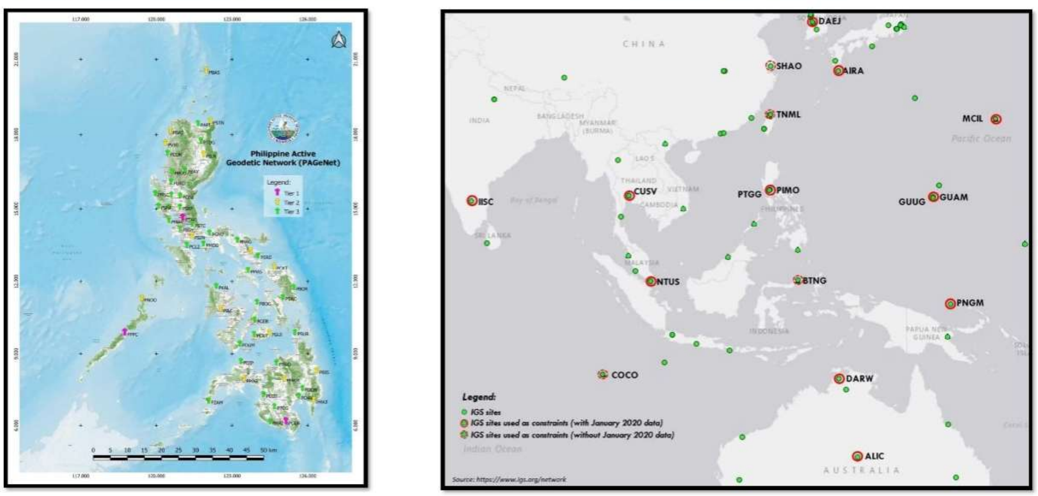

Figure: Philippines Active Geodetic Stations and IGS stations (Modernization of PGRS 2021)

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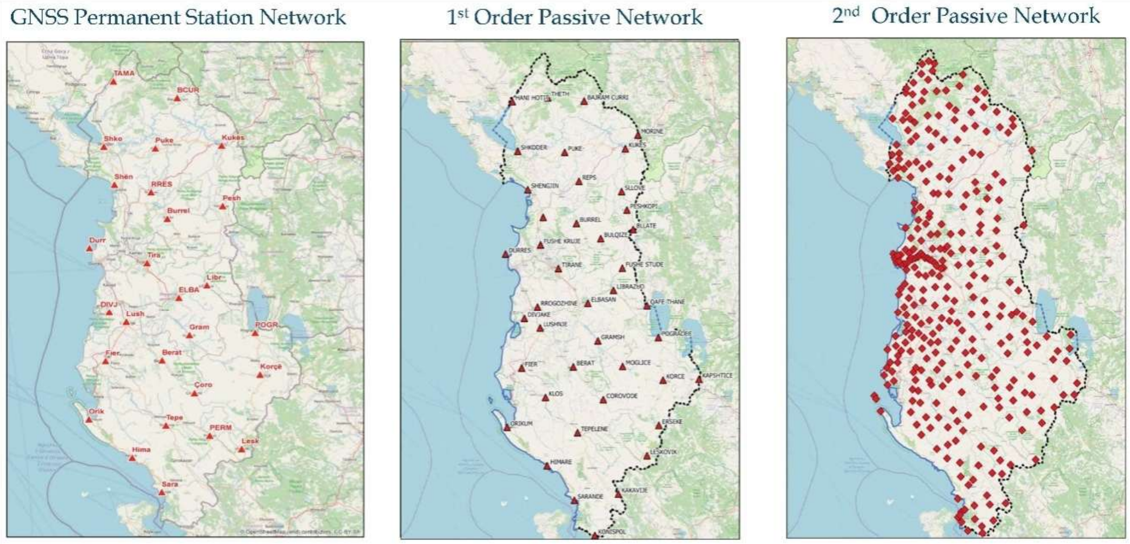

Figure: Geodetic network in Albania (ALBCORS 2019) (Nurce 2022)

Major Observations (based on Review of Existing Regional Reference Frames)

- **Suitable GNSS constellations for development of reference frame:** Currently with GPS, and Inclusion of NavIC in future.
- **Duration of observation data for processing:** Greater data volume leads to a more precise frame.
- **Need for our datum when we already have the most precise global ITRF frame:** Doesn't give a true representation of region-specific changes (Kehm et al., 2022).
- **Initial strategy for quality assessment of Indian CORS:** Based on Multipath, Signal to Noise Ratio (SNR), Cycle Slip Ratio (CSR), Data Availability, and Data Integrity (Kushwaha et al., 2024).
- **Best possible software for GNSS data processing:** Either Bernese or GAMIT/GLOBK; both are equivalent (Kushwaha et al., 2025). Development of indigenous data processing and adjustment software.

- **Better Choice of Adjustment:** Single level adjustment Vs Tier wise adjustment: Theoretically, Tier wise adjustment would be better. However, based on the vast Indian CORS, a three-tier network would be ideal.
- **Set of Tier-1 sites among available 1042 CORS:** Homogenous distribution of around 150-200 CORS, ensuring their availability for at least next 25 years.
- **Choice for datum: Static/Plate fixed datum or possibility of Dynamic datum:** Most realistic representation: Dynamic frames based on plate models; Practical sense: Static Datum with plate models (Harrison et al. 2023).
- **Appropriate time to update the frame:** Significant anthropogenic changes, natural calamities, development of new correction models, and poor performance of a large set of fiducial stations. Can be independently verified with instantaneous geocentric Epoch-based Reference Frames (ERFs).

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Research Progress at IIT Kanpur

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Development of Horizontal Datum for Uttar Pradesh

- **Consists of two parts:** Quality assessment of the complete network and baseline processing & network adjustment of the fiducial network.

Quality Assessment (QA)

- Preliminary analysis on CORS quality.
- Easy to apply QA checks based on existing software.
- Outcome of QA: Good, Average, or Poor station.
- Based on this analysis, the fiducial stations (backbone stations) have been found out.

QA Parameters

- Data Availability, Data Integrity, Signal to Noise Ratio (SNR), Multipath, and Cycle Slip Ratio (CSR).

Datasets and Software

- 66 CORS were chosen from Uttar Pradesh for this analysis.
- **Raw Data:** RINEX 3.04 version daily files with 30-second epoch interval from March 2022 to December 2024.
- **Software Used:**
  - ✓ For QC assessment: Japanese command line-based tool RINGO (RINEX pre-processing using GO language) developed in 2023 along with the use of Python shell scripts.
  - ✓ For baseline processing & network adjustment: Popular scientific software GAMIT/GLOBK was used.

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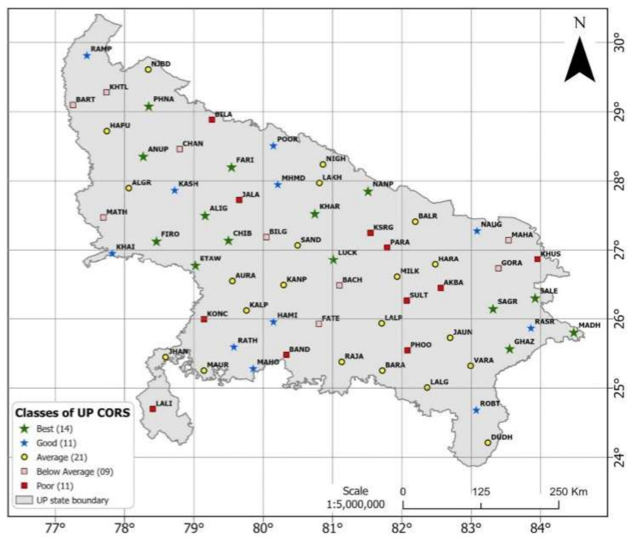
Classification of UP CORS network based on QA Results

- Based on the statistical measures from QA, stations were classified into five classes.
- Might be a possibility that station reflecting poor QC results has good coordinate repeatability, but in general, vice versa doesn't hold true.



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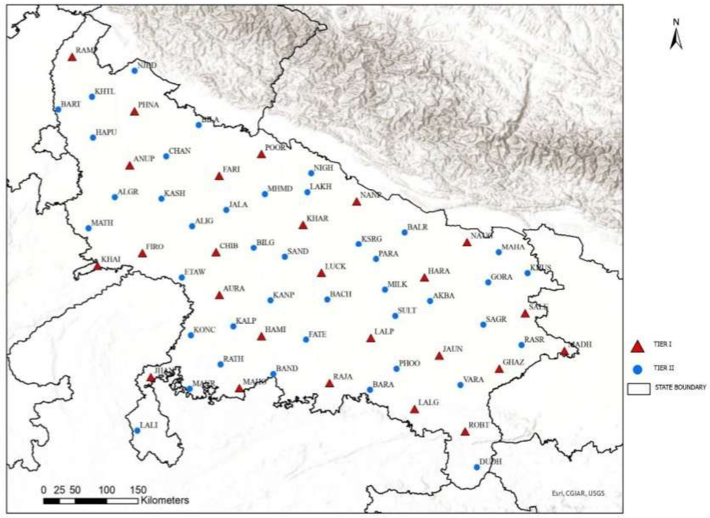
Tier 1 and Tier 2 network

- **Tier 1:** Fiducial network (24 stations).
- **Tier 2:** Second-order network.
- **Selection of Tier 1 sites:** Based on good quality station (A subset of Class 1, 2, and 3 stations) ensuring uniform geographical distribution.



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Processing of Tier 1 stations in the GAMIT/GLOBK v10.76

- GAMIT/GLOBK supports multiple GNSS constellations. It uses user-friendly shell scripts and integrates robust models that ensure that the data is corrected and processed to the required accuracy standards.
- The use of advanced algorithms for outlier detection and correction, ambiguity resolution, and performing network adjustment using different sets of constraints.
- Used 22 global IGS core sites to process and adjust UP CORS network.

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Strategy for GNSS data processing

- Observation data of these fiducial station from March 2022 to December 2024 were processed in the GAMIT/GLOBK software version 10.76.
- The daily solutions in GAMIT were used to generate a time series of positions using GLOBK.
- The residuals in N, E and U were examined for outliers.
- After removing 3σ outliers, the daily data were combined in GLOBK to provide a single solution for the year in the ITRF 2020 reference frame at epoch 31st December 2024 at 12:00:00.

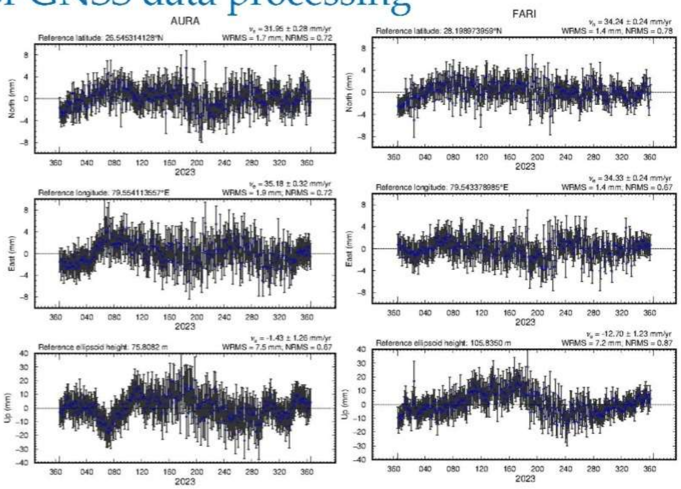

Figure. Position time series of station AURA & FARI

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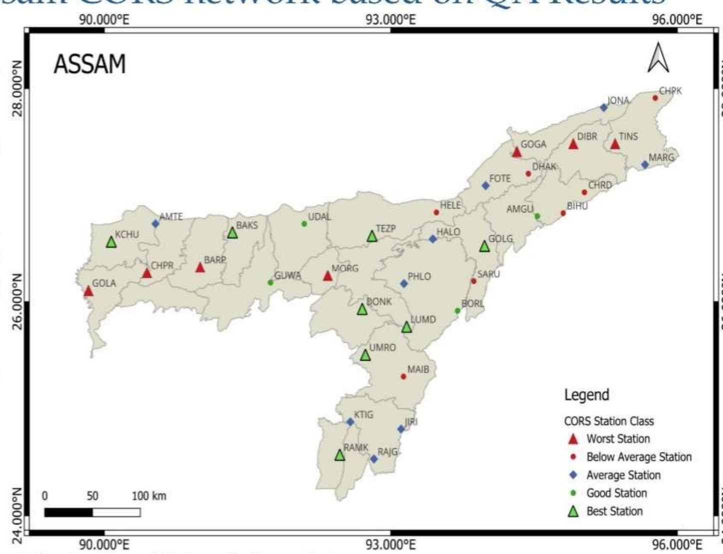
Classification of Assam CORS network based on QA Results

- Similar exercise on the Assam CORS network.
- High geophysically active zone (Seismic Zone V).
- QA done using 35 CORS in Assam based on around one year (mid 2024 to mid 2025) of RINEX datasets.
- Strategy can be extended to other Indian states.



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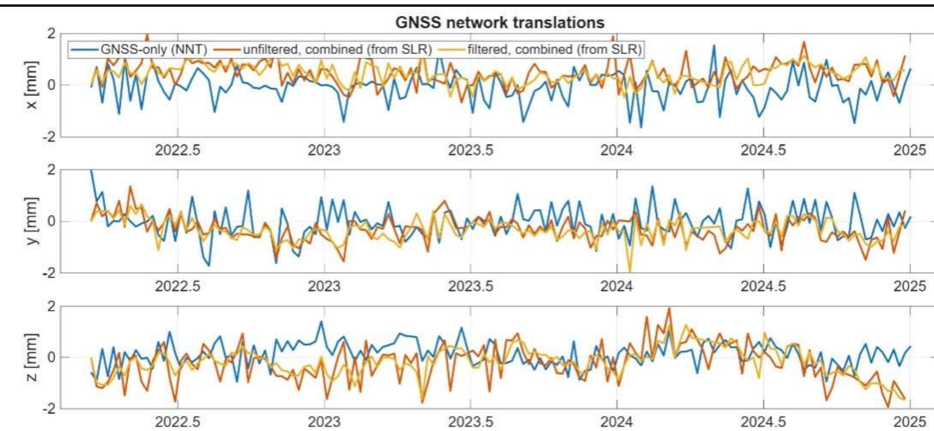
Novel Approach to Realize an RRF: **Epoch-based Reference Frames (ERF)**

- Realised on an epoch-wise basis (i.e. weekly) and provided in the form of station position time series.
- Aims to provide a direct geocentric realization of a reference frame throughout its observation period.
- To tackle the problem of non-instantaneous geocentricity of conventional secular reference frames.
- Problems in regions with high geophysical activities; the northern part of India, being close to the Himalayan region, is more prone to earthquakes and other natural calamities.
- **Conventional Frame using GNSS only solution**: Datum parameters are realized by aligning the frame to a global frame, such as ITRF2020 or IGS2020 frame.
- **To realize an Epoch-based Reference Frame:**
    - ❖ **Origin**: Realized by global network of Satellite Laser Ranging (SLR) stations,
    - ❖ **Scale**: Realized by weighted mean of global network of SLR & Very Long Baseline Interferometry (VLBI) scales.
    - ❖ **Orientation**: Either GNSS or Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) technique.
- Conventionally, it doesn't require a very long interval of datasets to realize an ERF.
- More relevant to near real-time applications.
- Can't be reliably extrapolated to an arbitrary epoch outside the observation period.
- Needs to be an operational product; regenerated on a regular basis.



- In GNSS-only solution, origin is realized by applying No-Net Translation (NNT) constraint w.r.t. a priori frame.
- In an Epoch-based Reference Frame (ERF), origin of a regional frame is realized by SLR only.
- Observation: Less Scatter in Unfiltered* and Filtered* ERF solution in comparison to GNSS only solution while computing helmert transformation (HT) parameters w.r.t. a priori frame i.e. ITRF2020-u2023 frame.

*Unfiltered: Classic ERF Solution
*Filtered: Modified ERF solution to bridge observational gaps in SLR and VLBI stations

Publications

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Conferences

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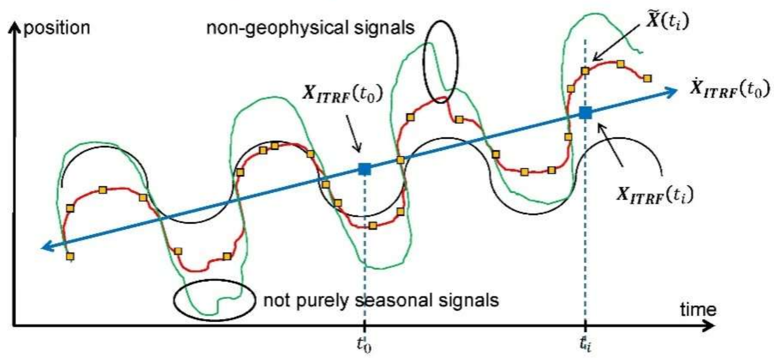
Appendix

Conceptual Understanding on Epoch-based Reference Frames (ERF)



- Instantaneous station position $X(t_i)$ related to the CM of the Earth
- Sum of n conventional correction models $\sum_n \Delta X_n(t_i)$
- Regularized station position $X_R(t_i)$
- ITRF station coordinate $X_{ITRF}(t_0)$ and station velocity $\dot{X}_{ITRF}(t_0)$
- Frequently estimated ERF (Epoch Reference Frame) station coordinate $\tilde{X}(t_i)$

Source: Bloßfeld et al. 2014

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Survey of India
विज्ञान और प्रौद्योगिकी विभाग
Department of Science & Technology

Modernization and Strengthening of National Geodetic Reference Frame

G. Varuna Kumar,
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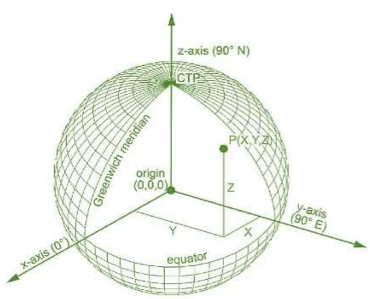
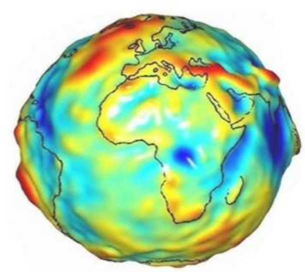
Modernization and Strengthening of National Geodetic Reference Frame

22-12-2025

Redefinition and Strengthening of National Horizontal Reference Frame (NHRF)	Modernization and Redefinition of National Vertical Reference Frame (NVRF)

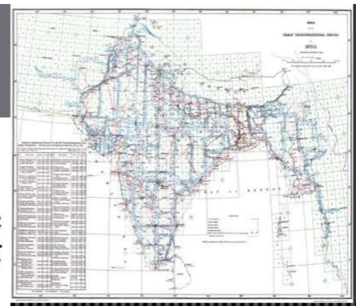




2

National Horizontal Reference Frame – Evolution

- **Great Trigonometrical Survey**
  - The aim was to provide a scientific Framework for Surveying and Mapping accurately.
  - One of the biggest scientific exercise of 19th Century.
  - About 3000 GTS stations were established.
  - The GTS based Reference Frame was being used as a reference for all Surveying & Mapping activity in the Indian sub-continent till 20th century.



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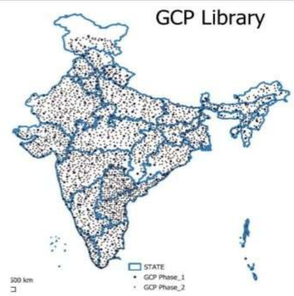
3

National Horizontal Reference Frame - Evolution

- **Geodetic Control Point (GCP) Library**
  - Since the mid-1980s, the use of GPS for the establishment of precise control points has grown steadily.
  - Establishment of GCP was started in 2005 and completed in 2014.
  - About 2500 GPS based Ground Control Points (Phase –I 291 Nos and Phase-II 2260 Nos) spread at a spacing of 30 to 40 km across the country were established.
  - Since 2005 till 2022, most of the surveying and mapping was carried out w.r.to GPS based ground control points library.



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4

National Horizontal Reference Frame - Evolution

- **Continuously Operating Reference Station (CORS)**
  - For upgrading GRF to provide online access to GRF and to provide high precision positioning services, SoI initiated Establishment of CORS Network in 2019 and as of today has established 1145 CORS stations all across country.

  https://cors.surveyofindia.gov.in/
  - The CORS Network is available 24 hours per day, 7 days a week and 365 days a year.
  - The CORS Network is capable of providing 3 to 4 cm accurate real time positioning.

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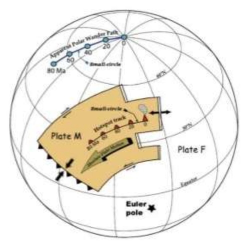
5

National Horizontal Reference Frame - Redefinition and Strengthening

- **Redefinition of NHRF**
  - Static Plate Fix coordinates in Latest ITRF realization
  - Rigid Plate Motion Model
  - Intra Plate Deformation Model
- **Development of Transformation models**
  - for converting legacy data to redefined Reference Frame
- **Strengthening of Online access to Reference Frame**
  - Reference Data Services
  - High accuracy Real time positioning services
  - Densification of CORS Network
  - Enhancing ICT infrastructure
- Integration of Modern Space Observation systems with NHRF



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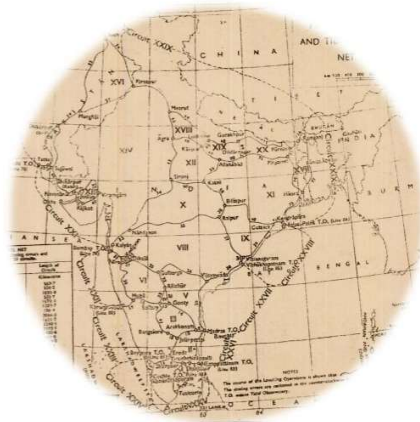
6

National Vertical Reference Frame - Evolution

- ✓ India's Vertical Datum was established in 1909, with reference to Mean Sea Level at 9 ports of Indian peninsula.
- ✓ Primary Level Network was laid by 86 levelling lines that were adjusted in 29 circuits for total 19,775 km observed from 1858 to 1909.
- ✓ Subsequently over the years, network was further extended and densified in other parts of the country.
- ✓ At every 25 to 30 km apart Bench Marks established.



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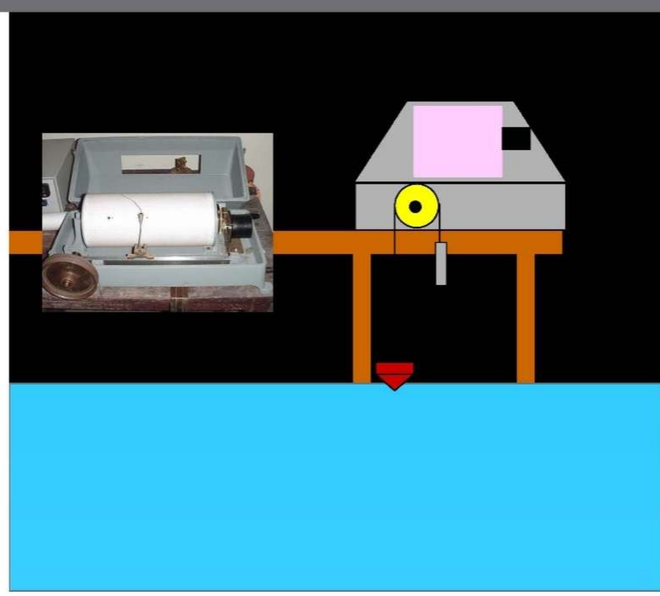

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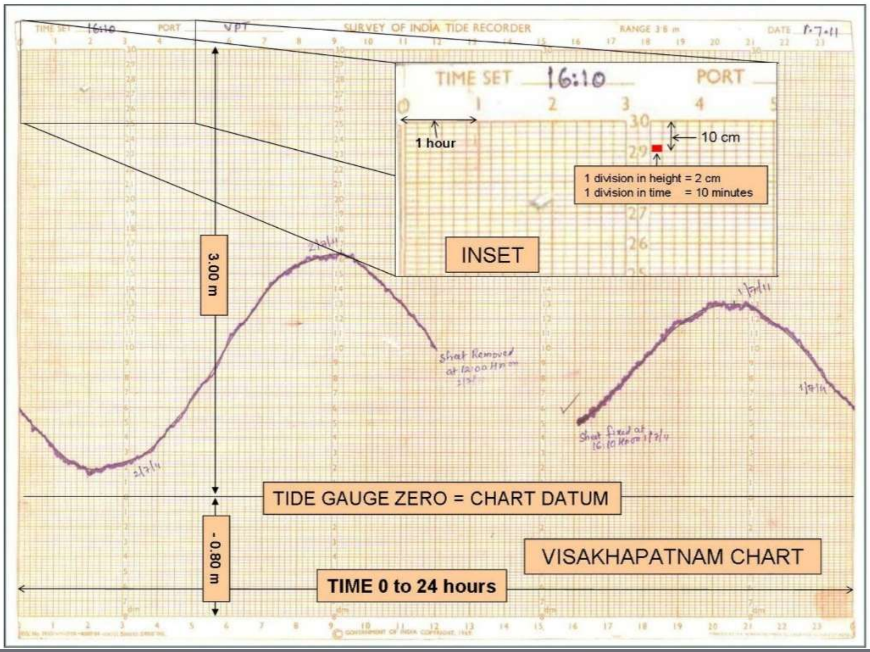

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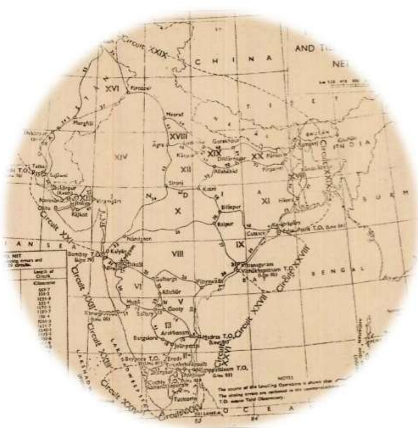
9

National Vertical Reference Frame - Evolution



- ✓ The levelling height information of First Level Net were more than 100 years old.
  - Computed without using actual gravity
  - Many of Bench marks established earlier were destroyed
  - Due to Tectonic Movements Earths Surface has been distorted since then
  - Intrinsic biases and distortions due to technical limitation

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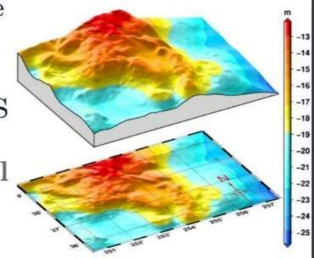
10

National Vertical Reference Frame -

Modernization and Redefinition

- **Redefinition of NVRF**
  - Densification of High Precision Levelling to all parts of Country
  - Geo-potential Numbers
  - Re-establishment of Gravity Reference Points
  - Development of Computation Model for adjustment of Gravity Data
- **Development of Transformation models**
  - for converting legacy data to redefined Reference Frame
- **Development of High Accuracy Geoid Model**
  - Hybrid Geoid Undulation model
  - Integration of Geoid Undulation service with CORS corrections
- **Modernization & Strengthening of Tidal Infrastructure**



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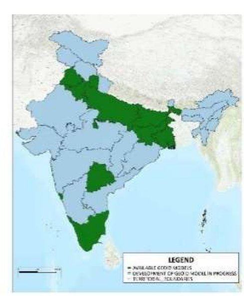
11

National Vertical Reference Frame -

Modernization and Redefinition

✓ Under Redefinition of Indian Vertical Datum. High precision levelling network of about 2,45,000 Lin Km, completed.

✓ Hybrid Geoidal Undulation model
- Through Satellite and Terrestrial Gravity data fitted on Levelling based height reference system.



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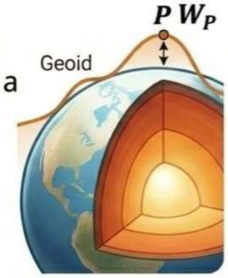
12

Types of Geoid-Referenced Heights

Geopotential Number (C_P)

The fundamental physical quantity. It is the potential difference between the Geoid (W_0) and a point P (W_P).

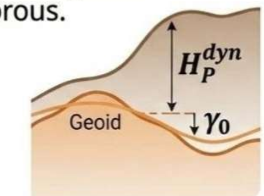
$$C_P = W_0 - W_P$$



Dynamic Height

Derived by scaling the geopotential number by a standard gravity value (γ_0). It has no geometric meaning but is physically rigorous.

$$H_P^{dyn} = \frac{C_P}{\gamma_0}$$



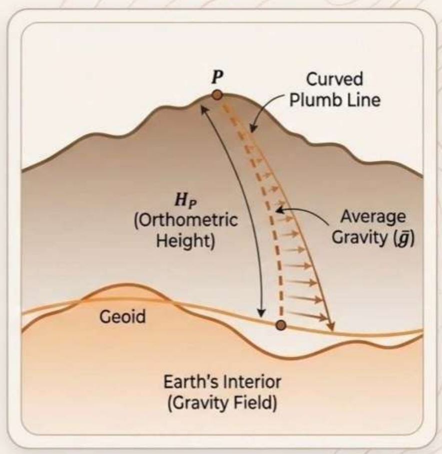
Orthometric Height

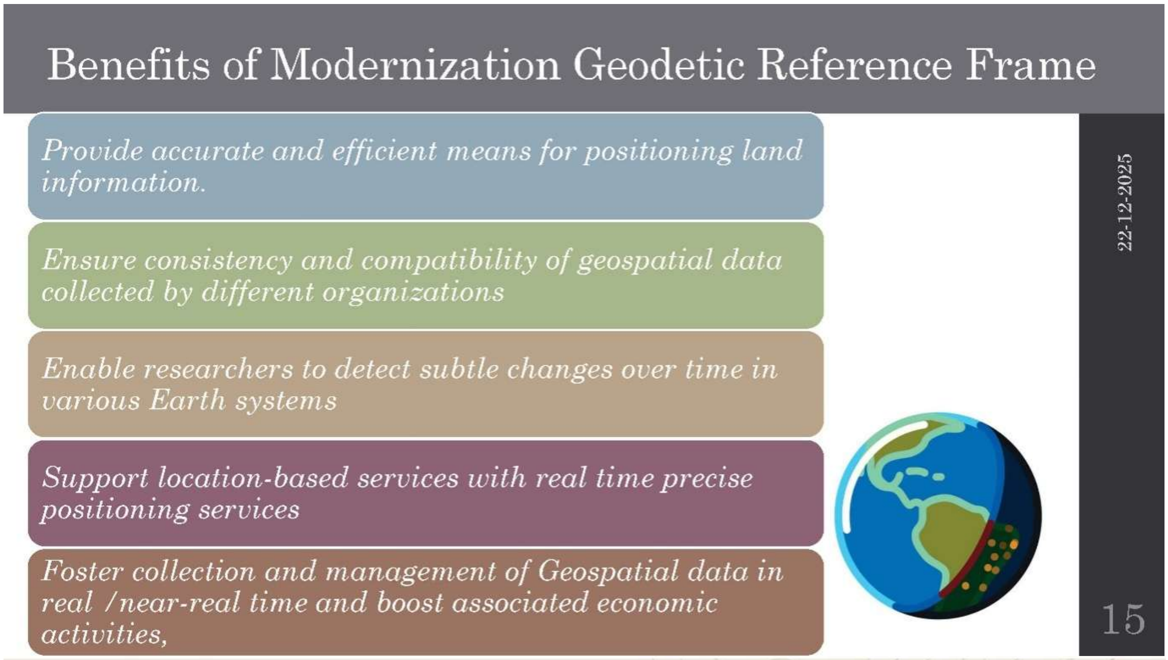
The geometric distance from the Geoid to point P along the curved plumb line.

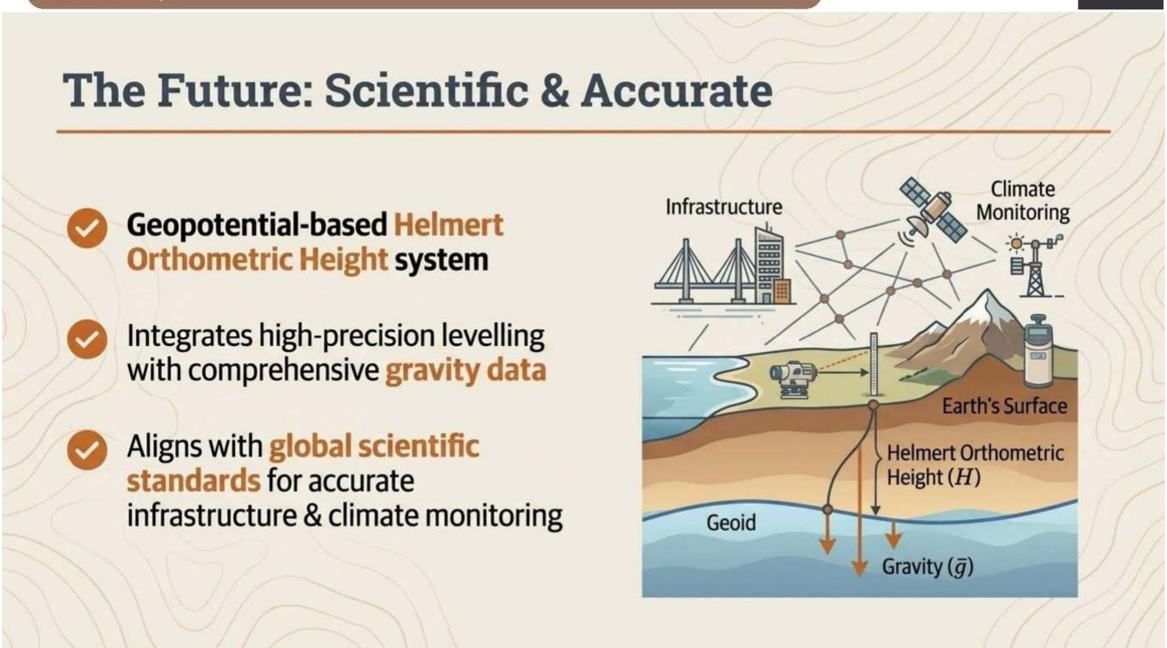
Calculated using the Geopotential Number (C_P) and the average gravity ($\bar{g}$) along the plumb line.

$$H_P = \frac{C_P}{\bar{g}}$$

Since measuring gravity inside the Earth's crust is impossible, we use models (like the Prey reduction) to estimate $\bar{g}$.




Benefits of Modernization Geodetic Reference Frame
Provide accurate and efficient means for positioning land information.
Ensure consistency and compatibility of geospatial data collected by different organizations
Enable researchers to detect subtle changes over time in various Earth systems
Support location-based services with real time precise positioning services
Foster collection and management of Geospatial data in real /near-real time and boost associated economic activities,
22-12-2025
15


The Future: Scientific & Accurate
Geopotential-based Helmert Orthometric Height system
Integrates high-precision levelling with comprehensive gravity data
Aligns with global scientific standards for accurate infrastructure & climate monitoring
Infrastructure
Climate Monitoring
Earth's Surface
Helmert Orthometric Height (H)
Geoid
Gravity ($\bar{g}$)

GENESYS

An Advanced Geospatial Mapping
Content and Solutions Company

Genesys High Definition – High Precision Mapping Adopted Across India

GENESYS

businessline.

Companies / Markets / Portfolio / Opinion / Economy / PREMIUM

Genesys wins GovConnect Award for Varanasi Digital Twin platform

The Genesys New India Map Stack deployed in Varanasi provides a high-precision 3D city model with 5-centimeter accuracy

By BL Mumbai Bureau
Updated - December 03, 2025 at 05:12 PM

THE TIMES OF INDIA

Genesys' 3D digital twin platform adopted as official map for Ayodhya

Genesys International, India's leading mapping company, has been chosen by the Ayodhya Development Authority as the official map for Ayodhya city. Their new India map platform integrates cutting-edge 2D navigation and a 3D-digital twin of the entire city, providing an immersive experience. The map will include

NDTV Profit

Genesys Bags Mandate To Use Digital Twin Tech For Dharavi Redevelopment

The order is valued at Rs 22 crore and is anticipated to be completed within a timeframe of nine months.

GEOSPATIAL WORLD

ADVANCING KNOWLEDGE FOR SUSTAINABILITY

Pune to Adopt Genesys International's Digital Twin

ET THE ECONOMIC TIMES

Mumbai: BMC Initiates 3D Digital Mapping Project For Extensive Urban Planning

The BMC will be taking the help of artificial intelligence for more accurate results.

Construction Week

Hubballi-Dharwad joins the digital transformation: Awards 3D map contract to Genesys

And many more.....

Viksit Bharat

GENESYS

"Harness the capability and content of companies like Genesys who have done pioneering work."

- Shri Amitabh Kant
CEO, Niti Aayog


The Genesys Constellation
GENESYS
AERIAL
Aircrafts
Helicopters
Drones
We Own and Operate India's Largest Constellation of Platforms and Sensors
GENESYS CONSTELLATION
Largest range of aerial, mobile & terrestrial sensors in India
TERRESTRIAL
Mobile LiDAR
Mobile Panoramic
Mobile LiDAR
Trolley LiDAR
Backpack LiDAR

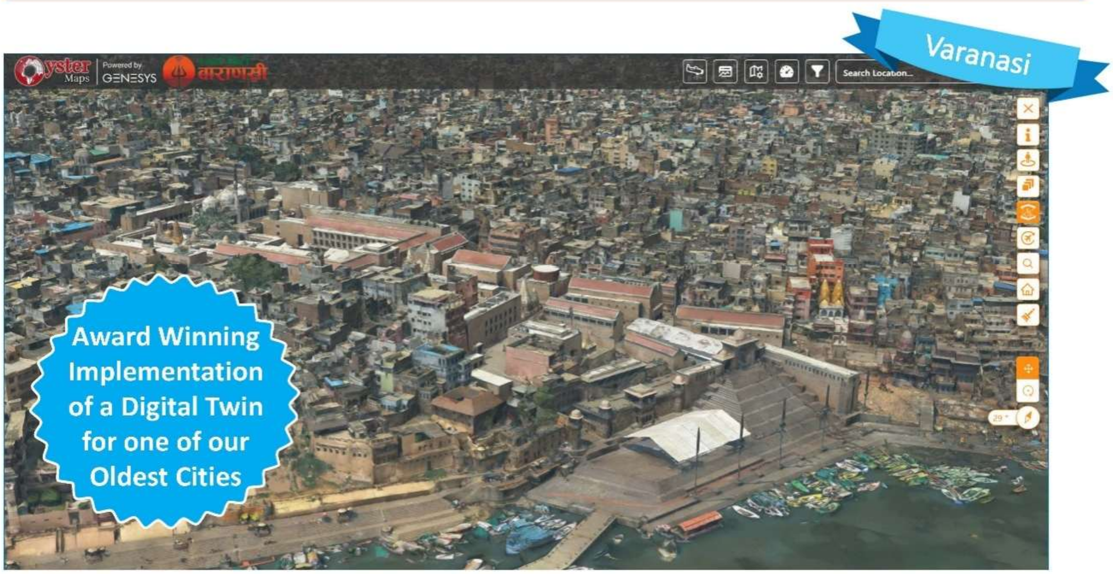

GENESYS
Our Digital Twin Portfolio
Multiple Cities Across India

World's Most Complex Urban Renewal Project

GENESYS

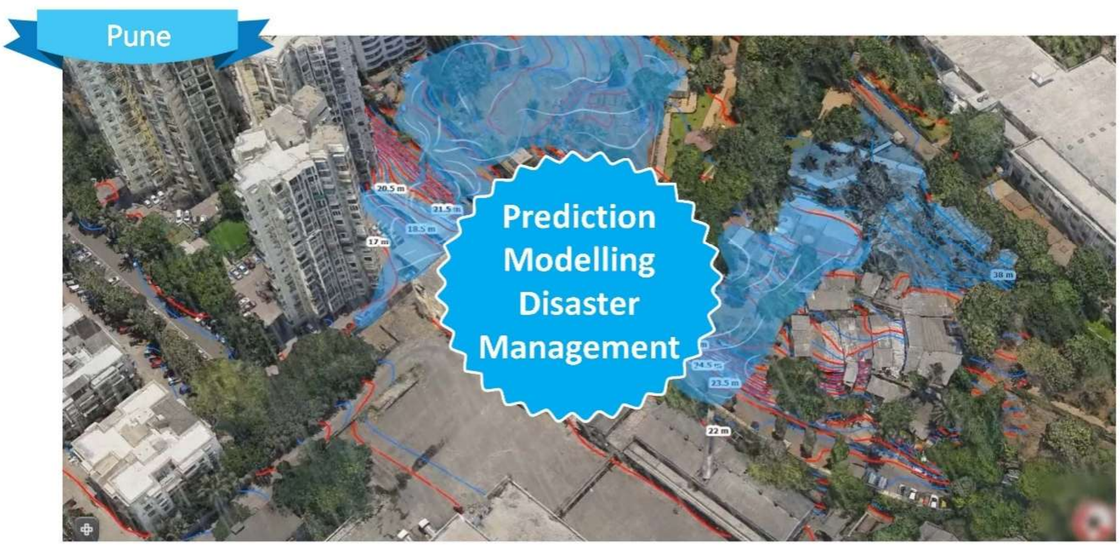
World's Oldest Cities: Massive Infrastructure Renewal Impact

GENESYS



Economic Capital: Huge Urban Infrastructure Impetus GENESYS

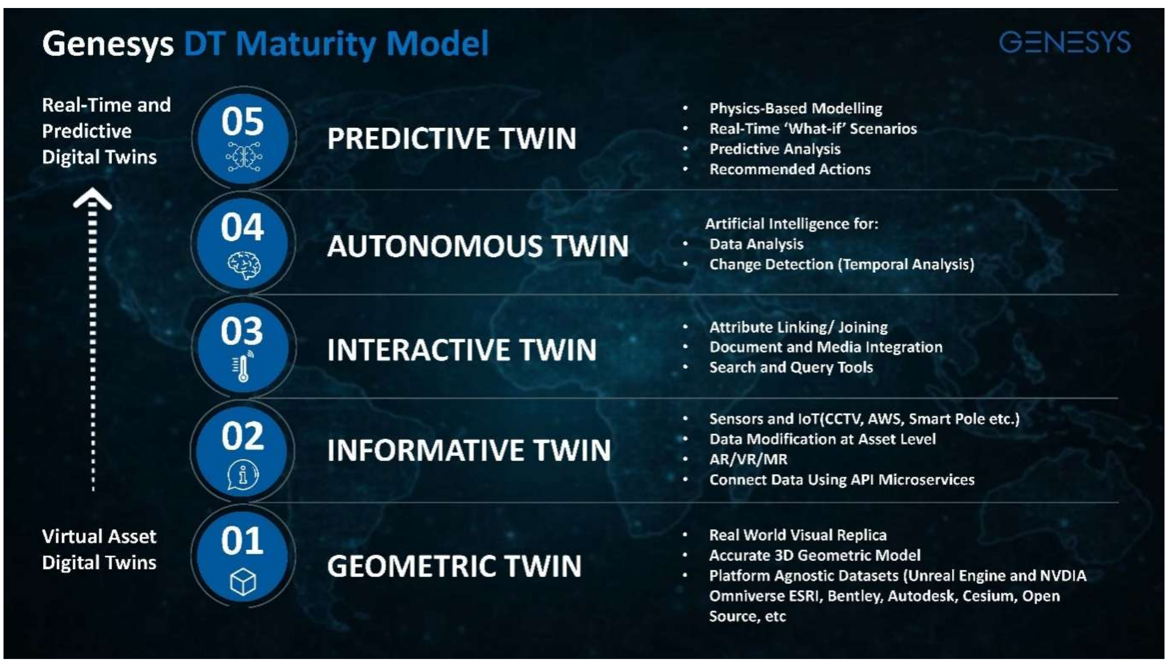
Urban Flooding Predictive Modelling GENESYS



World's Oldest Cities: Spiritual Center GENESYS

Property Tax GENESYS


A Truly Diverse Digital Twin Portfolio
GENESYS
Thane
Surat
Nashik
Indore
Goa
Ahmedabad
Ludhiana
One of the Largest Urban-Spatial Digital Twin Mapping Exercises in the World

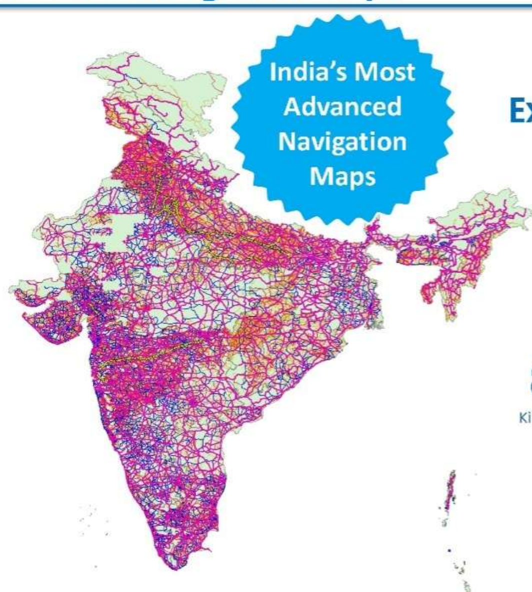

Genesys DT Maturity Model
GENESYS
Real-Time and Predictive Digital Twins
Virtual Asset Digital Twins
05 PREDICTIVE TWIN
Physics-Based Modelling
Real-Time 'What-if' Scenarios
Predictive Analysis
Recommended Actions
04 AUTONOMOUS TWIN
Artificial Intelligence for:
Data Analysis
Change Detection (Temporal Analysis)
03 INTERACTIVE TWIN
Attribute Linking/ Joining
Document and Media Integration
Search and Query Tools
02 INFORMATIVE TWIN
Sensors and IoT(CCTV, AWS, Smart Pole etc.)
Data Modification at Asset Level
AR/VR/MR
Connect Data Using API Microservices
01 GEOMETRIC TWIN
Real World Visual Replica
Accurate 3D Geometric Model
Platform Agnostic Datasets (Unreal Engine and NVDIA Omniverse ESRI, Bentley, Autodesk, Cesium, Open Source, etc

$3 Trillion of our $4 Trillion Economy comes from

Urban India

All India Navigation Maps

GENESYS



Leading the Way with Extensive Pan-India Coverage

7000+ Cities/Towns

490M Building Footprints

40M + Points of Interest & Addresses

8.3M Kilometers Roads

86K Clusters

22K Land Use

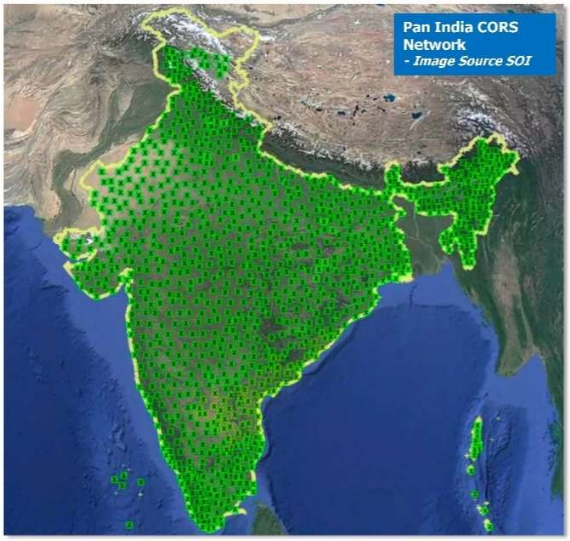
20K Localities

19K+ Pin codes

200+ Road Attributes

CORS and ADAS Announcement

GENESYS



Announcing today

ADAS Level 2+ Maps

for entire India's

National Highways and Expressways

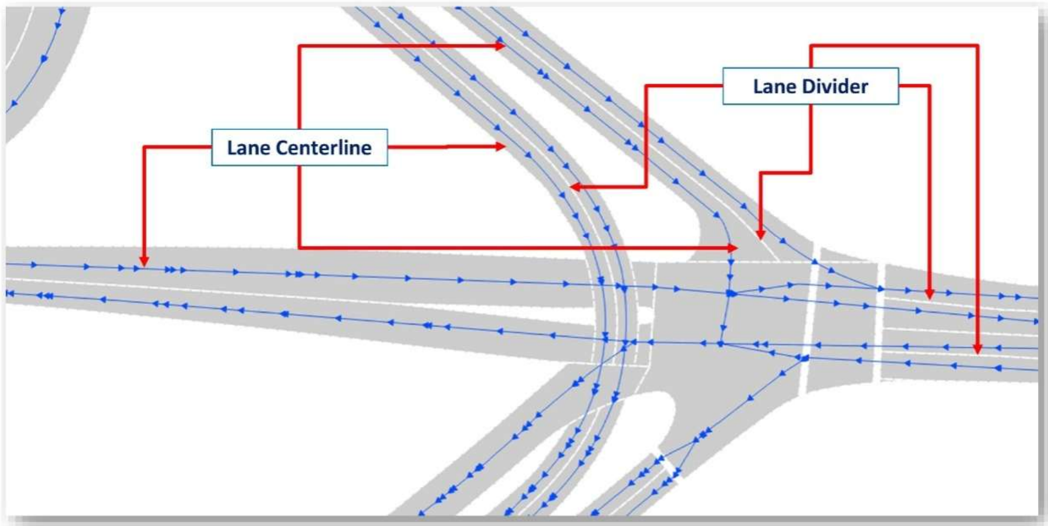
Elements of Road Safety

GENESYS

- **Building** - Outlines
- **Lanes** - Boundary, centerline, divider, marker, merge, split
- **Obstruction Objects** – Physical barriers, Noise barriers, Pedestrian Sign, Traffic Sign, Warning Sign, Traffic Signal,
- **Rail** – Railroad crossings.
- **Road** – Centreline, ROW, Carriageway, Road Shoulder, Medians, Kerbing, Bicycle Lane, Pedestrian, Parking Lane
- **Road Network** – Road Segment Connectivity, Stop Line, Junction, Speed Humps, Rumble Strip, Interchange, Road Structures
- **Road Side** - Trees, Vegetation, Hydro features
- **Parking** – Space, Sign
- **Street Furniture** – Street Light, Traffic Camera, Bus Stop, Fire Hydrant, Telephone Box, Kilometre Marker, POI, Advertising Hoardings, Gantry Sign Board, Utility Pole, Landmark Feature
- **Traffic Flow** – Congestion, Congestion Level, Density, Flow Direction, Speed Estimation

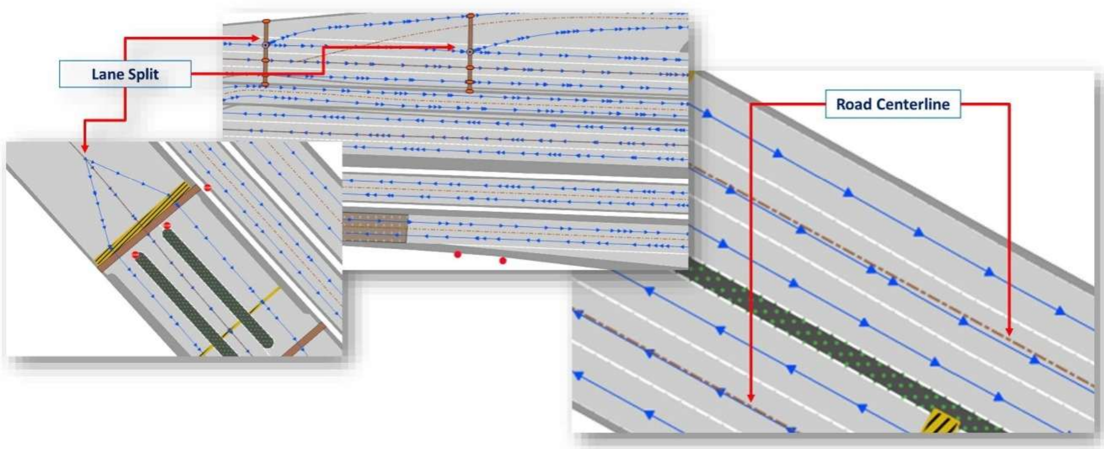
Elements of Road Safety

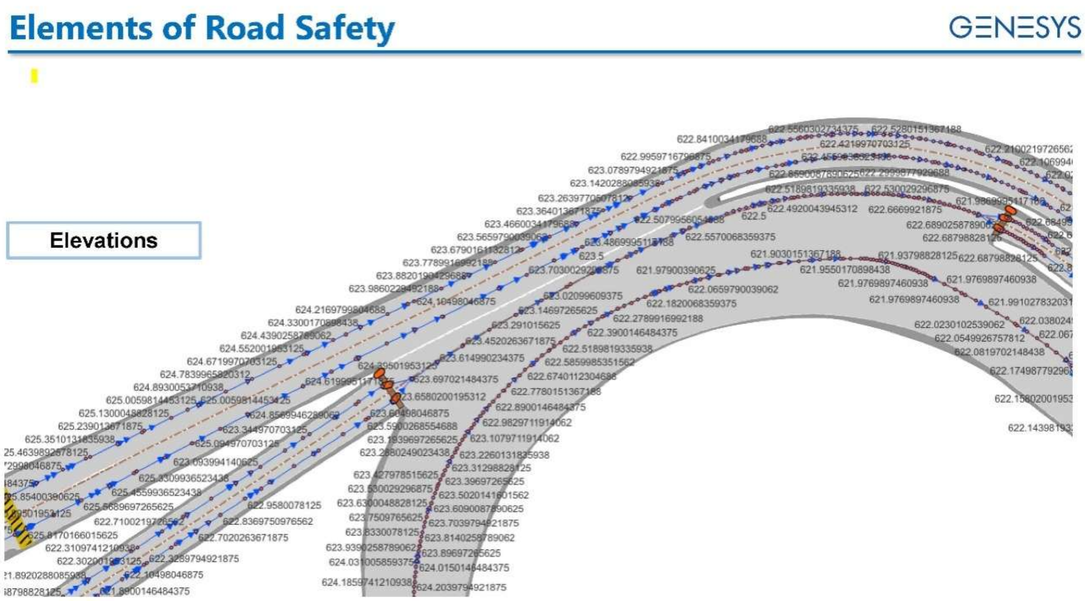
GENESYS



Elements of Road Safety

GENESYS




Elements of Road Safety
GENESYS
Elevations

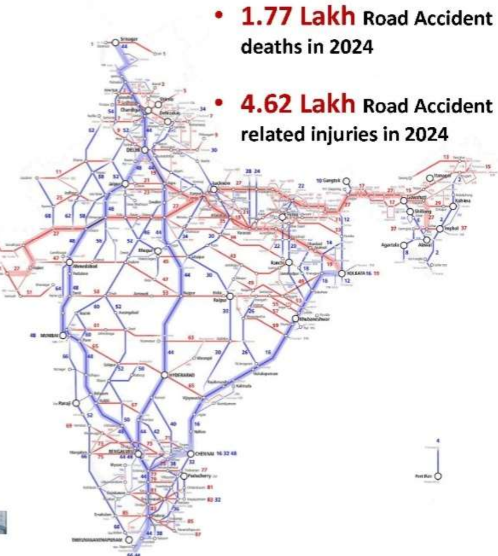

Elements of Road Safety
GENESYS
High precision mapping which will capture road details at 5 cms accuracy.
Rumble Strips
Traffic Lights
Speed Signs
Right of way
Lane geometry
Road edges & barriers
Curvature & slope
Signage & road furniture
Road types
Elevation
Lamp Poles
Road Shoulder
Street Sign
Lane Marking
Road Surface Marking
Median
Lane Count

Road Incident Statistics

GENESYS

≈ 3% of the Road Networks contributing
≈ 33% of Road Fatalities

- **1.77 Lakh** Road Accident deaths in 2024
- **4.62 Lakh** Road Accident related injuries in 2024



A Key Pivot for Road Safety

GENESYS

From **reactive safety measures**
To predictive, **data-driven interventions**

This shifts **safety from enforcement after the fact** to **intelligence before risk materializes**

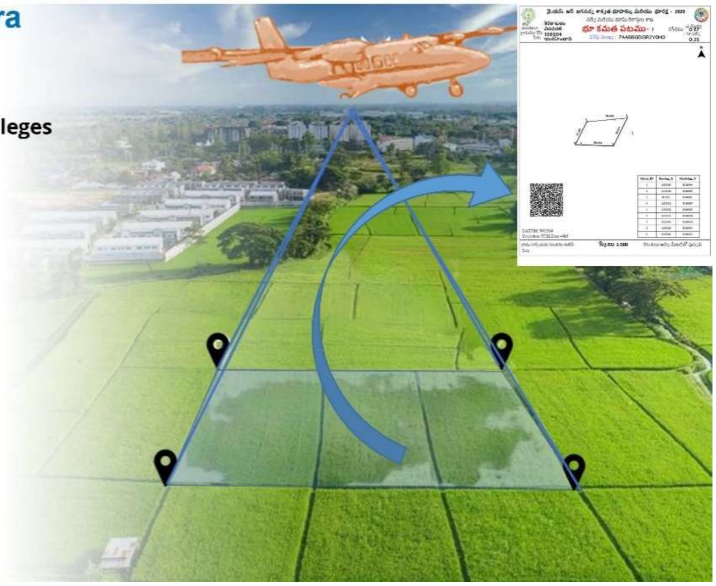
Land Records: Our Experience

GENESYS

Bhu Hakku Patra: Andhra Pradesh

Crucial document that states the property's ownership, rights, and privileges

Bhu – Land
Hakku – Claim / The Right
Patra – Paper / Document



➢ PROJECT DETAILS

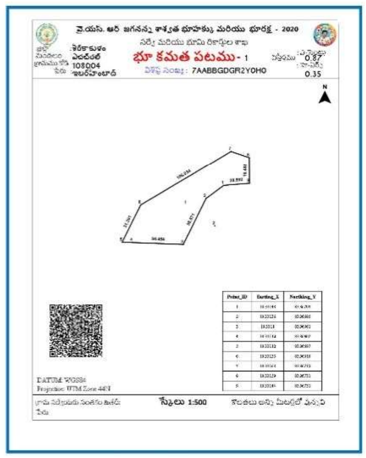
- Full fledged Re-survey of all lands covering **1.25 Lakh Sq Km**
- **First of its kind** in the country
- **Latest Technology** – Aerial Mapping Systems
- Provide dispute & error free **Bhu Hakka Patram** to Pattadar (Landowner) with textual data (ROR) and Land Parcel Map

Land Records: Our Experience

GENESYS

Aerial Data Acquisition → **Aerial Data Processing** → **Land Parcel Map Generation**

Ortho Rectified Imagery – 4cm GSD



Land Records: Our Experience

GENESYS

Bhu Hakku Patra

➢Spatial Data

- Map frame
- Map legend showing the geo-coordinates
- Map title showing the land parcel number, extent etc.
- QR Code showing the textual information of respective Land Parcel Map.

➢Accuracy

- True reflection

➢Identification

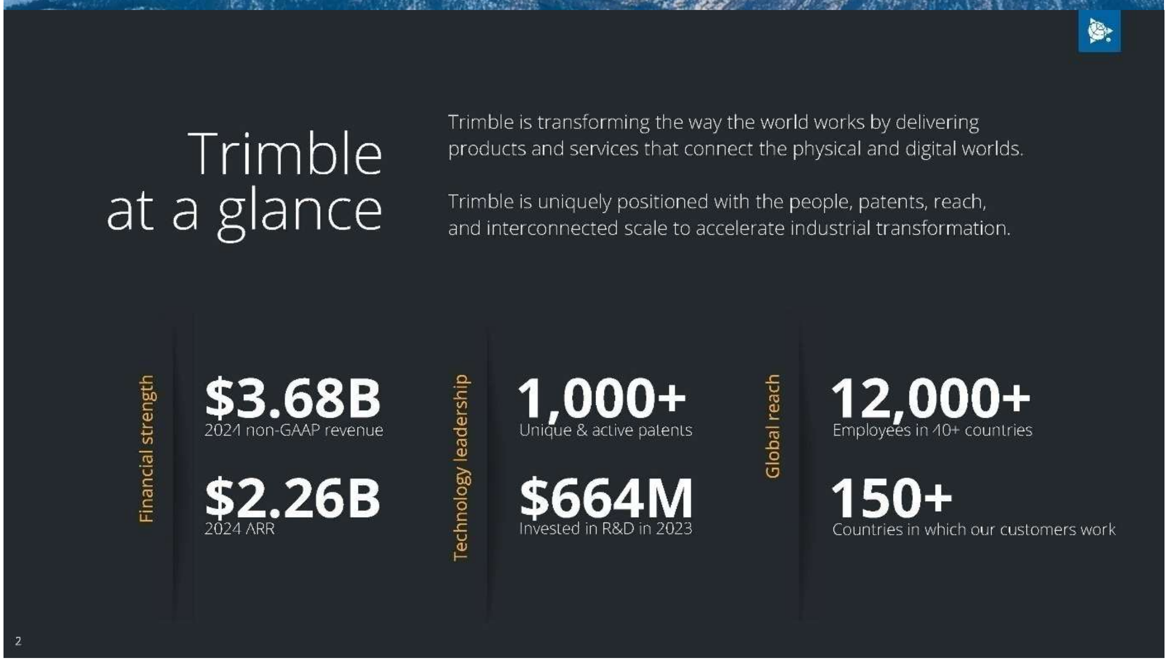
- Easy Identification of land using geo-coordinates
- Builds confidence in landowner since geo-fenced boundary

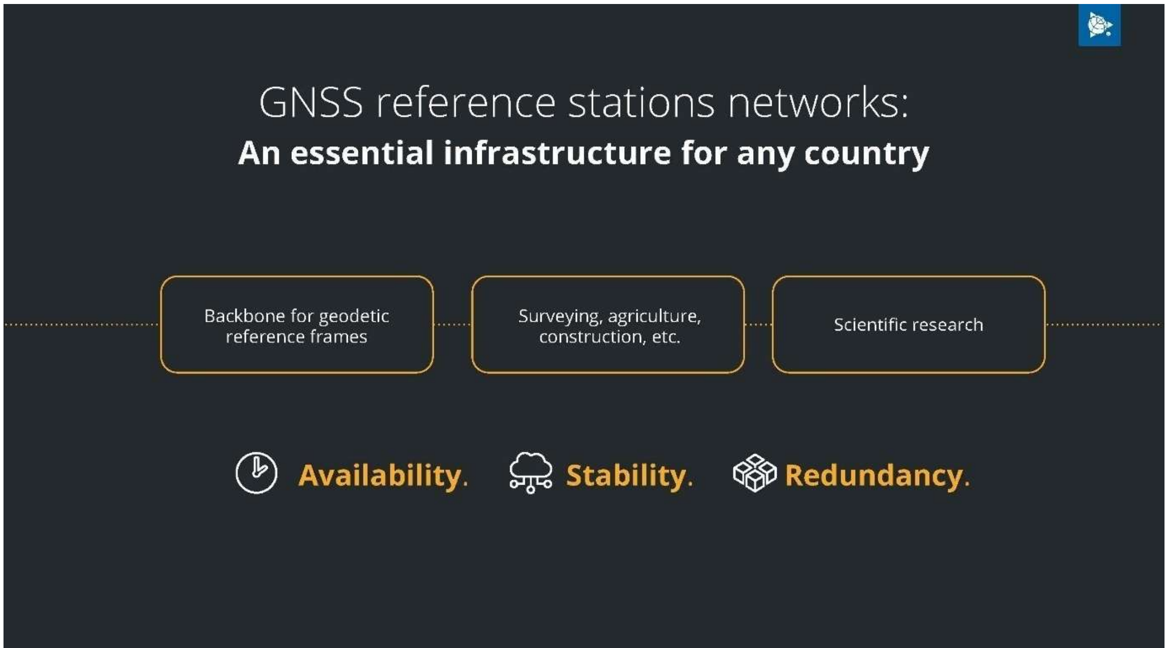
Our Suggestions on CORS

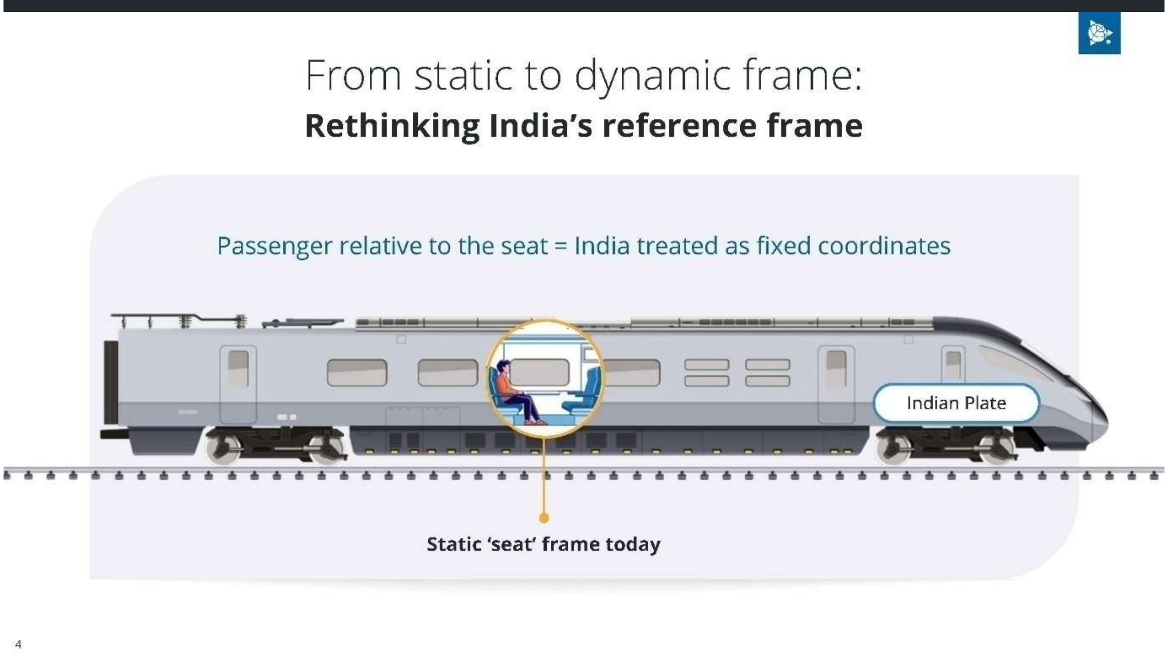
GENESYS

- **Accuracy** is **non-negotiable** in real-world execution. Despite using best-in-class sensors like Trimble, Leica, Pegasus Two, CityMapper and RIEGL, everything depends on the quality of the **reference frame**.
- CORS networks are critical but must be **denser and more resilient**. Urban canyons, mountains and remote regions still face signal challenges that impact precision applications.
- Industry often deploys its own base stations to maintain accuracy. This operational reality highlights the **need for a stronger, more uniformly available** national geodetic infrastructure.
- **Vertical reference frames** are as important as horizontal ones. Accurate heights underpin flood modelling, drainage planning, coastal monitoring and reliable Digital Twins.
- **India needs a coordinated national approach to geodesy.** Treat geodetic infrastructure as national public infrastructure, integrate advanced techniques operationally, and leverage industry capability through structured collaboration.

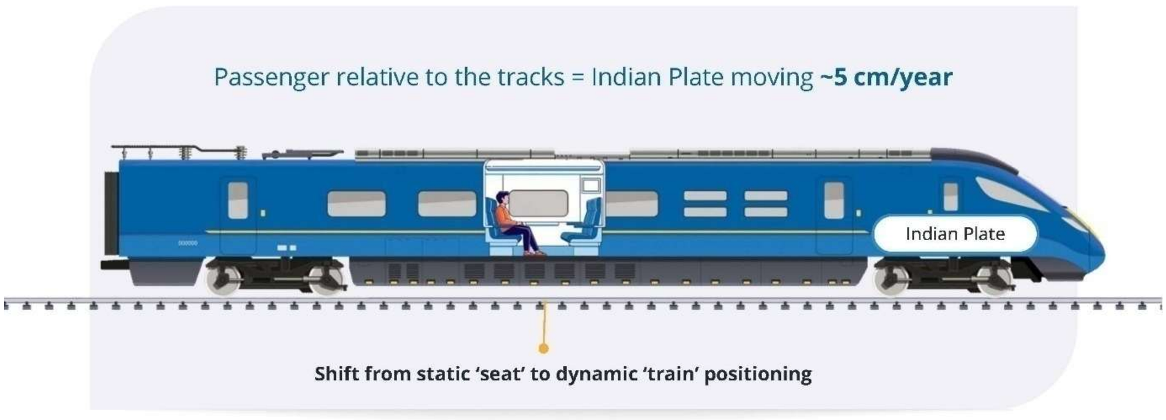

Trimble.
Modernizing India's
Geospatial Reference Frame
Aligning with global standards in a dynamic world
Presenter: Olivier Casabianca


Trimble
at a glance
Trimble is transforming the way the world works by delivering products and services that connect the physical and digital worlds.
Trimble is uniquely positioned with the people, patents, reach, and interconnected scale to accelerate industrial transformation.
Financial strength
$3.68B
2024 non-GAAP revenue
$2.26B
2024 ARR
Technology leadership
1,000+
Unique & active patents
$664M
Invested in R&D in 2023
Global reach
12,000+
Employees in 40+ countries
150+
Countries in which our customers work
2


GNSS reference stations networks:
An essential infrastructure for any country
Backbone for geodetic reference frames
Surveying, agriculture, construction, etc.
Scientific research
Availability.
Stability.
Redundancy.

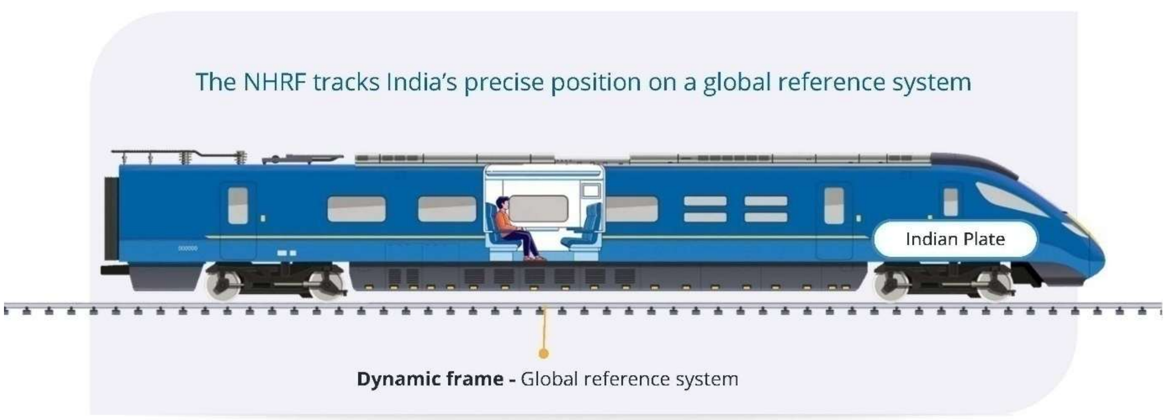

From static to dynamic frame:
Rethinking India's reference frame
Passenger relative to the seat = India treated as fixed coordinates
Indian Plate
Static 'seat' frame today
4

From static to dynamic frame:
From fixed assumptions to dynamic precise positioning

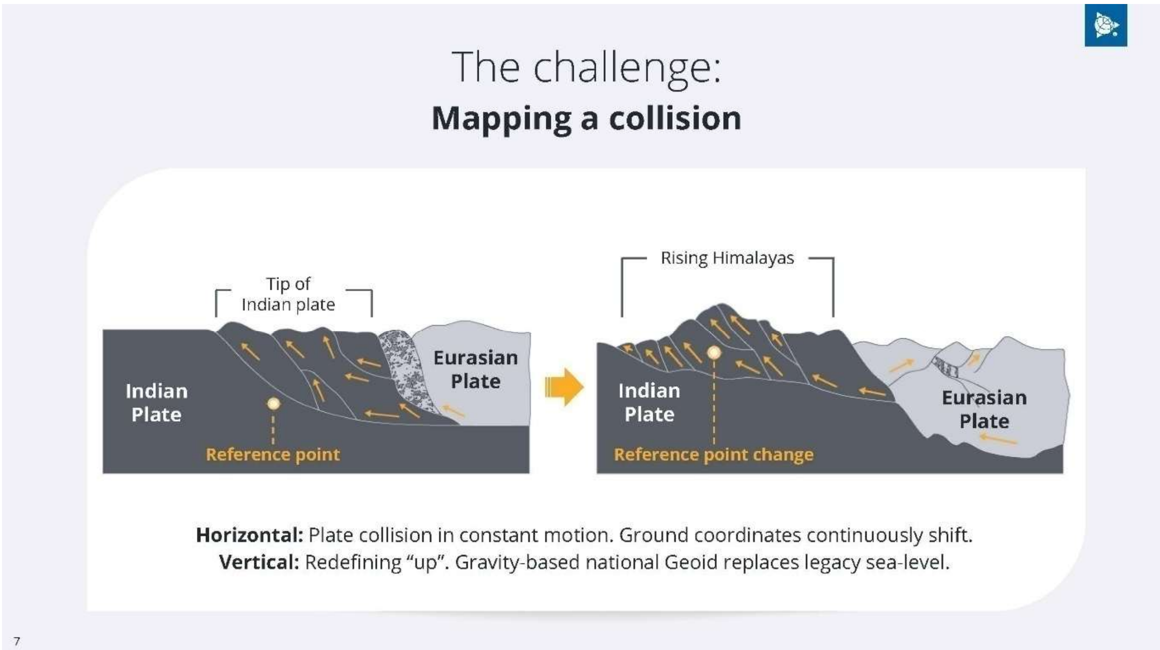


5

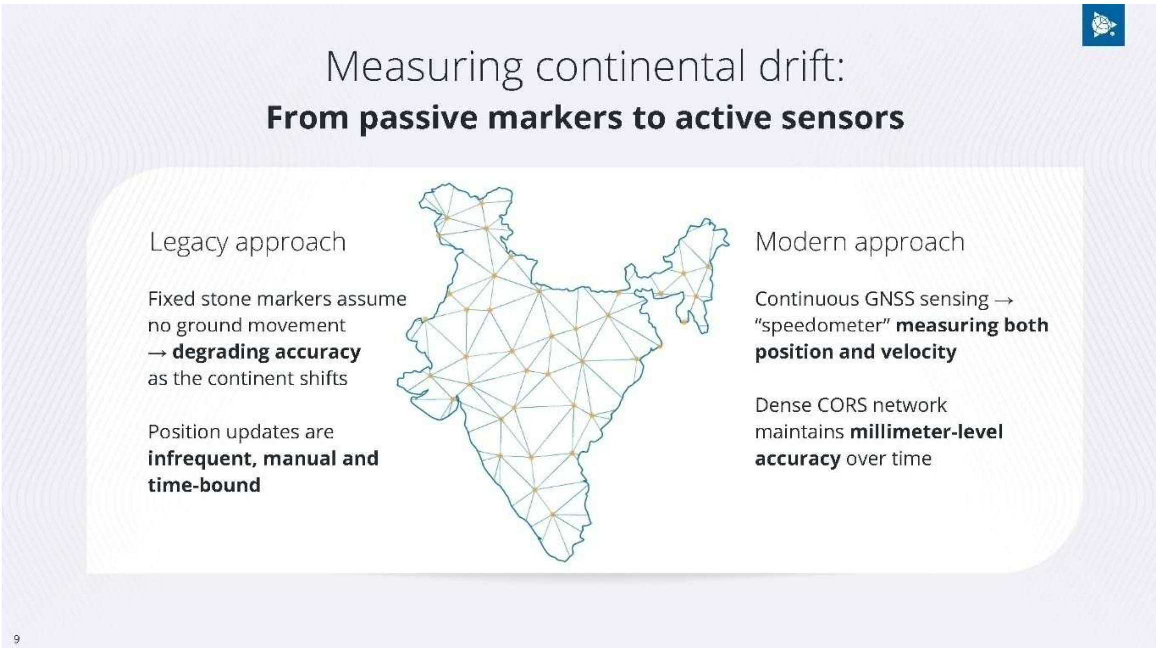
From static to dynamic frame:
The shift

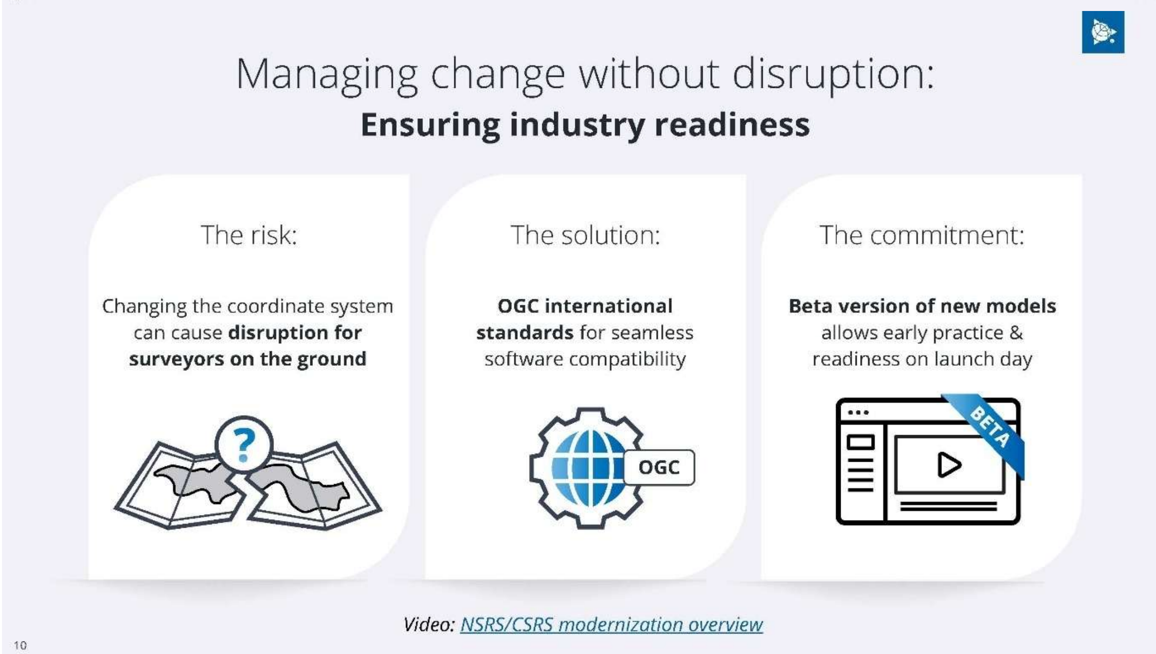


6


The challenge:
Mapping a collision
Tip of
Indian plate
Rising Himalayas
Indian
Plate
Eurasian
Plate
Reference point
Reference point change
Horizontal: Plate collision in constant motion. Ground coordinates continuously shift.
Vertical: Redefining "up". Gravity-based national Geoid replaces legacy sea-level.
7


Global context:
Aligning with international geospatial standards
CANADA
USA
INDIA
AUS
8


Measuring continental drift:
From passive markers to active sensors
Legacy approach
Fixed stone markers assume no ground movement → degrading accuracy as the continent shifts
Position updates are infrequent, manual and time-bound
Modern approach
Continuous GNSS sensing → "speedometer" measuring both position and velocity
Dense CORS network maintains millimeter-level accuracy over time
9


Managing change without disruption:
Ensuring industry readiness
The risk:
Changing the coordinate system can cause disruption for surveyors on the ground
The solution:
OGC international standards for seamless software compatibility
OGC
The commitment:
Beta version of new models allows early practice & readiness on launch day
BETA
Video: NSRS/CSRS modernization overview
10

GNSS CORS in India:
A success story

1105
Total CORS

523
Trimble CORS

02
Fully functional control centre

37
CORS under Naksha

Video: Survey of India establishes CORS network

11

One network, multiple applications:
Future plans: CORS feeds for Trimble RTX Fast

What is Trimble RTX Fast?

- PPP solution delivered via Satellite or the Internet in real time, no base required
- Fast convergence (**< 1 minute** on ProPoint), with RTK-level accuracy
- Leverages national CORS and global GNSS infrastructure

Maximizing the value:

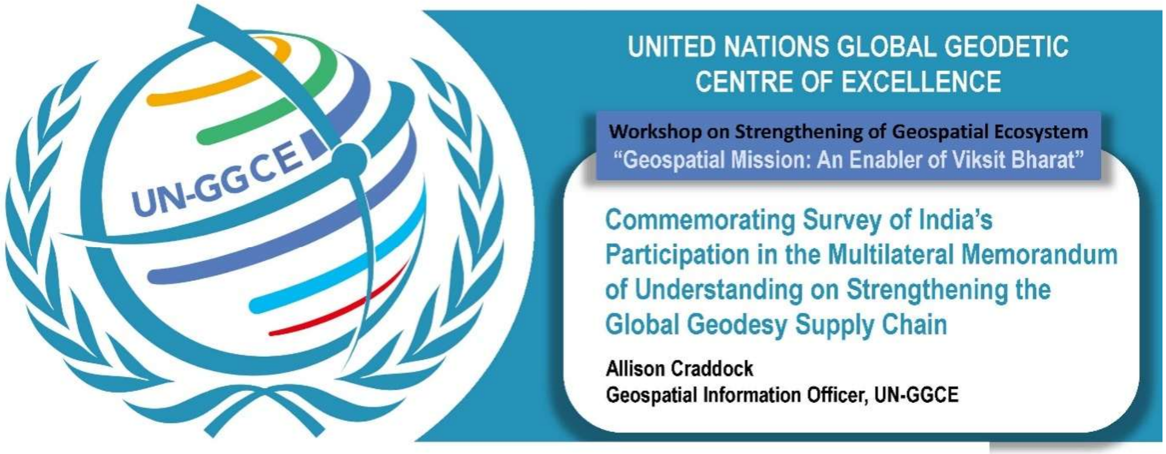
Extending high-accuracy positioning beyond station coverage

Strengthens national resilience and interoperability

Complementing national infrastructure, maximizing the return on existing CORS investments

Untethered | **Efficient** | **Accurate** | **Reliable**

12

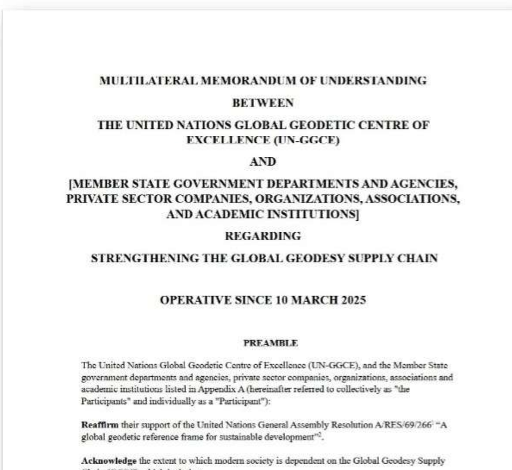

UN-GGCE
UNITED NATIONS GLOBAL GEODETIC CENTRE OF EXCELLENCE
Workshop on Strengthening of Geospatial Ecosystem
"Geospatial Mission: An Enabler of Viksit Bharat"
Commemorating Survey of India's Participation in the Multilateral Memorandum of Understanding on Strengthening the Global Geodesy Supply Chain
Allison Craddock
Geospatial Information Officer, UN-GGCE


GLOBAL GEODESY SUPPLY CHAIN (GGSC)
The global geodesy supply chain is the complete system that produces and delivers accurate geodetic data – from ground-based observatories – through to the final products used in mapping, disaster management, and sustainable development.
OBSERVATORIES
Constant observations of the Earth's shape, orientation and gravity field.
ANALYSIS
Translate the raw data into geodetic products.
DATA
Quality check the data and make it globally available.
GEODETIC PRODUCTS
Reference Frame, Gravity Model, Earth Orientation Parameters, and Satellite Orbits.
USER
Geodetic data is crucial for everyone, supporting our daily lives, guiding disaster response, and helping shape policies for a more sustainable world.
Learn More
https://ggim.un.org/UNGGCE/
https://www.linkedin.com/company/unggce/
United Nations Global Geodetic Centre of Excellence
Stronger. Together.

UN General Assembly Resolution

UN Global Geodetic Centre of Excellence

Survey of India, on behalf of the Government of India, joins Multilateral Memorandum of Understanding (MMOU) on Strengthening the Global Geodesy Supply Chain



MULTILATERAL MEMORANDUM OF UNDERSTANDING

BETWEEN

THE UNITED NATIONS GLOBAL GEODETIC CENTRE OF EXCELLENCE (UN-GGCE)

AND

[MEMBER STATE GOVERNMENT DEPARTMENTS AND AGENCIES, PRIVATE SECTOR COMPANIES, ORGANIZATIONS, ASSOCIATIONS, AND ACADEMIC INSTITUTIONS]

REGARDING

STRENGTHENING THE GLOBAL GEODESY SUPPLY CHAIN

OPERATIVE SINCE 10 MARCH 2025

PREAMBLE

The United Nations Global Geodetic Centre of Excellence (UN-GGCE), and the Member State government departments and agencies, private sector companies, organizations, associations and academic institutions listed in Appendix A (hereinafter referred to collectively as "the Participants" and individually as a "Participant"):

Reaffirm their support of the United Nations General Assembly Resolution A/RES/69/266[1] "A global geodetic reference frame for sustainable development"[2].

Acknowledge the extent to which modern society is dependent on the Global Geodesy Supply Chain (GGSC) which includes:

- Promotes **voluntary cooperati**on among the UN-GGCE, Member State agencies, private sector companies, and academic institutions to strengthen the Global Geodesy Supply Chain (GGSC).
- Raises **awareness of the critical, shared reliance** on the GGSC for accurate geodetic products essential to positioning, navigation, and timing services.

Annexure

Session – 2

National Hydrology Project (NHP)
17 Dec, 2025

SURVEY OF INDIA
(DEPARTMENT OF SCIENCE & TECHNOLOGY)

1

भारतीय सर्वेक्षण विभाग
Survey of India
विज्ञान और प्रौद्योगिकी विभाग
Department of Science & Technology

National Hydrology Project

- **SOI Role in NHP**
  - Major Deliverables
    - ✓0.5 m DEM of 68 K Sq Km area
    - ✓Geodatabase of 8.3 L Sq Km area
    - ✓Capacity Building

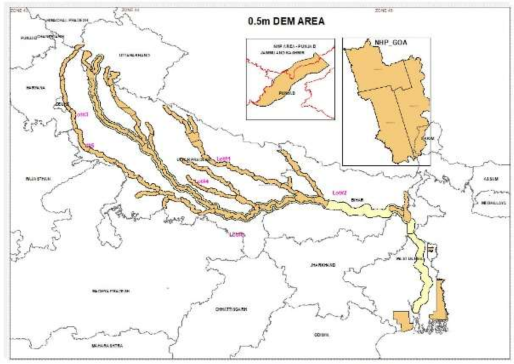
- **Additional Work**
  - Height to Hydromet stations of entire country
  - Bathymetric Survey for River Cross Sections
  - Geoid Model of 12 states
  - DEM in Goa, Punjab, WB and Tripura – Nagaland
  - Additional work in WB.. Geodatabase / 3-5m DEM

2

Work done by SoI Under National Hydrology Project

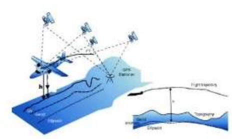
➤ **Generation of DEM of 0.5 m accuracy and 25 cm GSD ORI for 68,000 sq Km area covering**

- 5 km belt either side of river banks along River Ganga, Yamuna, Ghaghra, Ramganga, Gandak, Gomati , Sai, Kali, Betwa & Ken in UP state
- Entire state of Goa and some parts of State of Punjab, West Bengal, Tripura & Nagaland



➤ **Status**

Entire work completed & HR DEM Data of 68,094 Sq Km area has been supplied to NPMU/NWIC



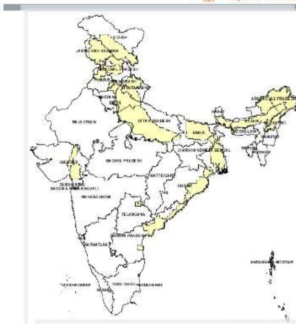
Work done by SoI Under National Hydrology Project

NHP Zone for 0.5m DEM	Final Data supplied to NWIC
Lot#1	8,527
Lot#3	10,896
Lot#5	8,028
W Bengal Pocket 'C'	725
Entire State of Goa	3,697
Area in Punjab	486
Lot#2	9,563
Lot#4	11,665
Lot#6	8,865
W Bengal Pocket 'A'	2,496
W Bengal Pocket 'B'	3,147
Total	**68,094**

4

Work done by SoI Under National Hydrology Project

- Generation of DEM of 3 to 5 m accuracy and 1:25,000 scale GIS Map for 8.3 Lakh Sq Km Area covering
  - Ganga River Basin
  - Brahmaputra River Basin
  - Indus River Basin
  - Sabarmati River Basin
  - Mahanadi River Basin and North Eastern Coast
  - Godavari River Basin



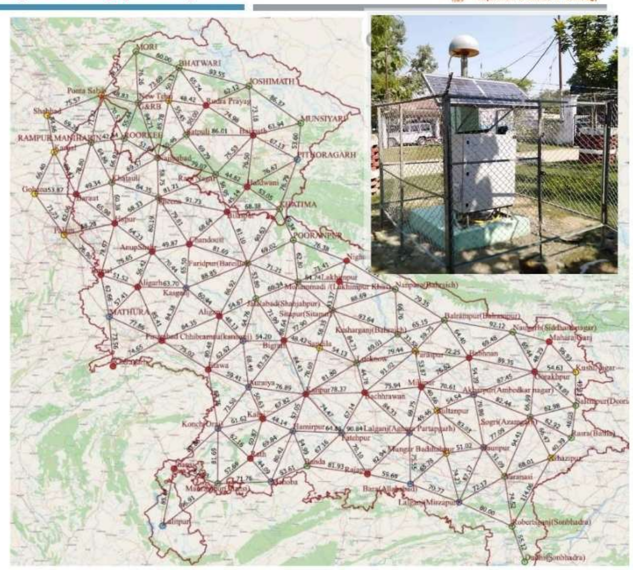
- Status

  Entire work completed & Data of 8.3 L Sq Km covering 4800 No. of 1:25k sheets has been supplied to NPMU/NWIC
- Data Format.. Geodata base, Pdf and DEM

Work done by SoI Under National Hydrology Project

भारतीय सर्वेक्षण विभाग
Survey of India
विज्ञान और प्रौद्योगिकी विभाग
Department of Science & Technology

- Establishment of Continuously Operating Reference Stations in states of UP and Uttarakhand
  - 81 CORS installed in UP and Uttarakhand
  - Made the observation of precise positin faster and cheaper.
  - Can be used to support various Geo scientific and economical activities, like monitoring Ground water level, weather forecast etc.



Work done by SoI Under National Hydrology Project

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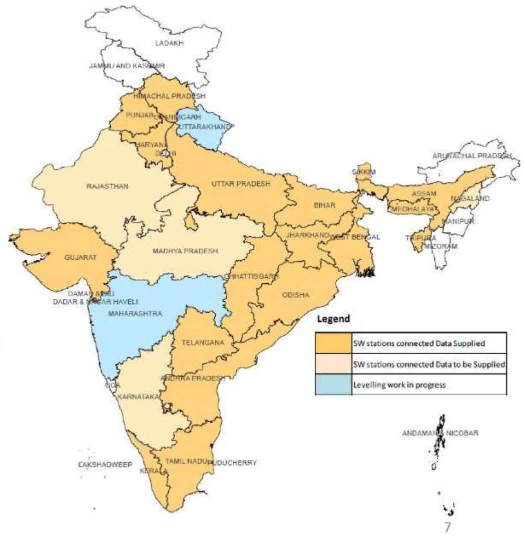
Survey of India
विज्ञान और प्रौद्योगिकी विभाग
Department of Science & Technology

➢ Connecting Hydromet Stations to MSL height

- More than 2000 Surface water stations are being connected with MSL in the entire country except Jammu Kashmir & Ladakh.
- SW stations of 22 states/IAs have been connected to MSL so far.
- For the remaining states Survey of India will complete the work by own resources and will supply the data.



7

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Sl. No.	Name of IA/ State	SWS to be connected	SWS connected	SW Supplied to NPMU	Status of Data Supply
1	Telangana	115	109	109	Final Heights Submitted to NPMU
2	BBMB	58	58	58	
3	Haryana	9	8	8	
4	DVC	21	21	21	
5	Punjab	6	6	6	
6	Bihar	61	61	61	
7	Jharkhand	26	26	26	
8	UP	42	42	42	
9	WB	56	56	56	
10	AP	51	46	46	
11	Sikkim	21	16	16	
12	Kerla	130	130	130	
13	Gujarat	104	98	98	
14	HP	41	41	41	
15	Tamilnadu	199	199	199	

Sl. No.	Name of IA/ State	SWS to be connected	SWS connected	SW Supplied to NPMU	Status of Data Supply
16	Puducherry	7	7	7	Supplied
17	Chhattisgarh	30	26	24	
18	Odisha	38	38	38	
19	Assam	75	75	58	
20	Tripura	11	11	11	
21	Meghalaya	25	16	14	
22	Rajasthan	116	116	116	
23	MP	23	23	0	
24	Karnataka	7	7	0	
25	Maharashtra	69	16	0	-
26	Uttrakhand	624	432	0	-
27	Arunachal Pd	45	25	0	-
28	Nagaland	32	28	0	-
29	Manipur	13	0	0	-
30	Mizoram	16	0	0	-
	TOTAL	**2071**	**1737**	**1185**	

Work done by SoI Under National Hydrology Project

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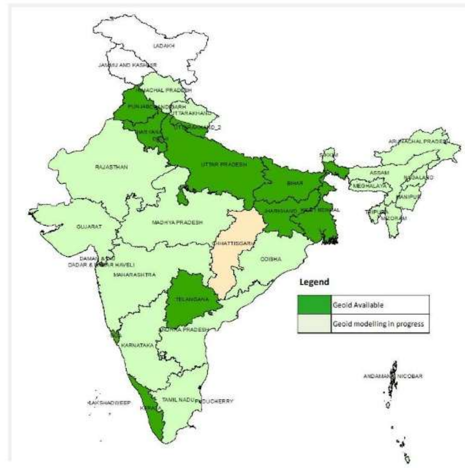
Department of Science & Technology

➢ Development of 10 cm Accuracy Geoid Model

- To convert easily acquirable GPS heights to Orthometric or MSL height
- Developed for states of Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal, Jharkhand, Telangana, Goa, Part of Uttrakhand and Kerala
- Work is in progress for remaining states



9

Work done by SoI Under National Hydrology Project

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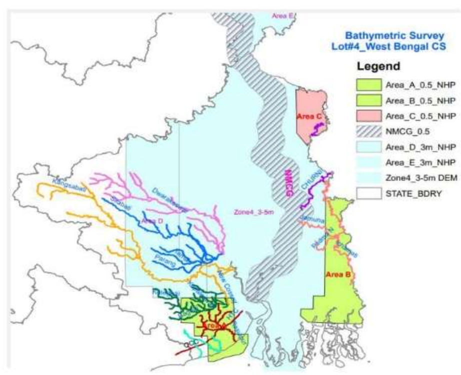
Survey of India
विज्ञान और प्रौद्योगिकी विभाग
Department of Science & Technology

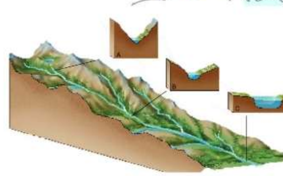
➢ Bathymetry Survey for generating River Cross Sections in Southern part of West Bengal

- Essentially required in flood forecasting hydrodynamic models.
- On Kangsabati, Silabati, Parang, Tamal, Dwarkeshwar, Kapaleshwari, New Cossey, Baghai, Keleghai, Rusulpur, Churani, Jamuna, Padma and Ichchamati Rivers of West Bengal.



➢ Status

Work completed & Data of 3602 no. of Cross sections(*Depth of Water across the river at every 10m and along the river at every 2 km*) supplied to state Implementing Agency (Irrigation & Waterways Deptt. Govt. of West Bengal)



Work done by SoI Under National Hydrology Project

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Department of Science & Technology

➢ Capacity building under NHP

Year Ending	No. of Trainings Conducted	No of Participants
2018	05	59
2019	05	41
2020	04	138
2021	07	106
2022	05	44
2023	06	66
2024	06	79
2025	06	95
Total	**44**	**628**

620+ trainees have been participated in the above offline/online trainings.

11

➢ Capacity building under NHP

GOVERNMENT OF PUNJAB
DEPARTMENT OF WATER RESOURCES

To

The Surveyor General of India
Survey of India
Hathibarkala Estate, Dehradun-248001

Subject: Regarding Geoid Model of Punjab State

1.0 In our efforts to bring the Water Resources Department, Punjab, in line with the latest technology, we are actively participating in NHP training programs and procuring modern instruments.

2.0 Our department deputed officers to your training program on **"CORS & Geoid Model"** conducted at NIGST, Hyderabad.

3.0 The highly informative and practical training provided by your officials has significantly benefitted our department in cadastral mapping, demarcations, and floodplain zoning. Additionally, our officers have started utilizing the CORS network, leading to considerable time savings and improved accuracy in our operations.

4.0 The department has already procured several GNSS instruments and is in the process of acquiring more to fully harness the advantages of modern technology.

5.0 However, to maximize the benefits from the contributions of the Survey of India, this department requires the Geoid Model file of Punjab, which has been developed by your esteemed organization.

6.0 The availability of this model will support both ongoing and future projects, ensuring that the objectives of the National Hydrology Project are fully realized.

7.0 A prompt response and provision of the required Geoid Model file from your office would be greatly appreciated.

Principal Secretary Water Resources

Endst. No. 111-13/CE/DRG/2025 **Dated** 21/01/2025

A copy of the above is forwarded to the following for information and further necessary action:-

1. The Director, Geodetic & Research Branch, 17, E.C. Road, DEHRA DUN, PIN - 248 001
2. Project Director, National Hydrology Project (NHP), 2nd Floor, Rear wing, MDSS (MTNL) Building, 9, CGO Complex, Lodhi Rd, New Delhi – 110003
3. Chief Engineer/Drainage-cum-Mining & Geology, Water Resources Department, Punjab

Principal Secretary Water Resources

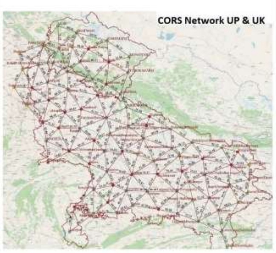
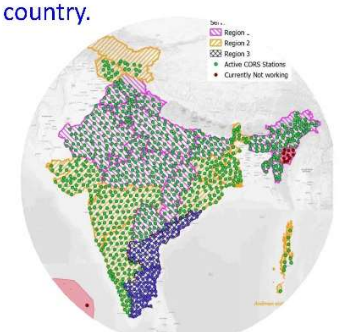
NHP

The Bigger Achievement / Change

13

The Big Picture -NHP Triggered the Geospatial Revolution in the Country

भारतीय सर्वेक्षण विभाग
Survey of India
विज्ञान और प्रौद्योगिकी विभाग
Department of Science & Technology

Activity	Brief Description	Bigger Achievement / Change
CORS Network 	• Triangulation based Ground Control Points popularly called GTS Points established in late 19th century • Replaced by GPS based Control Points library started in early 2000s. • Now, replaced by network of Continuous Operating Reference Stations (CORS). It is a network of continuously working GPS Stations. • **Converting Hours into Minutes**	CORS under NHP in UP/UK has triggered the establishment of CORS Network in the entire country. 

14

The Big Picture -NHP Triggered the Geospatial Revolution in the Country

भारतीय सर्वेक्षण विभाग
Survey of India
विज्ञान और प्रौद्योगिकी विभाग
Department of Science & Technology

Activity	Brief Description	Bigger Achievement / Change
Geoid Model	• Why required: Providing MSL heights in India is one of the major mandate of SOI. GPS provides Ellipsoidal heights but we need MSL hts for all use. Geoid model converts Ellipsoidal hts to MSL heights. • Under NHP, HR Geoid Model better than 10 cm accuracy is prepared first time • **Cost saving is more than 80%.**	High resolution Geoid Model is a major achievement of NHP and SoI is on the path of preparation of Geoid Model of the entire country, state by state, which is a major achievement of the country in Geo-Spatial field.

15

The Big Picture -

भारतीय सर्वेक्षण विभाग
Survey of India
विज्ञान और प्रौद्योगिकी विभाग
Department of Science & Technology

Activity	Brief Description	Bigger Achievement / Change
LiDAR Survey	Under NHP, DEM of approx 68,000 sq km area using air borne LiDAR (Light Detection & Ranging) of 0.5m accuracy is prepared.	The change can be understood by the fact that before NHP, India has only 3 aircrafts for LiDAR work. Now, there are at least 8 Aircrafts for LiDAR and other survey in the country. **Now we are ready to cover most part of the country**

16

The Big Picture -

भारतीय सर्वेक्षण विभाग
Survey of India
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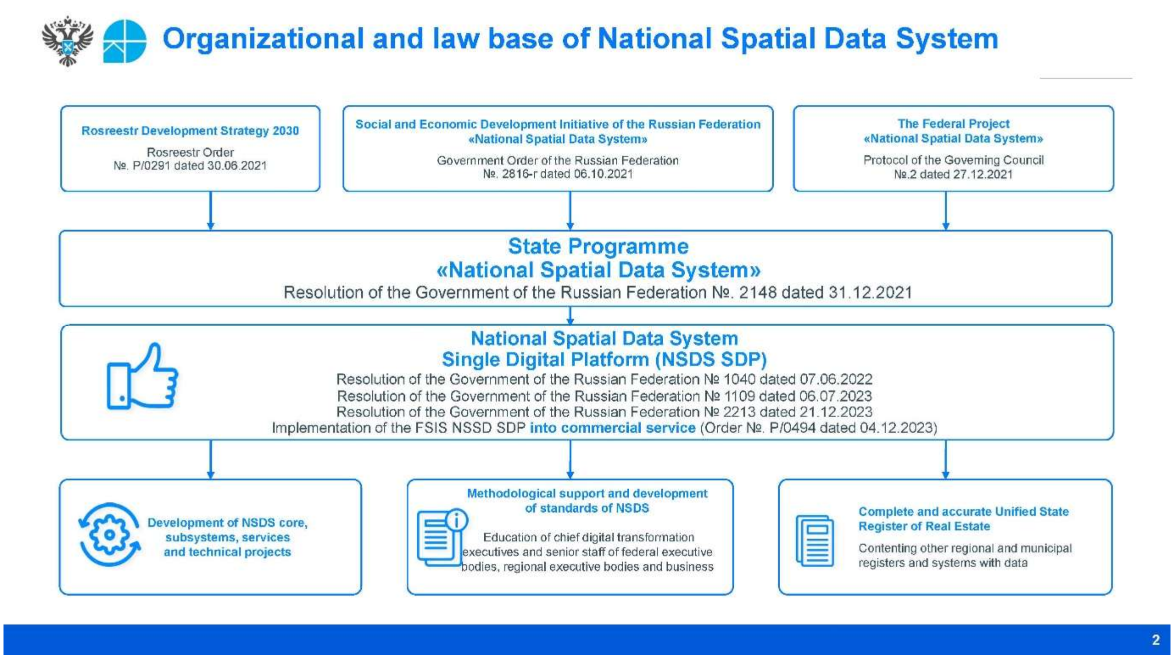
Department of Science & Technology

Activity	Brief Description	Bigger Achievement / Change
Geodata Base	• So far, Survey of India has created digital map data by digitizing hard copy Topo sheets which were in Everest datum and Polyconic Projection, which were converted using transformation parameters into WGS-84 Datum & UTM projection. • Under NHP Geo-Database of appx 8 L sq km - appx 25% of the country, is prepared.	Under NHP first time directly map data in digital Geodatabse format and WGS-84/UTM system is prepared which is **another leap transition for preparation of Geo-spatial data in the country.**

17


Роскадастр
National Spatial Data System
Single Digital Platform (NSDS SDP)
Creation, development and scale-up
Speaker:
Dr. Yury Filippov
Head of Department National Spatial Data System Roskadastr-Infotech
Russian Federation
kadastr.ru


Organizational and law base of National Spatial Data System
Rosreestr Development Strategy 2030
Rosreestr Order
№. P/0291 dated 30.06.2021
Social and Economic Development Initiative of the Russian Federation
«National Spatial Data System»
Government Order of the Russian Federation
№. 2816-r dated 06.10.2021
The Federal Project
«National Spatial Data System»
Protocol of the Governing Council
№.2 dated 27.12.2021
State Programme
«National Spatial Data System»
Resolution of the Government of the Russian Federation №. 2148 dated 31.12.2021
National Spatial Data System
Single Digital Platform (NSDS SDP)
Resolution of the Government of the Russian Federation № 1040 dated 07.06.2022
Resolution of the Government of the Russian Federation № 1109 dated 06.07.2023
Resolution of the Government of the Russian Federation № 2213 dated 21.12.2023
Implementation of the FSIS NSSD SDP into commercial service (Order №. P/0494 dated 04.12.2023)
Development of NSDS core, subsystems, services and technical projects
Methodological support and development of standards of NSDS
Education of chief digital transformation executives and senior staff of federal executive bodies, regional executive bodies and business
Complete and accurate Unified State Register of Real Estate
Contenting other regional and municipal registers and systems with data
2

Filling NSDS SDP with data

An open **list of source systems**, the composition of data and the procedure for data exchange are defined **in paragraphs 15-19 of the Regulations on the NSDS SDP** (approved by the Government Resolution dated 06/07/2022 No. 1040)

Formats of information interaction (approved by the order of the PLC "Roskadastr" dated 12/14/2023 № P/633-23)

In preparation for the information interaction, the following is held:

- **Survey** of the region/FOI on information systems containing spatial data
- **Examination of information** systems containing spatial data
- **Assessment of the completeness and quality** of spatial data contained in systems
- **Formation** of spatial data composition for integration

The general procedure for information interaction with the NSDS SDP is **determined by the agreement on information interaction**

The specific list of data, format and exchange procedure are determined by the **protocol of information interaction** (annex to the agreement)

Upon the transfer of data, **format-logical control**, **spatial analysis of the correctness of the data, and control of the time of receipt are carried out.**

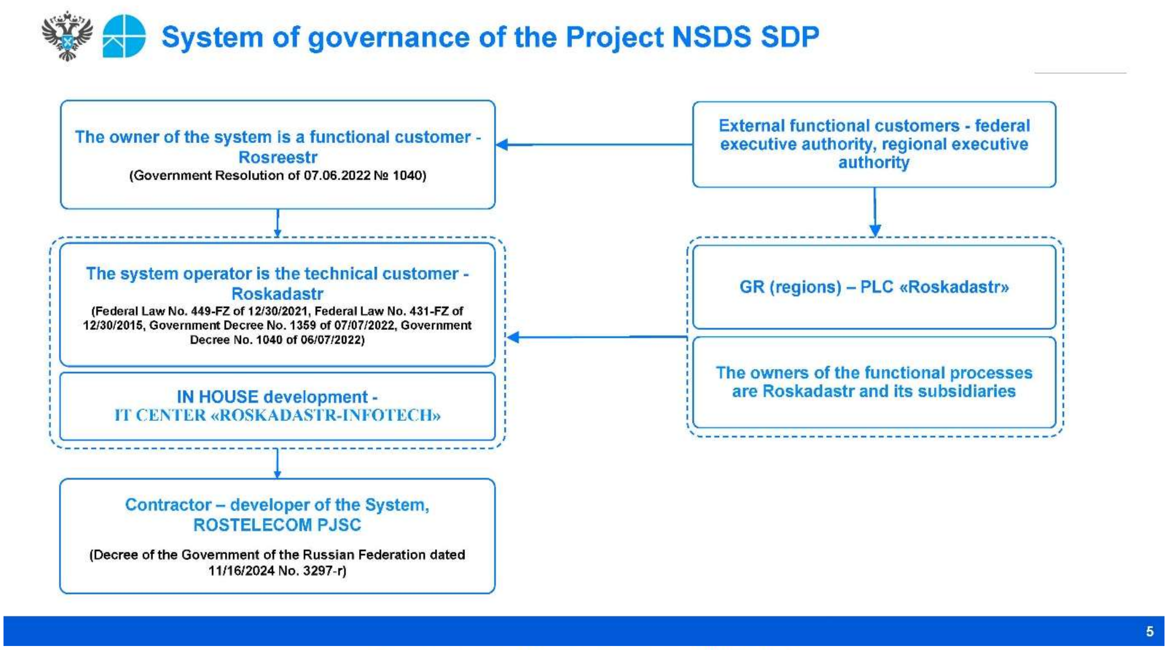
Identified **errors in the data are transmitted to the supplier** for correction.

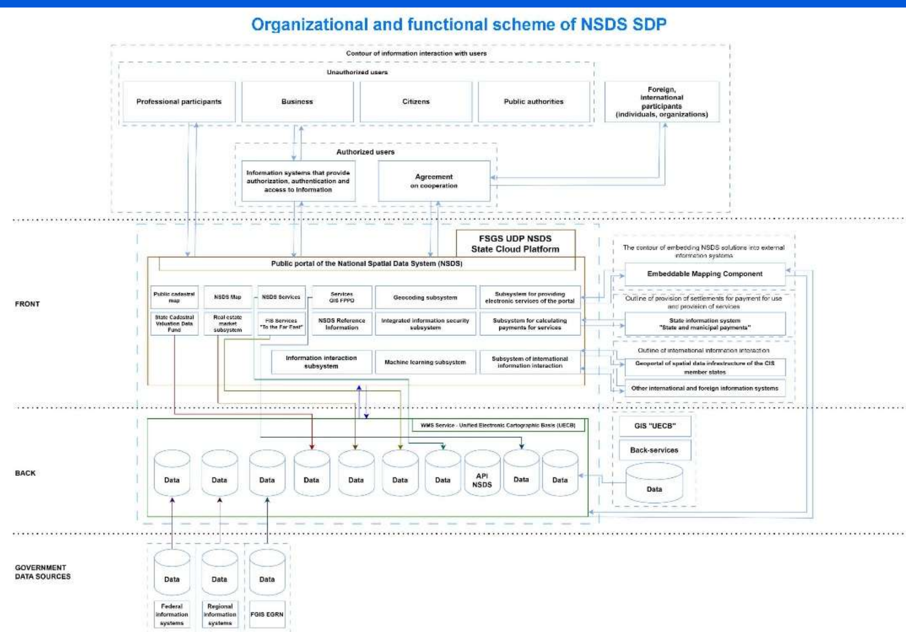
3

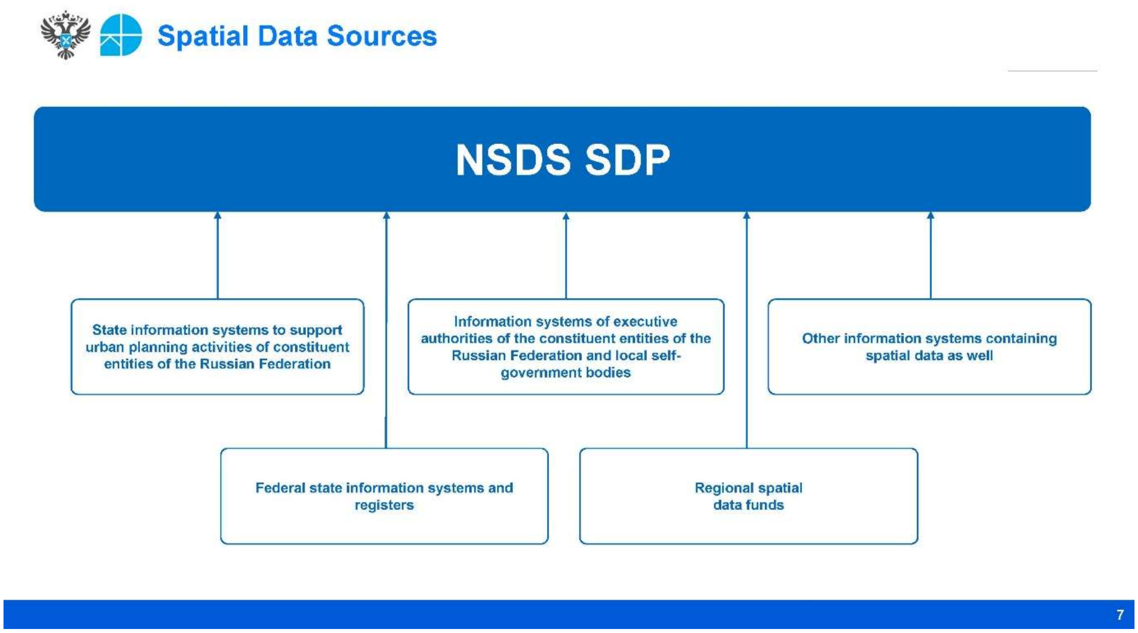
System users (RGRF № 1040 dated 07.06.2022)

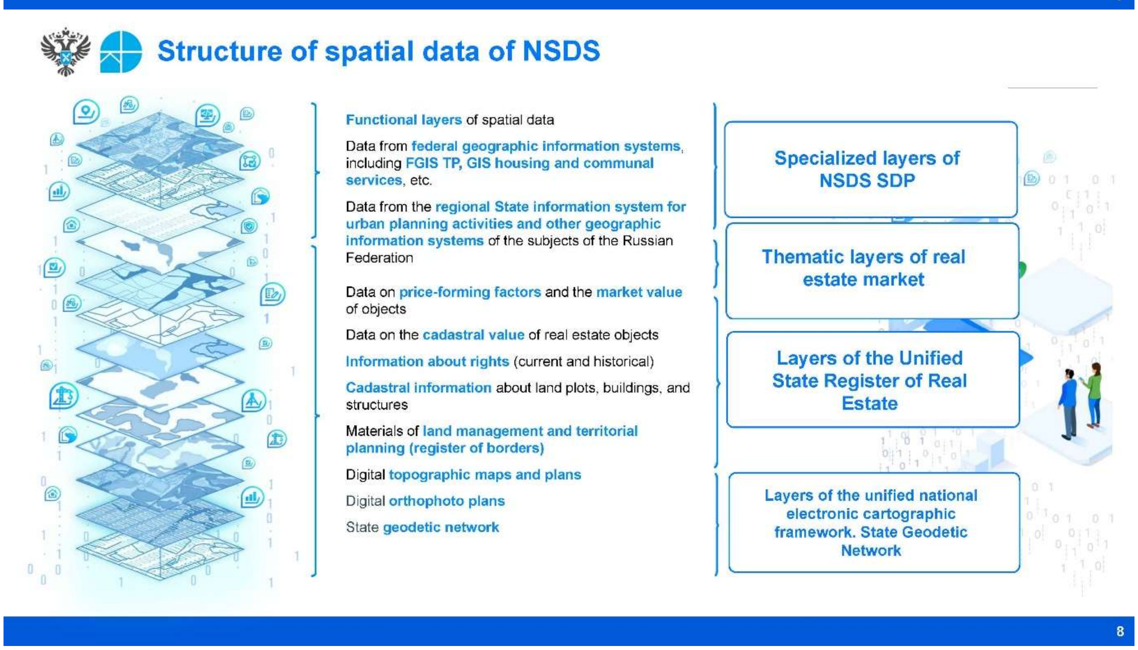
1. **Citizens of the Russian Federation**
2. **Stateless persons**
3. **Russian legal entities**
4. **Bodies of the Union State**
5. **State authorities of the constituent entities of the Russian Federation**
6. **State authorities of the constituent entities of the Russian Federation**
7. **Local self-government bodies using the system and (or) receiving information from the system**
8. **Foreign citizens, foreign legal entities, international organisations, foreign state bodies using the system and (or) receiving information from the system (except for cases when the use of the system and (or) receipt of information from the system by foreign citizens, foreign legal entities, international organisations, foreign state bodies is prohibited or restricted in accordance with federal law or a decree of the President of the Russian Federation).**

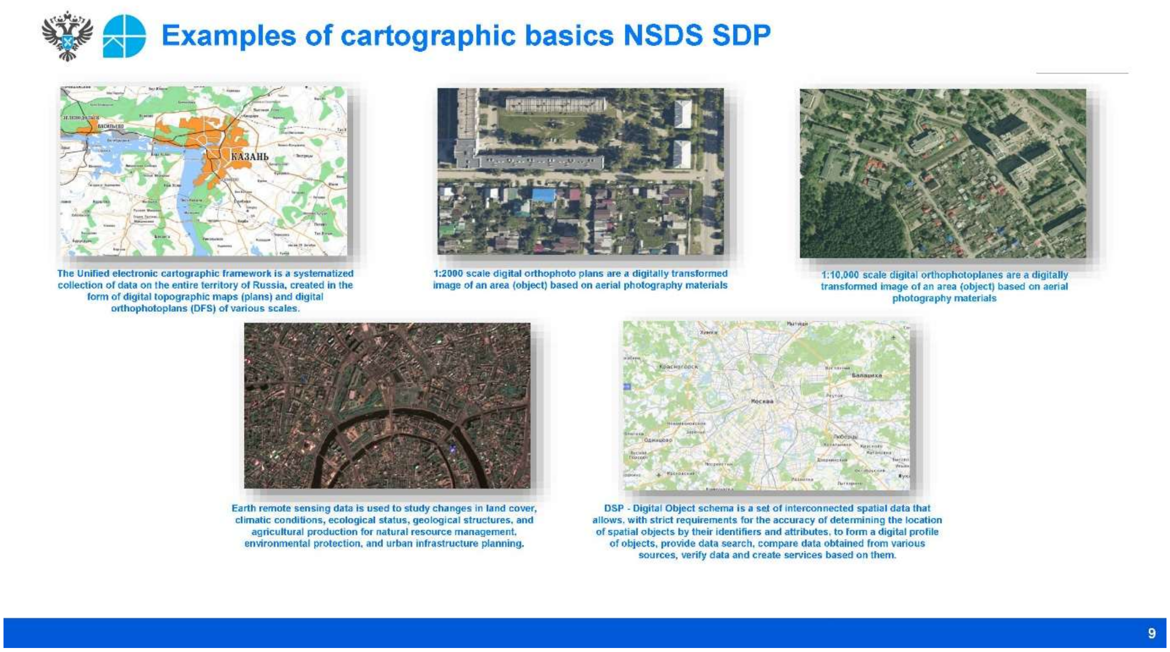
4

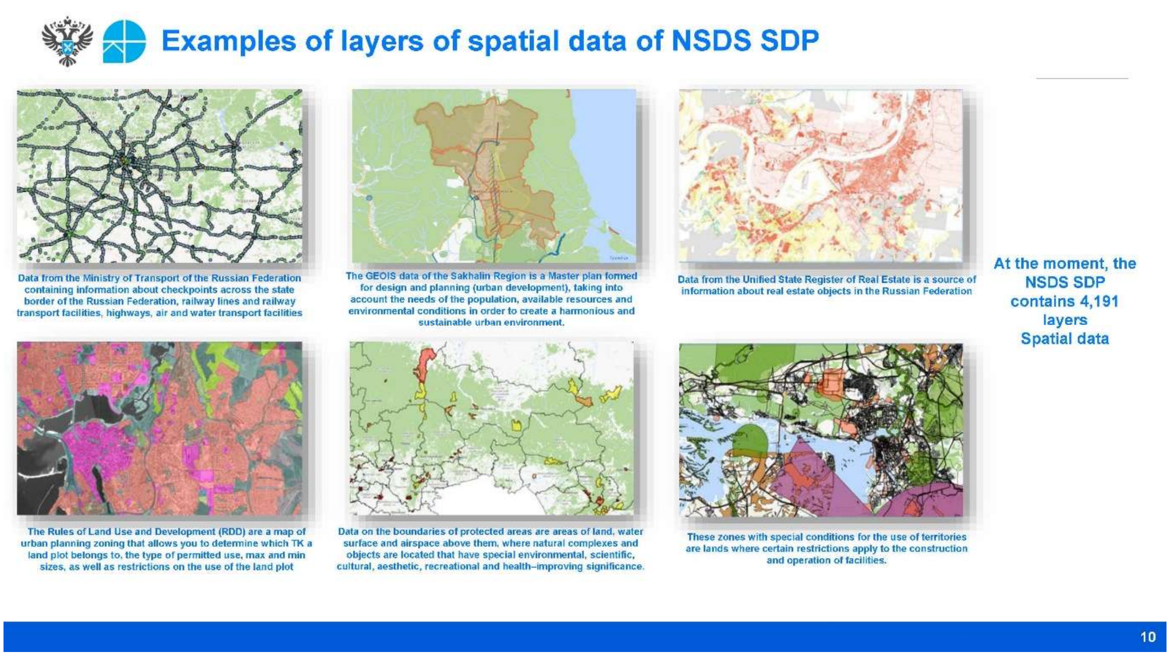

System of governance of the Project NSDS SDP
The owner of the system is a functional customer - Rosreestr
(Government Resolution of 07.06.2022 № 1040)
External functional customers - federal executive authority, regional executive authority
The system operator is the technical customer - Roskadastr
(Federal Law No. 449-FZ of 12/30/2021, Federal Law No. 431-FZ of 12/30/2015, Government Decree No. 1359 of 07/07/2022, Government Decree No. 1040 of 06/07/2022)
GR (regions) – PLC «Roskadastr»
IN HOUSE development -
IT CENTER «ROSKADASTR-INFOTECH»
The owners of the functional processes are Roskadastr and its subsidiaries
Contractor – developer of the System, ROSTELECOM PJSC
(Decree of the Government of the Russian Federation dated 11/16/2024 No. 3297-r)
5


Organizational and functional scheme of NSDS SDP
Contour of information interaction with users
Unauthorized users
Professional participants
Business
Citizens
Public authorities
Foreign, international participants (individuals, organizations)
Authorized users
Information systems that provide authorization, authentication and access to information
Agreement on cooperation
FSGS UDP NSDS
State Cloud Platform
Public portal of the National Spatial Data System (NSDS)
FRONT
Embeddable Mapping Component
Geocoding subsystem
Machine learning subsystem
BACK
GIS "UECB"
Back-services
Data
API NSDS
GOVERNMENT DATA SOURCES
FGIS EGRN


Spatial Data Sources
NSDS SDP
State information systems to support urban planning activities of constituent entities of the Russian Federation
Information systems of executive authorities of the constituent entities of the Russian Federation and local self-government bodies
Other information systems containing spatial data as well
Federal state information systems and registers
Regional spatial data funds
7


Structure of spatial data of NSDS
Functional layers of spatial data
Data from federal geographic information systems, including FGIS TP, GIS housing and communal services, etc.
Data from the regional State information system for urban planning activities and other geographic information systems of the subjects of the Russian Federation
Data on price-forming factors and the market value of objects
Data on the cadastral value of real estate objects
Information about rights (current and historical)
Cadastral information about land plots, buildings, and structures
Materials of land management and territorial planning (register of borders)
Digital topographic maps and plans
Digital orthophoto plans
State geodetic network
Specialized layers of NSDS SDP
Thematic layers of real estate market
Layers of the Unified State Register of Real Estate
Layers of the unified national electronic cartographic framework. State Geodetic Network
8


Examples of cartographic basics NSDS SDP
КАЗАНЬ
The Unified electronic cartographic framework is a systematized collection of data on the entire territory of Russia, created in the form of digital topographic maps (plans) and digital orthophotoplans (DFS) of various scales.
1:2000 scale digital orthophoto plans are a digitally transformed image of an area (object) based on aerial photography materials
1:10,000 scale digital orthophotoplanes are a digitally transformed image of an area (object) based on aerial photography materials
Earth remote sensing data is used to study changes in land cover, climatic conditions, ecological status, geological structures, and agricultural production for natural resource management, environmental protection, and urban infrastructure planning.
Москва
DSP - Digital Object schema is a set of interconnected spatial data that allows, with strict requirements for the accuracy of determining the location of spatial objects by their identifiers and attributes, to form a digital profile of objects, provide data search, compare data obtained from various sources, verify data and create services based on them.
9


Examples of layers of spatial data of NSDS SDP
Data from the Ministry of Transport of the Russian Federation containing information about checkpoints across the state border of the Russian Federation, railway lines and railway transport facilities, highways, air and water transport facilities
The GEOIS data of the Sakhalin Region is a Master plan formed for design and planning (urban development), taking into account the needs of the population, available resources and environmental conditions in order to create a harmonious and sustainable urban environment.
Data from the Unified State Register of Real Estate is a source of information about real estate objects in the Russian Federation
At the moment, the NSDS SDP contains 4,191 layers Spatial data
The Rules of Land Use and Development (RDD) are a map of urban planning zoning that allows you to determine which TK a land plot belongs to, the type of permitted use, max and min sizes, as well as restrictions on the use of the land plot
Data on the boundaries of protected areas are areas of land, water surface and airspace above them, where natural complexes and objects are located that have special environmental, scientific, cultural, aesthetic, recreational and health–improving significance.
These zones with special conditions for the use of territories are lands where certain restrictions apply to the construction and operation of facilities.
10

NSDS SDP today

NSDS SDP -

Russian geoinformation software designed to work with spatial data from federal and regional information systems and resources supplied to the platform as part of information interaction.

Put into commercial operation December 25, 2023

- **>800 virtual machines that ensure stable and fast System operation**
- **>100 software products forming a single environment**
- **comprehensive information security system**
- **> 5 types of databases and data warehouses for storing billions of records**
- **16 complex subsystems, including those using machine learning and artificial intelligence**

11

NSDS SDP 2023 and 2024 services

SERVICES 2023

- **Land for Building** — *Selection of land plot for construction*
- **Urban planning online** — *Analysing the possibilities of land plot use*
- **Construction approvals** — *Special authorisations in the construction cycle*
- **Individual housing construction** — *Placement of individual housing construction objects*
- **Land for tourism** — *Selection of land plot for recreational use*
- **My real estate properties** — *Monitoring of changes real estate properties*
- **Smart cadastre** — *Identification unregistered properties*
- **The Land is simple** — *Provision of land plots*
- **Arctic indigenous languages** — Creation of thematic maps
- **Application of spatial data in Supervisory and Control Activities** — Prevention of violations land use
- **Comprehensive development of the territory** — *A digital tool for comprehensive development*

SERVICES 2024

- **Certification of spatial data** — *Verification of authorities' decisions on the basis of the most complete data available*
- **State cadastral valuation tools** — *Fair cadastral value*
- **Small business locations** — *Provision of placement of non-stationary trade facilities*
- **Farm land** — *Searching for the most suitable land plots for agriculture*
- **Correction of register errors** — *Verification of boundaries digitally and on the ground*
- **Assistant surveyor** — *Provision of engineering surveys*
- **Preparation of spatial data for the National Data Management System** — *Development of data showcase in terms of working with spatial data*
- **Visualisation of spatial data** — *Creating graphics for text documents*
- **My address is** — *Address geocoding*

SERVICES 2025

- **Embeddable Mapping Component Service of the FGIS NSDS** — *Provides GIS with an access interface to the spatial data of the FGIS NSDS and map tools*
- **Custom Thematic Map Generation Service** — *Creates thematic maps based on value ranges and distribution, visualizes vector data sets*
- **Spatial Data Analytics Designer Service** — *Provides users with a developed set of various customizable algorithms for spatial checks*
- **Comprehensive Cadastral Works Service** — *Identifies territories where it is most expedient to perform CCW (Comprehensive Cadastral Works)*
- **Specialized Map Tools Service** — *Provides an access interface to map tools*
- **Real Estate Market Analytics Service** — *Calculates and displays a real estate price index based on USR (Unified State Register) data*

12

Land is simple

PURPOSE:

For government authorities

- **Backend** of processes of rendering state and municipal services on provision of state and municipal land plots (not less than 6 services)

For citizens and businesses

- **A tool for searching** and selecting plots of state and municipally owned land
- **Service for optimising** the receipt of state and municipal services for acquiring rights to land plots (from document preparation to interaction with authorised bodies)

PREVIOUSLY — **NO service**

- High costs of collecting initial data and preparing materials
- «Manual» collation of spatial information
- Interaction with government authorities through e-mail correspondence

IN PROSPECT — **3 million** accesses to the service

- Online access to specialised spatial data
- Geoinformation analysis tools
- Environment for automated information exchange

EFFECT

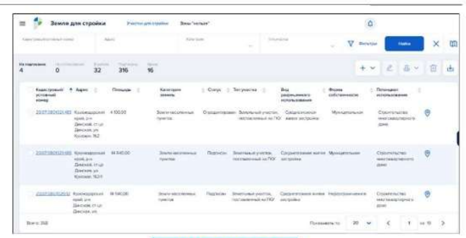
- **Selection** of investment-attractive plots for citizens and businesses
- **Simplification** of applications for services (including **reduction** of costs for preparation of land plot location schemes)
- **Reduction** (by 2 times) of the time required to obtain state and municipal services for acquiring rights to land plots
- **Increase** in positive results of receiving services (elimination of **90% of refusals** related to the preparation of land plot location schemes)

13

Land for building

PURPOSE :

- For government authorities
  a tool for creating a base of land plots intended for the implementation of projects in the sphere of agricultural production;
- For citizens and business
  reduce the number of services that need to be completed to obtain a land plot.
- **A service for reducing** the steps required to purchase a plot. **10,000 land plots for construction** are located on the **Public Cadastre Map**



PREVIOUSLY

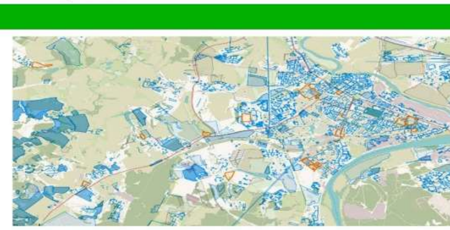
- Lack of information on promising areas for investment attraction
- Contradictions in assessments of the possibility of use for construction purposes
- A lengthy phase of land preparation for granting

IN PROSPECT

- Prefabricated sets of land that have been checked by authorised bodies to ensure that they can be used
- Plots prepared for provision

EFFECT

- Involvement of land plots in turnover for development in order to **achieve the indicators defined by Presidential Decree No. 474 dated 21.07.2020**
- **Elimination of costs for citizens and businesses** to go through the procedure of preliminary approval of land plots provision
- **Provision** of state or municipally owned land plots to individuals and legal entities (hereinafter referred to as applicants), starting from the search and formation of a land plot and ending with the registration of rights to land plots and the implementation of actions related to the procedures of state cadastral registration and registration of rights
- **Reduction** of land selection time from **half a year to 2 weeks**

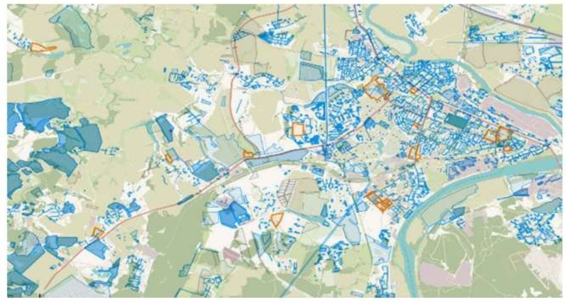


14

Farm land

PURPOSE :

- For government authorities
  a tool for creating a base of land plots intended for the implementation of projects in the sphere of agricultural production;
- For representatives of private farms
  reduce the number of services that need to be completed to obtain a land plot.



PREVIOUSLY

- Lack of information on promising areas for investment attraction
- Contradictions in assessments of the possibility of utilisation for the purpose of implementation of agricultural sector projects
- A lengthy phase of land preparation for granting

IN PROSPECT

- Ready sets of territories that have been checked by authorised bodies for the possibility of implementing agricultural projects

EFFECT

- Creating a spatial basis for **agricultural development**
- **Reduction** of land selection time from half **a year to 2 weeks**
- **Elimination of costs for private farms** to go through the procedure of preliminary approval of land plots provision

15

Urban planning online

PURPOSE (for citizens and businesses):

- Possibility to **get acquainted** with open data of UECF and USRRE «online»
- **Provision of comprehensive information** on regimes and regulations for the use of land plots, on zones with special conditions for the use of the territory (based not only on data from the Unified State Register of Registers, but also from SISUP and other GIS)

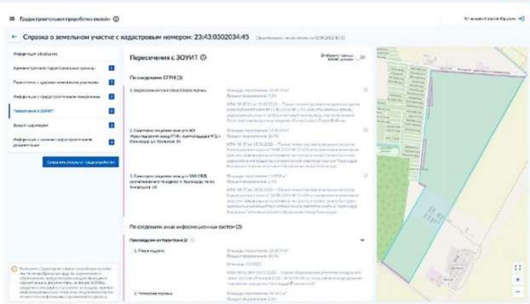
PREVIOUSLY — **NO** service

- Repeatedly referring to different sources to find the information needed
- Failure to obtain specialised information when selecting a site
- No information on what to do with existing restrictions and encumbrances on land use

IN PROSPECT — **15 million** accesses to the service

- A single point of access to all necessary information from various state Information Systems and Information Resources
- Opportunity to study the urban planning potential of any territory
- Interactive guide on how to change the terms of use in your favour

EFFECT



- **Optimisation** of the procedure for selection and analysis of the efficiency of using state, municipal and privately owned land plots
- **Obtaining** consolidated information on land plots by specified cadastral number or by selected boundaries
- **Ensuring** availability of specialised information (similar to the town-planning plan)

*UECF - Unified Electronic Cartographic Framework
*USRRE - Unified State Register of Real Estate
*SISUP - State Information System for Urban Planning Activities

16

Individual housing construction

PURPOSE:

For government authorities

- **Backend** of service delivery processes in the sphere of Individual housing construction (submission of notification of the beginning / end of construction / reconstruction)

For citizens and businesses

- **Toolkit** for analysing the possibility of construction and obtaining municipal services in the sphere of housing and communal services

PREVIOUSLY — **NO** service

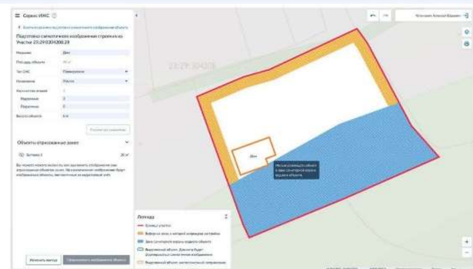
- Manual search for information on construction conditions on various Information Systems and Information Resources
- Costs of preparing the materials required to obtain services
- Contradictions between information in citizens and authorities

IN PROSPECT — **> 1 million** accesses to the service

- Unified verified information on construction conditions among citizens and authorities
- Simple digital tools for self-preparation of necessary materials

EFFECT

- **Optimisation** of the process of analysis of the most efficient use of land plots
- **Simplification** of applications for services Individual housing construction
- **Monitoring** of service delivery
- **Increased** positive outcomes of service delivery
- **Increase in positive results** of service provision (bringing the number of refusals to the indicator - **no more than 10% of the total number of applications)**



17

My real estate properties

PURPOSE (for citizens and businesses):

- **Combine** spatial data on real estate objects from different GIS
- **Eliminate** errors and contradictions in information on real estate objects
- **Track** changes in data on real estate objects (cadastral value) in different GIS
- **Monitor** changes in the surrounding area
- **Ensure** information interaction with property market aggregators

PREVIOUSLY — **NO** service

- Information on real estate objects is in different systems
- Citizens and businesses face mistakes at the worst possible time
- No tool for automated tracking of changes by its facilities or surrounding area

IN PROSPECT — **> 50 million** applicants

- Omincanal access to information on Real Estate Objects
- Timely reporting of errors and inconsistencies
- A digital tool for monitoring changes in information

EFFECT

- **Synchronised** and corrected information on real estate objects in all GIS
- **The possibility** of constant control over changes in information on real estate objects is ensured
- The processes of analysing the real estate market and forecasting the development of the territory **have been optimized**
- **Provided** information to the user about the real estate objects owned by him, the rights to which are registered in USRRE

18

Smart cadastre

PURPOSE (for government authorities):

- **Unified tool for mass identification** of unregistered real estate objects and changes in the state of land with the help of artificial intelligence
- **Backend** of remedial action processes

PREVIOUSLY — **6 800** of objects per YEAR

- Citizens' appeals, scheduled one-off inspections, yard rounds
- Spot and manual monitoring of land use
- Long process of detection and identification

IN PROSPECT — **39 511** objects per DAY

- Pre-trained neural networks and spatial analysis
- Algorithms for recognition of capital construction objects, land use violations based on Earth remote sensing materials

EFFECT

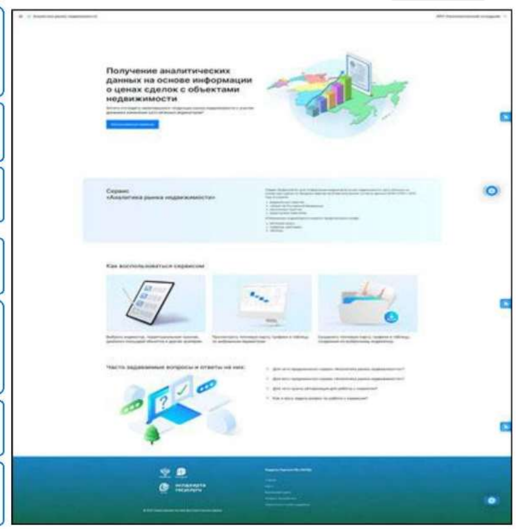
- Timely **identification** of misuse of funds
- **Guaranteeing rights and protecting** people's property interests
- **Involvement** of land in turnover
- **Cost optimization** for digitalisation of land control
- **Involvement** of unrecorded real estate objects in tax turnover (**more than 10% of 173 million** real estate **Reducing the costs** objects are not cadastrically registered in the Russian Federation)
- of control and supervisory activities in regions and municipalities
- **Timely identification** of misuse for response **(2124 times faster)**

19

Real Estate Market Analytics

Designed to calculate and display a price index indicator for the real estate market based on EGRN data (hereinafter referred to as the Indicator), with the capability to view the Indicator's dynamics as a graph and generate reports on its values:

- calculation of the median value per square meter for the formed sample;
- calculation and visualization of the computed median value per square meter and the Indicator, with export capability, in the form of a heat map, graphs, and a table;
- filtering of visualized values by territorial criteria, temporal criteria, and real estate object area group;
- providing the System Operator with the following functional capabilities:
  - modifying the composition of area groups and their ranges;
  - setting minimum and maximum value limits for subjects of the Russian Federation;
  - initiating a recalculation of the Indicator for the entire data storage period in the service;
  - uploading indicators (price indices) from external sources for subsequent visualization in the service, with the ability to display source information and its attributes.
- ability to export a list of cadastral numbers of real estate objects used in calculating the Indicator's values;
- visualization of Indicator values on the Portal PD NSD in the form of a heat map.



20

REAL ESTATE MARKET SUBSYSTEM FSIS NSDS SDP

Subsystem of real estate market

- State cadastral valuation support module
- State cadastral valuation data fund module
- Cadastral value determination module
- Market information module
- Property market analytics service
- Module of formation of digital profile of the object of assessment
- Module of declarations, comments, statements and appeals on issues of cadastral value of real estate objects
- Evaluation report register module
- Service Tools of state cadastral valuation

Unified platform for state cadastral valuation

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NSDS SDP Geocoding Subsystem

THE GEOCODING SUBSYSTEM PROVIDES :

- **storage and editing** of spatial data by addresses and address elements
- **direct geocoding - determining the coordinates** of an addressable object by its address
- **possibilities of using a universal tool** (REST API) for geocoding and use in external information systems (including mobile applications)
- **generation and updating** of data on addresses and address-forming elements, based on data from the entire set of information systems of NSDS SDP information providers
- **reverse geocoding - determining the address** of an addressable object by its coordinates

GEOCODED ADDRESS = POINT ON THE MAP

22

Mapping component of NSDS SDP

Working with spatial data - a ready-made embedded service that forms a window for GIS to access FSIS NSDS SDP spatial data and map tools

Secure access to spatial data

No development is required, all NSDS SDP capabilities are combined in one service

Simple and flexible customisation of the Service functionality (toolkit configuration):

easy to add to the code of your Information System

individual structure of the displayed spatial layers

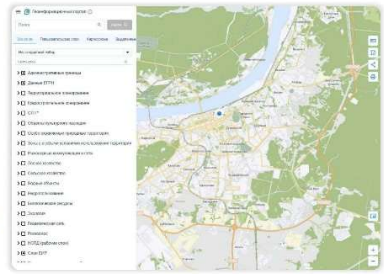
creating custom spatial data layers

setting up the possibility of placing information on public resources

spatial analysis tools - buffer zones, heat maps, etc.

30 000 simultaneous requests per second

<2 secs to display screen forms



Have deployed and are using the mapping component:

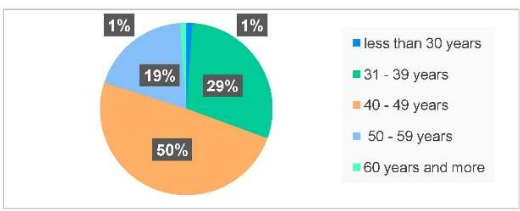
- Ministry of Construction, Housing and Utilities of the Russian Federation
- Ministry of Economic Development of the Russian Federation
- Federal Agency for State Property Management of the Russian Federation
- Analytical Centre of the Government of the Russian Federation

23

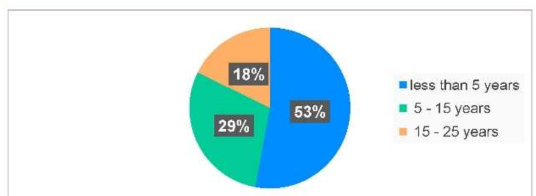
Personnel structure of IT CENTER «ROSKADASTR-INFOTECH»

8 Management departments: operation, development, maintenance, information security

The age of senior staff in IT departments:



Work experience of senior staff of IT departments in the Rosreestr system:

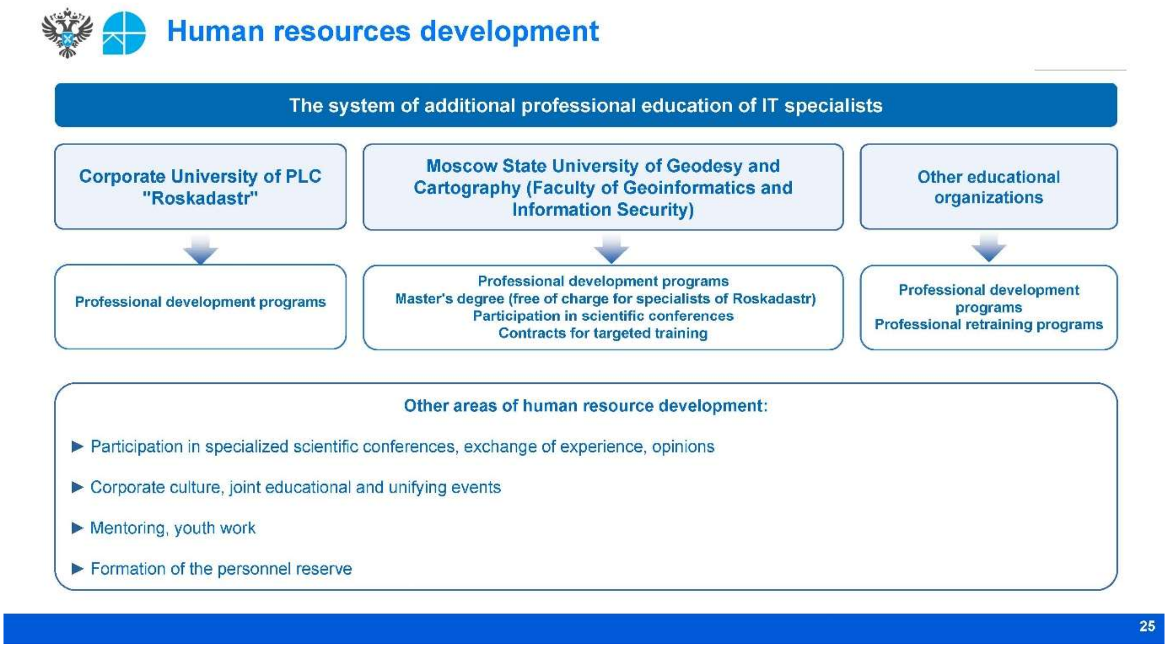


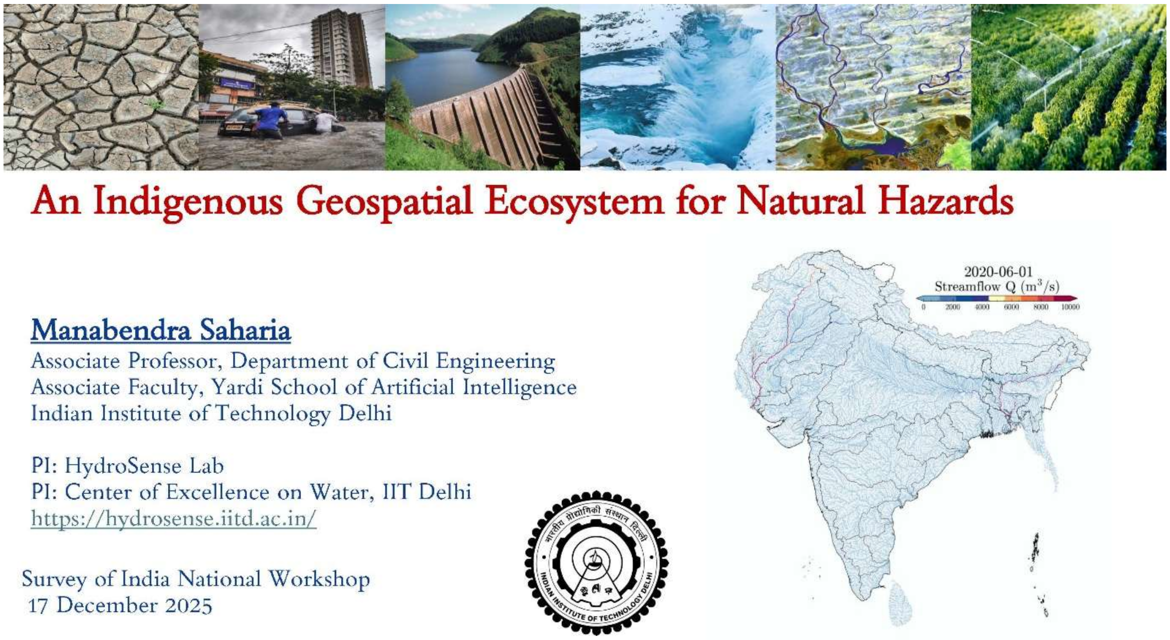
Qualification of specialists IT departments

Specialists in the field of information and telecommunication technologies

Specialists in urban planning, land use, cadastre and cartography

24


Human resources development
The system of additional professional education of IT specialists
Corporate University of PLC "Roskadastr"
Moscow State University of Geodesy and Cartography (Faculty of Geoinformatics and Information Security)
Other educational organizations
Professional development programs
Professional development programs
Master's degree (free of charge for specialists of Roskadastr)
Participation in scientific conferences
Contracts for targeted training
Professional development programs
Professional retraining programs
Other areas of human resource development:
► Participation in specialized scientific conferences, exchange of experience, opinions
► Corporate culture, joint educational and unifying events
► Mentoring, youth work
► Formation of the personnel reserve
25


An Indigenous Geospatial Ecosystem for Natural Hazards
Manabendra Saharia
Associate Professor, Department of Civil Engineering
Associate Faculty, Yardi School of Artificial Intelligence
Indian Institute of Technology Delhi
PI: HydroSense Lab
PI: Center of Excellence on Water, IIT Delhi
https://hydrosense.iitd.ac.in/
Survey of India National Workshop
17 December 2025
2020-06-01
Streamflow Q (m³/s)
0 2000 4000 6000 8000 10000


GIS is Dead
Long live
Geospatial!

The Three Horsemen of Geospatial Indigenization

Owning the Data

Owning the Models

Owning the Decisions

Geospatial touchpoints in the Disaster Cycle

Mitigation	Zoning, Risk Maps, Forecasts
Preparedness	Scenario models, Inventories
Response	Live dashboards, crowd-sourced reports
Recovery	Damage assessments, rebuild tracking

Why Open-Source GIS?

Zero license fees → budget for data & capacity
No vendor lock-in → full control of roadmap
Auditability & transparency
OGC standards ensure data longevity & exchange

The Future of GIS is vertically-integrated geospatial workflows, not one-off maps

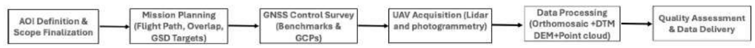
Open-Source GIS and GIS-ML Stack

Desktop: QGIS, GRASS
Datastore: PostGIS / SpatiaLite, Cloud-Optimised GeoTIFF (COG), Zarr
Services: GeoServer, GeoNode, MapServer, STAC API / PySTAC
Web Clients: Leaflet, MapStore, OpenLayers
Scripting & ETL: Python, GDAL, Rasterio, geopandas
Analytics and Machine Learning: xarray, Dask (parallel compute), PyTorch / TorchGeo, zarr

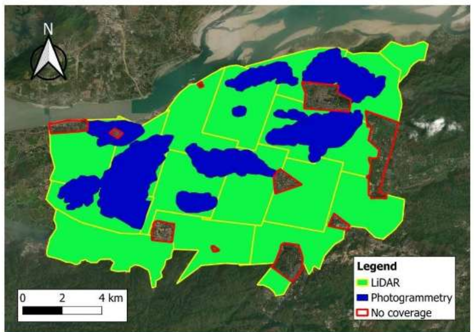
LiDAR Survey over the City of Guwahati

Survey Extent and Sensor Specifications

- 156 km² covering the city of Guwahati.
- LiDAR for city with 17 zones (125 km²)
- Photogrammetry for 10 hills (31 km²)
- Static DGPS Points: 148
- RTK DGPS Points: 370



Ground Control Points | Mission Planning | Matrice 350 RTK | Oblique imagery for 3D mapping



LiDAR and Photogrammetry Survey in Guwahati City

LiDAR Survey (UAV: DJI Matrice 350 RTK + Zenmuse L2 LiDAR Sensor)

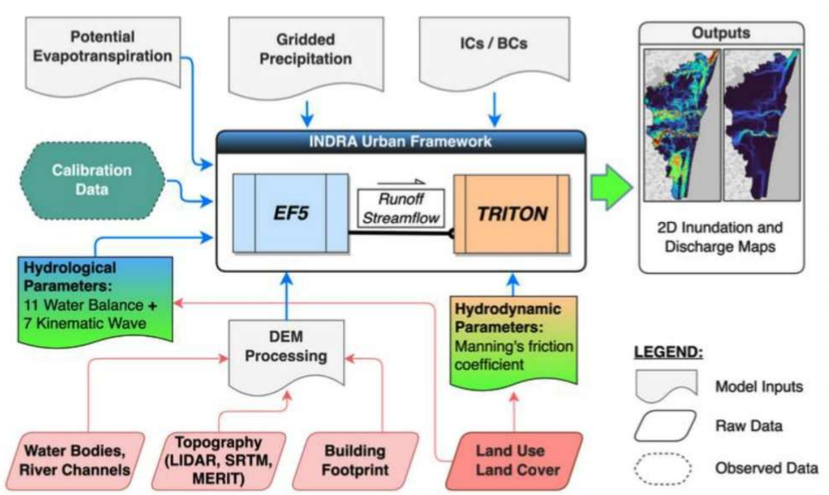
- LiDAR Accuracy (RTK):
  - Horizontal: 1 cm + 1 ppm
  - Vertical: 1.5 cm + 1 ppm
- LiDAR FOV: 30° (±15°)
- Camera (for colorization): 20 MP mapping camera

Photogrammetry (UAV: DJI Mavic 3 Enterprise)

- Camera Resolution: 48 MP (4/3" CMOS)
- Tilt Range: –90° (nadir) to +35°
- Field of View (FOV):
  - Horizontal: 84°–90° (depending on mode)
  - Vertical: ~103°

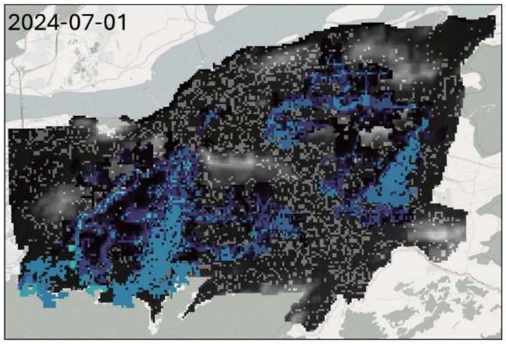
Dr. Manabendra Saharia, IIT Delhi 5

Inundation & Discharge Rapid Assessment (INDRA) Framework developed at IIT Delhi for LiDAR and GPU-based Flood Modeling

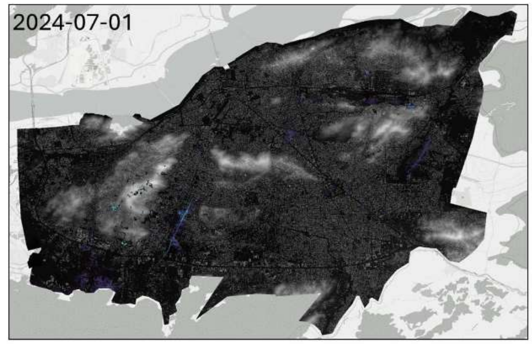


Dr. Manabendra Saharia, IIT Delhi 6

Urban Flood Simulations have been completed using Global and LiDAR-derived DEM



Inundation in the city of Guwahati using
90m global MERIT DEM

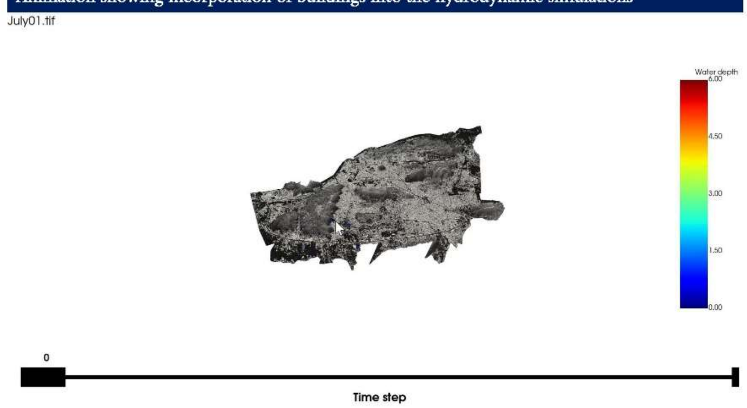


Inundation in the city of Guwahati using
high-resolution **10 m LiDAR DEM**

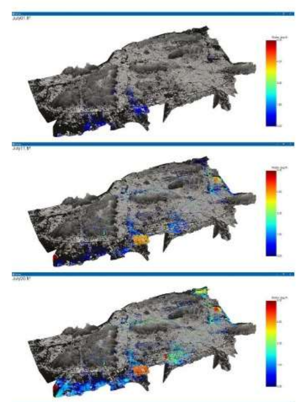
Area	Duration of Simulation	DEM Resolution	Time
Guwahati ($\sim 180km^2$)	365 days	10m (LiDAR)	~45 min.
	365 days	90m (Satellite)	~6.5 hrs.

Representing City Buildings in Our Models & Simulations

Animation showing incorporation of buildings into the hydrodynamic simulations



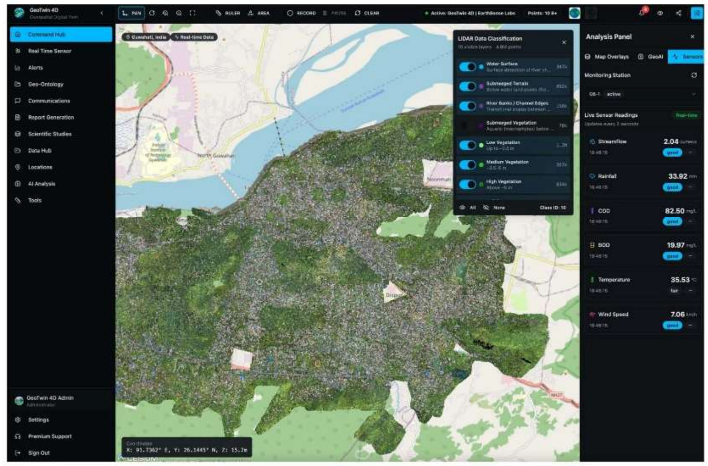
1. Approximately 3,90,000 buildings
2. We have incorporated the buildings into our hydrodynamic simulations



Snapshots showing flood inundation on July 01, July 11, and July 20, 2024

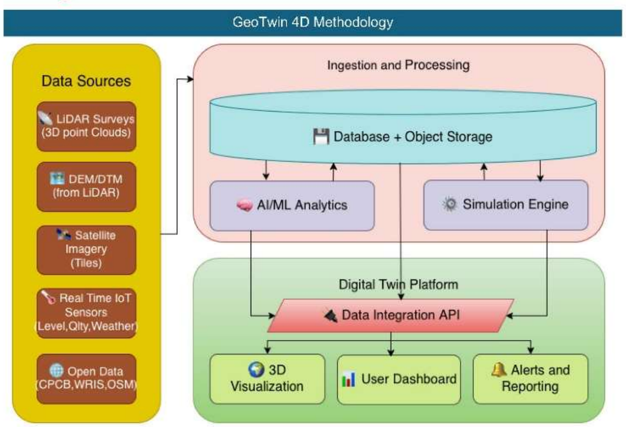
GeoTwin is a Sovereign 4D Digital Twin platform for Cities and Infrastructure that combines LiDAR, Sensors, and integrated Geospatial AI models

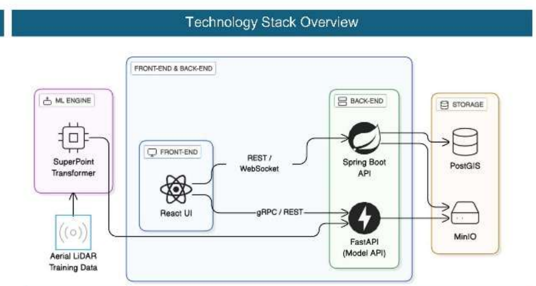
- Integration of multi-modal data with high-res. 3D point cloud
- User alert system
- Real time dashboard and data visualization
- Analytics from lidar point cloud and sensor's data
- Filter point clouds based on the object classes
- Reports generation

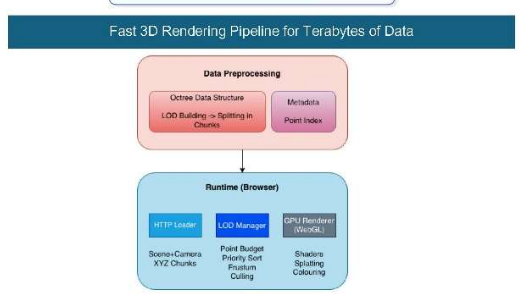


Developed indigenously at IIT Delhi

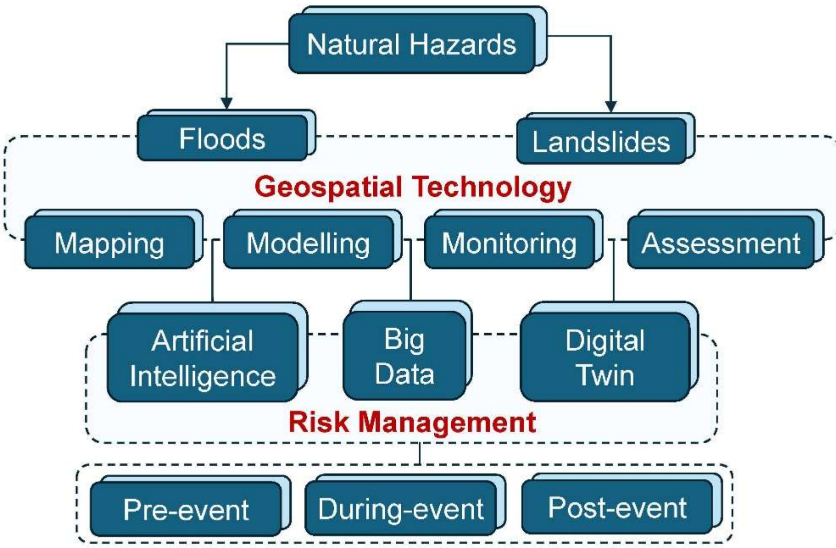
A Digital Twin pipeline for rapid rendering of Terabytes of data without lag and integrated GeoAI models







Geospatial Technologies for Natural Hazard Risk Management



Building India's Geospatial Intelligence for Disaster Risk Reduction

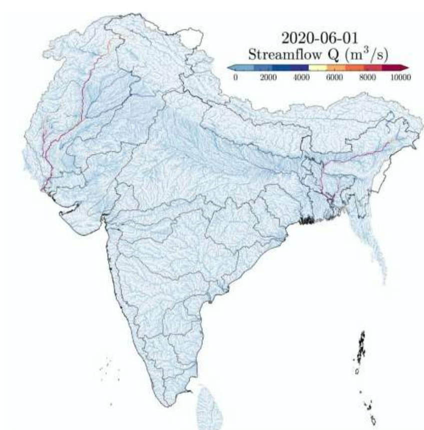
Dr. Manabendra Saharia, IIT Delhi 11

Research Vision of HydroSense Lab

A Hybrid Physics-AI Digital Twin leveraging Supercomputing, Data Assimilation, and Artificial Intelligence for transboundary land-water modeling and forecasting.

Impact Areas

- Disasters – Floods, Droughts, Landslides
- Climate Change Impact Assessment
- Water Resources Management



Science to Services

Dr. Manabendra Saharia, IIT Delhi 12


Simplifying Land Administration
Enhancing Efficiency
Ente Bhoomi
Digital Land Governance Transformation - The Kerala Model
From Digital Survey to conclusive Land Title - Building Precision, Trust & Citizen Empowerment
National Workshop on Strengthening of Geospatial Ecosystem
"Geospatial Mission: An Enabler of Viksit Bharat"
• How Kerala turned a century of paper records into a digital, trusted, and citizen-empowering land governance system — providing a solution to one of India's oldest administrative puzzles.
Sambasiva
Special Secretary (Electronics & IT) &
Director Department of Survey, Government of Kerala
Key Requirements for a Digital Land Cadastre
Authenticity of land Record
• Extent and boundaries; (Survey Record)
• Ownership details; Land type (Revenue record)
• Both should be accurate and seamlessly connected
Digital land parcel map for all Land holdings
• Pace of creation & Cost
• Accuracy (Quality)
• Ease of updation
Digital Land registry
• Unique ID for Parcel and Landholder
• Perpetuity
Why Digital Re-Survey instead of Incremental Survey (No more pertinent !!)
• Legacy field sketches get considerably deformed during georeferencing and makes it unsuitable for taking reliable measurements of boundary dimensions during resolution of disputes and discrepancies. Measurements annotated on the sketches cannot be fully relied upon. Village map - a mosaic of the block maps contain much more internal distortion which gets amplified during georeferencing.
• Survey of Private Land Records as per boundary and Survey of Govt Land utilizes plotted legacy data to identify original survey markers through an iterative geo-referencing and stake-out process.
• Dispute resolution on a case to case basis – based on actual possession details obtained during resurvey, land registration documents, and chain of land transactions.

Key Considerations

Conceptual Foundations for Designing a Digital Survey Program

Spatial Precision as the Backbone

- A modern land administration system demands spatial data that truly mirrors the reality on the ground.
- Absolute, Accurate and reliable coordinates to all parcel boundaries.

Technology as the Enabler, Not Just a Tool

- The design must leverage advanced, scalable technologies to ensure accuracy, efficiency, and integration.
- Technology choices should be forward-looking and fit for purpose, supporting seamless data capture and validation.

A Complete, Not Partial, Re-Imagining

- The survey design must aim for completeness — ensuring that all parcels are surveyed systematically rather than incrementally.
- The guiding vision should be to prevent future disputes and create a solid foundation for conclusive titling.

Pace without Compromise

- The design must balance speed with accuracy — enabling rapid creation of a reliable, authoritative digital land record. The goal is to achieve scale swiftly, while upholding data integrity.

Cost Optimization

- The program must aim for the best use of resources — using technology, process re-engineering, and integrated workflows to minimize costs. Emphasis on efficiency in both field operations and data processing.

Key Considerations

Conceptual Foundations for Designing a Digital Survey Program

Integration as a Core Design Principle

- The digital survey must be envisioned as part of a **unified land records ecosystem**, integrating textual and spatial records in real time.
- A seamless flow of data across functions is essential for **responsive land governance**.

Citizen-Centric and Transparent by Design

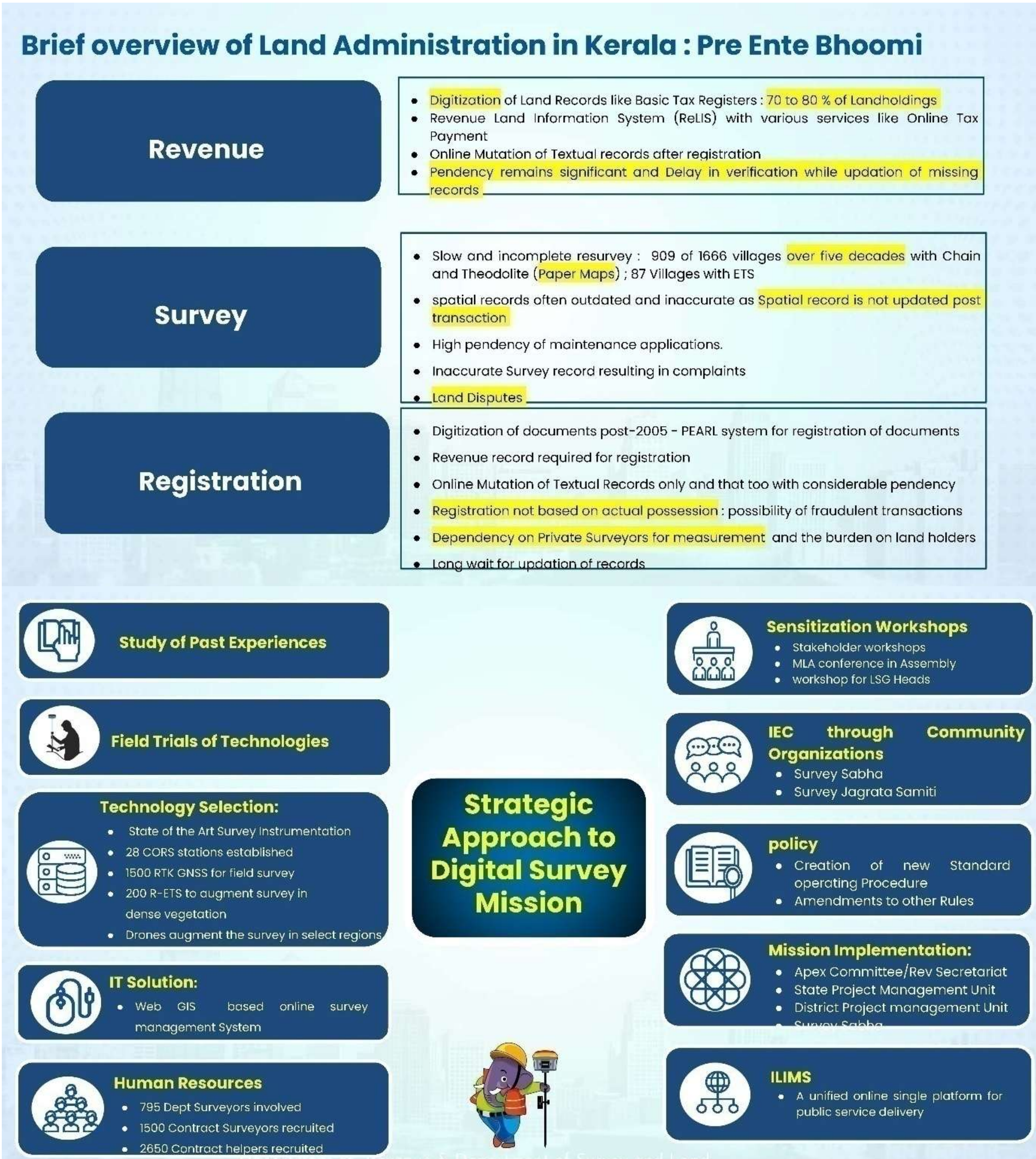
- The survey process must be conceived to actively **involve citizens, build trust, and resolve issues** as they surface.
- **Transparency** should be inherent in both the process and the access to data.

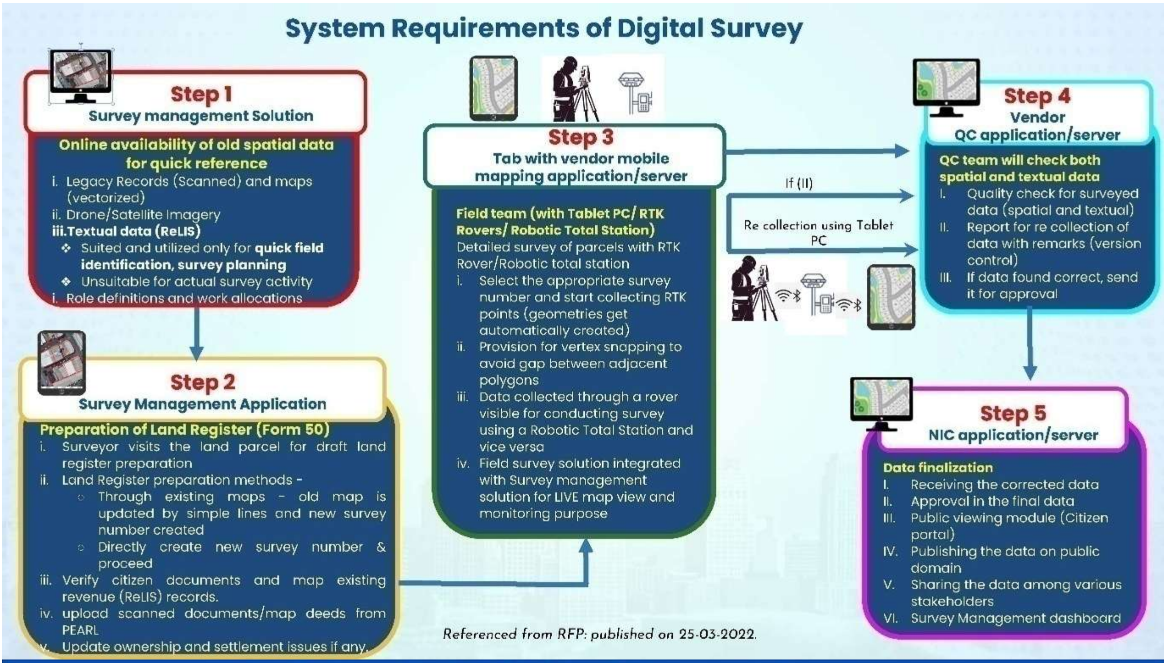
Quality and Governance as Non-Negotiables

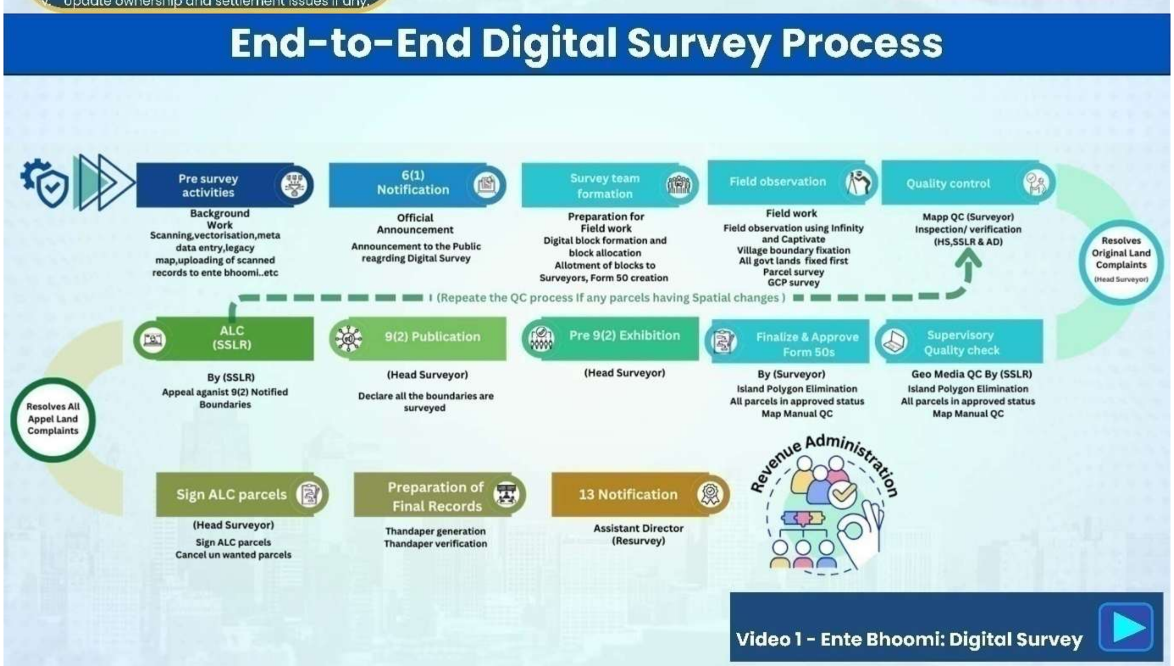
- A **robust governance model** must oversee the survey, ensuring standards are maintained at every level.
- Quality assurance should be embedded in the design, **enabling confidence in outcomes** from the outset.

Designed for Continuity and Future-Proofing

- The digital survey must lay the groundwork for ongoing, **real-time updates of land records** — ensuring the system remains dynamic and accurate over time.


Brief overview of Land Administration in Kerala : Pre Ente Bhoomi
Revenue
Digitization of Land Records like Basic Tax Registers : 70 to 80 % of Landholdings
Revenue Land Information System (ReLIS) with various services like Online Tax Payment
Online Mutation of Textual records after registration
Pendency remains significant and Delay in verification while updation of missing records
Survey
Slow and incomplete resurvey : 909 of 1666 villages over five decades with Chain and Theodolite (Paper Maps) ; 87 Villages with ETS
spatial records often outdated and inaccurate as Spatial record is not updated post transaction
High pendency of maintenance applications.
Inaccurate Survey record resulting in complaints
Land Disputes
Registration
Digitization of documents post-2005 - PEARL system for registration of documents
Revenue record required for registration
Online Mutation of Textual Records only and that too with considerable pendency
Registration not based on actual possession : possibility of fraudulent transactions
Dependency on Private Surveyors for measurement and the burden on land holders
Long wait for updation of records
Study of Past Experiences
Field Trials of Technologies
Technology Selection:
State of the Art Survey Instrumentation
28 CORS stations established
1500 RTK GNSS for field survey
200 R-ETS to augment survey in dense vegetation
Drones augment the survey in select regions
IT Solution:
Web GIS based online survey management System
Human Resources
795 Dept Surveyors involved
1500 Contract Surveyors recruited
2650 Contract helpers recruited
Strategic Approach to Digital Survey Mission
Sensitization Workshops
Stakeholder workshops
MLA conference in Assembly
workshop for LSG Heads
IEC through Community Organizations
Survey Sabha
Survey Jagrata Samiti
policy
Creation of new Standard operating Procedure
Amendments to other Rules
Mission Implementation:
Apex Committee/Rev Secretariat
State Project Management Unit
District Project management Unit
ILIMS
A unified online single platform for public service delivery
Department of Revenue & Department of Survey and Land


System Requirements of Digital Survey
Step 1
Survey management Solution
Online availability of old spatial data for quick reference
i. Legacy Records (Scanned) and maps (vectorized)
ii. Drone/Satellite Imagery
iii. Textual data (ReLIS)
❖ Suited and utilized only for quick field identification, survey planning
❖ Unsuitable for actual survey activity
i. Role definitions and work allocations
Step 2
Survey Management Application
Preparation of Land Register (Form 50)
i. Surveyor visits the land parcel for draft land register preparation
ii. Land Register preparation methods -
○ Through existing maps - old map is updated by simple lines and new survey number created
○ Directly create new survey number & proceed
iii. Verify citizen documents and map existing revenue (ReLIS) records.
iv. upload scanned documents/map deeds from PEARL
v. Update ownership and settlement issues if any.
Step 3
Tab with vendor mobile mapping application/server
Field team (with Tablet PC/ RTK Rovers/ Robotic Total Station)
Detailed survey of parcels with RTK Rover/Robotic total station
i. Select the appropriate survey number and start collecting RTK points (geometries get automatically created)
ii. Provision for vertex snapping to avoid gap between adjacent polygons
iii. Data collected through a rover visible for conducting survey using a Robotic Total Station and vice versa
iv. Field survey solution integrated with Survey management solution for LIVE map view and monitoring purpose
If (II)
Re collection using Tablet PC
Step 4
Vendor
QC application/server
QC team will check both spatial and textual data
I. Quality check for surveyed data (spatial and textual)
II. Report for re collection of data with remarks (version control)
III. If data found correct, send it for approval
Step 5
NIC application/server
Data finalization
I. Receiving the corrected data
II. Approval in the final data
III. Public viewing module (Citizen portal)
IV. Publishing the data on public domain
V. Sharing the data among various stakeholders
VI. Survey Management dashboard
Referenced from RFP: published on 25-03-2022.


End-to-End Digital Survey Process
Pre survey activities
Background Work
Scanning,vectorisation,meta data entry,legacy map,uploading of scanned records to ente bhoomi..etc
6(1) Notification
Official Announcement
Announcement to the Public reagrding Digital Survey
Survey team formation
Preparation for Field work
Digital block formation and block allocation
Allotment of blocks to Surveyors, Form 50 creation
Field observation
Field work
Field observation using Infinity and Captivate
Village boundary fixation
All govt lands fixed first
Parcel survey
GCP survey
Quality control
Mapp QC (Surveyor)
Inspection/ verification (HS,SSLR & AD)
Resolves Original Land Complaints (Head Surveyor)
(Repeate the QC process If any parcels having Spatial changes)
ALC (SSLR)
By (SSLR)
Appeal aganist 9(2) Notified Boundaries
9(2) Publication
(Head Surveyor)
Declare all the boundaries are surveyed
Pre 9(2) Exhibition
(Head Surveyor)
Finalize & Approve Form 50s
By (Surveyor)
Island Polygon Elimination
All parcels in approved status
Map Manual QC
Supervisory Quality check
Geo Media QC By (SSLR)
Island Polygon Elimination
All parcels in approved status
Map Manual QC
Resolves All Appel Land Complaints
Sign ALC parcels
(Head Surveyor)
Sign ALC parcels
Cancel un wanted parcels
Preparation of Final Records
Thandaper generation
Thandaper verification
13 Notification
Assistant Director (Resurvey)
Revenue Administration
Video 1 - Ente Bhoomi: Digital Survey

557/639
Field Survey Started (Phase I,II&III)

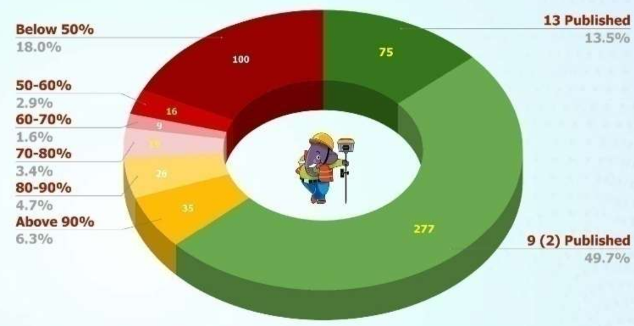
75
Total 13 Notification Published

277
9(2) Published (Phase I,II&III)
(to be 13 Published)

8,89,191.8 Ha
Area Surveyed (Phase I,II&III)

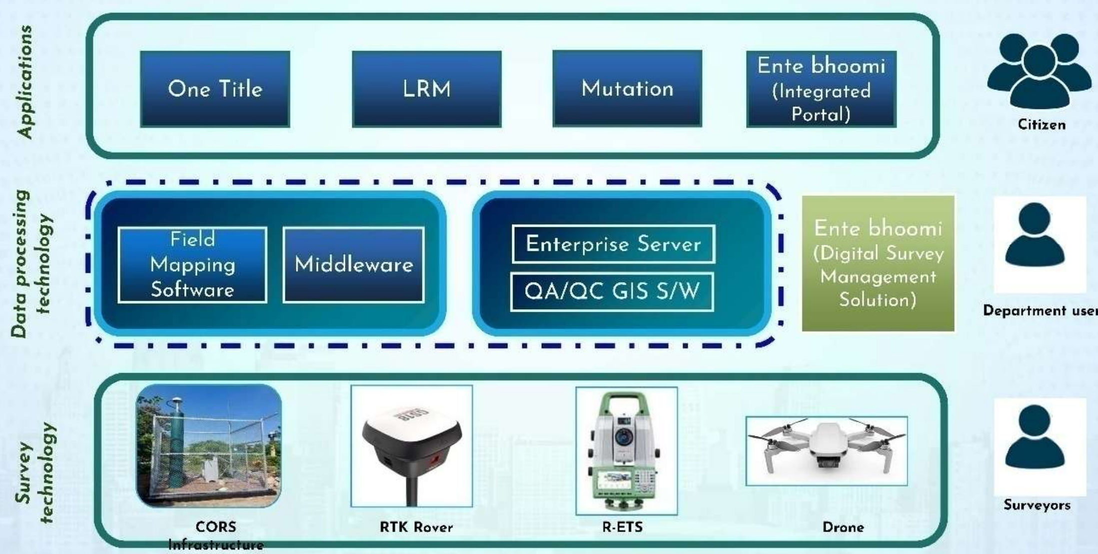
65,23,908 Nos
Parcel Surveyed Phase (I,II&III)

DLS Overview - All Three Phases - Till 15/12/2025



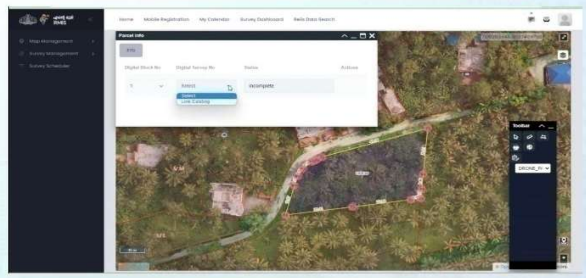
Villages	Total Villages	Field Survey Started	9(2) Published (to be 13 Published)	13 Published
Phase 1	200	200	135	65
Phase 2	239	233	127	10
Phase 3	200	124	15	0
Total	**639**	**557**	**277**	**75**

Kerala's Digital Survey Solution Architecture



Ente Bhoomi's Ground Truthing System Using Drone Data

- **Drone Ortho-Rectified Imagery (ORI)** is integrated into the **Ground Truthing Module** via **Web Map Service (WMS).**
- **Parcel Bend Points** are marked at **maximum zoom level** using a **Tab Touchpad Stylus.**
- **Selected points** are used to **generate the final land parcel boundaries.**
- **for incomplete geometries collect points using GNSS rover.**
- **Ownership attributes** are internally linked to parcels, fulfilling both **Map1 and Map2 requirements.**

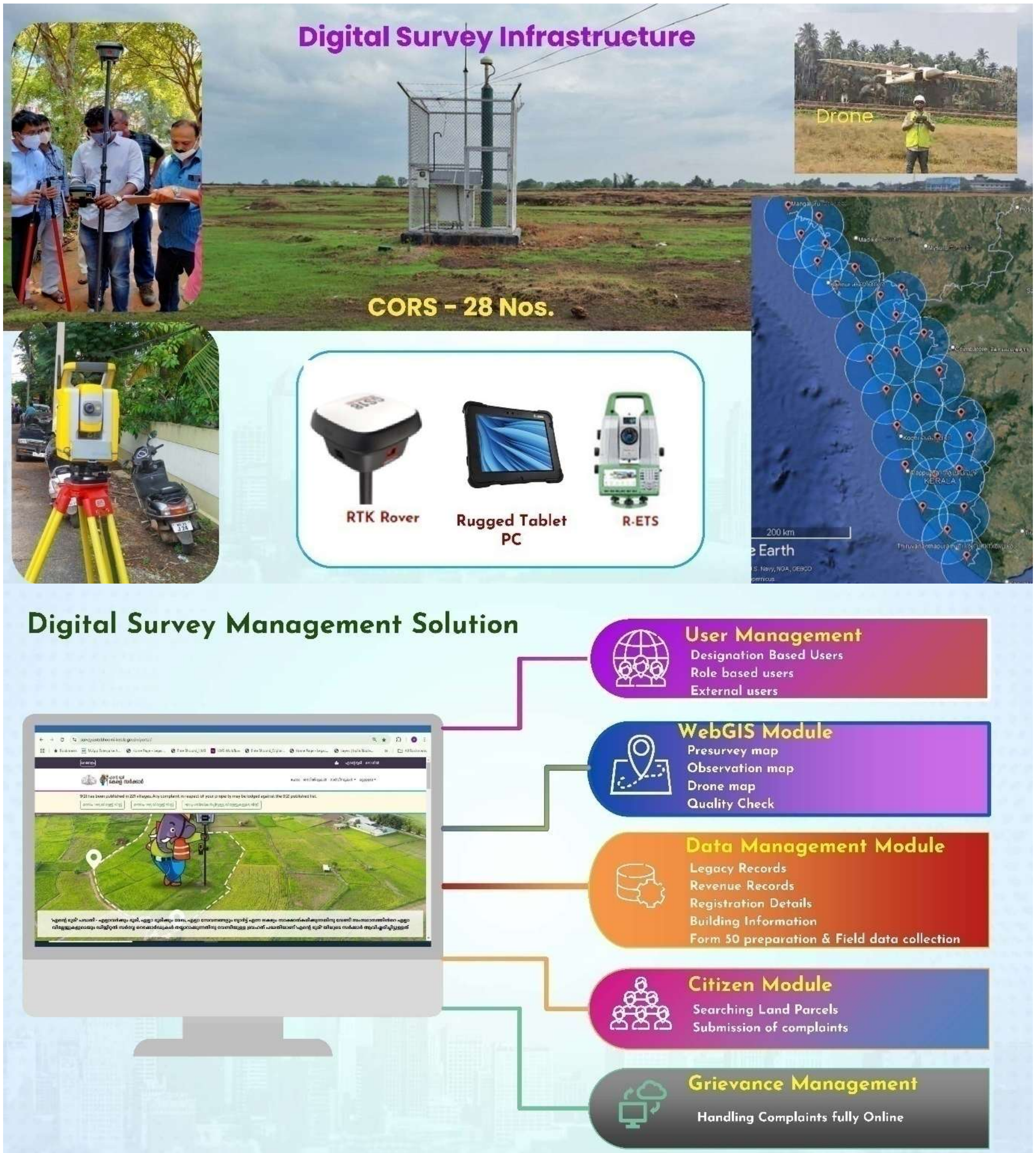


Drone utilization - Tradeoffs

- Drone Acquisition/georeferencing errors
- Errors caused due to manual digitization
- Canopy at the parcel corners and bend points cause non-visibility leading to wrong visual interpretation of the land parcel boundaries

Tradeoffs in RTK Rover Technology

- **Thick Vegetation** - drop in satellite view affects signal strength
- **NO Network region** - CORS requires internet connectivity for communicating with field RTKs. No network mean no connection with RTKs and no RTK correction
- **Dense Built-up** - Closely spaced high rise buildings can cause multipath scattering leading to loss of correction in RTK rovers


Digital Survey Infrastructure
Drone
CORS - 28 Nos.
RTK Rover
Rugged Tablet PC
R-ETS
Digital Survey Management Solution
User Management
Designation Based Users
Role based users
External users
WebGIS Module
Presurvey map
Observation map
Drone map
Quality Check
Data Management Module
Legacy Records
Revenue Records
Registration Details
Building Information
Form 50 preparation & Field data collection
Citizen Module
Searching Land Parcels
Submission of complaints
Grievance Management
Handling Complaints fully Online

Field Survey Solution

i. **Intermediary application** to download pre-survey data into the field control software

ii. **Field control software** - Handles the control and operation of the RTK Rover and R-ETS instruments

iii. The collection of land parcel **bend points** and **creation of parcel geometries** is taken care by the field control software with accuracy restricted to **5 cm**.

iv. the **surveyed data** is imported into the intermediary application and **uploaded to the web server**

v. QC applications for Geometry - **Topology checks**

Enterprise Survey Solution 1
Field survey solution

i. All field survey activity

ii. Module for govt land fixing - Georeference plotted sketches using shift/rotate/transform functionalities

iii. Integrated Handling of RTK/R-ETS data

iv. QC module for surveyors

v. Higher level QC modules for

Enterprise Survey Solution 2
Field Monitoring system

i. Daily progress monitoring

ii. LIVE RTK dashboard for real time CORS/RTK Tracking

iii. WebGIS Dashboard for parcel status Evaluation

iv. Monitoring tool to assess surveyor field activity

v. Mobile Device management system (MDM) - for real time supervision of field activity

vi. Remote Desktop facility through MDM for real time troubleshooting

Enterprise Survey Solution

RTK/R-ETS integrated workflow

Video 2 - RTK & R-ETS Integration

- RTKs are prone to fail in places of **no network coverage** unable to achieve the requisite accuracy as real time corrections will not be available from control centre.
- land parcel boundaries under **dense canopy** can also pose constraints in handling RTK instruments
- In such places **R-ETS is utilized** and surveyor use the same field control application to switch the mode from RTK to R-ETS and proceed with the work.
- The surveyor using the **RTK Rovers** measure the points where correction is available and **complete the geometry**.
- Measure **additional GCP points** to help setting up the R-ETS instruments and upload to web server.
- The incomplete geometry and the GCP points are available for the **R-ETS surveyor** to continue with the survey of the land parcel and **complete the geometry**.
- The process is fully seamless **without any manual data transfer** requirement

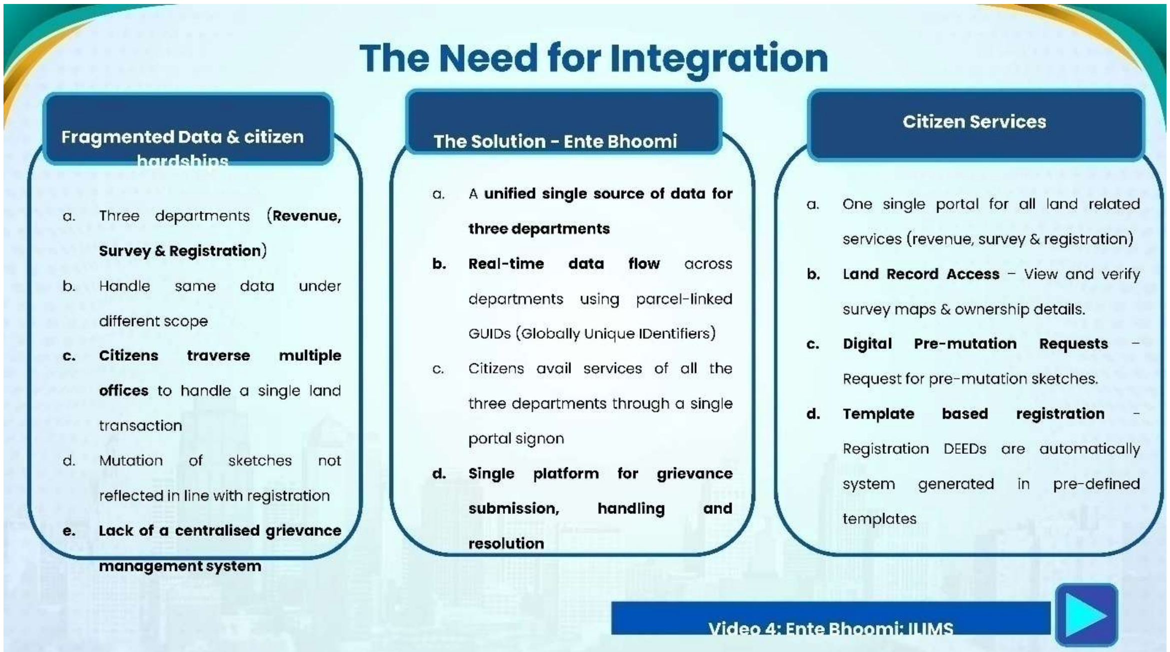
Enterprise Survey Solution

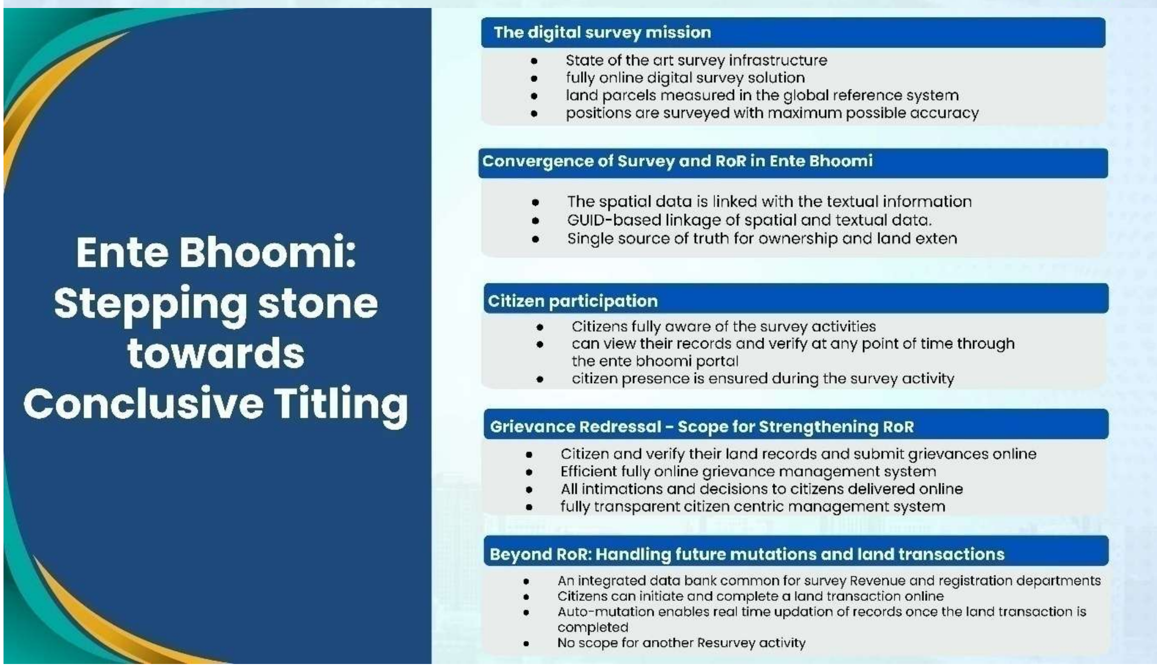
Govt land fixing

Video 3- Govt Land Fixing

- The legacy **govt land sketches are plotted and uploaded** to the dedicated web service.
- surveyors download the plotted data into the field application
- Surveyor visit the field to identify the **bend point stones** which are **intact** without any disturbance and measure the coordinates using RTK. At Least **three distinct points** are measured.
- Utilize the measured points to **Georeference the plotted sketches** using shift/rotate/transform functionalities
- this process is **iteratively done** to achieve maximum georeference accuracy
- Once completed, the remaining **bend points are staked out**
- If stones are displaced or non-traceable, the exact bend point is staked out and **new stones are planted**.


NAKSHA - Drone ORI of Vadakara ULB
Land parcel map with building footprint in Ente Bhoomi
without drone ORI background
Without Building Footprint
with drone ORI background
With Building Footprint
29/119
29/120
Parcel with all textual attributes &
building details
Digital Survey Field Register
Kozhikode / Vatakara


The Need for Integration
Fragmented Data & citizen hardships
a. Three departments (Revenue, Survey & Registration)
b. Handle same data under different scope
c. Citizens traverse multiple offices to handle a single land transaction
d. Mutation of sketches not reflected in line with registration
e. Lack of a centralised grievance management system
The Solution - Ente Bhoomi
a. A unified single source of data for three departments
b. Real-time data flow across departments using parcel-linked GUIDs (Globally Unique IDentifiers)
c. Citizens avail services of all the three departments through a single portal signon
d. Single platform for grievance submission, handling and resolution
Citizen Services
a. One single portal for all land related services (revenue, survey & registration)
b. Land Record Access – View and verify survey maps & ownership details.
c. Digital Pre-mutation Requests – Request for pre-mutation sketches.
d. Template based registration – Registration DEEDs are automatically system generated in pre-defined templates
Video 4: Ente Bhoomi: ILIMS


Ente Bhoomi: Stepping stone towards Conclusive Titling
The digital survey mission
State of the art survey infrastructure
fully online digital survey solution
land parcels measured in the global reference system
positions are surveyed with maximum possible accuracy
Convergence of Survey and RoR in Ente Bhoomi
The spatial data is linked with the textual information
GUID-based linkage of spatial and textual data.
Single source of truth for ownership and land exten
Citizen participation
Citizens fully aware of the survey activities
can view their records and verify at any point of time through the ente bhoomi portal
citizen presence is ensured during the survey activity
Grievance Redressal - Scope for Strengthening RoR
Citizen and verify their land records and submit grievances online
Efficient fully online grievance management system
All intimations and decisions to citizens delivered online
fully transparent citizen centric management system
Beyond RoR: Handling future mutations and land transactions
An integrated data bank common for survey Revenue and registration departments
Citizens can initiate and complete a land transaction online
Auto-mutation enables real time updation of records once the land transaction is completed
No scope for another Resurvey activity

Assessments of Drone Deliverable

Parameter	Description
Drone derived parcel Accuracy	The positional accuracy of points collected through drones and the potential errors from manual digitization
Data Quality	Assess the quality of the geometries where some points are drone derived and some are GNSS derived.
Ascertaining the administrative boundary	The exact legal boundary of a land parcel cannot be assessed from the drone parcel (in drone data, a compound wall may be digitized at the center whereas in field survey, the exact corner of the compound wall based on ownership can be identified.
Deviation in mapped area	The deviation in parcel boundary and the resultant deviation in area is a factor of assessment for efficiency of the methodology.
Building footprint	The area extracted from the drone derived building data does not match the plinth area used for building taxation
Building floor configuration	The building footprint does not provide the exact floor configuration of the building
Deriving building footprints in dense regions	Shorter buildings in between closely spaced high rises will be a hindrance for building mapping and the efficiency of oblique cameras need to be assessed.

- Acts as the **central command and monitoring hub** of the Kerala CORS network for implementation of the Digital Survey Mission
- Ensures continuous positioning reference for Digital Survey Mission and the Ente Bhoomi / ILIMS integrated system
- Network Monitoring & Health Management
- 24x7 monitoring of GNSS data streams, Station uptime and latency

Standards over Brands: Interoperable Digital Cadastral Surveys

Operational Modalities

- Digital cadastral surveys tend to adopt **multi-brand GNSS RTK rovers** for field survey activities
- Different vendors with diverse efficiencies can potentially tend to influence survey quality.

User Preference vs OEM Roles

- Field users often prefer **single-brand ecosystems** for ease of use and training.
- Without standardization, brand-specific firmware and filters may introduce bias.
- Responsibility of OEMs do not end with supply of survey infrastructure.
- Needs to be extended on ensuring field measurement is accurate till end of survey.

Need for a Tablet PC for digital survey

- Controllers have evolved from control interfaces to **full-fledged geospatial mapping tools.**
- **Tablet-based controllers** are preferred due to:
  - Real-time map visualization
  - GNSS + GIS integration
  - Field-level QC and validation
- Geospatial mapping is now **mandatory** for modern field surveys.

Integrated GNSS-Total Station Survey

- GNSS RTK limitations (vegetation, dense urban infrastructure) necessitate **Total Station integration**.
- Hybrid workflows use:
  - GNSS-derived control points
  - Common coordinate reference
  - Seamless GNSS-TS data fusion
- Ensures **continuous parcel geometry** even in GNSS-denied environments.

Learnings & Key Takeaways

- **Incremental survey** - though looks relevant may fail to achieve the ultimate goal of conclusive land Administration system
- **Drone survey** - Cannot be recommended as a universal procedure in the national level, Not viable in places of vegetation cover
- **Technology Architecture** - Should be well defined, supported by robust IT Solution with provisions for scaling up.
- **Survey Quality** - Ensure that survey quality is governed by standards, not by vendor characteristics.
- **Outsourced Survey** - No control on the accuracy and authenticity of the surveyed records leading to flooding of complaints by citizens
- **Diversified Land Administration** - Land records is unique to every state. Incentiwise and set standards for states to have their own solutions for land administrations.

Ente Bhoomi - Knowledge Exchange

- Ente Bhoomi has attracted interest from states and UTs such as **Andhra Pradesh, Tamil Nadu, Assam, Puducherry, West Bengal, Lakshadweep, Odisha & Rajasthan.** Several governments are studying its framework through virtual assessments or by visiting Kerala for training and demonstrations.

The survey department team and NIC team from Assam have visited Kerala for technology and knowledge transfer. Above are the photographs of the visit.

Following the letter request from Andhra Pradesh, a series of portal solution demonstrations and interactions were conducted with the AP Survey Department and NIC for solution development in AP land records. The screenshot above captures one of these discussions.

Communication from DoLR

Inauguration of the one-month intensive training on the Ente Bhoomi digital land survey system and technology, conducted by the Survey and Land Records Department, Kerala, for Pondicherry (UT).

Above is the official letter request from the Department of Land Resources (DoLR) for providing the 'Ente Bhoomi' software and technology services to the state of Assam for their survey project.

Above is the letter request from the Commissioner, Survey, Settlement, and Land Records, Andhra Pradesh, for the demonstration of the 'Ente Bhoomi' system for their survey project.

The above letter is a request from the Revenue Department of Lakshadweep (UT) seeking technical details regarding the survey equipment and IT solutions used for their survey operations.

Geospatial Data and Mapping Infrastructure

National Workshop

Geospatial Bharat

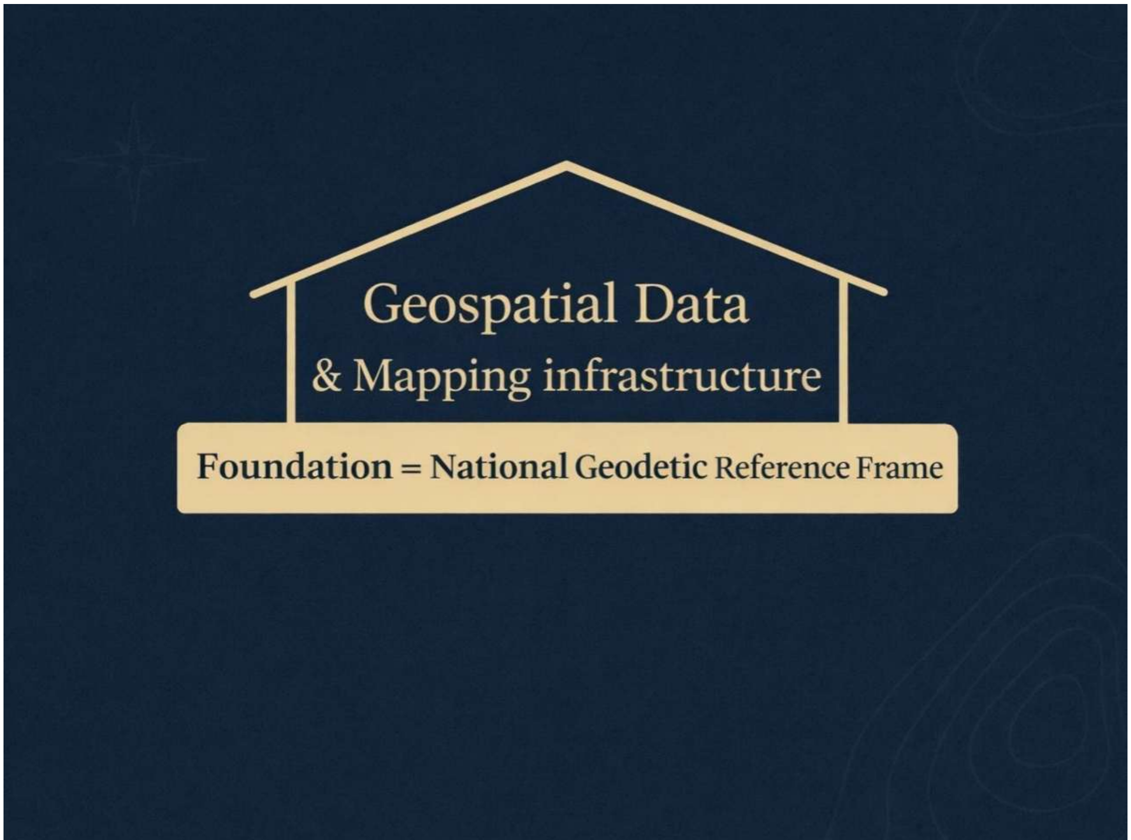
→ Viksit Bharat

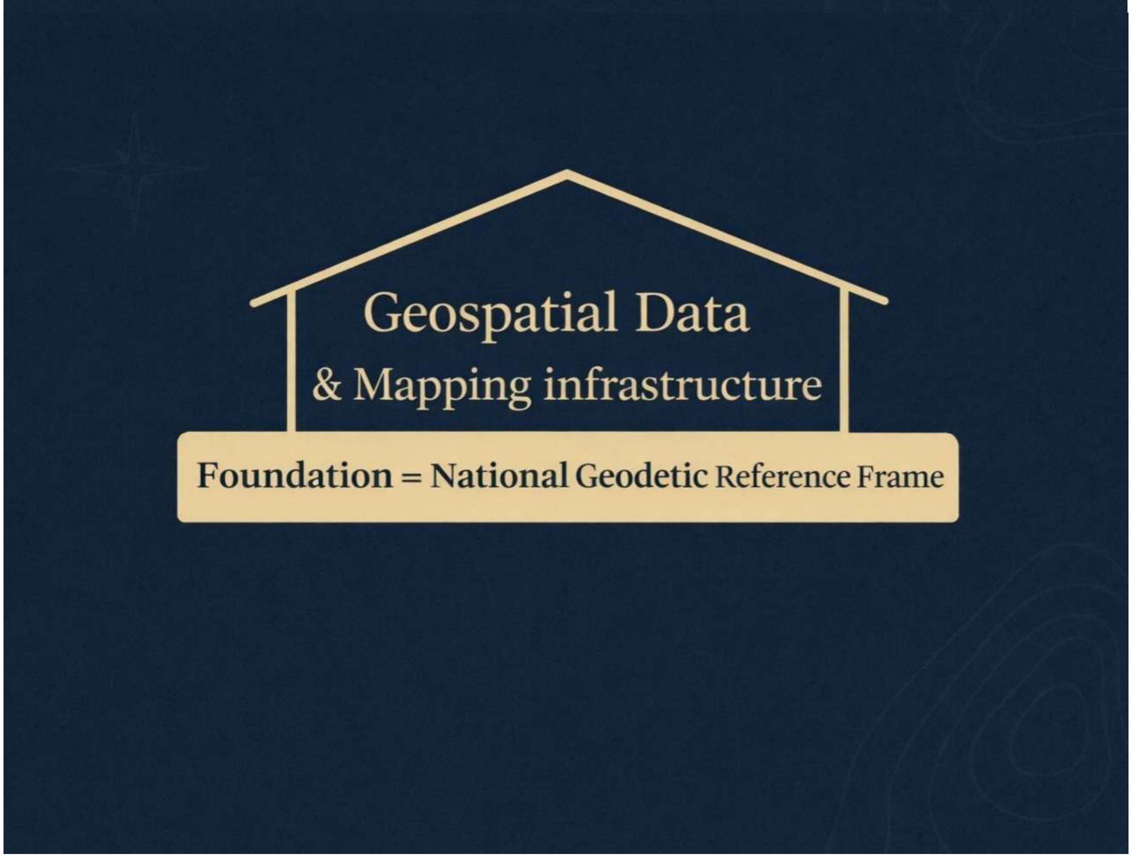
Foundation = National Geodetic Reference Frame

National Geodetic Reference Frame

=

'Common Currency'

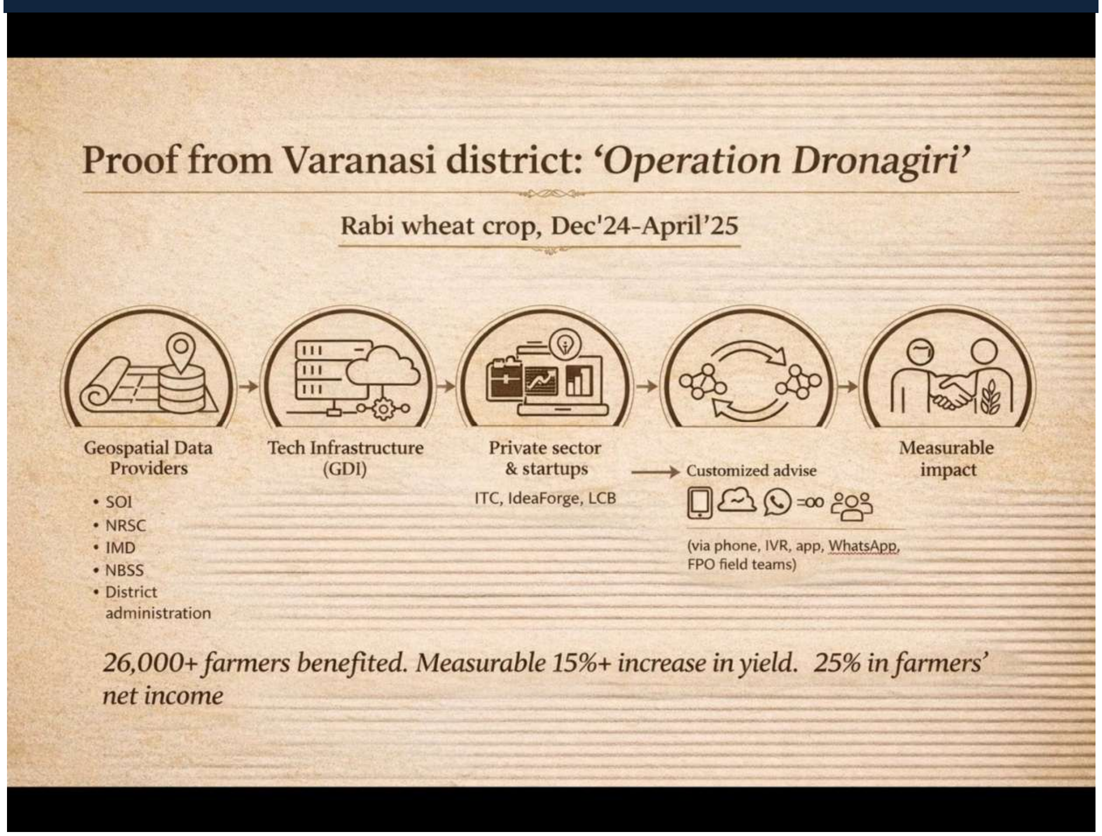

Geospatial Data
& Mapping infrastructure
Foundation = National Geodetic Reference Frame

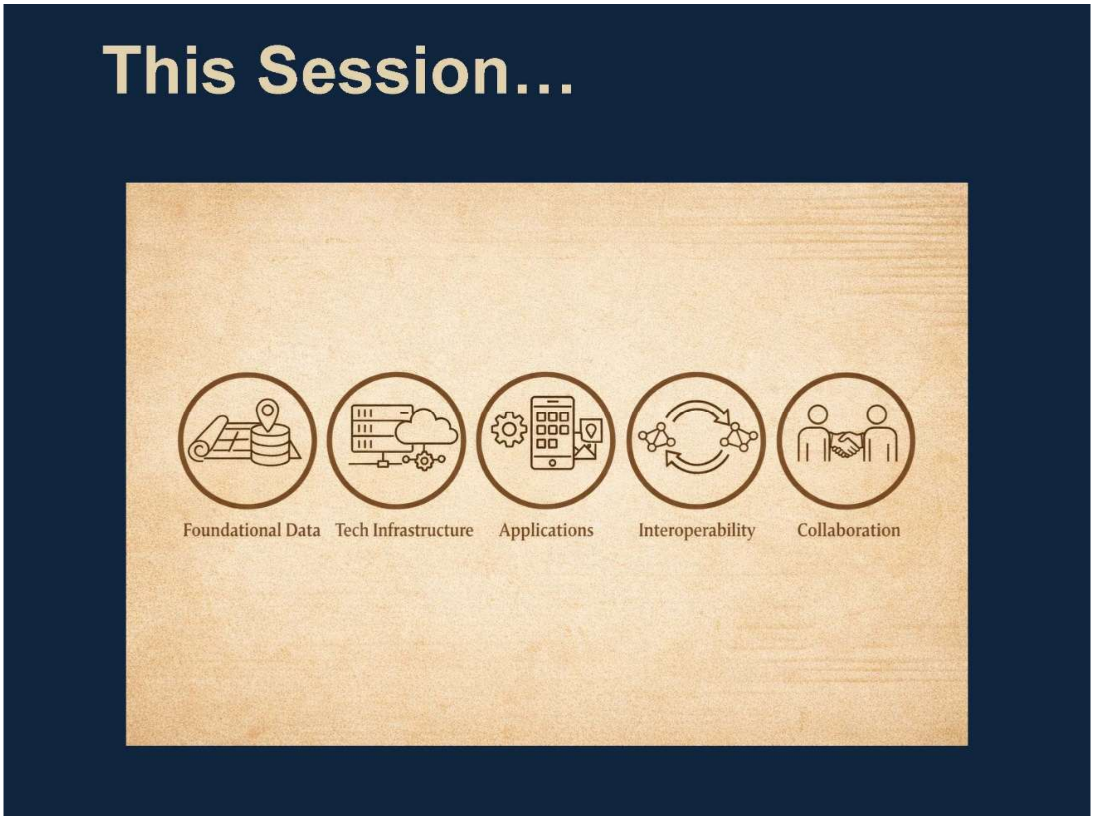

Geospatial Data
& Mapping infrastructure
Foundation = National Geodetic Reference Frame

GEOSPATIAL DATA & MAPPING INFRA

>>>>

ECONOMIC DEVELOPMENT & TECH SOVEREIGNTY




This Session…
Foundational Data
Tech Infrastructure
Applications
Interoperability
Collaboration


Distinguished line up…
Mr S.V Singh
ORI & DEM data sets
Mr Rohan Verma
Tech infrastructure & interoperability
Mr S.S. Rao
Applications (land records)
Dr Saharia
Applications (natural hazards)
Dr Prakash Chauhan
Inter-operability & Collaboration
Dr Yuri Fillipov
Global perspective

Annexure

Session – 3

National Workshop on Strengthening of Geospatial Ecosystem

Geospatial Mission: An Enabler of Viksit Bharat

Role of Standards in harmonizing Geospatial Frameworks:
Geospatial Ecosystem and its Vision 2040

WOOLPERT

Prof. Dr. Zaffar Sadiq Mohamed-Ghouse
HonFGCA FRGS FIEAust SMIEEE MAICD
Vice President and Director-Advisory & Innovation, Woolpert
Vice Chair, OGC Board of Directors
Chair, UN-GGIM, Geospatial Societies
Chair, UN-GGIM, Asia Pacific – Private Sector Network
Program Board Member, Group on Erath Observation
Australian Representative, ISO TC 211 Geospatial Information / Geomatics

We live in an era of rising complexity and mounting risks from fragmented systems.

From energy grids and global supply chains to emergency response and infrastructure development, the systems we depend on are increasingly interconnected. Yet, the data and decisions guiding them often remain siloed.

Geospatial information provides the foundation for managing this complexity this complexity. It tells us where things are, how they move, and how they relate to one another across time and space. From monitoring land use and tracking logistics to securing borders and planning for climate resilience, geospatial systems underpin some of society's most critical operations.

Image source:
https://www.renewableenergyworld.com/energy-storage/global-renewable-energy-grid-project-integrating-renewables-via-hvdc-and-centralized-storage/

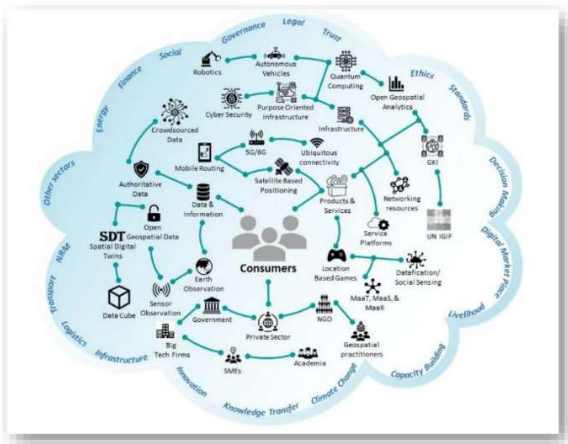
But today, it's not just about location. It's about **shared semantics**, **common frames of reference**, **data rights**, and **trust**. As systems become more complex and interdependent, knowing "where" is no longer enough. Decision-makers need to understand what it means, who controls it, how it can be used, and how it fits within a broader ecosystem.

That's the promise, and the challenge of the emerging **interconnected geospatial ecosystem**.

The paper 'Towards a Sustainable Geospatia. Ecosystem beyond, August 2021 defines Geospatial Ecosystem

- Serena Coetzee, University of Pretoria, South Africa
- Michael Gould, Esri and University of Jaume I, Spain
- Bruce McCormack, EUROGI
- **Zaffar Sadiq Mohamed-Ghouse, Spatial Vision, Australia**
- Greg Scott, UN Global Geospatial Information Management Alexander Kmoch, University of Tartu, Estonia
- Nadine Alameh, Open Geospatial Consortium
- Josef Strobl, University of Salzburg, Austria
- Andreas Wytzisk, Bochum University of Applied Sciences, Germany
- Thirumalaivasan Devarajan, Anna University, India

"A Geospatial ecosystem is where people from all over the world interact with each other directly or indirectly, utilizing dependable and accurate location-based data and advanced geo-analytics conveyed through dynamic geomedia or open computing environments. Like a natural ecosystem, Geospatial ecosystems are marked by solid interrelationships between actors and their surroundings, constant adaptation, and the potential for significant transformations resulting from certain events."



Source: https://ggim.un.org/meetings/GGIM-committee/11th-Session/documents/Towards_a_Sustainable_Geospatial_Ecosystem_Beyond_SDIs_Draft_3Aug2021.pdf

4

Bridging the Geospatial Digital Divide: Despite technological progress, significant disparities in geospatial capabilities persist between countries and regions. The future geospatial information ecosystem must prioritize inclusiveness, capacity development and equitable access to technologies and data, ensuring that all Member States, especially developing countries and small island developing States, can participate in and benefit from the evolving ecosystem.

Digital Transformation and Technological Convergence: Rapid advancements in digital technologies, including AI, IoT, cloud computing, and advanced analytics, are transforming how data is created, managed and utilized. Geospatial information must evolve to remain an integral component of this wider digital transformation, enabling real-time decision-making, predictive modeling and dynamic service delivery.

Climate Change and Resilience Building: Climate change presents an urgent global challenge requiring immediate, coordinated action. Location-based data is fundamental to understanding climate impacts, managing risks and building resilient societies. The future geospatial information ecosystem must empower decision-makers with integrated, geospatially enabled insights to drive mitigation, adaptation and resilience efforts.

Data as a Foundational Public Good: Geospatial information increasingly underpins critical public services, from health and transportation to disaster response and resource management. Recognizing geospatial data as a foundational public good promotes equitable access, fosters ethical use, and advances broad societal benefit, strengthening the role of national and global data infrastructures.

Strengthening Governance and Trust in the Digital Era: As data ecosystems become increasingly complex, maintaining public trust, upholding ethical governance and safeguarding data sovereignty are emerging as critical imperatives. The future geospatial information ecosystem must embed strong governance frameworks that prioritize transparency, accountability, inclusivity, and the protection of human rights, building and sustaining trust in the management and use of geospatial information.

Source: https://ggim.un.org/meetings/GGIM-committee/15th-session/documents/25-00062_UNGGIM_GeospatialEcosystem_report.pdf

5

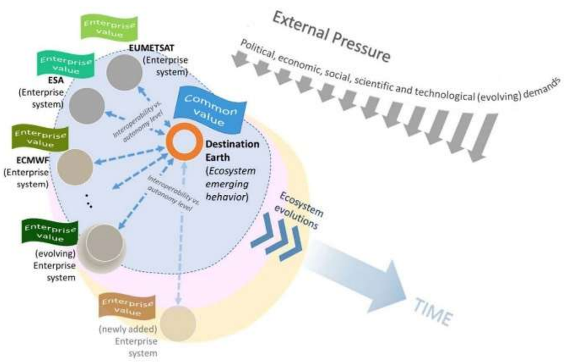
EU – Perspective : Destination Earth Enterprise View

(Digital) Ecosystem Principles

Destination Earth must be a **flexible and dynamic framework**, because of the dynamicity of the context where it will operate. Destination Earth ecosystem must be able to **evolve and continue operating**, in an effectively and efficiently way, in spite of the framework and context changes. Destination Earth must be **resilient and survive changes** (and even disruptions) that will likely occur in the coming years, due to technological, scientific, organizational, economic, political and societal changes.

To achieve that, the architecture must implement the following patterns:

- **High Flexibility and Modularity** level to effectively de-couple the enabling infrastructure and platform system (i.e. a system-of-systems) from the thematic digital twin ones. The aim is to implement a high scalable system that implements the elasticity features required by the collected business goals and objectives.
- **Independence from a specific provider, technology, or license** to defend the perceived European values and secure industrial competitiveness, in keeping with the European data and technology openness and autonomy.
- **Preserve and facilitate the co-evolution of the "digital species"** populating the digital environment in which the Destination Earth will operate ecosystem. This is important to maximize the Destination Earth resilience.
- **Equal opportunities of access** to the infrastructure and affordability for small organizations and across the ICT value chain.
- **Meta-systemic governance** of the ecosystem to govern its evolutions, adaptations, mutations, and strains. This will also control the observance of the EU Cybersecurity and Privacy rules.



The evolutionary nature of the Destination Earth DT ecosystem, its components, and the context in which they operate

Source: https://publications.jrc.ec.europa.eu/repository/handle/JRC124168

7

Moving Forward Together: The Emergence of the Interconnected Geospatial Ecosystem

By: Mohammed Yahya AlSayel[a], Ingo Simonis[b], Zaffar Sadiq Mohamed-Ghouse[a], Asim AlGhamdi[a]

a: General Authority for Survey and Geospatial Information (GEOSA)
b: Open Geospatial Consortium (OGC)

Cite as: Alsayel, M. Y., Simonis, I., Mohamed-Ghouse, Z. S., AlGhamdi, A. (2025). Moving Forward Together: The Emergence of the Interconnected Geospatial Ecosystem.
DOI: https://docs.ogc.org/techpaper/25-017.pdf

A New Era for Geospatial Collaboration

Around the world, decisions with far-reaching impact—on climate, infrastructure, finance, and national security—depend on timely, trusted geospatial information. For decades, Spatial Data Infrastructures (SDIs) have played a foundational role in enabling governments and industries to manage, share, and apply this data effectively.

As technologies, demands, and expectations evolve, so too must the systems that support them. What's emerging is a next-generation geospatial ecosystem: a dynamic, scalable, and interconnected environment where people, technologies, and data work together to solve real-world problems. These ecosystems build on the strengths of SDIs but go further—integrating not only stakeholders and systems, but also AI models, analytics, automation, and semantic standards—enabling more adaptive, intelligent, and collaborative approaches to some of the world's most pressing challenges.

In this ecosystem, actors—whether human or machine—can be added, removed, or reconfigured on demand. They form around specific needs, collaborate through shared data

1

What's Changing – and Why It Matters Now

Today's challenges, from energy transitions and economic diversification to AI integration and disaster preparedness, demand systems that are increasingly adaptive, connected, and context-aware. While traditional Spatial Data Infrastructures (SDIs) have provided a strong foundation, they often face limitations in fully addressing the complexity and pace of these evolving needs.

What's emerging instead is a geospatial ecosystem built on interconnected actors—not just people and systems, but also AI models, tools, standards, governance structures, and shared vocabularies. These actors work together through trusted data spaces, assembling dynamically around specific use cases and evolving national priorities.

This new model is defined by key capabilities:

- **Interoperability** – Seamless integration of diverse data sources and systems using open standards
- **Data Sovereignty –** Secure, governed data sharing that preserves ownership and control
- **Semantic Clarity** – Linked data and knowledge graphs that maintain meaning, provenance, and traceability
- **Scenario-Driven Design** – Systems structured around practical needs like urban planning, resource management, or emergency response
- **Agility** – The ability to evolve with emerging technologies, risks, and missions
- **Inclusion –** Broader participation through low-code platforms, training, and localized capacity building
- **Sustainability –** Designed with long-term social, economic, and environmental impact in mind
- **AI Readiness** – Enabled for direct consumption by AI agents and models

Source: https://www.ogc.org/blog-article/the-shift-thats-reshaping-geospatial-and-why-it-matters-now/

8

Open Geospatial Consortium

GEOSA
الهيئة العامة للمساحة والمعلومات الجيومكانية
General Authority for Survey and Geospatial Information

A Shared Responsibility—and a Path Forward

This shift toward a living, interconnected geospatial ecosystem opens new possibilities and new responsibilities. It's not just about improving technology; it's about strengthening coordination, trust, and the ability to act with clarity across systems, sectors, and borders.

At OGC, this transition is guiding a new generation of services, tools, and partnerships. We are:

- Modernizing standards to be modular, reusable, and community-driven
- Automating validation and compliance for real-time interoperability assurance
- Enabling decentralized ecosystems where communities and governments manage their own vocabularies, registers, and services
- Accelerating innovation through agile development and open experimentation
- Advancing semantic interoperability to power automation, integration, and responsible AI

A National Model with Global Relevance

Saudi Arabia's **National Geospatial Ecosystem (SANGE)** offers a concrete example of this shift. Developed under GEOSA's leadership, SANGE is laying the groundwork to integrate spatial data cubes, semantic standards, and AI into a sovereign, scalable platform that supports everything from infrastructure planning to land and resource monitoring.

"We are building a geospatial ecosystem that is secure, scalable, and built for long-term value," said Dr. **Eng. Mohammed Yahya Al Sayel**, President of GEOSA. "By integrating international standards with national priorities, and investing in local capacity, we are equipping Saudi Arabia—and the wider region—to lead in geospatial innovation and respond to emerging challenges with confidence."

While tailored to the Kingdom's strategic needs, the approach is broadly applicable. It offers a flexible, standards-based model for other nations and institutions seeking to modernize their geospatial capabilities in line with global digital transformation goals.

9

Saudi Arabia geospatial ecosystem is a flexible, scalable, and inclusive system that integrates people, technologies, data, standards, and governance models to enable the dynamic aggregation, analysis, and application of geospatial information. It is characterized by:

- **Interoperability:** Seamless integration of diverse data sources and systems.
- **Data Sovereignty:** Control remains with data owners, supported by trusted data spaces.
- **Semantic Clarity:** Use of linked data and knowledge graphs to ensure consistent meaning and traceability.
- **Scenario-Centric Design:** Focused on solving specific, real-world problems rather than generic data provision.
- **Agility and Scalability:** Ability to rapidly adapt to new technologies, policies, and user needs.
- **Inclusivity:** Engagement of a wide range of stakeholders, including non-experts via low-code/no-code tools.
- **Sustainability:** Consideration of environmental, economic, and social impacts.
- **AI-Readiness:** Enabled for direct consumption by AI agents and models

10

Focus on User Needs & Accessibility

New Approach:

- **User-Centric Design:** Designing geospatial services and interfaces with a deep understanding of user needs and workflows. This includes usability testing and iterative development.
- **Simplified Access:** Providing easy-to-use search and discovery tools that don't require specialized geospatial knowledge. Think of a "Google" for geospatial data.
- **Data Literacy Initiatives:** Investing in programs that improve data literacy and empower users to effectively use geospatial information.
- **Low-Code/No-Code Platforms:** These platforms empower non-technical users to develop custom geospatial applications, significantly lowering the barrier to entry. These platforms will play an increasingly important role in modern geospatial ecosystems, as they enable complex spatial analytics without extensive coding knowledge.

Image source: ID 217789283 © Ksenia Kolesnikova | Dreamstime.com

Source: https://www.ogc.org/blog-article/the-shift-thats-reshaping-geospatial-and-why-it-matters-now/

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From SDIs to Geospatial Ecosystems with Data Spaces

New Approach: The focus shifts to how the data is used – creating valuable services and knowledge derived from it. This includes:

- **API-First Design**: Data is increasingly accessed and used through Application Programming Interfaces (APIs), allowing developers to build custom applications and services without needing to directly interact with the underlying data. This is about making data actionable.
- **Data as a Service (DaaS):** Instead of downloading data, users access pre-processed, analyzed, and integrated data streams.
- **Model as a Service (MaaS):** Provides access to pre-trained (analytical)models.
- **Geospatial Analytics Platforms:** State-of-the-art platforms and cloud-based solutions are increasingly used to provide ready-to-use geospatial analytics and insights.
- **Knowledge Graphs:** Moving beyond simple metadata, knowledge graphs link geospatial data with other relevant information (e.g., demographics, economic indicators, environmental factors) to create richer contextual understanding.

Participants in a dataspace
Image source:
https://en.wikipedia.org/wiki/Dataspace

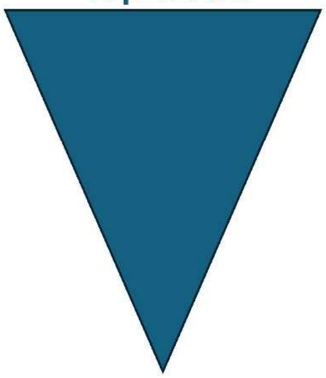
Source: https://www.ogc.org/blog-article/the-shift-thats-reshaping-geospatial-and-why-it-matters-now/

Image source: https://www.t-systems.com/de/en/data-intelligence/solutions/data-spaces

12

From Top-Down Government-Driven to Market-Driven & Collaborative

Top-Down



New Approach

- **Decentralization and Federation:** We are moving away from a centralized SDI toward distributed networks where data providers retain control and autonomy. Though, while this shift fosters innovation and responsiveness to local needs, it remains important to carefully balance public interests, private sector incentives, and community engagement.
- **Private Sector Involvement:** Encouraging the private sector to build geospatial services and applications. This leverages market forces and expertise.
- **Community-Based Data Initiatives:** Supporting citizen science project sand community-led data initiatives. This expands data coverage and improves data relevance; however, reliability and quality assurance processes need to be addressed carefully.
- **Open Data Principles:** Promoting open licenses significantly democratizes access, enhances transparency, and accelerates innovation. For instance, governments making geospatial data freely available have spurred innovation in urban planning and environmental monitoring. On the other side, while openness drives innovation and transparency, robust data governance and equitable access frameworks are essential in many cases, as the data spaces concept clearly shows.

Source: https://www.ogc.org/blog-article/the-shift-thats-reshaping-geospatial-and-why-it-matters-now/

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Key Challenges

- **Inertia aspects**: Overcoming the existing infrastructure and processes of traditional SDIs.
- **Data Governance:** Establishing clear data governance frameworks for decentralized data networks.
- **Sustainability:** Developing sustainable funding models for new geospatial services.
- **Interoperability:** Ensuring that different geospatial data formats and platform scan work together.
- **Economic and Business Models:** Discussing monetization strategies for geospatial ecosystems, including public-private partnerships, and cost-benefit analysis of transitioning from SDIs is necessary to understand the economic implications.
- **Change Management and Capacity Building:** Transitioning to ecosystems requires organizational change strategies, training programs for participating organizations, and stakeholder engagement frameworks.
- **Environmental Impact:** Considering the carbon footprint of cloud computing, AI, and IoT is increasingly important for sustainable digital infrastructure.

Source: https://www.ogc.org/blog-article/the-shift-thats-reshaping-geospatial-and-why-it-matters-now/

14

Vision 2040

A unified, intelligent geospatial-AI-data ecosystem

A future where the world's digital fabric becomes living, real-time and trustworthy

16

Key Technology Trends for 2040

Artificial Intelligence (AI) & AGI	• AI becomes deeply embedded, evolving towards Artificial General Intelligence (AGI) that surpasses human intellect, driving autonomous systems and hyper-personalized services.
Biotechnology & Genetics	• CRISPR and gene editing become common, drastically reducing disease; synthetic biology creates new materials and food, transforming healthcare and agriculture.
Brain-Computer Interfaces (BCI)	• Non-invasive wearables and neural implants allow direct thought control of devices, thought-sharing, and enhanced learning, making the mind the primary interface.
Quantum Computing	• Solves complex problems beyond classical computers, accelerating scientific discovery and AI development.
Immersive Realities (Metaverse)	• Virtual and augmented realities become indistinguishable from reality, offering deep sensory immersion for work, entertainment, and social connection.
Robotics & Automation	• Service robots become household staples, while autonomous vehicles and drones dominate transport, supported by smart cities.
Sustainable Energy	• Fusion power becomes commercially viable, solar power from space is feasible, and lunar bases/asteroid mining become routine.
Advanced Materials & 4D Printing	• Nanomaterials and self-assembling (4D) printed objects revolutionize manufacturing, construction, and medicine.
Hyper-Connectivity	• Beyond 5G, networks support pervasive IoT, smart infrastructure, and massive data flow for AI.
Space Exploration and Commercialization	• Expanded space activities, routine on-orbit servicing/assembly/manufacturing, increased competition for space dominance, decreased role of government.

17

Geospatial technology will be pivotal to the major tech trends of 2040

Fueling AI and Predictive Analytics

Geospatial data will provide the critical spatial context that AI and Machine Learning (ML) algorithms need to make highly accurate predictions. This will power applications like forecasting climate change impacts, predicting disease outbreaks, and optimizing global supply chains with unprecedented precision.

Enabling Autonomous Systems

Self-driving cars, drones, and robots will rely heavily on high-definition 3D maps and real-time geospatial data for safe and efficient navigation. Location intelligence will be fundamental to the operation of autonomous delivery networks and public transportation systems.

Powering the Internet of Things (IoT) & Smart Cities

Billions of IoT sensors embedded in infrastructure, vehicles, and the environment will continuously stream real-time location-specific data. This data will be ingested by geospatial systems to enable the management of smart cities, optimizing energy consumption, traffic flow, and waste disposal in real time.

Enhancing Human-Machine Interaction

Augmented Reality (AR) and Virtual Reality (VR) applications, which will be common by 2040, will use location information to overlay digital information onto the physical world, creating immersive and highly personalized experiences for users, from navigation to retail.

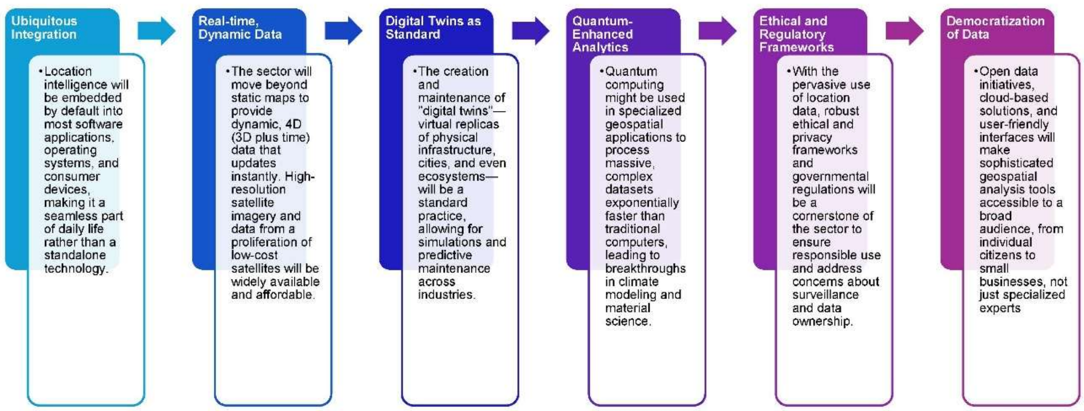
Supporting Biotechnology and Resource Management

Geospatial data will be vital for precision agriculture, monitoring crop health and optimizing irrigation using satellite and drone imagery. It will also be critical for environmental monitoring, conservation efforts, and managing natural resources in the face of climate change.

18

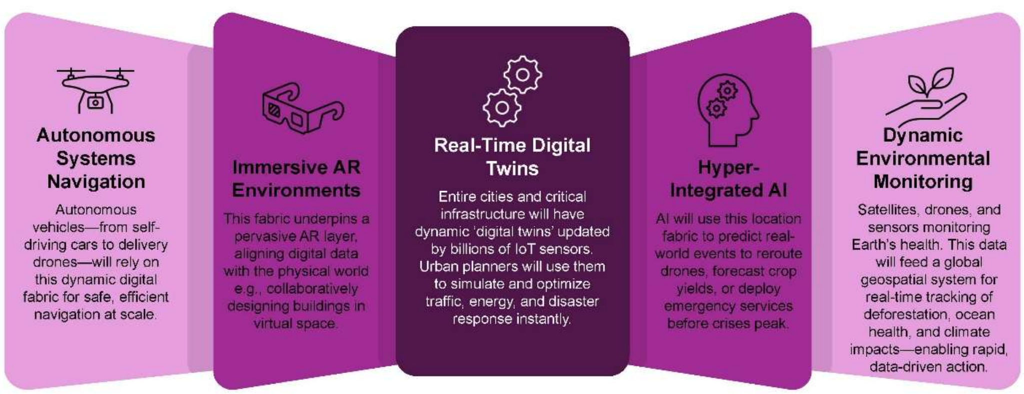
Geospatial in 2040: A Glimpse

A multi-trillion-dollar economy, fundamentally transformed from a niche domain to a universally accessible utility.



19

Key elements of this "living digital fabric" will include



Geospatial won't **just provide maps**; it will provide the **dynamic, intelligent context** that makes all future technology possible, creating a **seamless, interconnected existence between our digital and physical realities**.

20

Foundation: Next-Gen Geospatial Infrastructure

Robust geospatial foundations are essential—standards, models, and services create the backbone.

- Global geospatial data grids
- Semantic models & standards
- Geo-enabled public services
- Interconnected national digital twins

21

Drivers for the New Vision 2040

AI as the Reasoning Layer

- Automated feature extraction & classification
- Predictive analytics for climate, disasters, cities
- Geo-AI copilots for governments, businesses, citizens

Data Spaces as Connective Tissue

- Federated data architectures
- Cross-border, cross-sector data sharing
- Shared governance, privacy-preserving exchange

The Role of Sensors and Observations

- Earth observation satellites
- IoT sensor networks
- Community-generated geospatial data
- Digital identity of objects, locations, ecosystems

Applications in 2040

- Climate early-warning ecosystems
- Planetary-scale supply chain transparency
- Hyper-personalized mobility & urban services
- Biodiversity protection through live monitoring

Governance for a Trusted Digital Fabric

- Interoperable global standards
- Ethical & responsible AI
- Transparency, auditability, digital rights
- Shared stewardship between public, private, civil society

Economic & Social Transformation

- New industries built on live geospatial intelligence
- Reduced disaster losses
- Increased efficiency in agriculture, energy, transport
- Empowered communities & local decision-making

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Challenges in Achieving a Living Digital Fabric by 2040

Ethical & Regulatory Challenges

Privacy Risks from Location Data
Sensitive location data collection risks personal privacy through re-identification and potential misuse.
Informed Consent Challenges
Passive data collection by IoT devices often occurs without clear user consent, creating ethical concerns.
Regulatory Inconsistencies
Different global privacy laws complicate compliance and create gaps in universal ethical standards.
Surveillance and Civil Liberties
Digital fabric infrastructure may enable mass surveillance, threatening human rights and freedoms.

Security & Infrastructure Risks

Critical Infrastructure Vulnerability
Spatial data for smart cities could be exploited to disrupt power grids, transport, and communication systems.
Cyber Espionage and Data Breaches
High-resolution geospatial data is a prime target for cybercriminals risking national security and personal data exposure
Data Integrity and Trustworthiness
Reliable real-time geospatial data is essential to prevent manipulation that could cause emergency response failures.
Need for Advanced Cybersecurity
Protecting critical systems requires advanced security measures, continuous monitoring, and international cooperation.

Technical & Market Challenges

Interoperability and Standardization
Integrating diverse data sources requires robust frameworks that are not yet universally adopted, hindering seamless data use.
Data Availability and Quality
High-resolution foundational datasets are scarce or inaccessible, complicating efforts to ensure consistent and accurate data.
Skills Gap in Geospatial Industry
A shortage of geo-generalists skilled in AI, data science, and urban planning limits effective data management and analysis.
Market Awareness and Adoption
Lack of awareness among stakeholders in underdeveloped markets slows adoption of geospatial services and technology.

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Path to 2040

Technologists / Private Sector

Drive Innovation & Commercialization
Build scalable solutions to realize the vision.
Develop Interoperable Platforms
Create open standards for seamless data integration.
Prioritize Security-by-Design
Embed strong cybersecurity from the start.
Invest in AI & Analytics
Advance AI/ML for real-time spatial data and predictive insights.
Build Public Trust
- Ensure transparency, clear policies, and user control over data.

Academia /Research

Drive Fundamental Research
Explore quantum computing, AR/VR visualization, and advanced data analytics.
Lead Ethical Dialogue
Develop frameworks for responsible data use and study unintended impacts.
Reform Curriculum & Foster Talent
Create interdisciplinary programs to build "geo-generalists" skilled in AI, data science, and urban planning.
Facilitate Knowledge Transfer
Partner with industry and government to turn research into practical solutions.

Government

Establish Clear Regulations
Define global rules for privacy, consent, and data ownership.
Invest in Data Infrastructure
Fund high-resolution, open-access geospatial datasets.
Promote Public-Private Partnerships
Collaborate on climate resilience, smart cities, and disaster management.
Champion International Standards
Enable seamless cross-border geospatial operations.
Lead by Example
Adopt "geo-by-default" policies in governance and planning.

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A unified, intelligent geospatial-AI-data ecosystem - where India's digital fabric becomes living, real-time and trustworthy.

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India's National Missions Enabled by a Unified Geospatial Ecosystem

Governance, Platforms & Cross-Cutting Systems

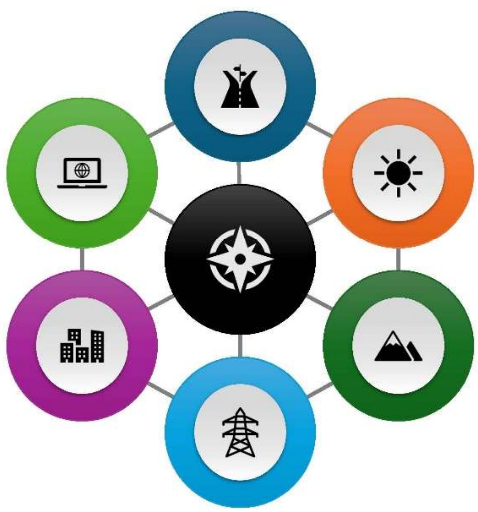
Bhuvan platform. Open Government Data Platform. State geospatial portals. E-governance portals

Urban & Rural Development, Water & Sanitation

Jal Jeevan Mission. Namami Gange. National Hydrology Project. Atal Bhujal Yojana. Inter-basin transfer and command area mapping. Jal Shakti Abhiyan. CITIIS 2.0. AMRUT. Swachh Bharat Mission. Digital Farmer Registry. Soil Health Card. Crop insurance and PMFBY. MGNREGA. Ayushman Bharat. School mapping. Ccensus mapping.

Energy, Utilities & Power

Rooftop Solar Mission. Power distribution. PM Surya Ghar Muft Bijli Yojana



Core Infrastructure and Logistics

PM GatiShakti. Unified Logistics Interface Platform (ULIP). Bharatmala Pariyojana. Sagarmala. Pradhan Mantri Gram Sadak Yojana. Urban Infrastructure Development Fund (UIDF). Amrit Bharat Station Scheme. BharatNet

Climate, Environment & Disaster Management

National Database for Emergency Management (NDEM). Forest Conservation /CAMPA (Compensatory Afforestation). Air quality & emissions mapping. MOSDAC (meteorological & climate GIS feeds).

Land & Natural Resource Management

DILRMP. SVAMITVA scheme. NAKSHA. GSI) mapping. Coal, oil & gas pipeline corridor GIS. Coastal Regulation Zone (CRZ) compliance mapping.

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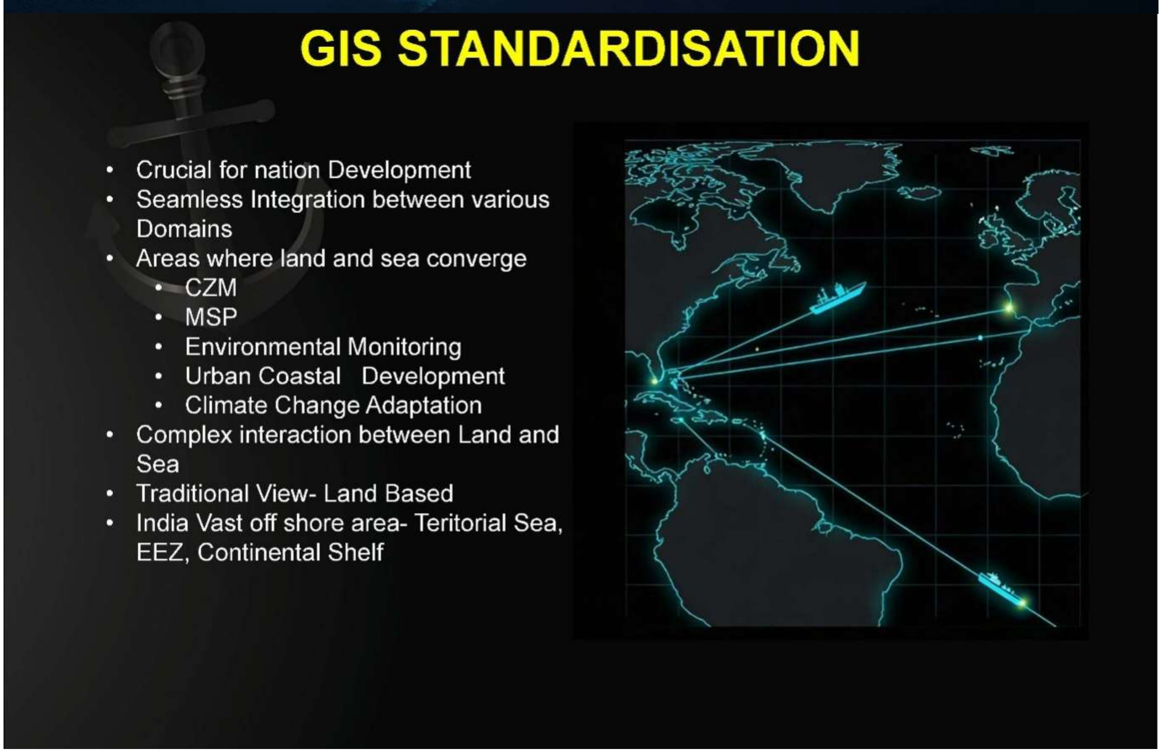
STANDARDISATION OF GIS DATA IN MARINE ENVIRONMENT
Overcoming Challenges


GIS STANDARDISATION
• Crucial for nation Development
• Seamless Integration between various Domains
• Areas where land and sea converge
• CZM
• MSP
• Environmental Monitoring
• Urban Coastal Development
• Climate Change Adaptation
• Complex interaction between Land and Sea
• Traditional View- Land Based
• India Vast off shore area- Teritorial Sea, EEZ, Continental Shelf

CHALLENGES IN GEOSPATIAL DATA

LACK OF STANDARDIZATION

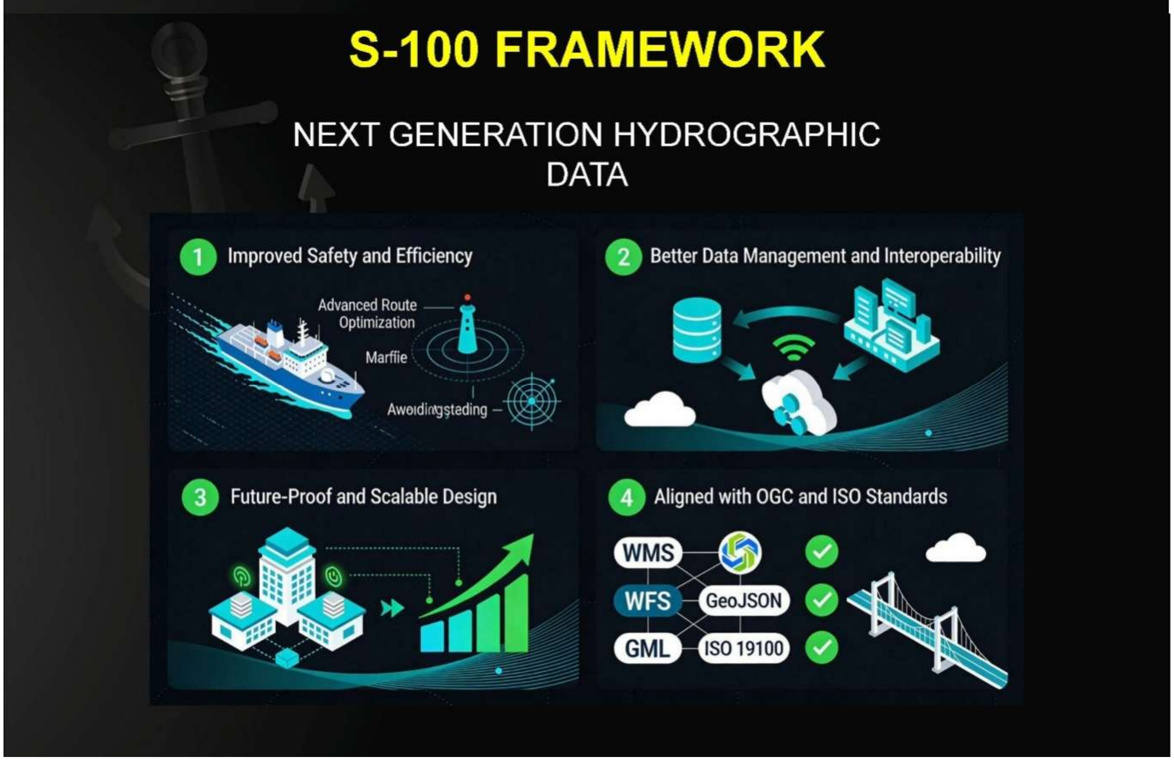
- GIS Systems developed in silos
- Different reference system, data collection and exchange standards
- Limited interoperability between land, sea and air domains

HYDROGRAPHY AND IHO

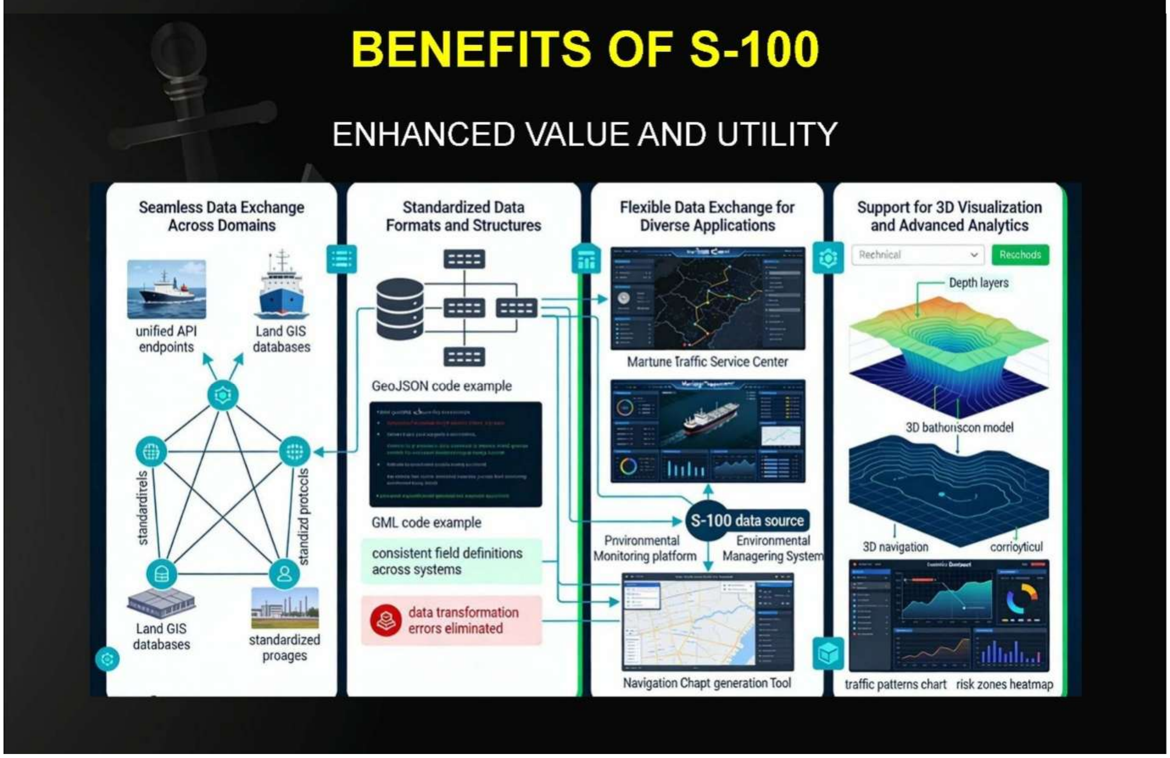
MAPPING THE SEAS

- Oceans and seas: Cheapest medium for cargo transport
- International Hydrographic Organization (IHO)
- S-4 standards for paper charts
- S-57 format for electronic data exchange


DRAWBACKS OF S-57
(1)
Limited flexibility
(2)
Outdated structure
(3)
Limited attribute support
(4)
No support for 3D data
(5)
Compatibility issues
(6)
Limited metadata support


S-100 FRAMEWORK
NEXT GENERATION HYDROGRAPHIC DATA
1 Improved Safety and Efficiency
Advanced Route Optimization
Marffie
2 Better Data Management and Interoperability
3 Future-Proof and Scalable Design
4 Aligned with OGC and ISO Standards
WMS
WFS
GeoJSON
GML
ISO 19100


S-100 OGC COMPLIANCE
ENSURING INTEROPERABILITY
➢ OGS web services (WMS, WFS, CSW)
➢ GeoJSON and GML encoding
➢ ISO 19100 series compliance
GeoJON / GML Encoding Formats
OGC Web Services
WMS
WFS
CSW
ISO 19100 Series Compliance
XMOL
10bbr8
Seamless Integration
Seamless Integration
land
Sea
Air


BENEFITS OF S-100
ENHANCED VALUE AND UTILITY
Seamless Data Exchange Across Domains
unified API endpoints
Land GIS databases
standardirels
standizd protocols
Land GIS databases
standardized proages
Standardized Data Formats and Structures
GeoJSON code example
GML code example
consistent field definitions across systems
data transformation errors eliminated
Flexible Data Exchange for Diverse Applications
Martune Traffic Service Center
S-100 data source
Pnvironmental Monitoring platform
Environmental Managering System
Navigation Chapt generation Tool
Support for 3D Visualization and Advanced Analytics
Depth layers
3D bathoriscon model
3D navigation
corrioyticul
traffic patterns chart
risk zones heatmap

TRANSFORMATION AND ADOPTION

MOVING FORWARD

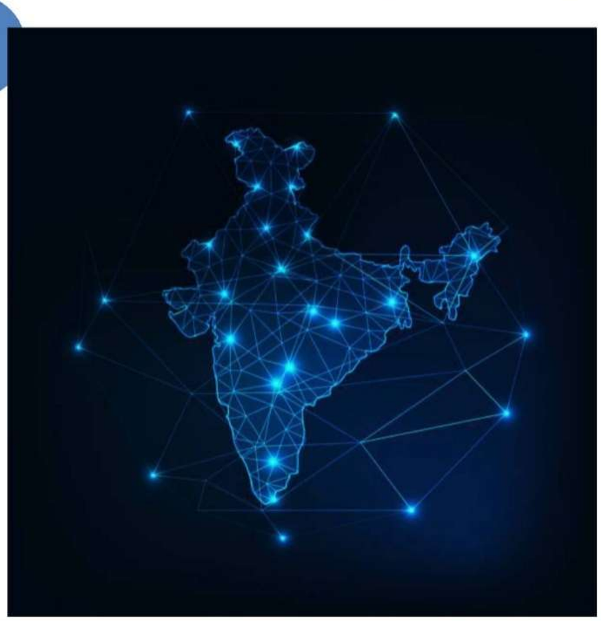
- Tools for transforming legacy S-57 data
- Human intervention required
- Global adoption of S-100

CONCLUSION

NEXT GENERATION HYDROGRAPHIC PRODUCTS

- S-100 framework ensures seamless integration, interoperability and data exchange

Role of Standards in Harmonizing Geospatial Frameworks



Dr. DEBAPRIYA DUTTA
Former-SCIENTIST "G" (ADVISOR)
DEPARTMENT OF SCIENCE AND TECHNOLOGY.GOVERNMENT OF INDIA. NEW DELHI.
Chairman LITD 22
BIS

The Challenge

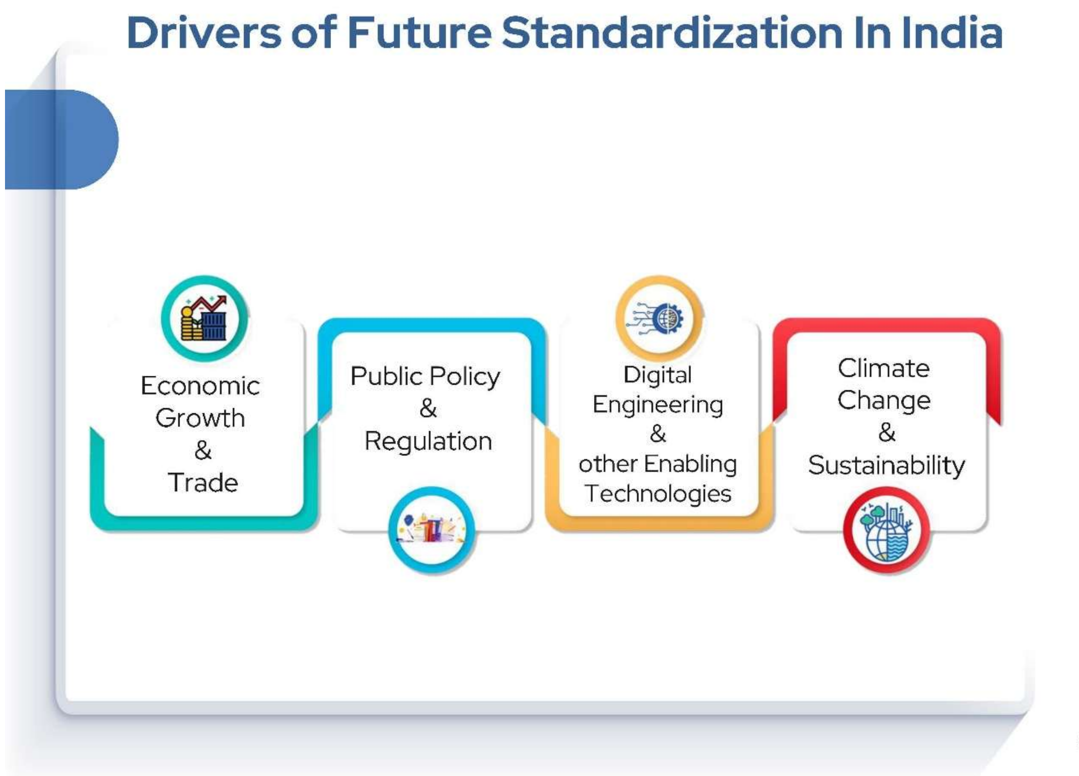
- Geospatial data remains fragmented across jurisdictions and domains
- Incompatible data formats, coordinate systems, and metadata structures
- Lack of interoperability hinders integrated geospatial services
- Digital transformation requires seamless ecosystem-wide data exchange

What Are Geospatial Standards?

- Internationally agreed technical specifications that enable consistent geospatial data management, exchange, and interoperability across organisations and domains.
- Developed by ISO/TC 211 and OGC (Nearly 100 specifications)
- Cover data models, formats, metadata, and web services
- Enable seamless integration across jurisdictions

मानकः पथप्रदर्शकः
Bureau of Indian Standards

Standards National Action Plan 2022-27



Core ISO/TC 211 Standards

ISO 19115 Metadata

Defines schema for describing geographic information, enabling efficient data discovery.

Adopted: IS 16439:2016 (national standard)

ISO 19157 Data Quality

Establishes principles for assessing quality aspects like completeness and accuracy.

Adopted: IS 18565 (Parts 1 & 2: 2024)

ISO 19168 Geospatial API

Defines APIs for accessing geospatial data, enabling interoperable services.

Adopted: IS 18620: 2024

ISO 19153 Digital Right

Framework for managing digital rights, defining access and usage rules.

Also known as: GeoDRM

Key Indian standards of Geospatial Information

Sl. No.	IS No.	Title
1.	IS 13393 : 2017; ISO 6709	Standard representation of geographic point location by coordinates (First Revision)
2.	IS 16439 : 2016	Metadata standard for geospatial information
3.	IS 16554 : 2017	Data exchange standard for geospatial information
4.	IS 16626 : 2017; ISO 19136 : 2007	Geographic information - Geography markup language (GML)
5.	IS 16626 (Part 2) : 2018; ISO 19136-2 : 2015	Geographic information - Geography markup language (GML): Part 2 extended schemas and encoding rules
6.	IS 16699 : 2018; ISO 19128 : 2005	Geographic information - Web map server interface
7.	IS 16701 : 2021; ISO 19142: 2010	Geographic information — Web Feature Service
8.	IS 16966 : 2018; ISO 19132 : 2007	Geographic Information — Location-Based Services — Reference Model
9.	IS 16967 : 2018; ISO 19133 : 2005	Geographic information - Location - Based services - Tracking and navigation
10.	IS 16968 : 2018; ISO 19134 : 2007	Geographic information - Location - Based services - Multimodal routing and navigation
11.	IS 16970 : 2018; ISO 19109 : 2015	Geographic information - Rules for applications schema
12.	IS 17007 : 2018; ISO 19103 : 2015	Geographic information - Conceptual schema language
13.	IS 18565 (Part 1) : 2024; ISO 19157-1 :2023	Data quality Part 1 General requirements
14.	IS 18565 (Part 2) : 2024; ISO/TS 19157-2	Geographic Information Data Quality Part 2: XML Schema Implementation
15.	IS 18594 : 2024; ISO 19152:2012	Land Administration Domain Model (LADM)
16.	IS 18620 (Part 1) : 2024; ISO 19168-1:2020	Geospatial API for features Part 1: Core

CURRENT PROJECTS IN LITD 22

- Data Content Standard for Geospatial Information – Soils, Geology, Forest.
- Cadastral Data Content standard for Geospatial Information
- Revision of IS 16439 ‘Metadata Standard for Geospatial Information
- Standards on LIDAR
- NAVIC RECEIVERS

Future Indian Standards in Geospatial Sector
)

Data Content Standards for all Fundamental Data Themes is a requirement

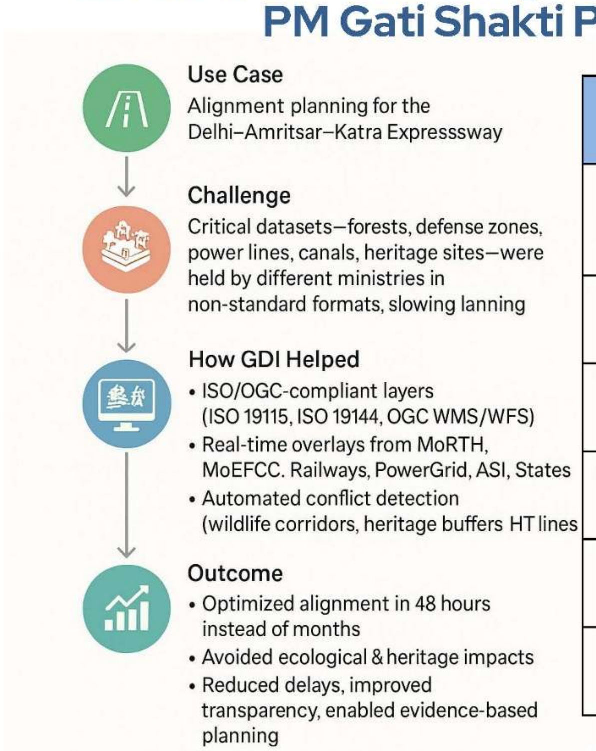
How Standards Enable Harmonization

- UML-based data models ensure consistency across jurisdictions
- Common metadata structures (ISO 19115) improve data discovery
- Standardized XML schemas facilitate automated data exchange
- FAIR principles (Findable, Accessible, Interoperable, Reusable)

How Standards Enable Harmonization

- UML-based data models ensure consistency across jurisdictions
- Common metadata structures (ISO 19115) improve data discovery
- Standardized XML schemas facilitate automated data exchange
- FAIR principles (Findable, Accessible, Interoperable, Reusable)

GDI in Action : Multi-Agency Interoperability in PM Gati Shakti Programme



Before GDI	After GDI
Fragmented datasets	ISO/OGC-standardized layers
Manual data exchange	Real-time multi-agency overlays
Months for analysis	Insights within 48 hours
Duplication & conflicts	Single authoritative dataset
Low transparency	Fully auditable decisions
Environmental risks	Early conflict detection

ISO-OGC Co-operative Framework

- 30-year partnership advancing geospatial standardization
- OGC develops implementation standards and specifications
- Fast-track process for equivalence with ISO standards
- OGC Web Services (WFS, WCS) ↔ ISO 191XX alignment

ISO-OGC Standards Harmonisation in the Indian Context

Bhuvan portal , ISRO

The Bhuvan geoportal integrates a range of OGC Standards to facilitate seamless access, visualization, and querying of geospatial data, including:

- Web Mapping Service (WMS) [OGC WMS / ISO 19128]
- Web Feature Service (WFS)[OGC WFS 2.0/ ISO 19142:2010]
- Web Coverage Service (WCS)
- Catalogue Service for the Web (CSW)[OGC CSW/ISO 19115/19139]
- Keyhole Markup Language (KML)
- Web Map Tile Service (WMTS)
- Web Processing Service (WPS)
- Sensor Observation Service (SOS)

ISO-OGC Standards Harmonisation in the Indian Context

Integrated Geospatial Data Exchange Interface (GDI)

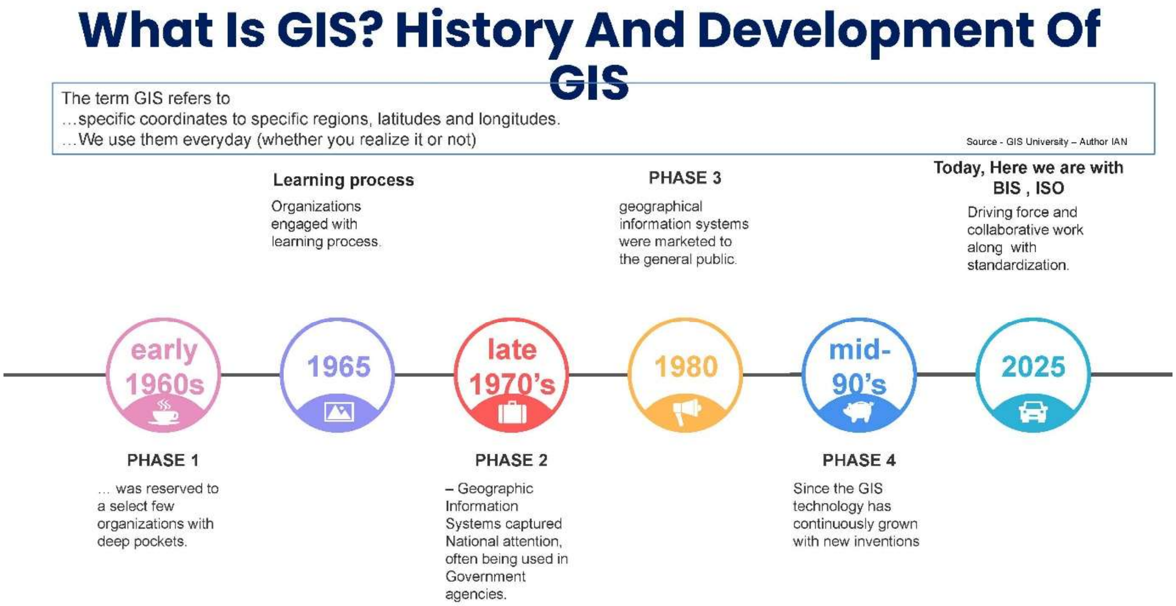
- Unified, open-access system built on OGC APIs, designed to make metadata-rich, analysis-ready geospatial data available for application developers, researchers, startups, and policymakers alike.
- To deliver its services, GDI relies on the following OGC API Standards:
  - OGC Features API – for accessing vector data [ISO 19168-1:2025]
  - OGC Tiles API – for visualising raster and vector data as base maps [ISO 19177-1: Geographic information — Geospatial API for tiles — Part 1: Core]
  - OGC Coverage API – for accessing coverage data[ISO 19123-1:2023]

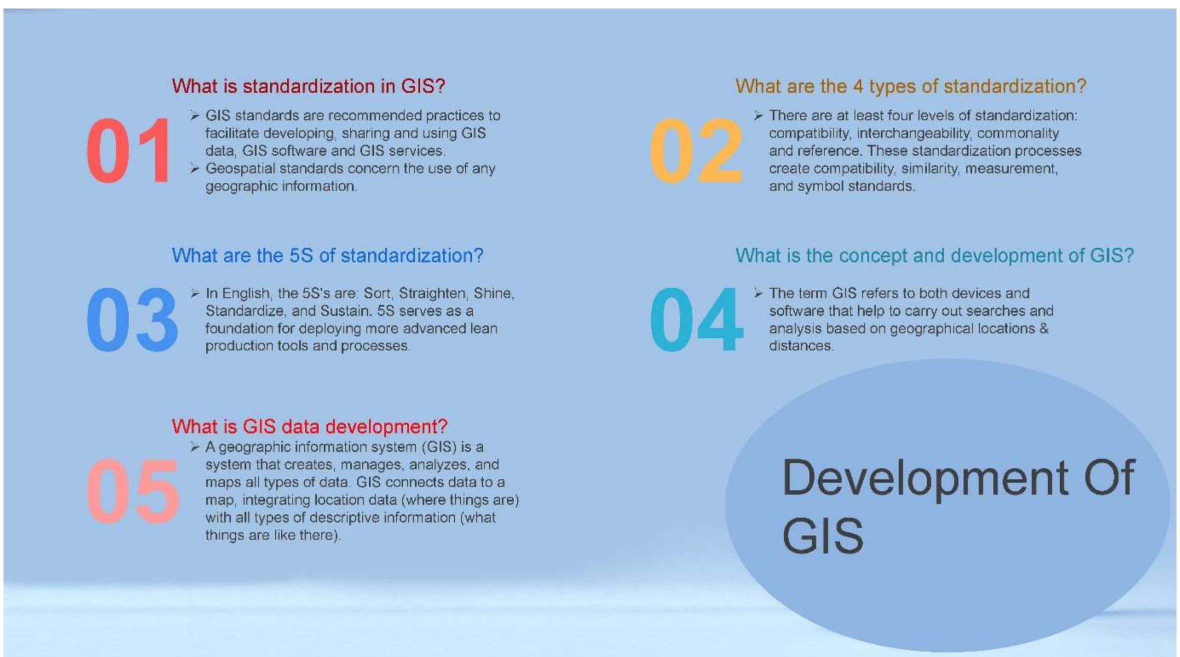
Standards & Geospatial Framework

Rajendra Gaikwad
Scientist,
Space Applications Centre, Ahmedabad

Overview

- Standards
- Geospatial framework
- Applications


What Is GIS? History And Development Of GIS
The term GIS refers to
…specific coordinates to specific regions, latitudes and longitudes.
…We use them everyday (whether you realize it or not)
Source - GIS University – Author IAN
Learning process
Organizations engaged with learning process.
PHASE 3
geographical information systems were marketed to the general public.
Today, Here we are with BIS , ISO
Driving force and collaborative work along with standardization.
early 1960s
1965
late 1970's
1980
mid-90's
2025
PHASE 1
… was reserved to a select few organizations with deep pockets.
PHASE 2
– Geographic Information Systems captured National attention, often being used in Government agencies.
PHASE 4
Since the GIS technology has continuously grown with new inventions


01
What is standardization in GIS?
➢ GIS standards are recommended practices to facilitate developing, sharing and using GIS data, GIS software and GIS services.
➢ Geospatial standards concern the use of any geographic information.
02
What are the 4 types of standardization?
➢ There are at least four levels of standardization: compatibility, interchangeability, commonality and reference. These standardization processes create compatibility, similarity, measurement, and symbol standards.
03
What are the 5S of standardization?
➢ In English, the 5S's are: Sort, Straighten, Shine, Standardize, and Sustain. 5S serves as a foundation for deploying more advanced lean production tools and processes.
04
What is the concept and development of GIS?
➢ The term GIS refers to both devices and software that help to carry out searches and analysis based on geographical locations & distances.
05
What is GIS data development?
➢ A geographic information system (GIS) is a system that creates, manages, analyzes, and maps all types of data. GIS connects data to a map, integrating location data (where things are) with all types of descriptive information (what things are like there).
Development Of GIS

Metadata is first element and interface of the user to a Natural Resources Repository, which enables a user to find, on-line, spatial data that is available.

Metadata serves two major purposes
i.e. both for the Geospatial data generator *and for the* Geospatial data user.

For the generator,
the metadata standard provides a framework to document the spatial data and declare its content for users.

For the user,
the metadata standard serves many important purposes such as finding the spatial data of the need, browsing spatial data, deciding on whether the spatial data will meet the application need and finding how the spatial will meet the application need and finding how the spatial data can be accessed.

DEVELOPMENT OF METADATA STANDARDS:
Over the years, NNRMS has provided the impetus to use of data from the Indian Remote Sensing Satellites (IRS) series and has generated spatial databases through
National mapping missions of NNRMS - Use of satellite images and GIS for creation of large-databases.

In 1998, the NNRMS took a major leap in defining GIS standards for the project 'Natural Resources Information System (NRIS)' and adopted the "NRIS Standards", the first GIS standardization in the country. To define the standards, the efforts at standardization in the remaining world – especially in USA (through the US-NSDI and USGS National Map); Europe (through the IGN Standards of France and Eurogi Standards for Europe); Australia (through the AUSLIG NSDI Standards) and the international efforts of GSDI, ISO, CEOS, ISPRS etc. have been studied. Most of these standardization efforts are "compartmentalized" and address separately for images, cartographic mapping, thematic mapping, GIS and outputs – thus many even face difficulty of internal inter-operability.

The metadata elements and schema needs to be standardized at National level.
In this regard, the metadata standards have been developed earlier by National Natural Resources Management System (NNRMS), *ISRO and the same was adopted by NSDI and declared open at National level in the year 2003.*

NNRMS

1 CONCEPTUAL FRAMEWORK OF RASTER AND VECTOR STRUCTURES

2 GIS DATABASE DESIGN

3 TILE CONCEPT OF GIS DATABASE DESIGN

4 PROCEDURE FOR SPATIAL DATABASE CREATION

5 FRAMEWORK OF NETWORKING AND AGGREGATION

VISION
INFRASTRUCTURE FOR THE AVAILABILITY OF ORGANISED SPATIAL AND NONSPATIAL DATA AND MULTIMLEVEL INFORMATION NETWORKING TO CONTRIBUTE TO LOCAL, NATIONAL AND GLOBAL NEEDS OF SUSTAINED ECONOMIC GROWTH, ENVIRONMENTAL QUALITY AND STABILITY AND SOCIAL PROGRESS

NSDI 2.0 – Metadata Standard

metadata standards with 28 elements

(9 elements are made mandatory and rest of the 19 elements as optional for every spatial data generating agency in the country).

ISRO, with the involvement of Survey of India (SOI), National Informatics Centre (NIC), Geological Survey of India (GSI), Forest Survey of India (FSI), National Bureau of Soil Survey and Land Use Planning (NBSS&LUP), National Atlas and Thematic Mapping Organisation (NATMO), Central Ground Water Board (CGWB), Central Water Commission (CWC) and the private sector, has led the effort of defining a 'National Metadata Standards'.

2009

Sr. No.	Elements	Scheme
1	Data Identification Information	Name of the Dataset Name of the Data Theme Keywords Access Constraints Use Constraints Purpose of Creating Data Data Type
2	Contact Information	Contact Person Organization Mailing Address City/Locality Country Contact Telephone Contact Fax Contact Email
3	Coverage	
		coverage.x.min
		coverage.x.ma
		coverage.y.min WGS84LL
		coverage.t.late CE date
		coverage.t.early
		coverage.PlaceName
		coverage.PeriodName
		coverage.spatial.resolution
		coverage.spatial.georeference
		coverage.spatial.aggregation
		coverage.temporal.precision
		coverage.temporal.interval
		coverage.temporal.aggregation

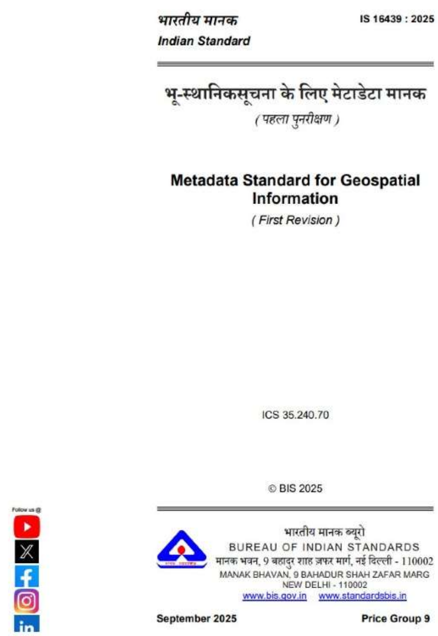
Elements - 2009

4	Geographic location of the dataset (by four coordinates or by description)	Metadata.identificationInfo > DataIdentification.extent > Extent > GeographicBoundingBox or GeographicDescription
5	Citation	Data Prepared by Original Source Source Scale and Date Mapping year digitizing year survey year Lineage Associated Project preparing the data Associated Publications person.Email person.Affiliation CorporateName CorporateName.Address
6	Metadata date stamp	Metadata.dateStamp M ISO08601
7	Type	Data Format Data File Size Data Physical Location (Computer + path)
8	Subject	subject.specific
		subject.domain
9	Description	description
		description.history
10	Publisher	Publisher
		publisher.address
11	Dataset responsible party	Metadata.identificationInfo > DataIdentification.pointOfContact > ResponsibleParty
12	Distribution Format	Metadata.distributionInfo > Distribution > Format

IS 16439 : 2016 **भारतीय मानक** ***Indian Standard***

भू-स्थानिक सूचना के लिए मेटाडाटा मानक
Metadata Standard for Geospatial Information

Metadata Standard for Mandatory Elements and Schema



भारतीय मानक
Indian Standard

IS 16439 : 2025

भू-स्थानिकसूचना के लिए मेटाडेटा मानक
(पहला पुनरीक्षण)

Metadata Standard for Geospatial Information
(First Revision)

ICS 35.240.70

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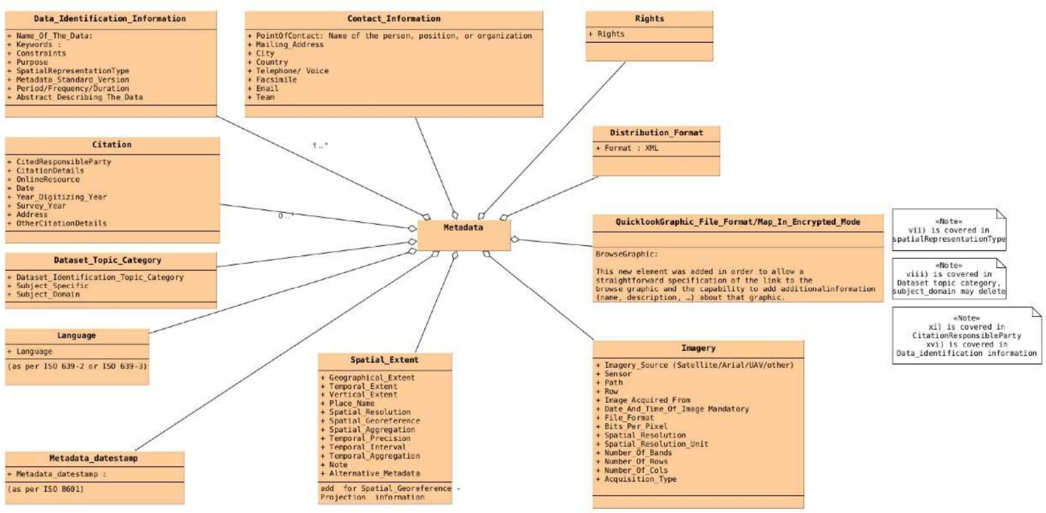
September 2025 **Price Group 9**



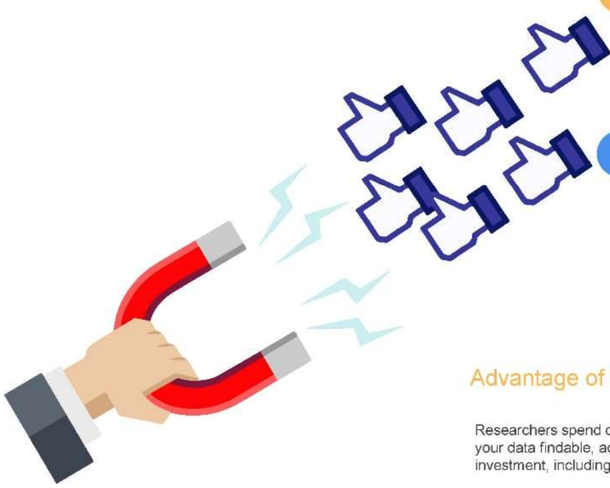
IS 16439 : 2025 first revision भारतीय मानक *Indian Standard*

2025 completed

Where we are ?

- There is also a 'many-to-many' problem. For every organization involved in sharing or accessing data, you have more data translations that need to take place. Say ten organizations are working together. This means 10 x 10 possible data transfers, resulting in 100 potential translators required to move the data. (Hintz, 2021)
- The use of geospatial information and data is increasing rapidly, not just in governmental, private, and academic communities but also among the general public, often contributing to collecting information involuntarily. Mass amounts of data derived from different sources lead to data inconsistency and potential storage problems. (Innerebner et al., 2017)
- Another issue is that the satellites are capturing enormous data at higher spatial and spectral resolutions than ever before, leading to larger download volumes and the need for extensive in-house IT infrastructure if local processing is chosen instead of cloud computing. (OGC 2018)

FAIR Data



Findable

The data has sufficiently rich metadata and a unique and persistent identifier to be easily discovered by others. This includes assigning a (like a or), having rich to describe the data and making sure it is findable through disciplinary local or international discovery portals.

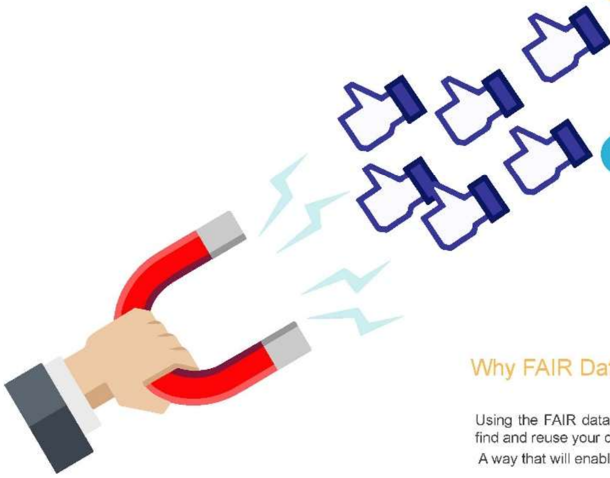
Accessible

The data is retrievable by humans and machines through a standardized communication protocol, with authentication and authorisation where necessary. The data does not necessarily have to be open. Data can be sensitive due to privacy concerns, national security or commercial interests. When it's not able to be open, there should be clarity and transparency around the conditions governing access and reuse.

Advantage of FAIR.

Researchers spend considerable time, money and effort collecting and interrogating data. Making your data findable, accessible, interoperable and reusable (FAIR) maximizes the impact of that investment, including gaining more citations for your data sets.

FAIR Data (cont..)



Interoperable

The associated data and metadata uses a 'formal, accessible, shared, and broadly applicable language for knowledge representation'. This involves using community accepted languages, *formats* and *vocabularies* in the data and metadata. Metadata should reference and describe relationships to other data, metadata and information through *identifiers*.

Reusable

The associated metadata provides rich and accurate information, and the data comes with a clear usage licence and detailed provenance information. Reusable data should maintain its initial richness. For example, it should not be diminished for the purpose of explaining the findings in one particular publication. It needs a clear machine readable licence and provenance information on how the data was formed. It should also use discipline-specific data and metadata standards to give it rich contextual information that will allow reuse.

Why FAIR Data is Important

Using the FAIR data principles can accelerate the impact of your work as more researchers can find and reuse your data.

A way that will enable maximum use and reuse.

Indian NSDI publishes Metadata Standards ver 2.0

By Geospatial World - 03/20/2009 • 1 Minute Read

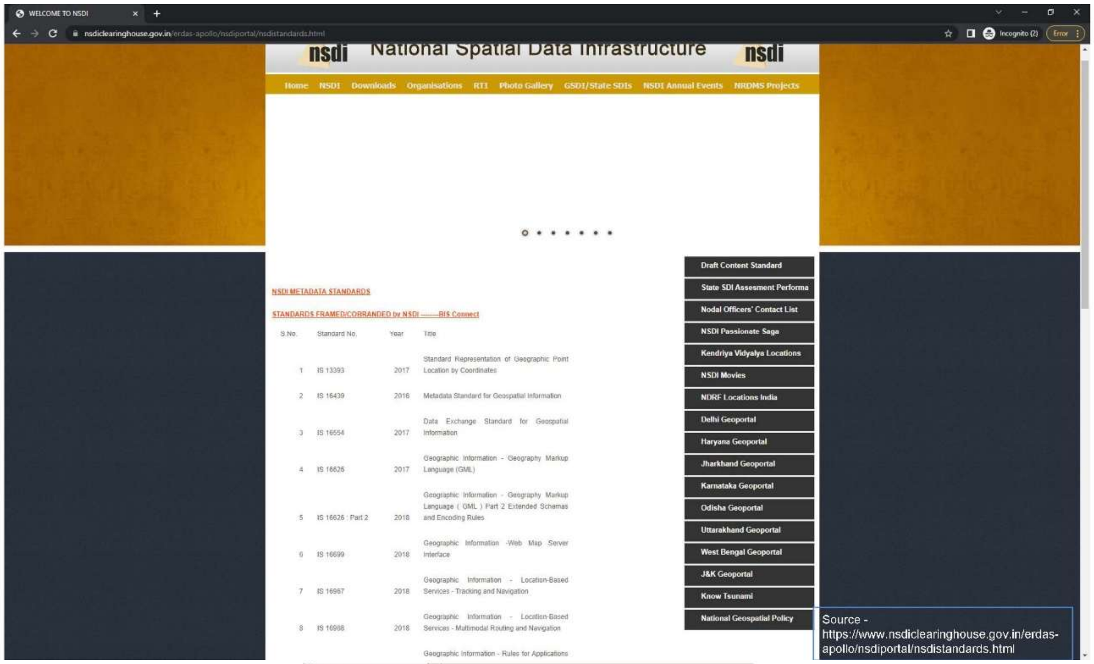
India: The National Spatial Data Infrastructure (NSDI), under Department of Science & Technology of Government of India, has released Metadata Standard 2.0. The publication is prepared by the working group on 'Metadata Standards' chaired by Dr. S K Pathan, from Space Applications Centre (SAC), ISRO, Ahmadabad.

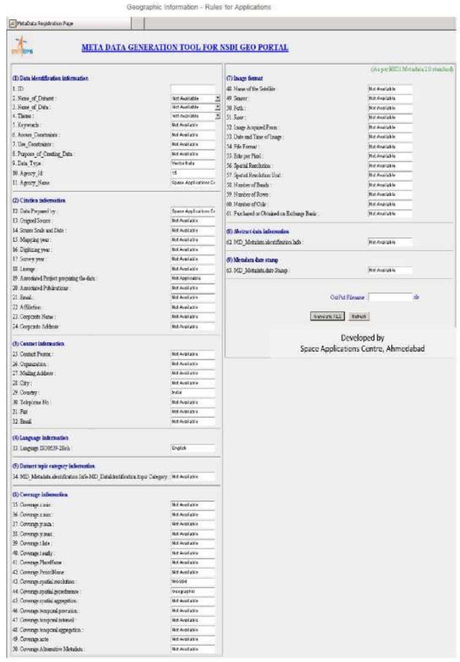
The National Natural Resources Management System (NNRMS) Metadata Standards defines the schema and design for the NSDI Metadata. The Metadata standards contain a set of relational tables that standardise the layer metadata, the geographic search metadata, the access metadata etc.

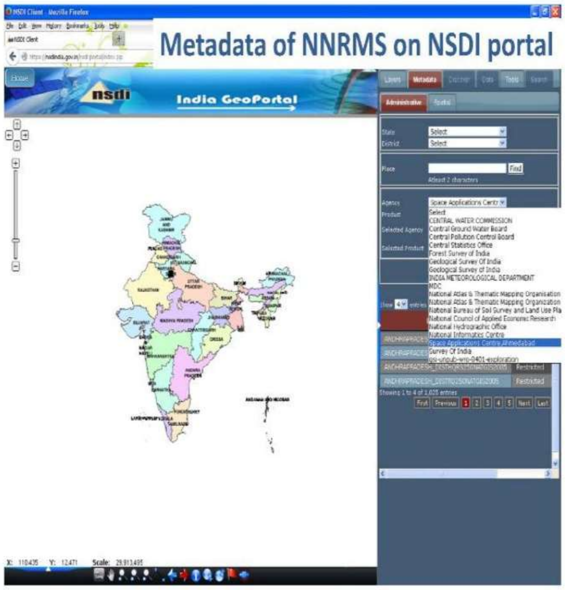
Metadata is first element of the NSDI which enables a user to find spatial data that is available in different NSDI Agency servers. Metadata serves two major purposes – both for the spatial data generator and for the spatial data user. For the generator, the Metadata provides a framework to document the spatial data and declare its content for users. For the user, Metadata serves many important purposes, including finding the spatial data as per need; browsing spatial data; deciding on whether the spatial data will meet the application need and finding how the spatial data can be accessed. This Metadata Standards 2.0 is an important document that defines the schema and design for NSDI Metadata.

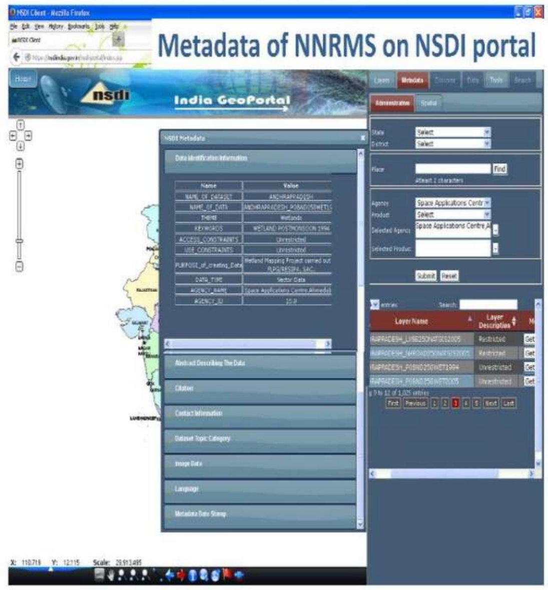
ISRO, with the involvement of Survey of India (SOI), National Informatics Centre (NIC), Geological Survey of India (GSI), Forest Survey of India (FSI), National Bureau of Soil Survey and Land Use Planning (NBSSLUP), National Atlas and Thematic Mapping Organisation (NATMO), Central Ground Water Board (CGWB), Central Water Commission (CWC) and the private sector, has led the effort of defining a 'National Metadata Standards'.

Source - https://www.geospatialworld.net/news/indian-nsdi-publishes-metadata-standards-ver-2-0/


WELCOME TO NSDI
nsdiclearinghouse.gov.in/erdas-apollo/nsdiportal/nsdistandards.html
nsdi
National Spatial Data Infrastructure
nsdi
Home NSDI Downloads Organisations RTI Photo Gallery GSDI/State SDIs NSDI Annual Events NRDMS Projects
NSDI METADATA STANDARDS
STANDARDS FRAMED/COBRANDED by NSDI ——BIS Connect
S.No. Standard No. Year Title
1 IS 13393 2017 Standard Representation of Geographic Point Location by Coordinates
2 IS 16439 2016 Metadata Standard for Geospatial Information
3 IS 16554 2017 Data Exchange Standard for Geospatial Information
4 IS 16626 2017 Geographic Information - Geography Markup Language (GML)
5 IS 16626 : Part 2 2018 Geographic Information - Geography Markup Language (GML) Part 2 Extended Schemas and Encoding Rules
6 IS 16699 2018 Geographic Information -Web Map Server Interface
7 IS 16987 2018 Geographic Information - Location-Based Services - Tracking and Navigation
8 IS 16988 2018 Geographic Information - Location-Based Services - Multimodal Routing and Navigation
Geographic Information - Rules for Applications
Draft Content Standard
State SDI Assesment Performa
Nodal Officers' Contact List
NSDI Passionate Saga
Kendriya Vidyalya Locations
NSDI Movies
NDRF Locations India
Delhi Geoportal
Haryana Geoportal
Jharkhand Geoportal
Karnataka Geoportal
Odisha Geoportal
Uttarakhand Geoportal
West Bengal Geoportal
J&K Geoportal
Know Tsunami
National Geospatial Policy
Source - https://www.nsdiclearinghouse.gov.in/erdas-apollo/nsdiportal/nsdistandards.html


META DATA GENERATION TOOL FOR NSDI GEO PORTAL
Developed by
Space Applications Centre, Ahmedabad





What are Standards and Why are They Important?

A standard is a mechanism/tool for provider and users, which establish consensus, to provide rules, guidelines and services for specific purpose.

Developers - working knowledge about what standards are required for specific purpose for implementing geospatial standards and interoperable solutions.

Users - who must understand the importance of adhering to standards and use of the implemented standards for organisations.

NATIONAL GEOSPATIAL POLICY, 2022

- Preamble 1.1. Geospatial technology has applications in almost every domain of the economy ranging from agriculture to industries, development of urban or rural infrastructure, administration of land, economic activities of banking and finance, resources, mining, water, disaster management, social planning, delivery services, etc. Geospatial data is now widely accepted as a critical national infrastructure and information resource with proven societal, economic and environmental value that enables government systems and services, and sustainable national development initiatives, to be integrated using 'location' as a common and underpinning reference frame.
- 1.2. The National Geospatial Policy, 2022 (the Policy) is a citizen-centric policy that seeks to strengthen the Geospatial sector to support national development, economic prosperity and a thriving information economy. The Policy builds on conducive environment generated by the "Guidelines for acquiring and producing Geospatial Data and Geospatial Data Services including Maps" dated 15.02.2021 (the Guidelines), issued by Department of Science and Technology (DST), Government of India (GoI). While the Guidelines deregulated the Geospatial sector by liberalizing Geospatial data acquisition/production/ access, the Policy takes it further by laying down an overarching framework for holistic development of the Geospatial ecosystem. It spells out the vision, goals for the Geospatial sector and outlines the strategies for achieving them. It seeks to develop Geospatial infrastructures, Geospatial skill and knowledge, standards, Geospatial businesses, promote innovation and strengthen the national and sub-national arrangements for generation and management of Geospatial information. The Geospatial data acquisition/production/access will continue to be governed by the Guidelines in its present form or as stipulated by DST from time to time with an aim to promote private sector participation through continued enhancements of Ease of Doing Business in the sector.

Refer page 14 THE GAZETTE OF INDIA : EXTRAORDINARY [PART II—SEC. 3(ii)]

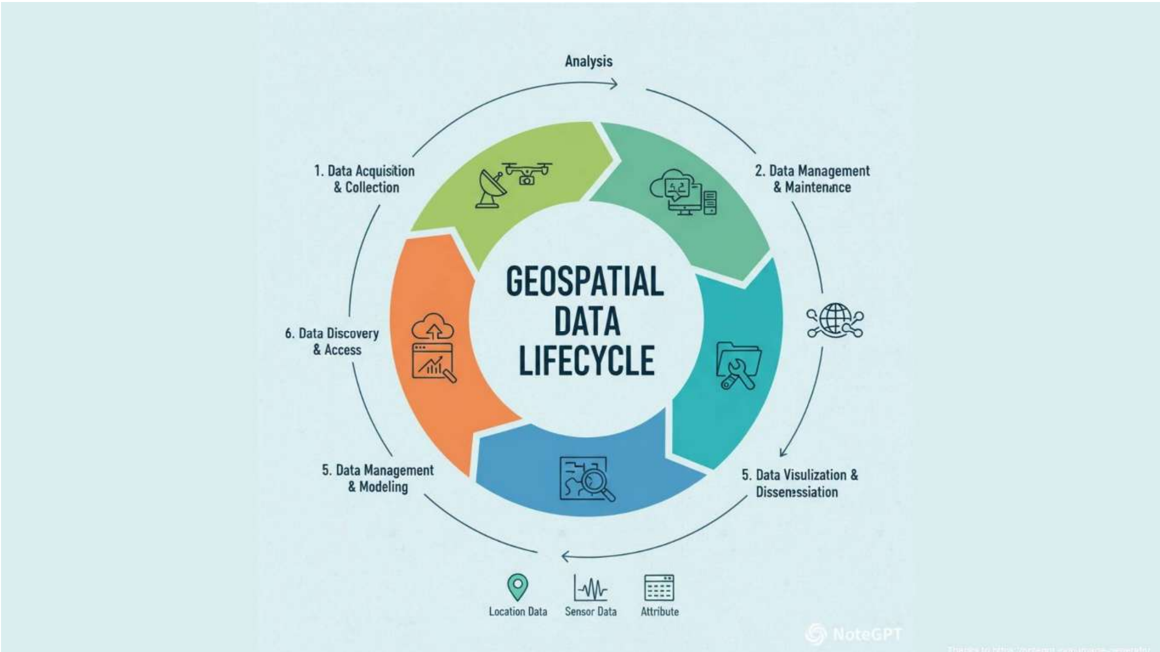
2. Vision and Goals
2.1.1. To make India a World Leader in Global Geospatial space with the best in the class ecosystem for innovation.
2.1.2. To develop a coherent national framework in the country and leverage it to move towards digital economy and improve services to citizens.
2.1.3. To enable easy availability of valuable Geospatial data collected utilizing public funds, to businesses and general public.
2.1.4. To have a thriving Geospatial industry in the country involving private enterprise.

3.6. Standards: The Policy will encourage open standards, open data and platforms. It will promote establishment and adoption of best practice standards and compliance mechanisms for enabling data and technology interoperability to deliver integrated Geospatial information and location-based knowledge creation.

3.7. Capacity Development: The Policy will encourage enduring capacity development and education programs so that the value and benefits of integrated Geospatial information management is sustained in the long term. It will also aim at the spread of Geospatial thinking and education to the young minds from school level onwards wherein there would be standardization and certification of courses and skill sets in line with the global best practices.

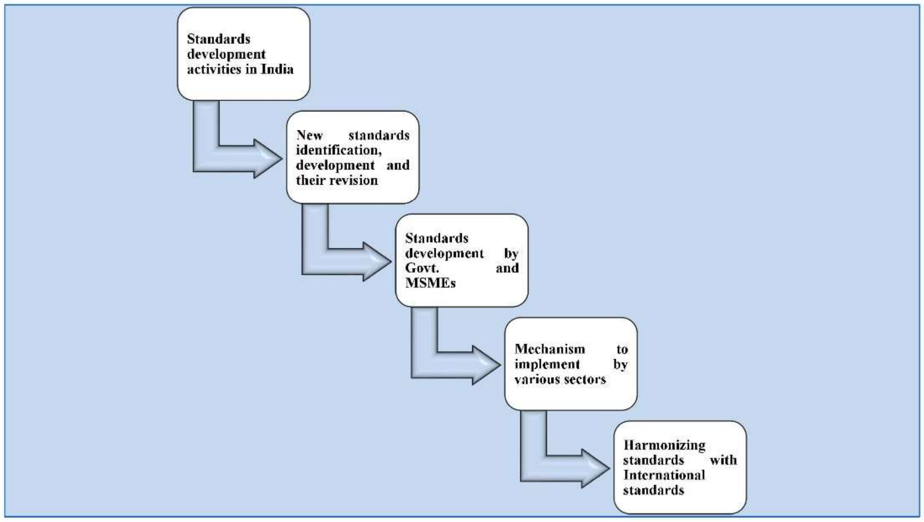
3.8. Ease of Doing Business: Continued liberalization in line with the Guidelines will be carried out and supported.

3.9. Democratization of Data: The Survey of India (SoI) topographic data and other Geosp


Analysis
1. Data Acquisition & Collection
2. Data Management & Maintenance
GEOSPATIAL DATA LIFECYCLE
6. Data Discovery & Access
5. Data Management & Modeling
5. Data Visulization & Dissemssiation
Location Data
Sensor Data
Attribute
NoteGPT


GEOSPATIAL STANDARDS: UNIYING OUR WORLD'S DATA
SATELLITE IMAGERY
ENVIRONMENTAL SENSOR DATA
OGC STANDARDS
NSDI FRAMEWORKS
CADASTRAL & URBAN PLANS
DEMOGRAPHIC & SOCIAL DATA
NoteGPT
Thanks to https://notegpt.io/ai-image-generator

Standardization ---



Geospatial framework scenario

Geospatial framework scenario

To implement of usable, beneficial, economically viable ,
reliable, specific to organization needs, interoperable and sustainable solutions for Geospatial standards and harmonize geographic services in the framework.

Geospatial framework scenario

key points of geospatial standards.

- Decision-makers: They require guidance and coordination to comprehend the advantages of standards and the significance of establishing strategic objectives to enhance geospatial usage.
- Developers of Interoperable Solutions: They need practical knowledge regarding the necessary and applicable standards for different scenarios. They also require methods to access these standards and initiate the crucial steps for implementing geospatial standards and interoperable solutions.
- Standards users: They must recognise the importance of adhering to standards and providing feedback for the continuous improvement of implemented standards.
- Practitioners in the Public and Private Sectors as well as Civil Society:
They need to understand the benefits of working with standardised data. They should also grasp the reasons behind how things function, enabling them to share their experiences and success stories related to standards with others.

Geospatial framework scenario

Development of a National Digital Geospatial Data Framework
Federal Geographic Data Committee April 1995 came with

Purpose and Goals

The framework is a basic, consistent set of digital geospatial data and supporting services that will:
provide a geospatial foundation to which an organization can add detail and attach attribute information.
provide a base on which an organization can accurately register and compile other themes of data, such as soils, vegetation, or geology.

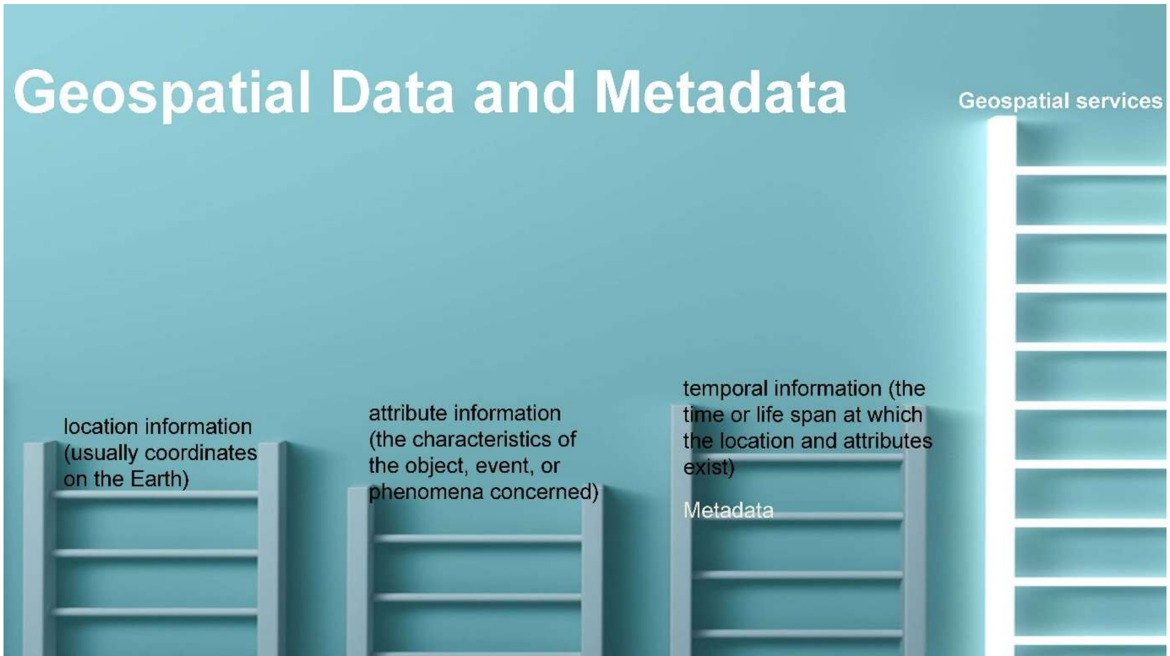
orient and link the results of an application to the landscape.

The framework will help data producers locate their information in its correct position and provide a means of integrating this information with other geospatial data.

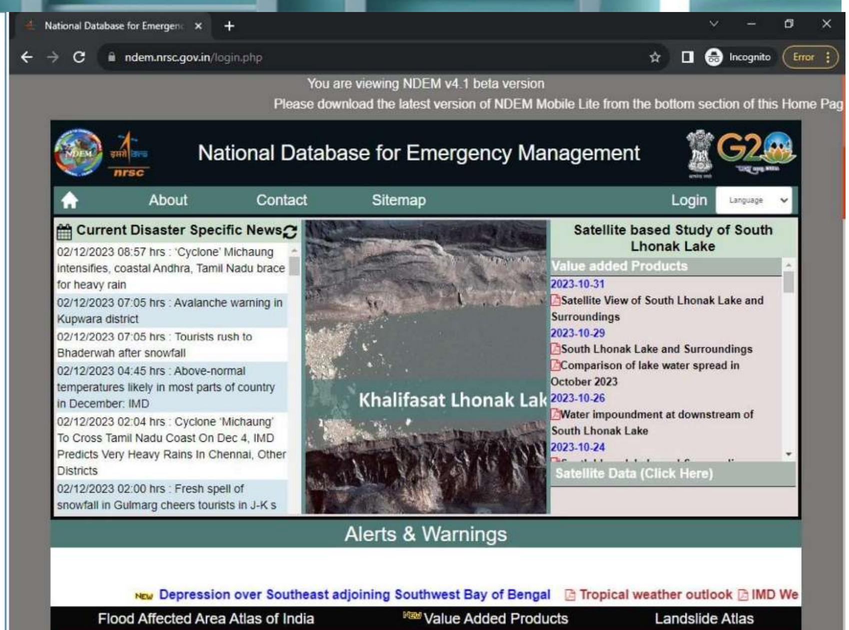
Applications

Applications

The national metadata standard widely adopted for describing geographic information and services.



About NDEM
National Database for Emergency Management (NDEM) is a unique Geo-portal to disseminate space-based inputs along with services of forecasting organizations addressing all natural disasters in all phases at PAN India level with the amalgamation of multi-scale geospatial database coupled with decision support system tools. At the behest of Ministry of Home Affairs (MHA), Government of India, National Remote Sensing Centre (NRSC), ISRO has established the state-of-art facility at NRSC, Hyderabad with structured framework with multi-institutional participation to assist the decision makers, disaster management officials of all States/UTs, NDRF/SDRF for preparedness, hazard/risk zonation, damage assessment and emergency response.



NDEM Metadata Standards

NDEM Metadata provides a framework for organizing multi-scale geospatial data for dissemination to entire country for effective disaster management in the country .

It includes information such as:

- ✓ Identification Information
- ✓ Data Quality Information
- ✓ Spatial Data Organization Information
- ✓ Spatial Reference Information
- ✓ Entity and Attribute Information

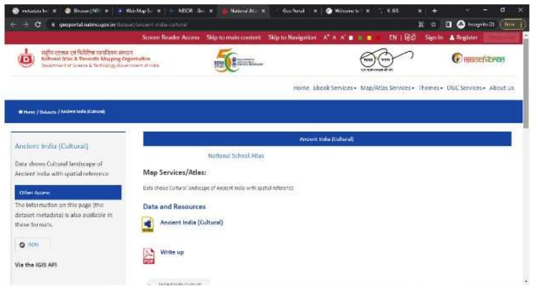
NSDI Metadata Standards are adopted to share the geospatial information.

I.Data Identification	
Name of Dataset	Maharastra Land Use Land Cover
Name of theme	Thematic Layer
Keywords	Land Use,Land Cover,1:50,000
Access Constarints	For authorized NDEM users
User Constarints	As a Web Map Service
Purpose	For Disaster Management
Data Type	Vector-Polygon
II.Contact Information	
Name of Contact Person	Project Director, NDEM, RRES
Organization	National Remote Sensing Centre
Mailing Address	Balanagar
City	Hyderabad
Country	India
Telephone	+91-40-23884543/+91-8542-225414
Fax no	+91-40-23880445
Email ID	ndem_admin@nrsc.gov.in
III.Coverage	
MinX / MinY	72.64265 / 15.606371
MaxX / MaxY	80.89836 / 22.026573
Spheroid/datum	GCS / WGS_1984
Coverage Area	MAHARASTRA
Coverage Period	LULC 2nd Cycle,2011_2012

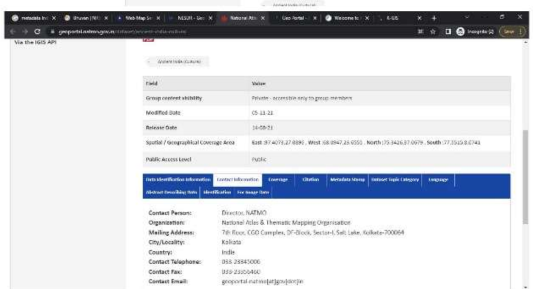
IV.Citation	
Dataset Prepared By	National Remote Sensing Center
Original Source Of Data	Resourcesat-2,LISS-III
Mapping Year	2013
Data Scale	1:50,000
V. Metadata Date Stamp	
Date Stamp	23/05/2014
VI. Dataset Topic Category	
Dataset Identfication	Geospatial/Thematic Layers
VII. Metadata Language	
Language	Language ISO 0639-2Bsh English
VIII. Description	
Abstract	It is a Land Use Land Cover Database on 1:50,000 scale, Created using the three seasions ResourceSat,LISS-III data of the year 2011-2012

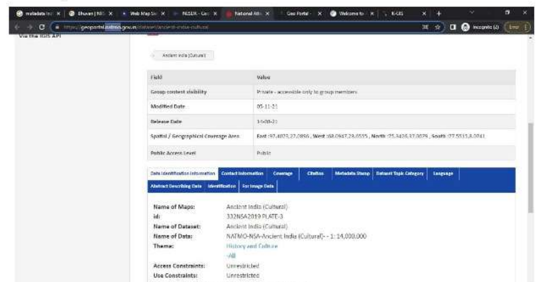
NSDI format

#	Elements	Scheme	Description
1	Data Identification Information	Name of the Dataset	Name of the layer
		Name of the Data	Name of the Data that layer consists
		Theme	Theme of the Layer
		Keywords	Keywords to acess the layer
		Access Constraints	Limitations for accessing the data
		Use Constraints	Limitations for using the data
		Purpose of Creating Data	Purpose of datasets
		Data Type	Type of data (Ex:Vector/Raster)
2	Contact Information	Contact Person	Contact Person Name
		Organization	Organization Name
		Mailing Address	Contact address
		City/Locality	City Name
		Country	Country Name
		Contact Telephone	Telephone Number
		Contact Fax	Fax Number
		Contact Email	Email of contact person
3	Coverage	coverage.x.max	Maximum Longitude value of Dataset
		coverage.x.min	Maximum Longitude value of Dataset
		coverage.y.max	Maximum Latitude value of Dataset
		coverage.y.min	Minimum Latitude value of Dataset
		coverage.spatial.georeference	Coordinate System of Dataset
4	Citation	Data Prepared by	Name of Data Prepared Organization
		Original Source	Source of Data
		Source Scale and Date	Scale and Date of Source data
		Mapping year	Year of Mapping
5	Date stamp	MD_Metadata.dateStamp ISO08601	Meta data Prepared date
6	Dataset topic category	MD_DataIdentification.topicCategory	Dataset topic used to identify the data in Portal
7	Language	language ISO0639-2Bsh	Metadata language
8	Abstract describing the data	MD_DataIdentification.abstract	Description about data.
9	Image Data	Name of the Satellite	Name of the Satellite
		Sensor	Name of Sensor
		Path	Orbit of a satellite
		Row	It refers to the latitudinal center line of a frame of imagery
		Image Acquired From	Name of Organization that acquires image
		Date and Time of Image	Data and Time of Image Acquisition
		File Format	File extension
		Bits per Pixel	Bites per pixel in a image
		Spatial Resolution	Spatial resolution of the dataset
		Spatial Resolution Unit	Units of Spatial Resolution
		Number of Bands	Number of Bands in a raster dataset
		Number of Rows	Number of Rows in a dataset
		Number of Cols	Number of Cols in a dataset



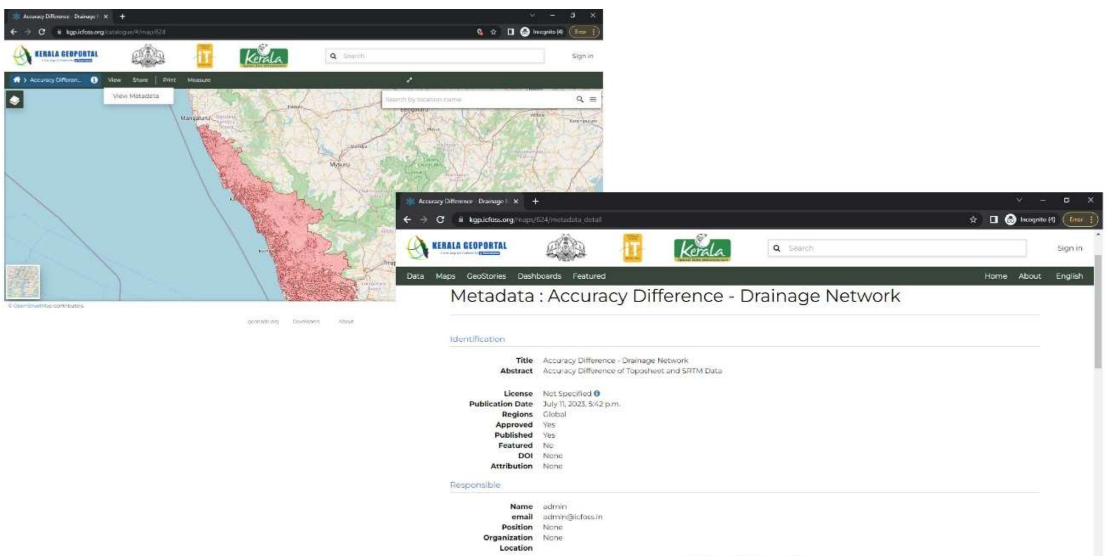
राष्ट्रीय एटलस एवं थिमैटिक मानचित्रण संगठन / National Atlas & Thematic Mapping Organisation





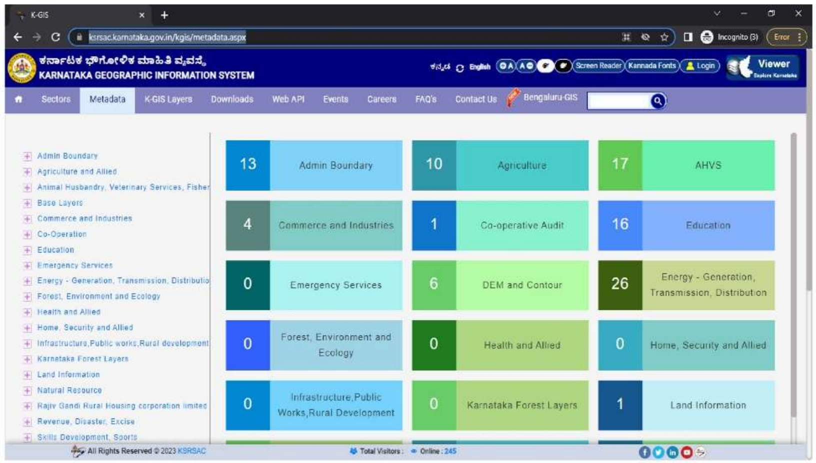
Source - https://geoportal.natmo.gov.in/dataset/ancient-india-cultural
राष्ट्रीय एटलस एवं थिमैटिक मानचित्रण संगठन / National Atlas & Thematic Mapping Organisation

STANDARDS



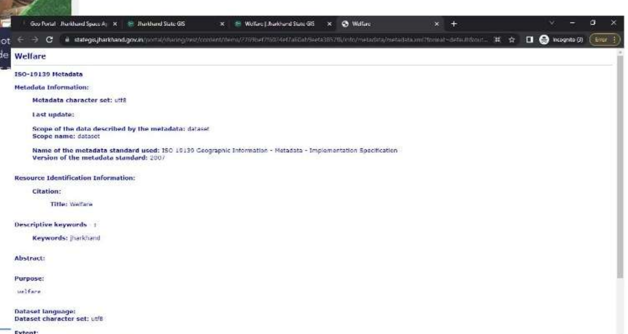
Source - https://kgp.icfoss.org/maps/624/metadata_detail

STANDARDS



Source - https://ksrsac.karnataka.gov.in/kgis/metadata.aspx

STANDARDS

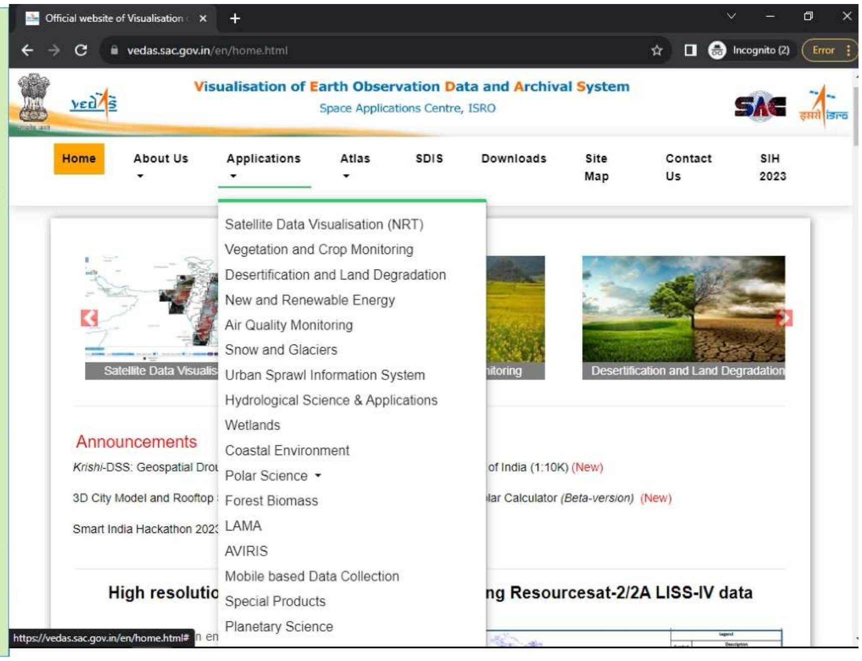


Source - https://stategis.jharkhand.gov.in/portal/sharing/rest/content/items/2769bef7f6024ef7a60ab9eefa3857f6/info/metadata/metadata.xml?format=default&output=html

STANDARDS

Visualisation of Earth Observation Data and Archival System (VEDAS)

Space Applications Centre (SAC) is responsible for carrying out research and applications of optical and microwave remote sensing data in a large number of disciplines including Agriculture, Land use, Photogrammetry, Forestry and Environment, Coastal & Marine Resources, Hydrological Studies, Climate Change Studies, Urban & Infrastructure, Cryosphere, Spatial Data Infrastructure, Atmospheric and Ocean Sciences, Early Warning and Disaster Management Support, Planetary Sciences etc. These are also aimed at meeting the requirements of various user ministries of the country. The advancements in EO systems and data products will strengthen natural resources inventory and management, information on the state of the environment, research on climate change and support for mitigation of natural disasters. The end-product from the EO applications will help towards establishment and operationalization of spatial infrastructure and information dissemination system.



REST API of VEDAS Layers for Metadata

MEATADATA SAMPLE FOR RASTER DATA

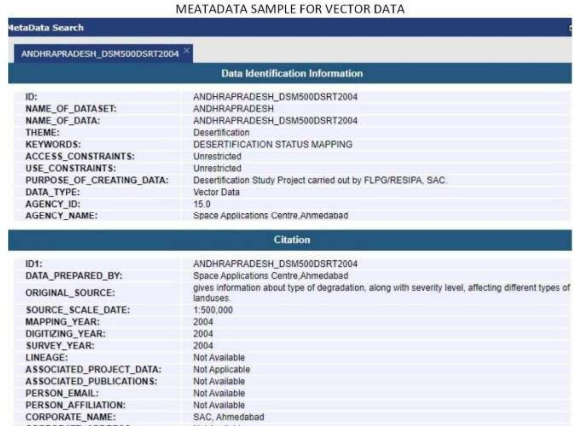
MetaData Search

fsi_fcm_2005

Data Identification Information	
ID:	fsi_fcm_2005
NAME_OF_DATASET:	Forest Cover Density Map(1:50K) 2005
NAME_OF_DATA:	Forest Cover 2005
THEME:	Forest
KEYWORDS:	FCM 2005, FSI, 1:50K, SFR 2005
ACCESS_CONSTRAINTS:	Not Accessible
USE_CONSTRAINTS:	Not Accessible
PURPOSE_OF_CREATING_DATA:	Forest Cover Estimation and Monitoring
DATA_TYPE:	RASTER
AGENCY_ID:	7.0
AGENCY_NAME:	Forest Survey of India

Citation	
ID1:	fsi_fcm_2005
DATA_PREPARED_BY:	Forest Survey of India
ORIGINAL_SOURCE:	Forest Survey of India
SOURCE_SCALE_DATE:	1:50K
MAPPING_YEAR:	2005.0
DIGITIZING_YEAR:	NA
SURVEY_YEAR:	2004.0
LINEAGE:	NA
ASSOCIATED_PROJECT_DATA:	NA
ASSOCIATED_PUBLICATIONS:	State Forest Report(SFR)
PERSON_EMAIL:	mukundsifs@gmail.com
PERSON_AFFILIATION:	Government of India
CORPORATE_NAME:	Forest Survey of India
CORPORATE_ADDRESS:	Joint Director (NFDMC), Forest Survey of India, PO- IPE, Kaulagarh Road, Dehradun

Contact Information



MEATADATA SAMPLE FOR VECTOR DATA

MetaData Search

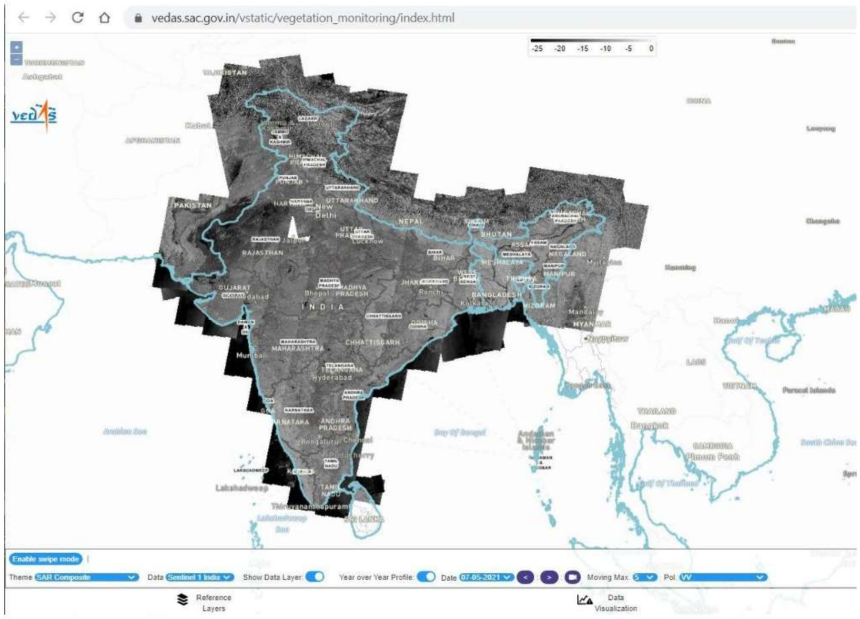
ANDHRAPRADESH_DSM500DSRT2004

Data Identification Information	
ID:	ANDHRAPRADESH_DSM500DSRT2004
NAME_OF_DATASET:	ANDHRAPRADESH
NAME_OF_DATA:	ANDHRAPRADESH_DSM500DSRT2004
THEME:	Desertification
KEYWORDS:	DESERTIFICATION STATUS MAPPING
ACCESS_CONSTRAINTS:	Unrestricted
USE_CONSTRAINTS:	Unrestricted
PURPOSE_OF_CREATING_DATA:	Desertification Study Project carried out by FLPG/RESIPA, SAC.
DATA_TYPE:	Vector Data
AGENCY_ID:	15.0
AGENCY_NAME:	Space Applications Centre,Ahmedabad

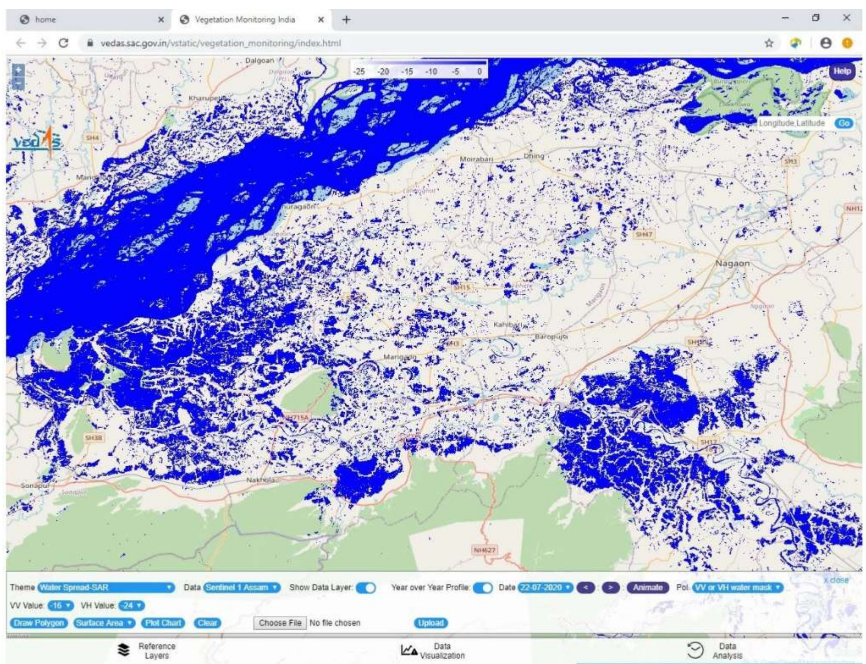
Citation	
ID1:	ANDHRAPRADESH_DSM500DSRT2004
DATA_PREPARED_BY:	Space Applications Centre,Ahmedabad
ORIGINAL_SOURCE:	gives information about type of degradation, along with severity level, affecting different types of landuses.
SOURCE_SCALE_DATE:	1:500,000
MAPPING_YEAR:	2004
DIGITIZING_YEAR:	2004
SURVEY_YEAR:	2004
LINEAGE:	Not Available
ASSOCIATED_PROJECT_DATA:	Not Applicable
ASSOCIATED_PUBLICATIONS:	Not Available
PERSON_EMAIL:	Not Available
PERSON_AFFILIATION:	Not Available
CORPORATE_NAME:	SAC, Ahmedabad
CORPORATE_ADDRESS:	Not Available

वेदास Vedas

A fully automated procedure is now established for downloading, processing and publishing of Sentinel1-A&B SAR data on VEDAS (https://vedas.sac.gov.in). User can perform web-based visualisation and analysis at very high speed.

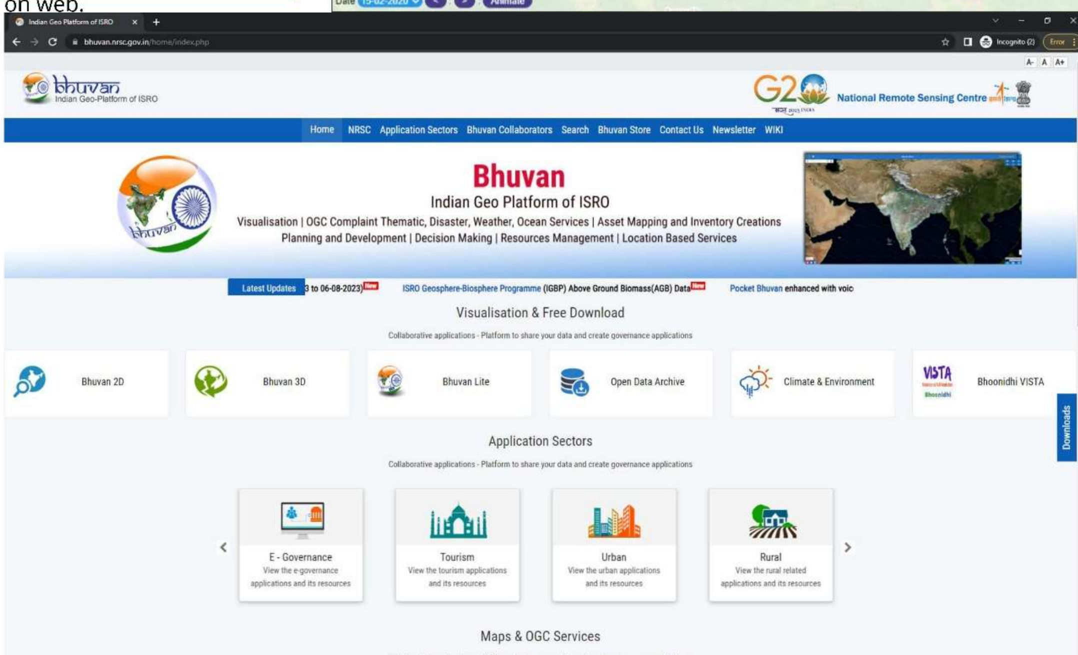


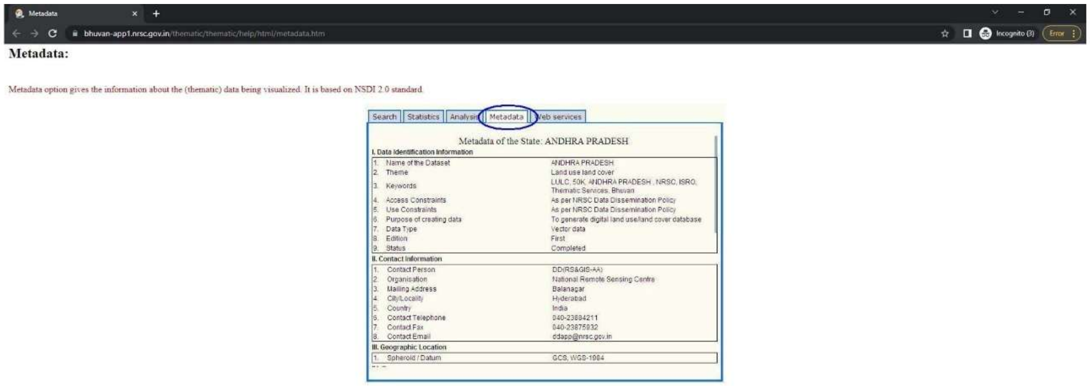
A fully automatic application on VEDAS for Flood monitoring of Assam using Sentinel-1 data. It has capability for changing thresholds by the user



वेदास Vedas

Vegetation Monitoring on VEDAS provides information of NDVI and crop growing environment. It facilitates user defined visualization and analysis on web.





Metadata:

Metadata option gives the information about the (thematic) data being visualized. It is based on NSDI 2.0 standard.

Search | Statistics | Analysis | Metadata | Web services

Metadata of the State: ANDHRA PRADESH

I. Data Identification Information

1.	Name of the Dataset	ANDHRA PRADESH
2.	Theme	Land use land cover
3.	Keywords	LULC, 50K, ANDHRA PRADESH , NRSC, ISRO, Thematic Services, Bhuvan
4.	Access Constraints	As per NRSC Data Dissemination Policy
5.	Use Constraints	As per NRSC Data Dissemination Policy
6.	Purpose of creating data	To generate digital land use/land cover database
7.	Data Type	Vector data
8.	Edition	First
9.	Status	Completed

II. Contact Information

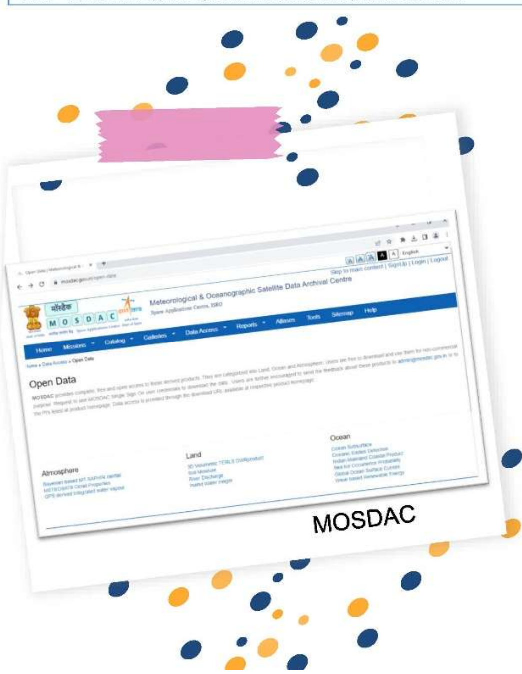
1.	Contact Person	DD(RS&GIS-AA)
2.	Organisation	National Remote Sensing Centre
3.	Mailing Address	Balanagar
4.	City/Locality	Hyderabad
5.	Country	India
6.	Contact Telephone	040-23884211
7.	Contact Fax	040-23875832
8.	Contact Email	ddapp@nrsc.gov.in

III. Geographic Location

1.	Spheroid / Datum	GCS, WGS-1984

Bhuvan

Source - https://bhuvan-app1.nrsc.gov.in/thematic/thematic/help/html/metadata.htm

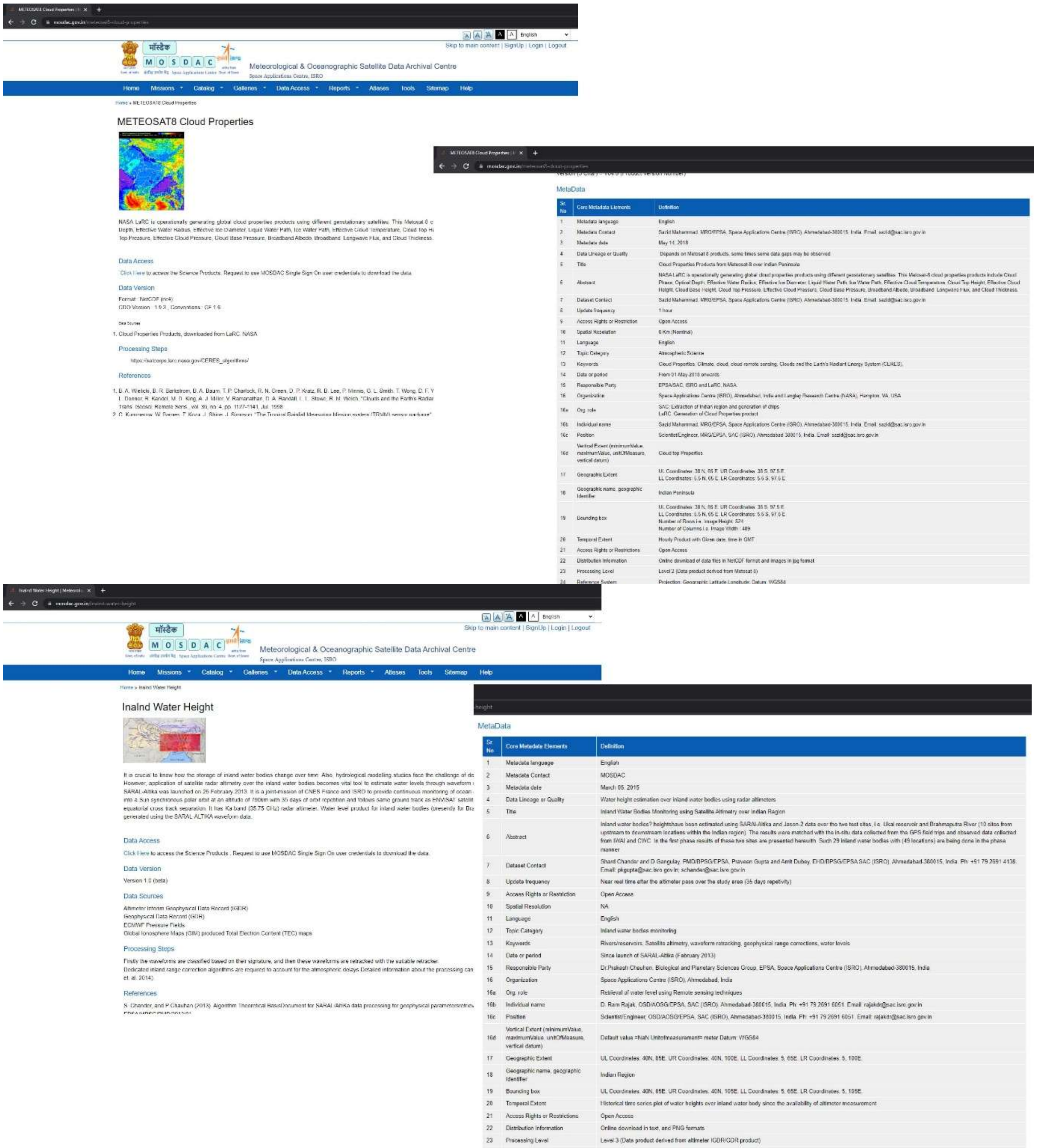


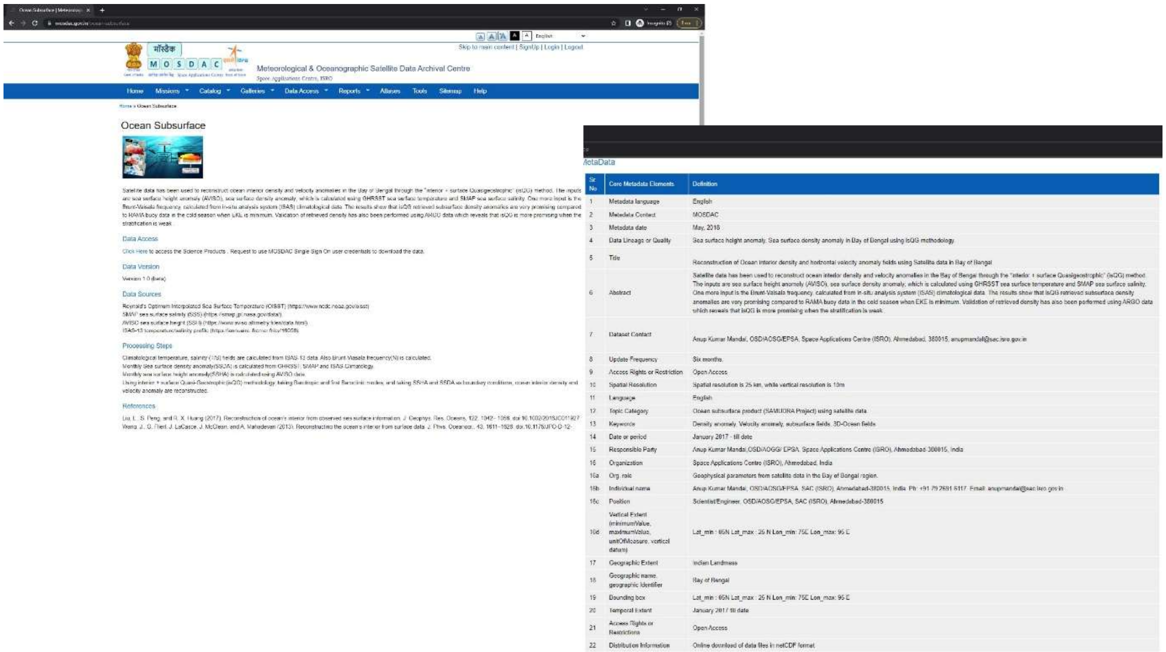
Space Applications Centre, ISRO

Meteorological & Oceanographic Satellite Data Archival Centre

Meteorological and Oceanographic Satellite Data Archival Centre (MOSDAC) is a Data Centre of Space Applications Centre (SAC) and has facility for satellite data reception, processing, analysis and dissemination. MOSDAC is operationally supplying earth observation data from Indian meteorology and oceanography satellites, to cater to national and international research requirements.

ISRO


Meteorological & Oceanographic Satellite Data Archival Centre
METEOSAT8 Cloud Properties
MetaData
Meteorological & Oceanographic Satellite Data Archival Centre
Inalnd Water Height
MetaData



Standards

Get a globally accepted Standard .

Geospatial Standards for a Federated India

Current Progress, Challenges & Road Ahead

National Geospatial Policy 2022 : The Transformative Framework

Strategic Policy Shift

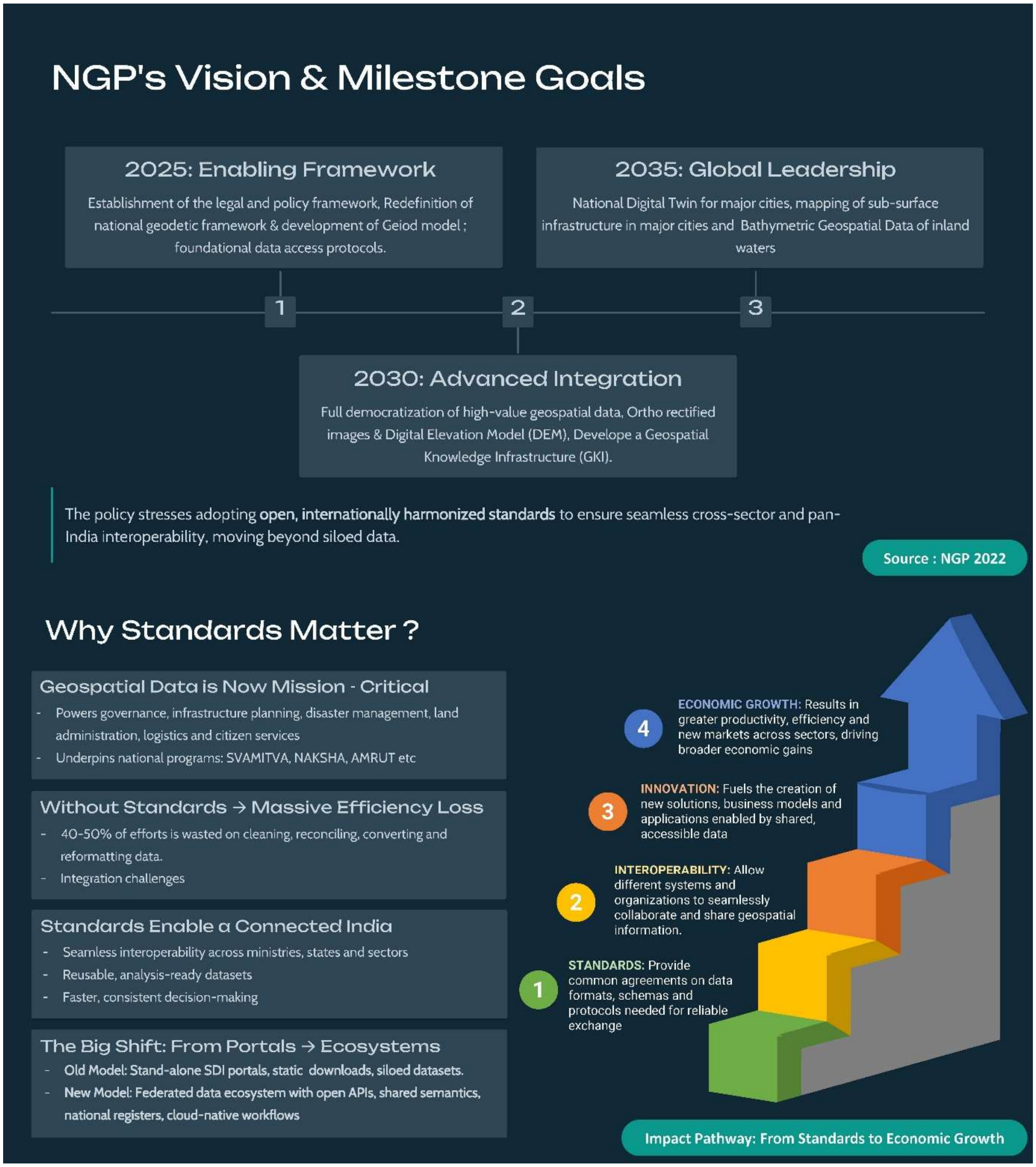
The NGP provides a clear, comprehensive policy and legal framework designed to unlock the economic and social value of geospatial information.

Data Democratization

It mandates open access and sharing of high-value geospatial data to foster innovation and competition across all sectors.

Standards as Infrastructure

Standards are positioned as the essential backbone, ensuring national interoperability, efficient data exchange, and reliable public service delivery.


NGP's Vision & Milestone Goals
2025: Enabling Framework
Establishment of the legal and policy framework, Redefinition of national geodetic framework & development of Geiod model ; foundational data access protocols.
2035: Global Leadership
National Digital Twin for major cities, mapping of sub-surface infrastructure in major cities and Bathymetric Geospatial Data of inland waters
1
2
3
2030: Advanced Integration
Full democratization of high-value geospatial data, Ortho rectified images & Digital Elevation Model (DEM), Develope a Geospatial Knowledge Infrastructure (GKI).
The policy stresses adopting open, internationally harmonized standards to ensure seamless cross-sector and pan-India interoperability, moving beyond siloed data.
Source : NGP 2022
Why Standards Matter ?
Geospatial Data is Now Mission - Critical
- Powers governance, infrastructure planning, disaster management, land administration, logistics and citizen services
- Underpins national programs: SVAMITVA, NAKSHA, AMRUT etc
Without Standards → Massive Efficiency Loss
- 40-50% of efforts is wasted on cleaning, reconciling, converting and reformatting data.
- Integration challenges
Standards Enable a Connected India
- Seamless interoperability across ministries, states and sectors
- Reusable, analysis-ready datasets
- Faster, consistent decision-making
The Big Shift: From Portals → Ecosystems
- Old Model: Stand-alone SDI portals, static downloads, siloed datasets.
- New Model: Federated data ecosystem with open APIs, shared semantics, national registers, cloud-native workflows
4
ECONOMIC GROWTH: Results in greater productivity, efficiency and new markets across sectors, driving broader economic gains
3
INNOVATION: Fuels the creation of new solutions, business models and applications enabled by shared, accessible data
2
INTEROPERABILITY: Allow different systems and organizations to seamlessly collaborate and share geospatial information.
1
STANDARDS: Provide common agreements on data formats, schemas and protocols needed for reliable exchange
Impact Pathway: From Standards to Economic Growth

Standards in Action: Benefits Across Sectors

Urban Planning

Data-driven infrastructure planning reduces project delays and mitigates land use conflicts.

Logistics

Optimized routing, improved addressing, and better supply chain management due to precise location data.

Disaster Management

Accurate, interoperable data facilitates faster emergency response and effective risk mitigation strategies.

Agriculture

Enables precision farming, crop monitoring, and resource optimization based on standardized spatial data.

Environment

Supports effective conservation efforts, monitoring of environmental change, and sustainable resource management.

Key Gaps: Standards Exit, Adoption Lags

Stakeholder insights (Government, Industry & Academia)

- Standards exist as documents, not an operational framework
- Lack of foundational information model leads to divergent schema
- No national registers for parcels, buildings, addresses and other fundamental data themes.
- States & ministries follow different vocabularies and classifications
- Standards are voluntary → implementation is inconsistent

Key Structural Challenges

- Fragmented semantics → datasets cannot be merged easily
- Program – driven schema development instead of national alignment
- Duplicate data creation across agencies.
- Limited institutional capability for transforming legacy data, validation and model governance.

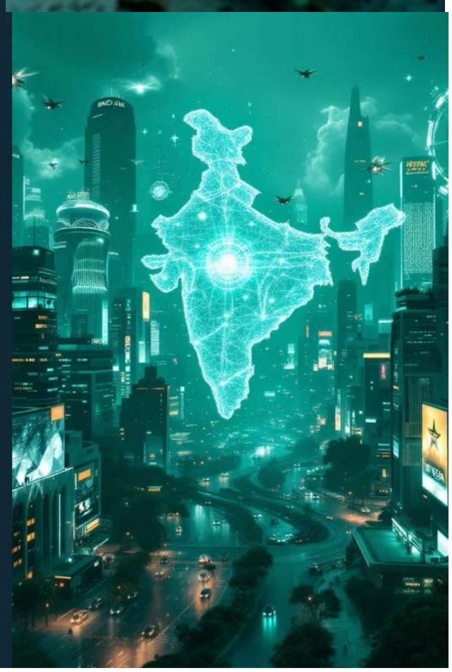
Governance Mechanism for National Geospatial Data Standard

GDPDC – National Mandate

- Apex body for implementation of NGP 2022
- Mandated to: Develop, promulgate and periodically review standards, Cover national and sectoral data themes
- GDPDC has directed nodal ministries to create Thematic Working Group (TWG)
- Ensure adoption by partnering and nodal agencies.

BIS & LITD 22 Standard Development Mechanism

- BIS is the National Standard Body and represent India in ISO & IEC.
- LITD 22 (Geospatial Information Sectional Committee): National Mirror Committee of ISO/TC 211- Geographical Information /Geomatics.
- Responsible for formulation of Indian Geospatial Standard aligned with global norms; Enable Indian participation in international standardization



Survey of India's Initiatives: Policy to Practice

The Survey of India (SoI) plays a central, guiding role in translating the NGP's vision into technical reality, focusing on foundational datasets and core infrastructure.

Theme Based Standard Development

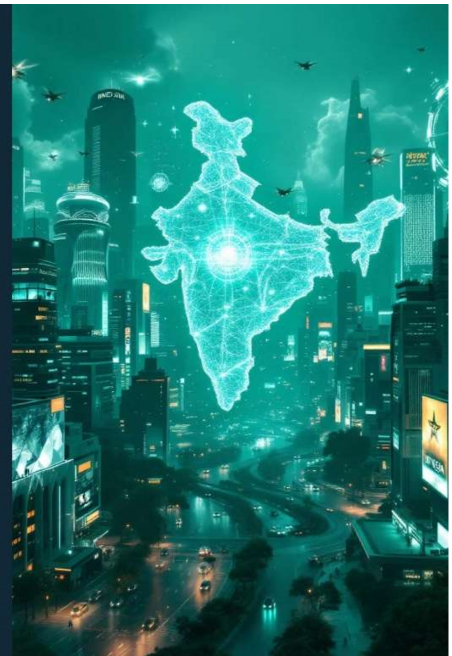
SoI led TWG covers: Geodetic Reference, Elevation, Orthoimagery, Elevation, Boundaries, Toponymy and Data base Harmonization..

Houses a dedicated Standard Wing

Responsible for developing foundational theme standard under BIS. Assist GDPDC in framing the standard.

Coordinate with ministries, state and data producing agencies.

Promote awareness, harmonization and adoption across stakeholder.



India's Current Landscape & Priority Standards Work Underway

- 24+ ISO/OGC – aligned BIS standards published (metadata, schemas, exchange, CRS , APIs)
- Thematic standards by LITD22 and line ministries
- Thematic standards for fundamental themes, land, water, soil, geomorphology, geology
- Metadata modernization (IS 16439 revisions)
- Exchange formats (IS 16554, OGC API Features)
- Alignment attempts with LADM, City GML, COG/STAC, DGGS.

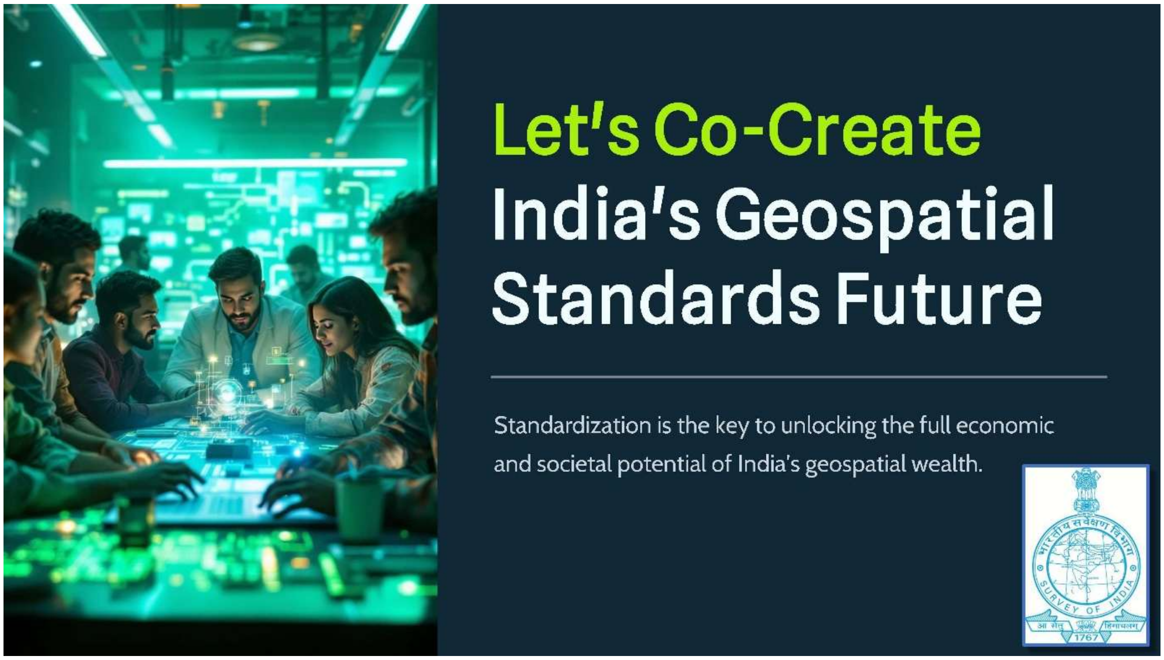
International Lessons

Insights from International Webinar on Standards Implementation

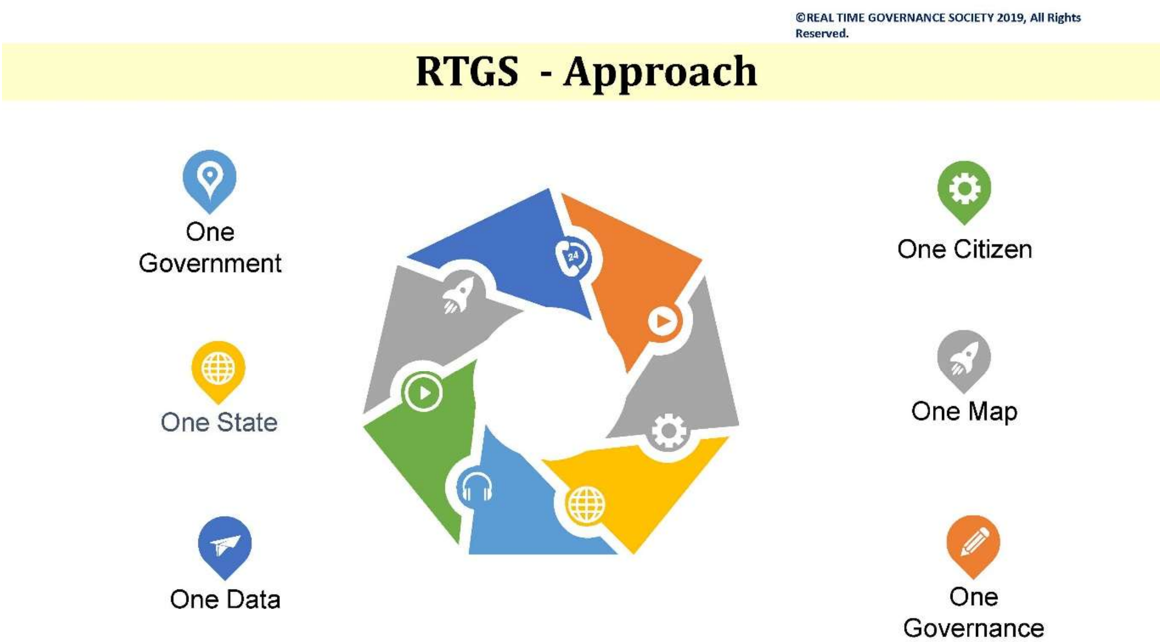
- **Start with Clear National Priorities :** Global experts emphasized that standards succeed when tied to specific national missions—not abstract SDI goals. India must link standards to prime national programs like Gati Shakti, SVAMITVA, AMRUT, etc.
- **Build a Foundational Information Model First:** Countries like the Netherlands showed that a core semantic model + sector extensions is essential for consistency across ministries and states. Without shared semantics, interoperability is impossible.
- **Establish Authoritative Registers:** International practice highlights the need for trusted registers (parcels, buildings, roads, addresses, admin boundaries) to prevent duplication and conflict.
- **Move from Portals to API-Driven Ecosystems:** Experts stressed a shift from "publishing layers" to OGC API–based, cloud-native, real-time data exchange that supports analytics, AI, and Digital Twins.
- **Create Light-Touch Adoption Mechanisms:** Models such as "Comply or Explain", used in Europe, encourage adoption without heavy regulation—ensuring flexibility while maintaining alignment.
- **Invest in Implementation Tools, Not Just Standards:** Validation tools, ETL workflows, sample datasets, and reference implementations were identified as critical enablers for adoption across agencies.
- **Build Long-Term Capacity & Institutional Memory:** International agencies stressed continuous training, certification, and multi-agency capacity programs—not one-time workshops—to sustain standards compliance.

Six Priority Action Areas for India

1. Open & Accessible Infrastructure	Standardized metadata, open formats, and interoperable platforms across central & state agencies.
2. Policy-Led Standards Adoption	Tiered standards framework; compliance matrix
3. Capacity & Awareness Programs	National upskilling for ministries, states, academia & industry on standards implementation.
4. Innovation & Digital Transformation	API gateways, semantic standards, cloud-ready datasets, AI/ML-friendly frameworks.
5. Legal & Policy Harmonization	Alignment of sectoral regulations, data-sharing rules, privacy/licensing norms.
6. Transparent Monitoring & Feedback	Dashboards, audits, and structured reporting aligned with GDPDC mandates.


Let's Co-Create
India's Geospatial
Standards Future
Standardization is the key to unlocking the full economic and societal potential of India's geospatial wealth.

REAL TIME
GOVERNANCE



RTGS HUBs

- Data Integration and Governance Hub
- AI and Deep Tech Innovation Hub
- Product Development Hub
- Multi Source Visual Intelligence Hub
- People Perception Hub
- AWARE Hub

3

Data Integration and Governance Hub

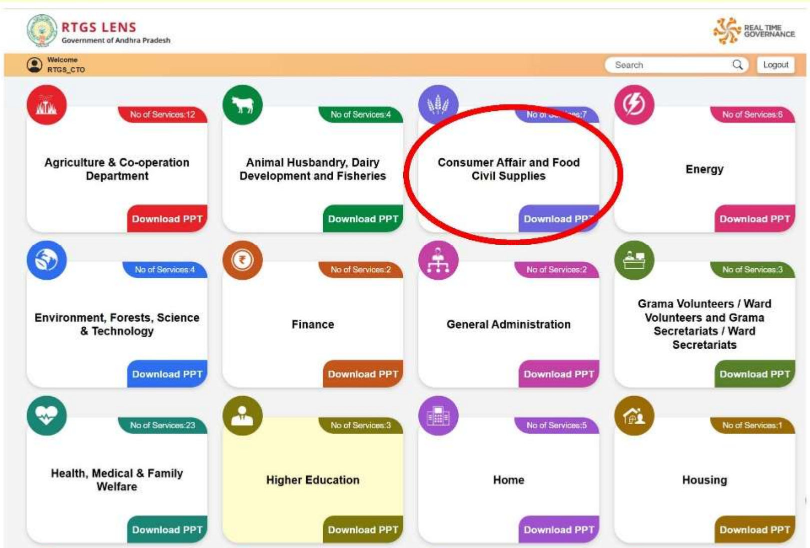
1. **Objective**: The Government of Andhra Pradesh aims to establish a Single Source of Truth (SSOT) by integrating data from:
    1. 40 departments
    2. 92 Heads of Departments (HoDs)
    3. 614 autonomous organizations
2. **Facilitating Body**: The integration is facilitated through the Data Integration, Analytics & Governance Hub within the Real Time Governance Society (RTGS).
3. **Data Consolidation**:
    1. Data from various sources is consolidated into a central Data Lake.
    2. This Data Lake serves as a unified repository, helping to reduce redundancies.
4. **Benefits**:
    1. Promotes coordinated actions across departments.
    2. Provides a centralized platform for structured and unstructured data.
5. **Advanced Analytics**:
    1. Analytics applied on the centralized Data Lake offer valuable insights.
    2. Helps optimize allocation, track performance metrics, and supports evidence-based policymaking.
6. **Data Governance**:
    1. Ensures data integrity, security, and compliance.
    2. Promotes transparency and supports a data-driven governance model in Andhra Pradesh.

4

Ongoing projects under various Hubs

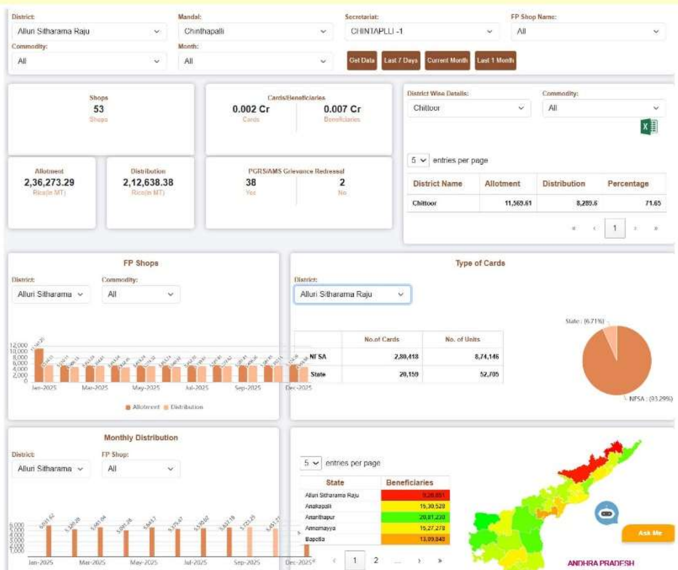
Si No	Name of Hub	Name of Project
1	Data Integration Hub	1.Data Lake 2.RTGS Lens
2	AI and Deep Tech Innovation Hub	1.Traffic Analytics 2.People's emotion Capturing 3.PGRS through Image/Voice processing 4.NCD(Non-Communicable Diseases) Tracking
3	Product Development Hub	1.APCRS portal 2.APPMG
4	Multi Source Visual Intelligence Hub	1.CCTV Footage 2.Image Analytics - Drone 3.Satellite Data 4.IOT Devices 5.Access to School - Improvement
5	People Perception Hub	Monitoring 21 KPIs for

Data Lens (powered by Data Lake)



Data Lens (Civil Supplies)

Data Lens (PDS/Civil Supplies)



From Insight to Impact

All this is great! You are turning **data** which sits in departmental silos into **Information** at a central platform.

Can this **information** be turned into **Actionable Intelligence?**

SDG 4.1 Education

"Walk to School" Analysis of 31,165 Rural Households

New Education Policy 2020
1 Km for Primary School
3 Km for Secondary School

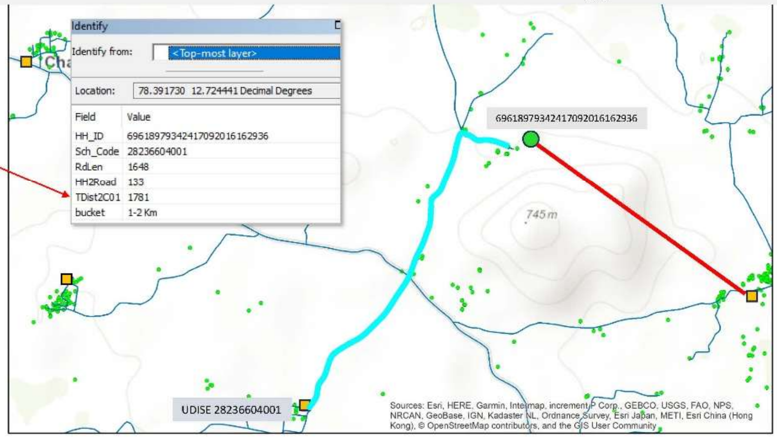
Road Distance	Access to Class 5 (1 Km)		Access to Class 8 (3 Km)	
<1 Km	25,810	82.9%	15,458	49.7%
1-2 Km	4,739	15.2%	8,284	26.6%
2-3 Km	329	1.1%	4,879	15.7%
3-4 Km	79	0.3%	1,673	5.4%
4-5 Km	1	0.0%	419	1.3%
> 5Km	177	0.6%	296	1.3%

Source: PSS Data and UDISE

SDG 4.1 Education

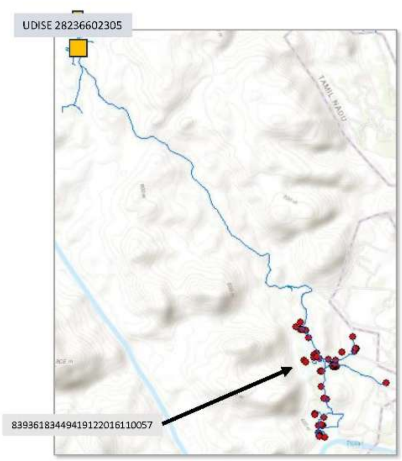
"Walk to School" Methodology

Distance from Home to School is 1,781 Meters



Primary School Citizen Home Walking route to School

Actionable Intelligence



Primary School Household > 8 Km

The issue:
Tribals have the right to live inside forests under the RoFR act.

The Problem:
School Education Dept can not get permission to set up School in a forest area.

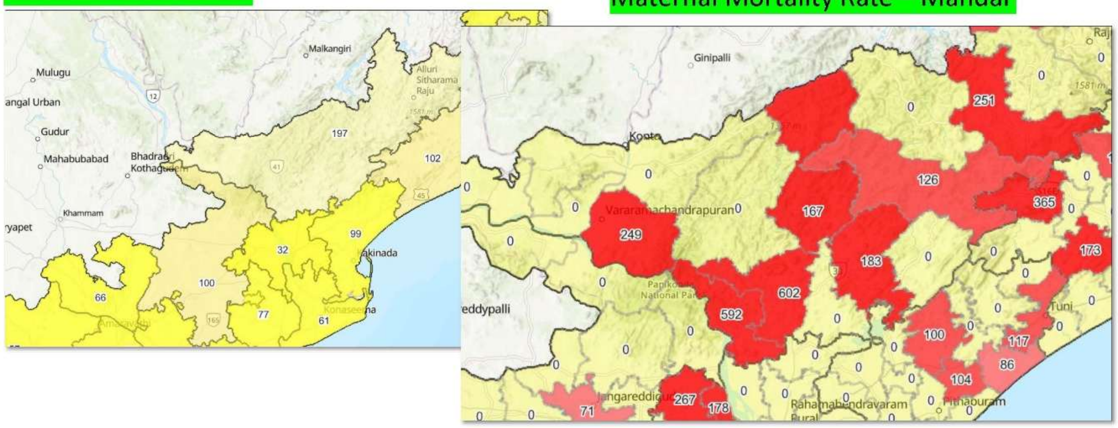
The solution:
Provide bus service and/or Hostels

12

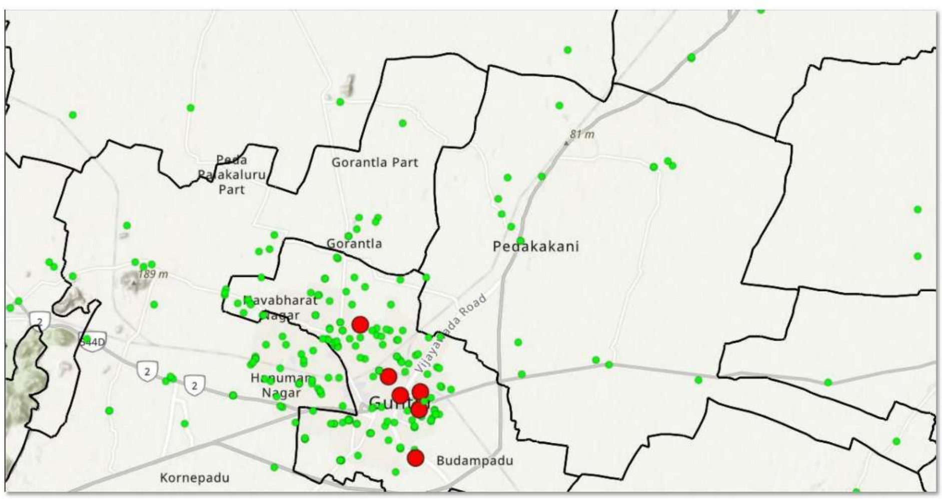
MMR – Maternal Mortality Ratio

MMR – District Level

Maternal Mortality Rate – Mandal



MMR – Why in Urban areas?



High MMR? What is Health Dept doing?

	As per ABDM		As per HMIS			As per RCH		
NO	Health Facility Name (Hospital Name)	Hospital Facility id	Facility Type	Facility Name	NIN	Facility Name as per RCH 2.0	Facility Name as per RCH 1.0	RCH ID
1	AREA HOSPITAL NARSIPATNAM	IN2810000093	SDH	AH Narsipatnam	1111577183	Area Hospital Narsipatnam	AH Narsipatnam	3679
2	AREA HOSPITAL TADIPATRI	IN2810000492	SDH	AH Tadipatri	1111638621	AH Tadipatri	CHC-Tadipatri	3466
3	Area Hospital Rayadurg	IN2810000634	SDH	AH Rayadurg	6456567871	AH Rayadurg	CHC-Rayadurg	3464
4	AREA HOSPITAL DHARMAVARAM	IN2810000472	SDH	AH Dharmavaram	1111643639	AH Dharmavaram	[illegible]mavaram	3480
5	COMMUNITY HEALTH CENTER GOOTY	IN2810007436	UCHC-FRU	CHC Gooty	1111641682	CHC Gooty	AH-Gooty	3479
6	COMMUNITY HEALTH CENTER PENUKONDA	IN2810007701	FRU CHC	CHC Penukonda	1111644322	CHC Penukonda	CHC-Penukonda	3469
7	CHC URAVAKONDA	IN2810000649	FRU CHC	CHC Uravakonda	1111657647	CHC Uravakonda	CHC-Uravakonda	3468
8	COMMUNITY HEALTH CENTRE KALYANDURG	IN2810007990	UCHC-FRU	CHC Kalyandurg	1111644140	CHC Kalyandurg	CHC- Kalyandurg	3476
9	CHC CHENNEKOTTAPALLI	IN2810001227	UCHC-FRU	CHC C.K. Palli	1111634455	CHC CHENNEKOTHAPALLI	C.K.Pally	3481

Uniformity and Standards

DistrictLgdCode	Revenue District Code	DistrictName	MandalLgdCode	Revenue Mandal Code	MandalName	Village Lgd Code	Revenue Village Code	VillageCode	Survey No	SynoTotal Extent
505	4	ఈస్ట్ గోదావరి	4958	1	కొవ్వూరు	588268	401006	దొమ్మేరు	301	0.73
505	4	ఈస్ట్ గోదావరి	4958	1	కొవ్వూరు	588268	401006	దొమ్మేరు	213	7.55
505	4	ఈస్ట్ గోదావరి	4958	1	కొవ్వూరు	588268	401006	దొమ్మేరు	579	5.34
505	4	ఈస్ట్ గోదావరి	4958	1	కొవ్వూరు	588268	401006	దొమ్మేరు	170	4.34
505	4	ఈస్ట్ గోదావరి	4958	1	కొవ్వూరు	588268	401006	దొమ్మేరు	17	2.26
505	4	ఈస్ట్ గోదావరి	4958	1	కొవ్వూరు	588268	401006	దొమ్మేరు	107	5.14
505	4	ఈస్ట్ గోదావరి	4958	1	కొవ్వూరు	588268	401006	దొమ్మేరు	66	16.82

- Farmer owns land
- Farmer gets seeds and fertilizers from Agri Dept
- Farmer get water from irrigation department
- Farmer gets crop insurance from SLBC?
- Farmer sells to RSK, Civil Supplies Dept.

RSK Code	District Name	Mandal Name	RSK Name
V/9/120	Alluri Seetharama Raju	Chintapalli	Chowdupalli-ii
V/9/001	Alluri Seetharama Raju	Chintapalli	Kommangi
V/9/123	Alluri Seetharama Raju	Chintapalli	Kothapalem-i
V/9/124	Alluri Seetharama Raju	Chintapalli	Kothapalem-ii
V/9/049	Alluri Seetharama Raju	Chintapalli	Kudumsari
V/9/126	Alluri Seetharama Raju	Chintapalli	Lammasingi
V/9/002	Alluri Seetharama Raju	Chintapalli	Lothugedda
V/9/212	Alluri Seetharama Raju	Chintapalli	Pedabarada
V/9/127	Alluri Seetharama Raju	Chintapalli	Tajangi-i
V/9/213	Alluri Seetharama Raju	Chintapalli	Tajangi-ii
V/9/128	Alluri Seetharama Raju	Chintapalli	Thammangula
V/9/129	Alluri Seetharama Raju	Chintapalli	Yerrabommalu
V/4/010	Alluri Seetharama Raju	G.maddugula	Bheeram
V/4/043	Alluri Seetharama Raju	G.maddugula	G.Madugula 2

If nothing is connected, how are we managing?

Why is Integration a Challenge?

Departments Work Well Independently: Integration Changes Everything

- Department-specific systems are optimized locally.
- Resistance to sharing data
- Challenges emerge when multiple systems intersect across sectors, scales, and mandates.
- As integrations scale, **complexity** concentrates around **identifiers**, **metadata**, and **spatial** consistency.

The Process

3. To facilitate seamless data integration, it is essential that all departments furnish accurate and updated GIS layers and latitude–longitude database related to departmental assets, infrastructure and service delivery points any other relevant Geo-spatial datasets maintained by the department.

4. Accordingly, your department is requested to submit the following:

- GIS Layers / Geo-Spatial Data in Shape file / KML / GeoJSON format /DB link.
- Location-wise Latitude–Longitude in Database /Excel
- Metadata Details, including coordinate system, creation date, update frequency, data custodian, and departmental contact point.

5. The above information will be used for official purposes through RTGS platforms such as departmental dashboards and the Multi-Source Visual Intelligence Hub GIS Dashboard. You are requested to furnish the GIS datasets in soft copy to the Director – Multi Source Visual Intelligence, RTGS Dr. N. Bhaskara Rao, 1st Block, A.P. Secretariat, Email id: dir-msvi-rtgs@ap.gov.in.

6. Please ensure that the datasets are submitted as early as possible to enable the timely completion of the ongoing integration process.

K. VIJAYANAND
CHIEF SECRETARY TO GOVERNMENT

Final Takeaways

1. Without harmonized standards, integrations become one-off solution; With Standards, integration becomes scalable and replicable.

2. ISO and non-ISO frameworks together enable interoperability while respecting national and sector-specific systems

3. A state-level pilot can help operationalize national geospatial standards in real governance conditions.

4. AP offers a live, operational environment to test and refine standards-based geospatial governance.

Annexure

Session – 4

MINISTRY OF
ELECTRONICS &
INFORMATION TECHNOLOGY
GOVERNMENT OF INDIA

NIC National Informatics Centre

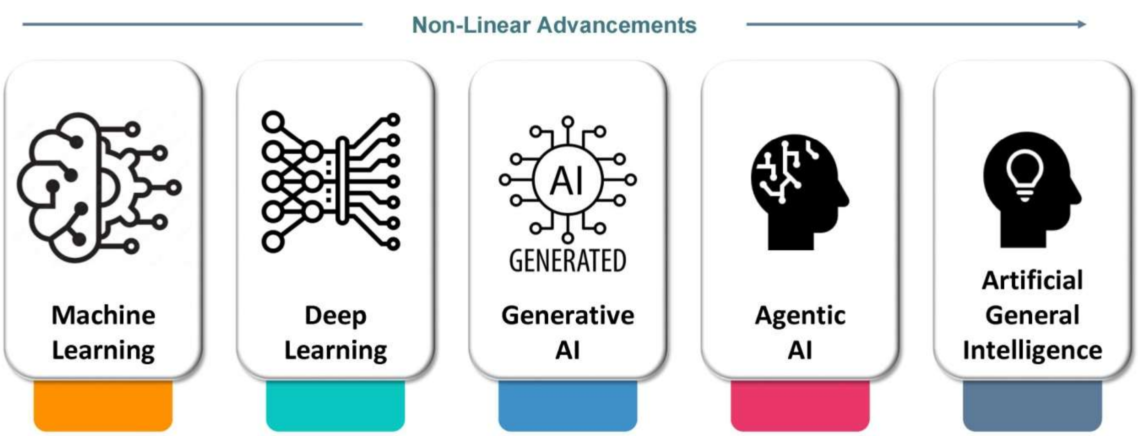
Enabling a Technology Advanced, Spatially Intelligent India

Abhishek Singh
Additional Secretary, MeitY, GoI
Director General, National Informatics Centre HQ

dg@nic.in

Artificial Intelligence I The Evolution

Recent advances in AI have significantly **catapulted** its **capabilities** to catalyze **large scale socio-economic transformation**



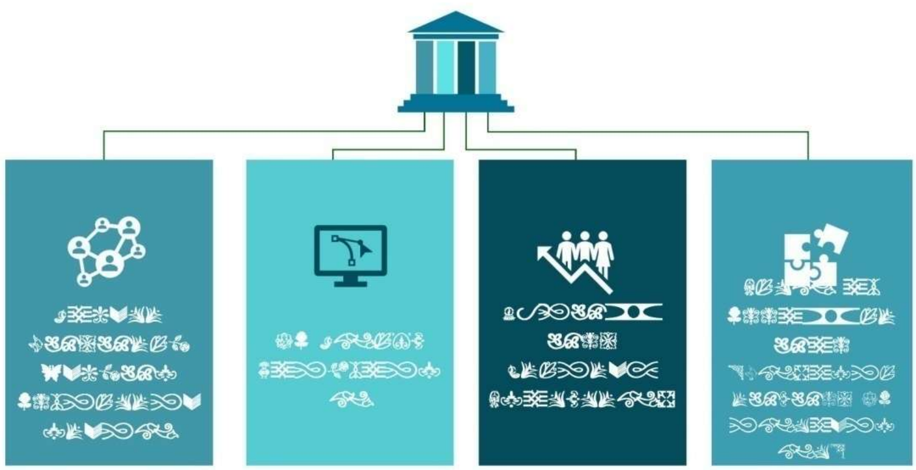
Why AI Matters for India

- Artificial Intelligence (AI) and automation to create **47 Lakh new tech jobs**
- AI is expected to add **$967 Bn to the Indian economy by 2035**
- AI is critical for enabling data-driven decision-making for more effective public service delivery
- AI can boost innovation and productivity in India – India has **Eight AI unicorns**

Source -IndiaAI 2023: Expert Group Report – First Edition; NASSCOM AI ADOPTION INDEX 2022

India's AI Strengths

India is uniquely positioned to drive the next generation of AI Innovation

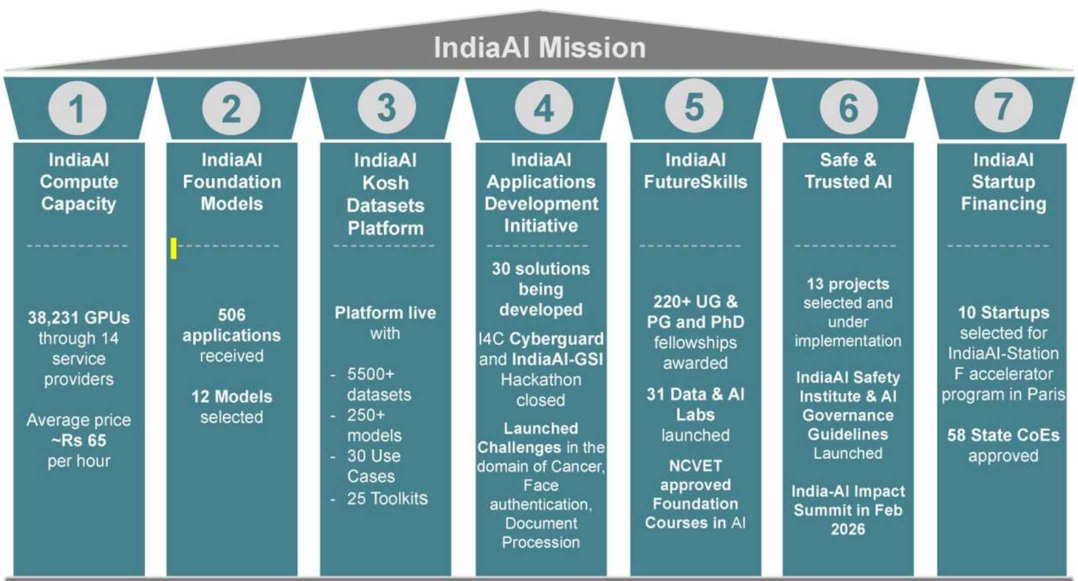


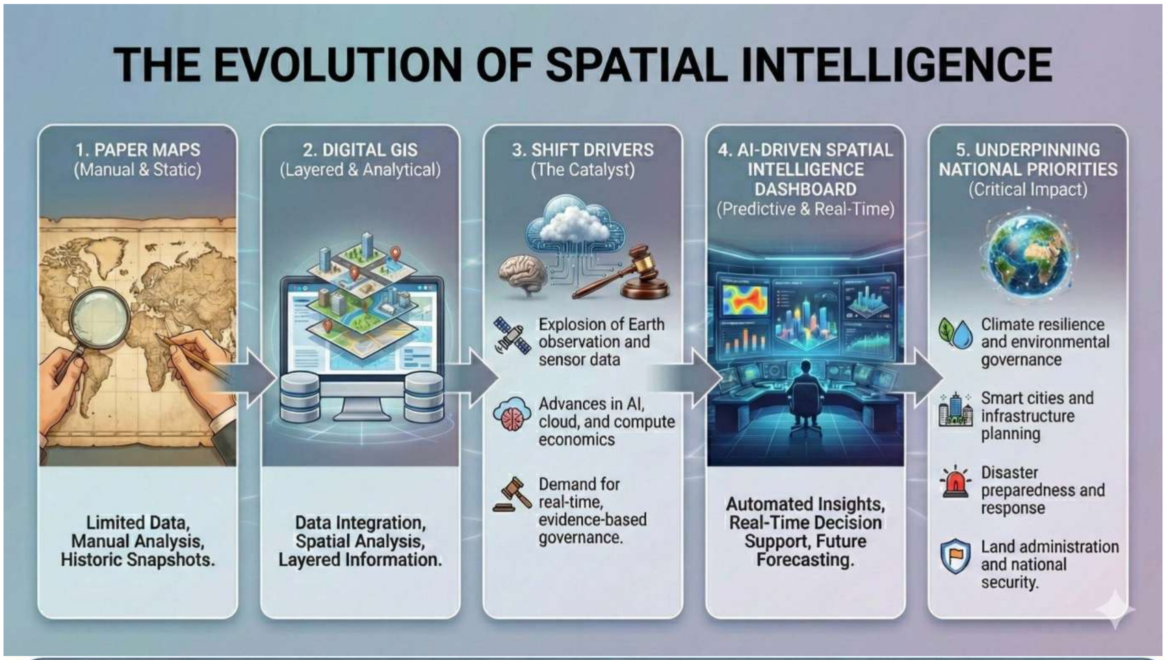
Challenges in Deployment & Adoption of AI

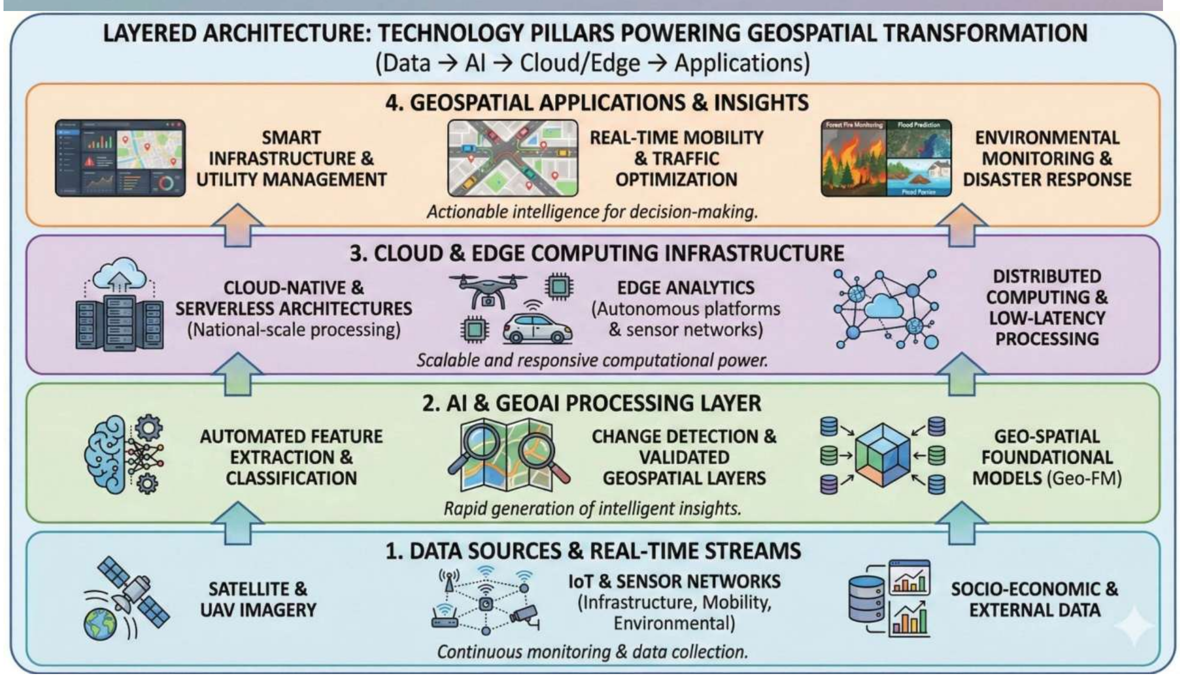
Current Challenges

- Need to develop **indigenous foundational models** built on Indian languages and contextualized to our socio-economic realities
- Need to streamline access to **quality, diverse datasets**
- **Need to ramp-up access to modern, hyper-scale AI Compute Infrastructure** to meet the evolving demands of AI applications
- **Develop guardrails** and governance frameworks for AI that meet India's **unique requirements** as a **developing Country**

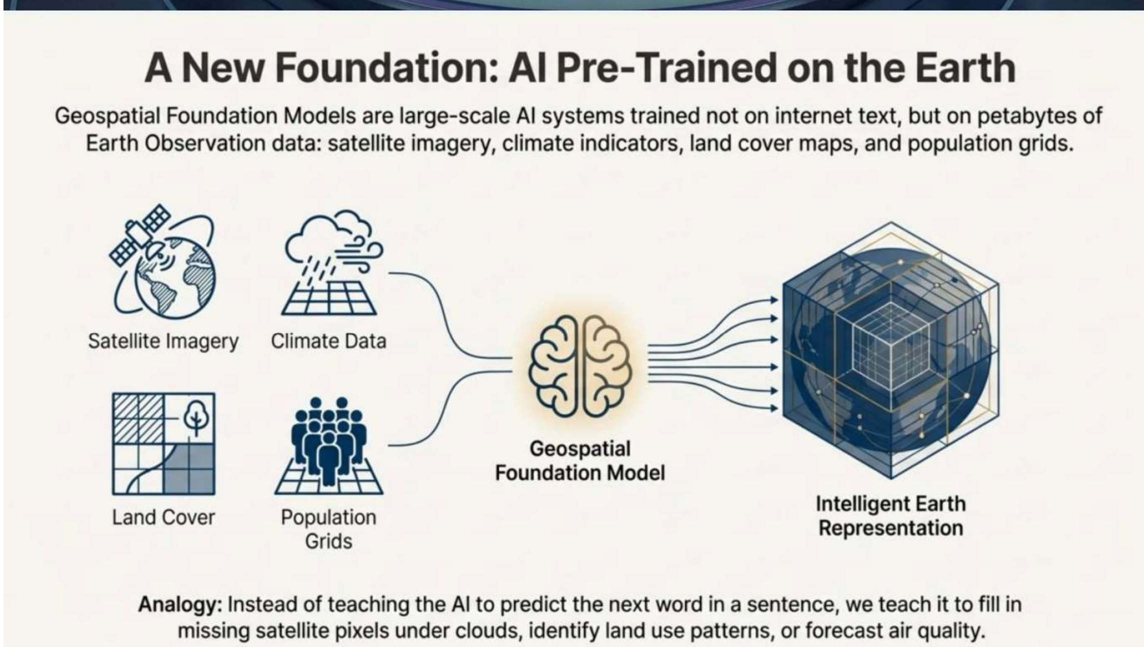
IndiaAI Mission: Key updates

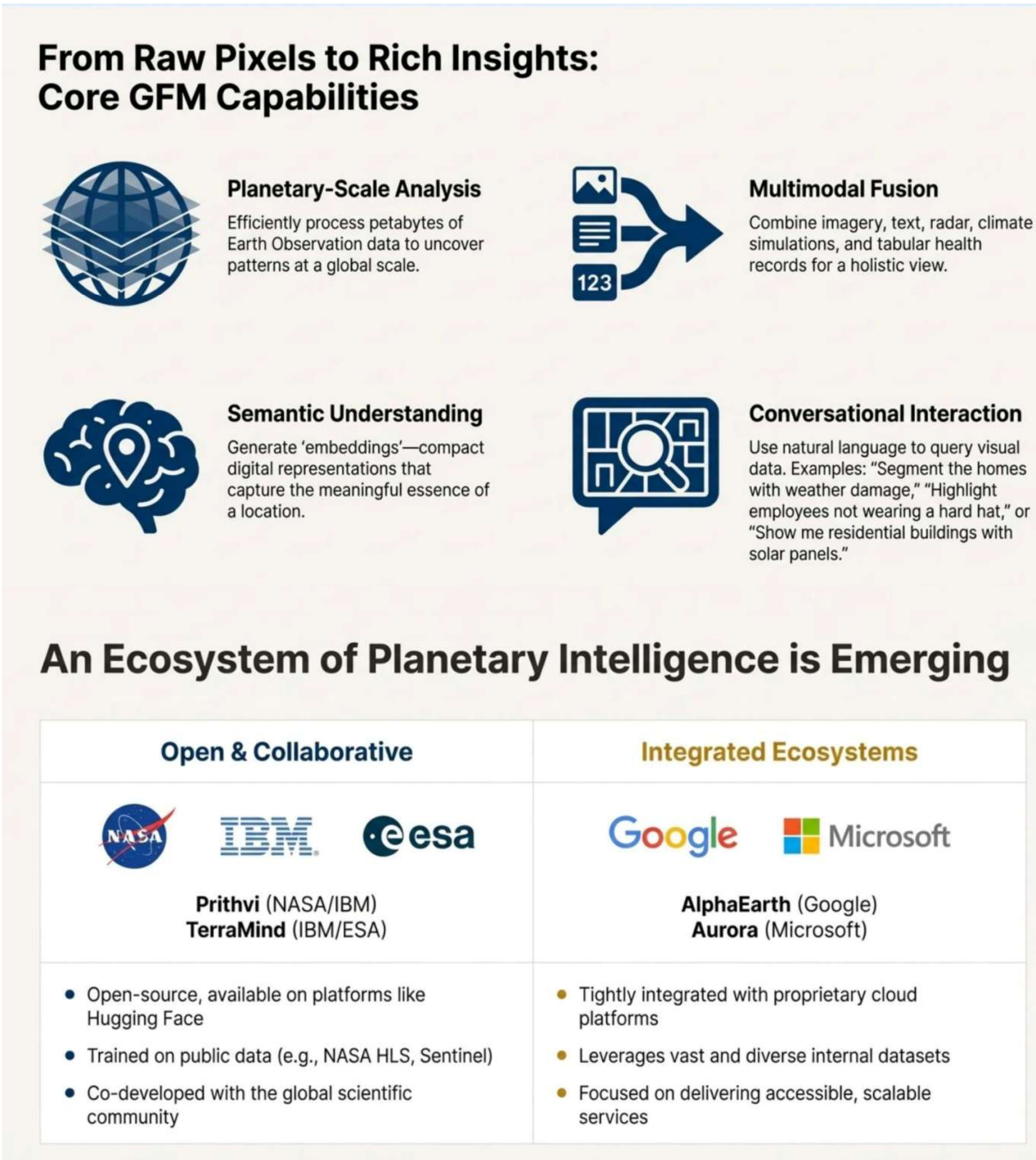


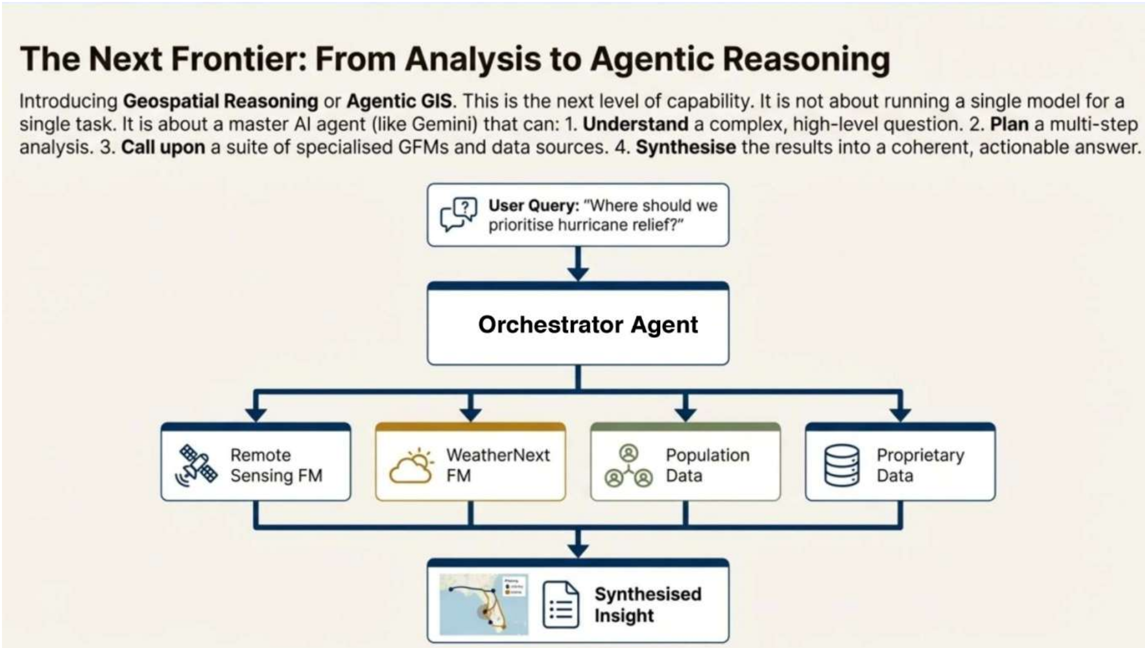

THE EVOLUTION OF SPATIAL INTELLIGENCE
1. PAPER MAPS
(Manual & Static)
Limited Data, Manual Analysis, Historic Snapshots.
2. DIGITAL GIS
(Layered & Analytical)
Data Integration, Spatial Analysis, Layered Information.
3. SHIFT DRIVERS
(The Catalyst)
Explosion of Earth observation and sensor data
Advances in AI, cloud, and compute economics
Demand for real-time, evidence-based governance.
4. AI-DRIVEN SPATIAL INTELLIGENCE DASHBOARD
(Predictive & Real-Time)
Automated Insights, Real-Time Decision Support, Future Forecasting.
5. UNDERPINNING NATIONAL PRIORITIES
(Critical Impact)
Climate resilience and environmental governance
Smart cities and infrastructure planning
Disaster preparedness and response
Land administration and national security.

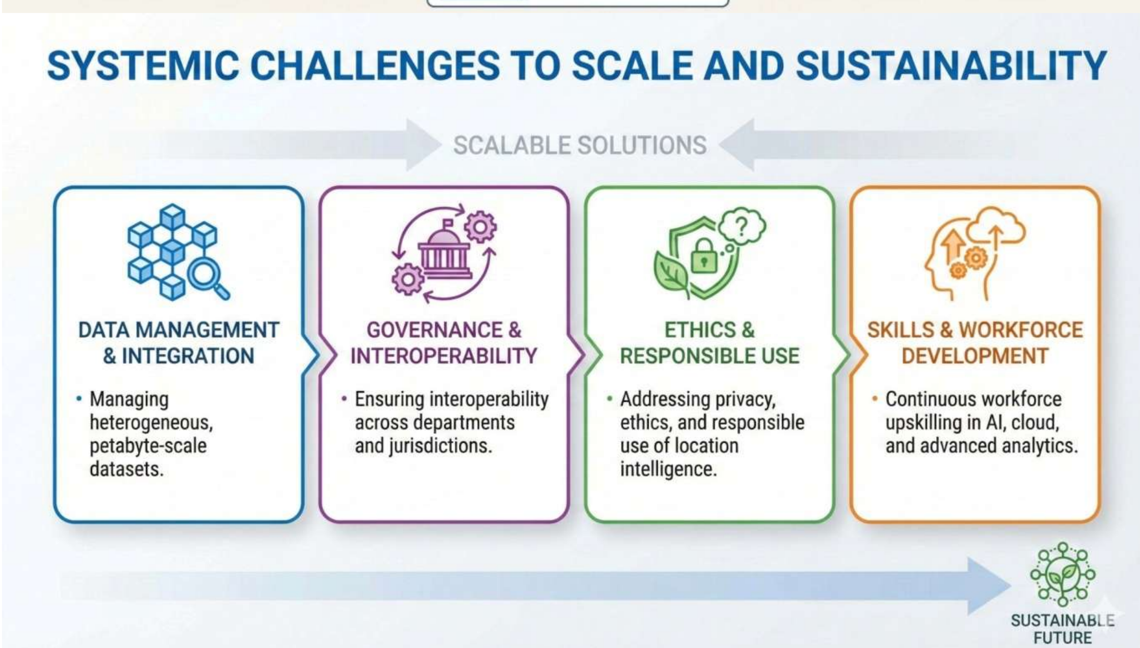

LAYERED ARCHITECTURE: TECHNOLOGY PILLARS POWERING GEOSPATIAL TRANSFORMATION
(Data → AI → Cloud/Edge → Applications)
4. GEOSPATIAL APPLICATIONS & INSIGHTS
SMART INFRASTRUCTURE & UTILITY MANAGEMENT
REAL-TIME MOBILITY & TRAFFIC OPTIMIZATION
ENVIRONMENTAL MONITORING & DISASTER RESPONSE
Actionable intelligence for decision-making.
3. CLOUD & EDGE COMPUTING INFRASTRUCTURE
CLOUD-NATIVE & SERVERLESS ARCHITECTURES
(National-scale processing)
EDGE ANALYTICS
(Autonomous platforms & sensor networks)
DISTRIBUTED COMPUTING & LOW-LATENCY PROCESSING
Scalable and responsive computational power.
2. AI & GEOAI PROCESSING LAYER
AUTOMATED FEATURE EXTRACTION & CLASSIFICATION
CHANGE DETECTION & VALIDATED GEOSPATIAL LAYERS
GEO-SPATIAL FOUNDATIONAL MODELS (Geo-FM)
Rapid generation of intelligent insights.
1. DATA SOURCES & REAL-TIME STREAMS
SATELLITE & UAV IMAGERY
IoT & SENSOR NETWORKS
(Infrastructure, Mobility, Environmental)
SOCIO-ECONOMIC & EXTERNAL DATA
Continuous monitoring & data collection.

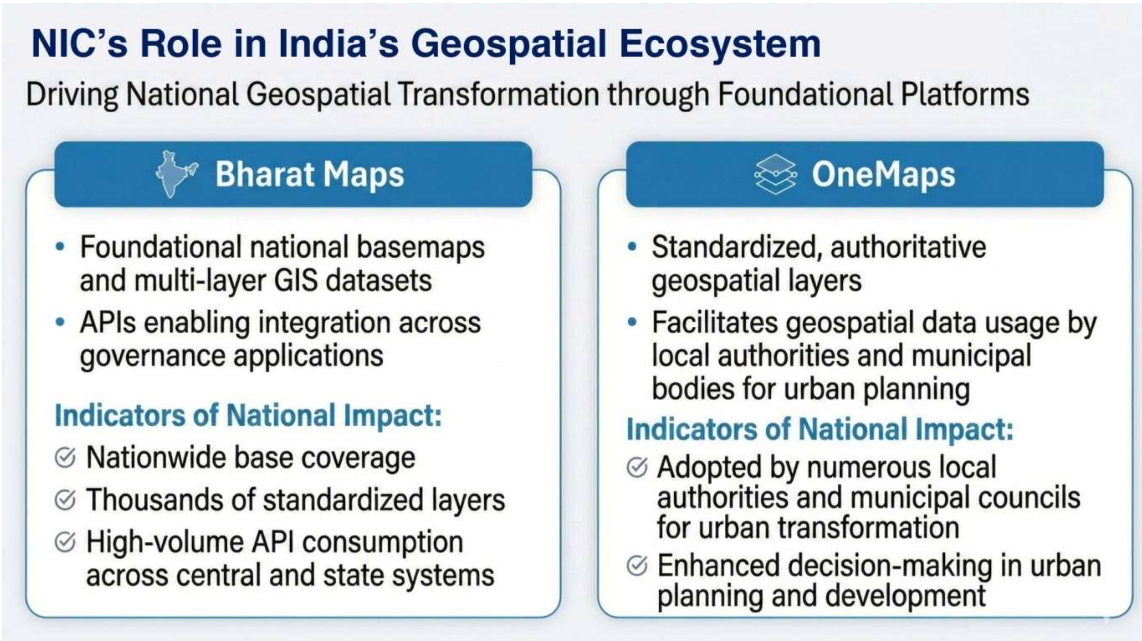

Data Layers
Search
DATA LAYERS
ADVANCED CAPABILITIES
EXPANDING THE GEOSPATIAL STACK
3D / 4D MAPPING & DIGITAL TWINS
Past
Present
Future
Time-enabled simulations for scenario planning
High-resolution 30 city and terrain models
UAVs & REALITY CAPTURE
High-frequency, high-resolution data acquisition
UAV
REALITY CAPTURE
Repid mapping for land, infrastructure, and disaster response
Integration of IoT feeds into digital twins
AI Analytics
Predictive Modeling
Anomaly Detection
Resource Optimization
IoT Feeds: Traffic
IoT Feeds: Environment
IoT Feeds: Energy
IoT Feeds: Water Quality
IoT Feeds: Waste Management
IoT Feeds: Public Safety
IoT Feeds: Water Quality
IoT Feeds: Public Safety
BLOCKCHAIN FOR DATA INTEGRITY
Provenance and temper proof geospatial recurds
LAND RECORDS
GOVERNANCE
COMPLIANCE SYSTEMS
Critical for land recurits, governance, and compliance systems

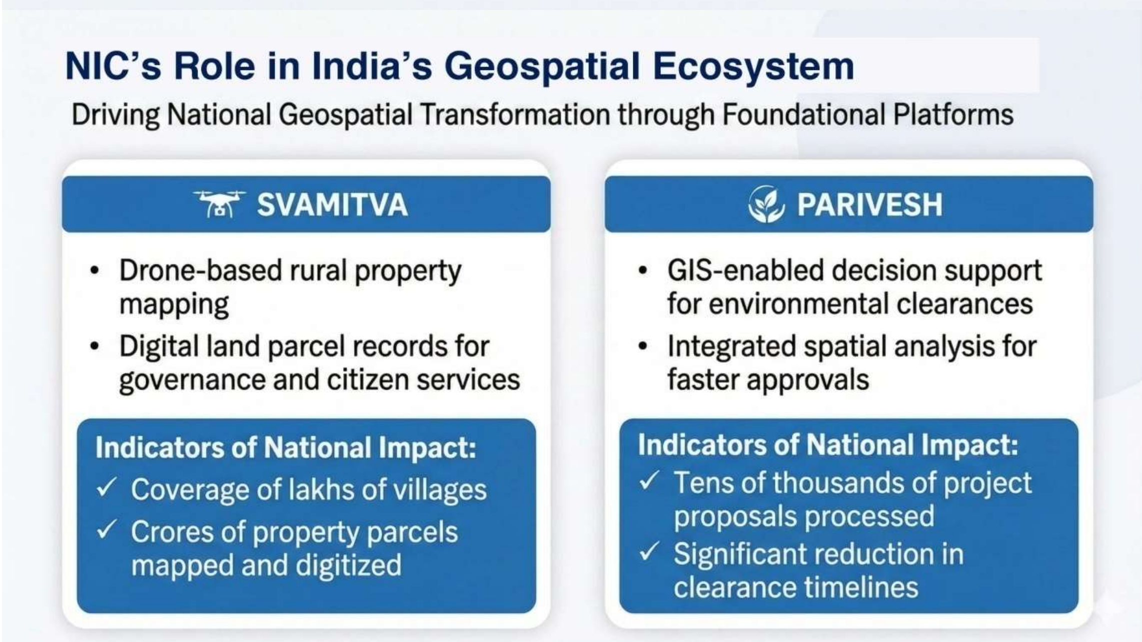

A New Foundation: AI Pre-Trained on the Earth
Geospatial Foundation Models are large-scale AI systems trained not on internet text, but on petabytes of Earth Observation data: satellite imagery, climate indicators, land cover maps, and population grids.
Satellite Imagery
Climate Data
Land Cover
Population Grids
Geospatial Foundation Model
Intelligent Earth Representation
Analogy: Instead of teaching the AI to predict the next word in a sentence, we teach it to fill in missing satellite pixels under clouds, identify land use patterns, or forecast air quality.

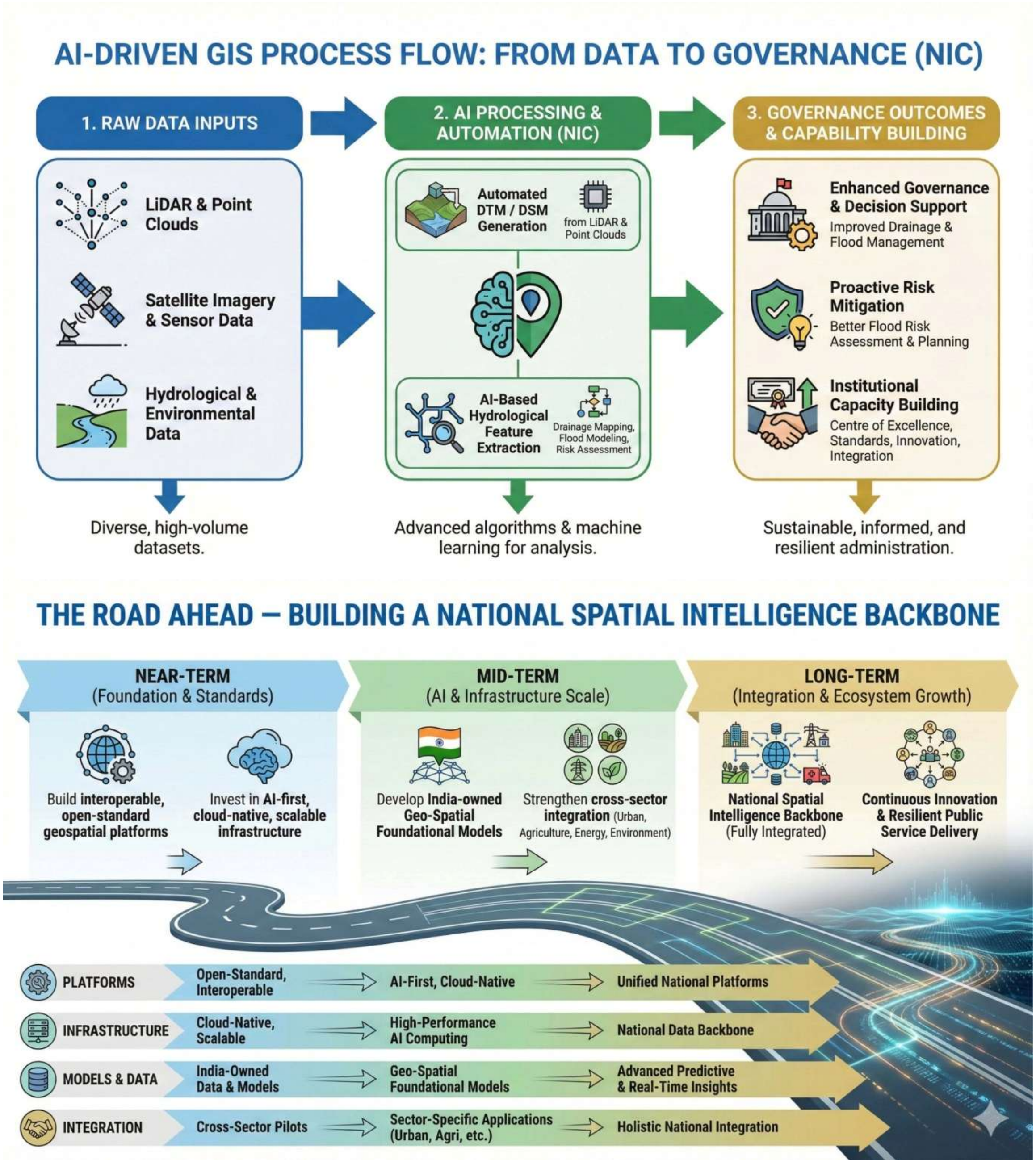

From Raw Pixels to Rich Insights:
Core GFM Capabilities
Planetary-Scale Analysis
Efficiently process petabytes of Earth Observation data to uncover patterns at a global scale.
Multimodal Fusion
123
Combine imagery, text, radar, climate simulations, and tabular health records for a holistic view.
Semantic Understanding
Generate 'embeddings'—compact digital representations that capture the meaningful essence of a location.
Conversational Interaction
Use natural language to query visual data. Examples: "Segment the homes with weather damage," "Highlight employees not wearing a hard hat," or "Show me residential buildings with solar panels."
An Ecosystem of Planetary Intelligence is Emerging
Open & Collaborative
Integrated Ecosystems
NASA
IBM
esa
Google
Microsoft
Prithvi (NASA/IBM)
TerraMind (IBM/ESA)
AlphaEarth (Google)
Aurora (Microsoft)
Open-source, available on platforms like Hugging Face
Trained on public data (e.g., NASA HLS, Sentinel)
Co-developed with the global scientific community
Tightly integrated with proprietary cloud platforms
Leverages vast and diverse internal datasets
Focused on delivering accessible, scalable services


The Next Frontier: From Analysis to Agentic Reasoning
Introducing Geospatial Reasoning or Agentic GIS. This is the next level of capability. It is not about running a single model for a single task. It is about a master AI agent (like Gemini) that can: 1. Understand a complex, high-level question. 2. Plan a multi-step analysis. 3. Call upon a suite of specialised GFMs and data sources. 4. Synthesise the results into a coherent, actionable answer.
User Query: "Where should we prioritise hurricane relief?"
Orchestrator Agent
Remote Sensing FM
WeatherNext FM
Population Data
Proprietary Data
Synthesised Insight


SYSTEMIC CHALLENGES TO SCALE AND SUSTAINABILITY
SCALABLE SOLUTIONS
DATA MANAGEMENT & INTEGRATION
• Managing heterogeneous, petabyte-scale datasets.
GOVERNANCE & INTEROPERABILITY
• Ensuring interoperability across departments and jurisdictions.
ETHICS & RESPONSIBLE USE
• Addressing privacy, ethics, and responsible use of location intelligence.
SKILLS & WORKFORCE DEVELOPMENT
• Continuous workforce upskilling in AI, cloud, and advanced analytics.
SUSTAINABLE FUTURE

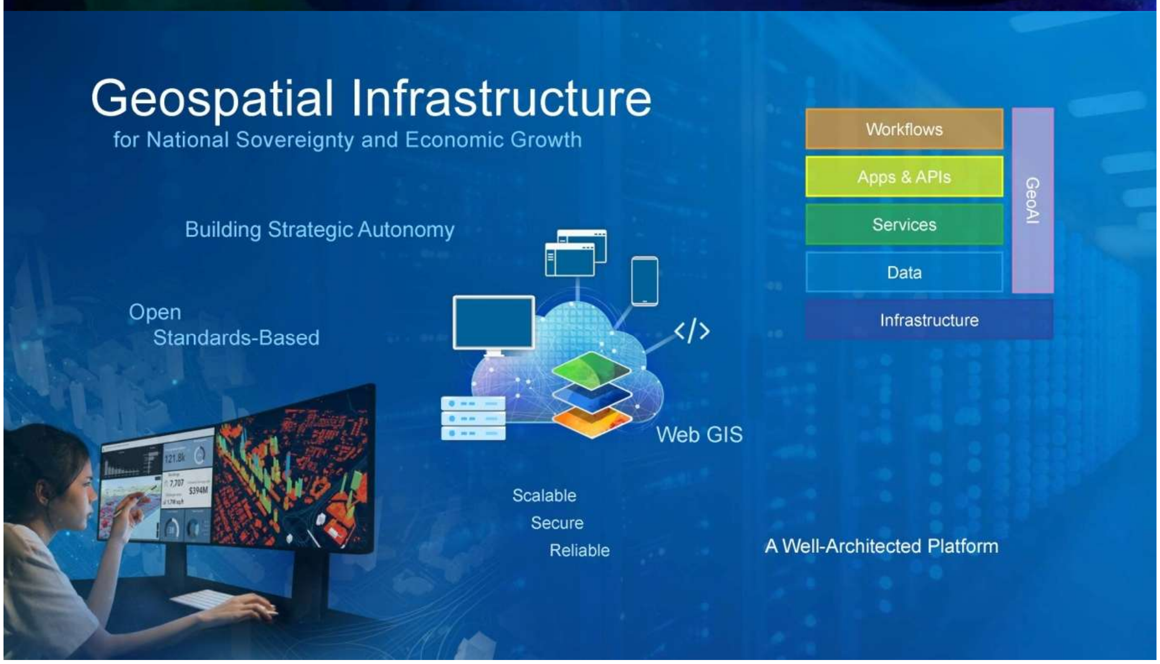

NIC's Role in India's Geospatial Ecosystem
Driving National Geospatial Transformation through Foundational Platforms
Bharat Maps
• Foundational national basemaps and multi-layer GIS datasets
• APIs enabling integration across governance applications
Indicators of National Impact:
Nationwide base coverage
Thousands of standardized layers
High-volume API consumption across central and state systems
OneMaps
• Standardized, authoritative geospatial layers
• Facilitates geospatial data usage by local authorities and municipal bodies for urban planning
Indicators of National Impact:
Adopted by numerous local authorities and municipal councils for urban transformation
Enhanced decision-making in urban planning and development

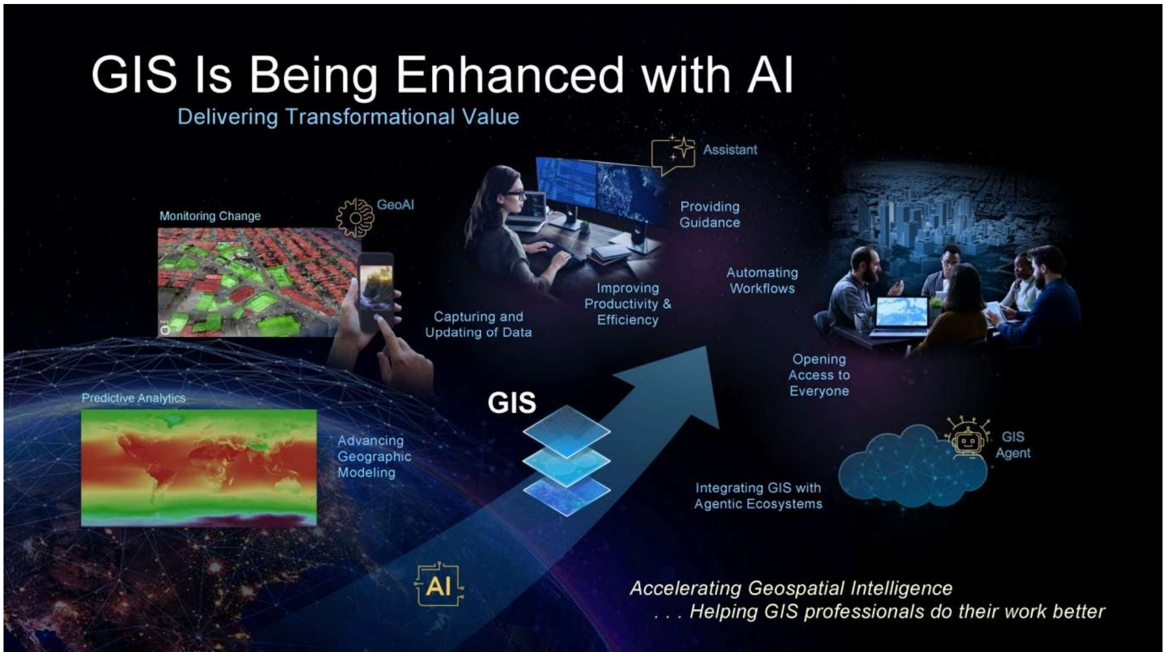

NIC's Role in India's Geospatial Ecosystem
Driving National Geospatial Transformation through Foundational Platforms
SVAMITVA
• Drone-based rural property mapping
• Digital land parcel records for governance and citizen services
Indicators of National Impact:
✓ Coverage of lakhs of villages
✓ Crores of property parcels mapped and digitized
PARIVESH
• GIS-enabled decision support for environmental clearances
• Integrated spatial analysis for faster approvals
Indicators of National Impact:
✓ Tens of thousands of project proposals processed
✓ Significant reduction in clearance timelines

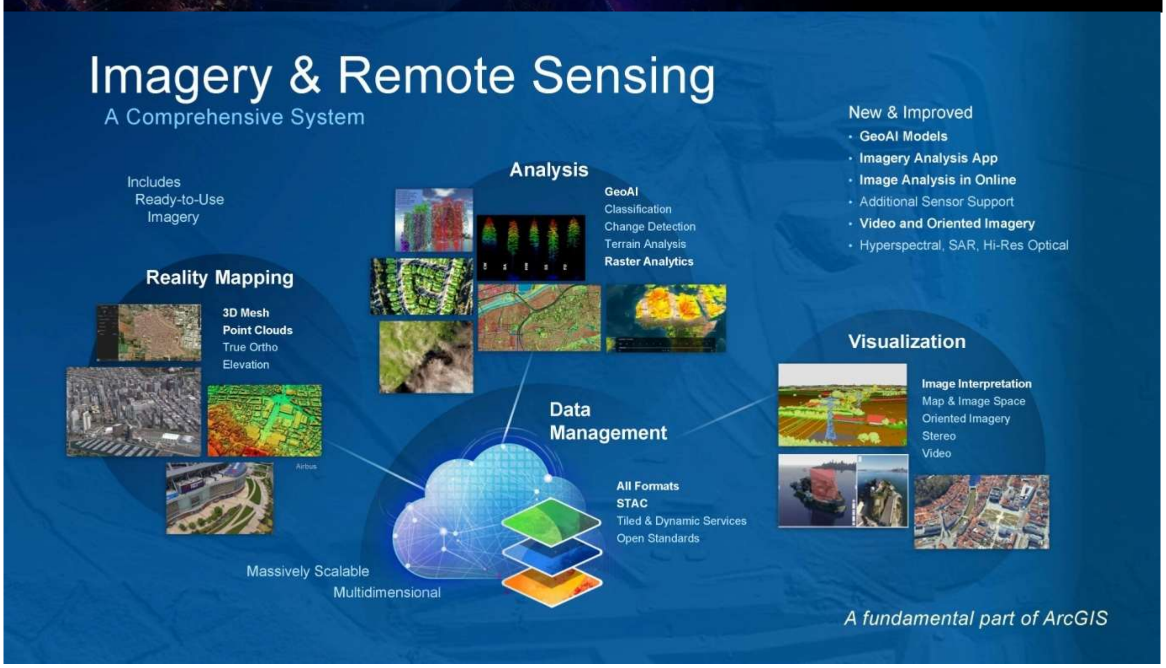

AI-DRIVEN GIS PROCESS FLOW: FROM DATA TO GOVERNANCE (NIC)
1. RAW DATA INPUTS
2. AI PROCESSING & AUTOMATION (NIC)
3. GOVERNANCE OUTCOMES & CAPABILITY BUILDING
LiDAR & Point Clouds
Satellite Imagery & Sensor Data
Hydrological & Environmental Data
Automated DTM / DSM Generation
from LiDAR & Point Clouds
AI-Based Hydrological Feature Extraction
Drainage Mapping, Flood Modeling, Risk Assessment
Enhanced Governance & Decision Support
Improved Drainage & Flood Management
Proactive Risk Mitigation
Better Flood Risk Assessment & Planning
Institutional Capacity Building
Centre of Excellence, Standards, Innovation, Integration
Diverse, high-volume datasets.
Advanced algorithms & machine learning for analysis.
Sustainable, informed, and resilient administration.
THE ROAD AHEAD — BUILDING A NATIONAL SPATIAL INTELLIGENCE BACKBONE
NEAR-TERM
(Foundation & Standards)
MID-TERM
(AI & Infrastructure Scale)
LONG-TERM
(Integration & Ecosystem Growth)
Build interoperable, open-standard geospatial platforms
Invest in AI-first, cloud-native, scalable infrastructure
Develop India-owned Geo-Spatial Foundational Models
Strengthen cross-sector integration (Urban, Agriculture, Energy, Environment)
National Spatial Intelligence Backbone (Fully Integrated)
Continuous Innovation & Resilient Public Service Delivery
PLATFORMS
Open-Standard, Interoperable
AI-First, Cloud-Native
Unified National Platforms
INFRASTRUCTURE
Cloud-Native, Scalable
High-Performance AI Computing
National Data Backbone
MODELS & DATA
India-Owned Data & Models
Geo-Spatial Foundational Models
Advanced Predictive & Real-Time Insights
INTEGRATION
Cross-Sector Pilots
Sector-Specific Applications (Urban, Agri, etc.)
Holistic National Integration


CLOSING PERSPECTIVE
THE FUTURE OF GEOSPATIAL: SYSTEMS THAT ARE...
INTELLIGENT
AI-powered predictive insights
IMMERSIVE
3D Visualization & Digital Twins
AUTOMATED
Streamlined processes & updates
REAL-TIME
Continuous data flow & monitoring
INDIA'S LEADERSHIP - CONVERGENCE ENGINE
AI
Artificial Intelligence
CLOUD
Scalable Infrastructure
3D
Spatial Modeling
IoT
Sensor Networks
DIGITAL TWINS
Virtual Representations
RESILIENT, FUTURE-READY GEOSPATIAL FOUNDATION
CRITICAL FOR GOVERNANCE AT SCALE
Data-driven decision making, sustainable development, and efficient public service delivery.


Technological Advancements
. . . . . . in Geospatial Field
Integrating Everything, Everywhere
Agendra Kumar
Esri India


Geospatial Infrastructure
for National Sovereignty and Economic Growth
Building Strategic Autonomy
Open
Standards-Based
Web GIS
Scalable
Secure
Reliable
Workflows
Apps & APIs
Services
Data
Infrastructure
GeoAI
A Well-Architected Platform

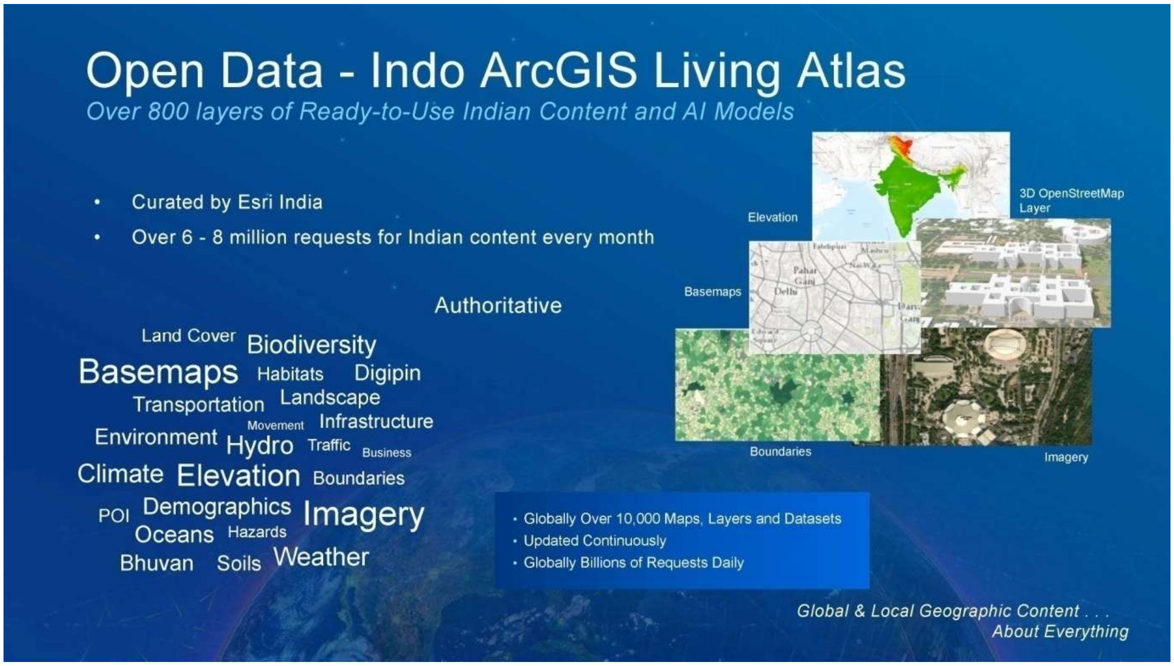

GIS Is Being Enhanced with AI
Delivering Transformational Value
Assistant
Providing Guidance
Monitoring Change
GeoAI
Automating Workflows
Improving Productivity & Efficiency
Capturing and Updating of Data
Opening Access to Everyone
Predictive Analytics
GIS
Advancing Geographic Modeling
GIS Agent
Integrating GIS with Agentic Ecosystems
AI
Accelerating Geospatial Intelligence
. . . Helping GIS professionals do their work better


Imagery & Remote Sensing
A Comprehensive System
New & Improved
GeoAI Models
Imagery Analysis App
Image Analysis in Online
Additional Sensor Support
Video and Oriented Imagery
Hyperspectral, SAR, Hi-Res Optical
Includes Ready-to-Use Imagery
Analysis
GeoAI
Classification
Change Detection
Terrain Analysis
Raster Analytics
Reality Mapping
3D Mesh
Point Clouds
True Ortho
Elevation
Visualization
Image Interpretation
Map & Image Space
Oriented Imagery
Stereo
Video
Data Management
All Formats
STAC
Tiled & Dynamic Services
Open Standards
Massively Scalable
Multidimensional
A fundamental part of ArcGIS


Reality Mapping for GIS
Creates Accurate Representations
. . . Using Drone, Aerial & Satellite Imagery
ArcGIS Reality
Satellite
Aerial
Drone
Outputs
• 3D Meshes
• True Orthos
• Orthomosaics
• Surface Models
• Point Clouds
• Gaussian Splats (Coming)
Aerial — Prague, Czech Republic
Courtesy of IPR Praha
Satellite — Beirut, Lebanon
Courtesy of Maxar
New & Improved
• Mesh Editing
• Lidar Integration
Supporting Local to National Scales
Modernizing photogrammetry . . .
. . . Fueling 3D digital twins


3D GIS
Enabling Living Digital Twins
Analytics
Building Extraction
Advanced Point Cloud Processing
Web Analytics
Visualization
New Tree Library
Urban Digital Twin
Immersive
Mobile
Global Visualization
XR Viewer
Data Management
Point Cloud
3D Editing
Mesh & BIM
3D Feature & Building Layers
Voxel Layer
Many 3D Formats
(Mesh, BIM . . .
. . . 3D Tiles, Terrains)
New & Improved
• 3D Feature Performance
• 3D Building Layer
• Web Analytics
• Volumetric Clouds
• 3D Tiles
• KML Tracks
• Elevation Data Quality Tools
• XR Viewer (beta)
Coming Soon
• Gaussian Splats
• CityGML


Geospatial Data Management
Improving Capabilities & Workflows
Geodatabase
Prune Branch History
Attribute Rules Templates
Utility Network Migration
Full-Text Search
Longer Field Names
Offline Capabilities
Industry Models (Parcels, Utilities . . .)
Editing
ArcGIS Web Editor
Unified Metadata Editor (Pro & Web)
OCR COGO Entry
Vertices and Node Display
Nonversioned Editing
3D Features & Meshes
Feature Template Sharing
Data Integration
New Formats (NoSQL, GeoParquet . . .)
ArcGIS Data Pipelines
AI Assistant for Query Layers (beta)
Automate Connection
Data Engineering Tools
Cloud Storage and Data Lakes
Microsoft Power Platform
Real-Time
Integrating Sensors & Dynamic Data
FlightAware Aircraft Positions
On-Time Transit Performance
Analysis
Alerting & Actuation
Visualization
Data Management
Ingestion
Velocity
SaaS
GeoEvent Server
Software
New & Improved
Ready-to-Use Feeds
Notifications & Automation
Industry-Focused Solutions
Coming
Velocity for Enterprise
More Partner Integrations
Supporting operations & improving decision making


Open Data - Indo ArcGIS Living Atlas
Over 800 layers of Ready-to-Use Indian Content and AI Models
• Curated by Esri India
• Over 6 - 8 million requests for Indian content every month
Authoritative
Land Cover Biodiversity
Basemaps Habitats Digipin
Transportation Landscape
Movement Infrastructure
Environment Hydro Traffic Business
Climate Elevation Boundaries
POI Demographics Imagery
Oceans Hazards
Bhuvan Soils Weather
Elevation
3D OpenStreetMap Layer
Basemaps
Boundaries
Imagery
• Globally Over 10,000 Maps, Layers and Datasets
• Updated Continuously
• Globally Billions of Requests Daily
Global & Local Geographic Content . . .
About Everything

सत्यमेव जयते

SVAMITVA SCHEME

Survey of Villages and Mapping with Improvised Technology in Village Areas

Ministry of Panchayati Raj
Government of India

17 December 2025

1

Ministry of Panchayati Raj, GoI

सत्यमेव जयते

About Svamitva Scheme

Panchayati Raj

SVAMITVA (FY 2020-26) aims to provide the 'Record of Rights' to village household owners in rural inhabited (abadi) areas and issuance of Property cards

- National: Ministry of Panchayati Raj
- State/UT: Revenue Department/ Panchayati Raj Department
- Technology Partner: Survey of India
- Covers all rural inhabited areas.
- Use of CORS Network for ground control Points.

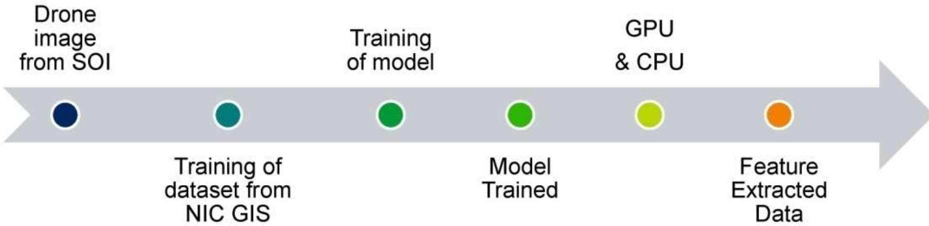
Gram Manchitra: Gram Manchitra is a unified Geo Spatial Platform meant for Rural Local Bodies. It is a Spatial Planning Application that has tools for facilitating and supporting Gram Panchayat users to draw plans for the use of Geo-spatial Technology. The 1:500 scale SVAMITVA maps, in the coming four years, shall also be used to enhance applications and strengthen the State's capacity to leverage them.

2

Ministry of Panchayati Raj, GoI

Feature extraction process flow using AI/ML

Panchayati Raj



Extracted features List

S.no	Spatial data layer	Layer type	Layer Description
1	Roof top	Polygon	Feature extraction type of roof as RCC,Tiled,others
2	Road	Polygon	Road based on width to be captured as polygon feature
3	Water Body	Polygon	All available water bodies extracted as polygon feature
4	Others	Points	Transformer, Electric pole, based on availability

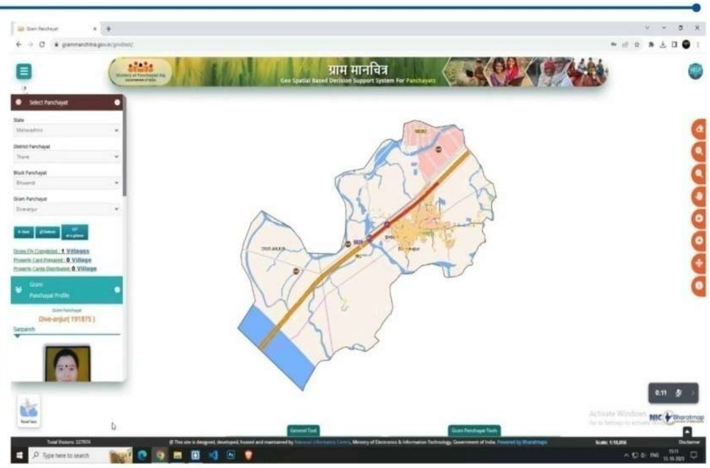
3

Ministry of Panchayati Raj, GoI

AI/ML-Based Solar Potential Assessment Using SVAMITVA Data

Panchayati Raj

1. Select Roof Type
2. Selected Roof Type Highlighted
3. Select Panel Capacity



Solar Panel Based Visualization

4

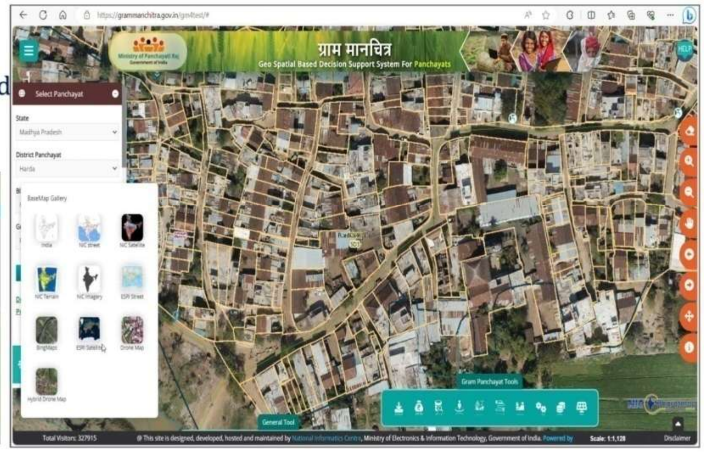
Ministry of Panchayati Raj, GoI

सत्यमेव जयते

SVAMITVA Data-Driven AI/ML Visualization for Village Travel Feasibility

Panchayati Raj

1. Select Source & Destination
2. Select vehicle Type
3. Vehicle Allowed in Green Color Road
4. Live vehicle navigation



Village Travel Feasibility Analysis with various vehicles

5

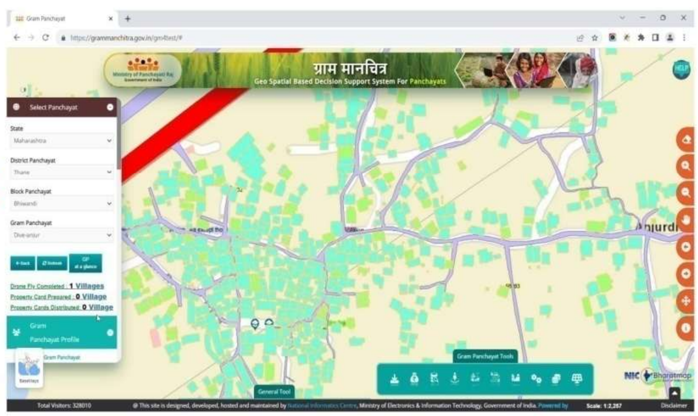
Ministry of Panchayati Raj, GoI

सत्यमेव जयते

SVAMITVA Data-Driven,AI/ML-Enabled Property Tax Visualization

Panchayati Raj

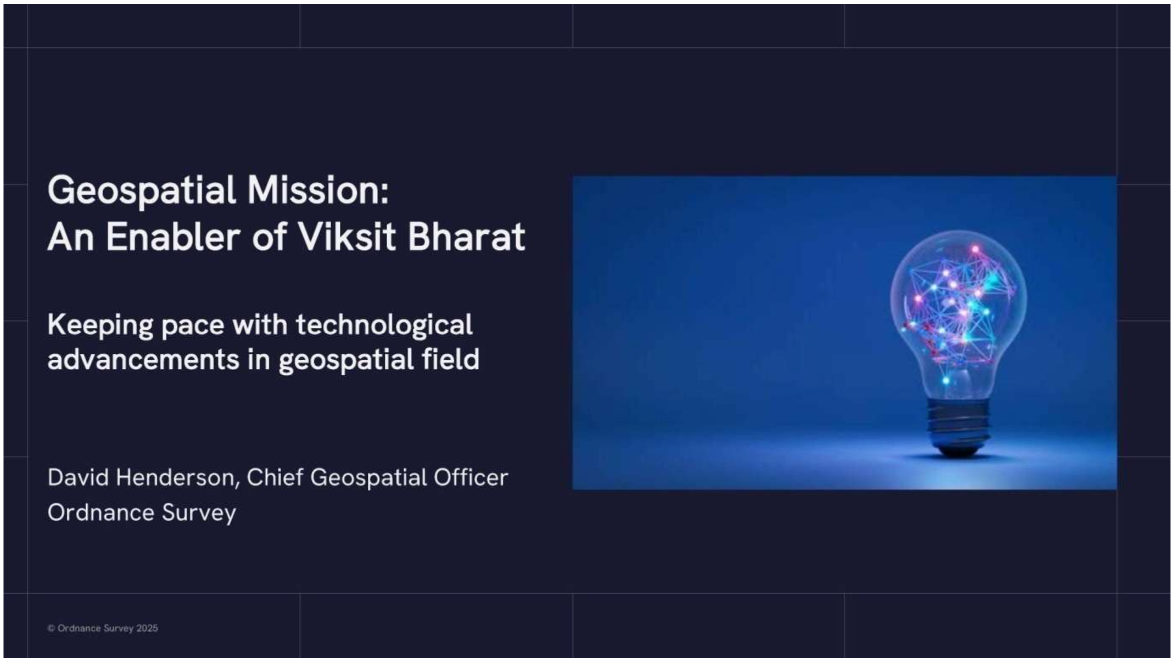
1. Select Area-wise & Individual Property Tax
2. Select roof area count
3. Live visualization of tool

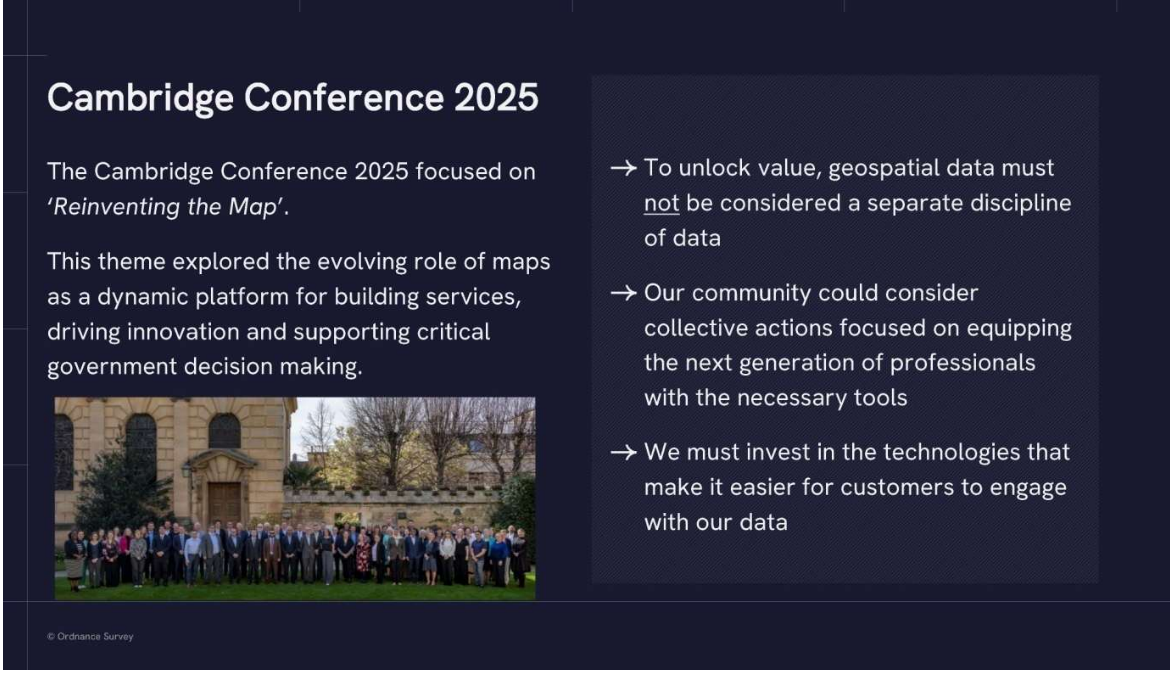


Property Tax Visualization

6

Ministry of Panchayati Raj, GoI


Geospatial Mission:
An Enabler of Viksit Bharat
Keeping pace with technological advancements in geospatial field
David Henderson, Chief Geospatial Officer
Ordnance Survey
© Ordnance Survey 2025


Cambridge Conference 2025
The Cambridge Conference 2025 focused on 'Reinventing the Map'.
This theme explored the evolving role of maps as a dynamic platform for building services, driving innovation and supporting critical government decision making.
→ To unlock value, geospatial data must not be considered a separate discipline of data
→ Our community could consider collective actions focused on equipping the next generation of professionals with the necessary tools
→ We must invest in the technologies that make it easier for customers to engage with our data
© Ordnance Survey

Harnessing the value of data

By 2035, UK will be a global leader in data-driven innovation enabled by a robust, secure, interoperable data infrastructure which supports enhanced public services, improves productivity and delivers sustainable growth.

1. Treat data as socio-economic asset

Create right conditions for investment in data and how value is realised across the economy

2. Provide tools, infrastructure + capabilities

To businesses, innovators and public sector to confidently and responsibly produce and use data

3. Transform how data is used

Empower individuals / businesses to do more with data by making it easier to use, leveraging AI

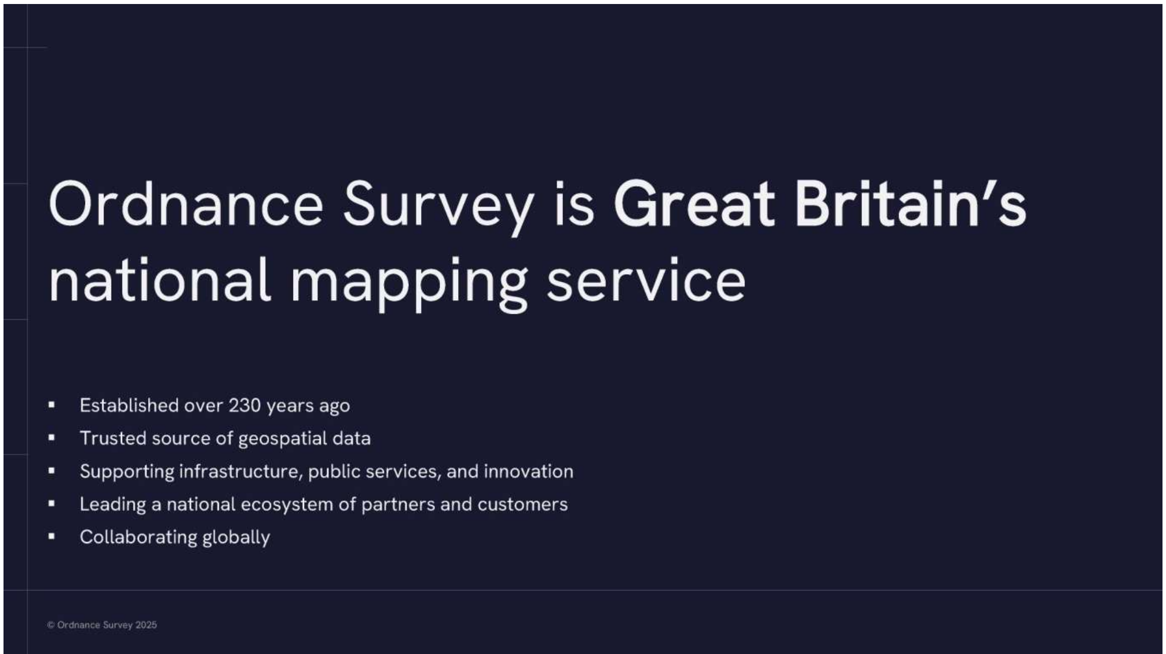
Source: The UK's Modern Industrial Strategy 2025

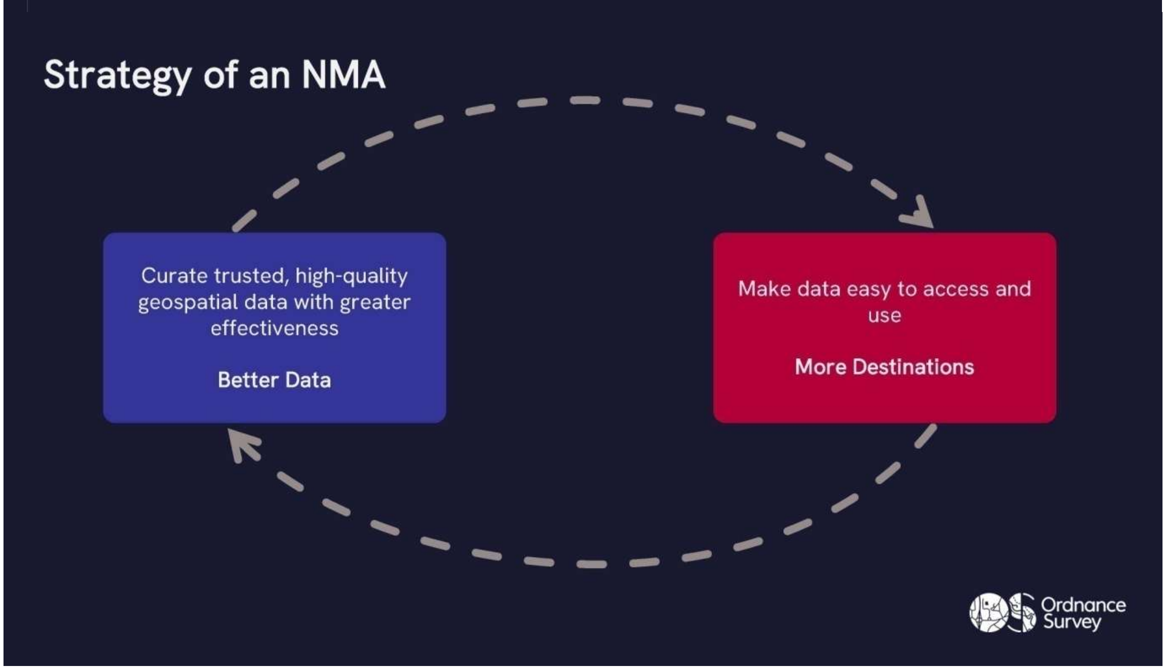
Foresight 2030

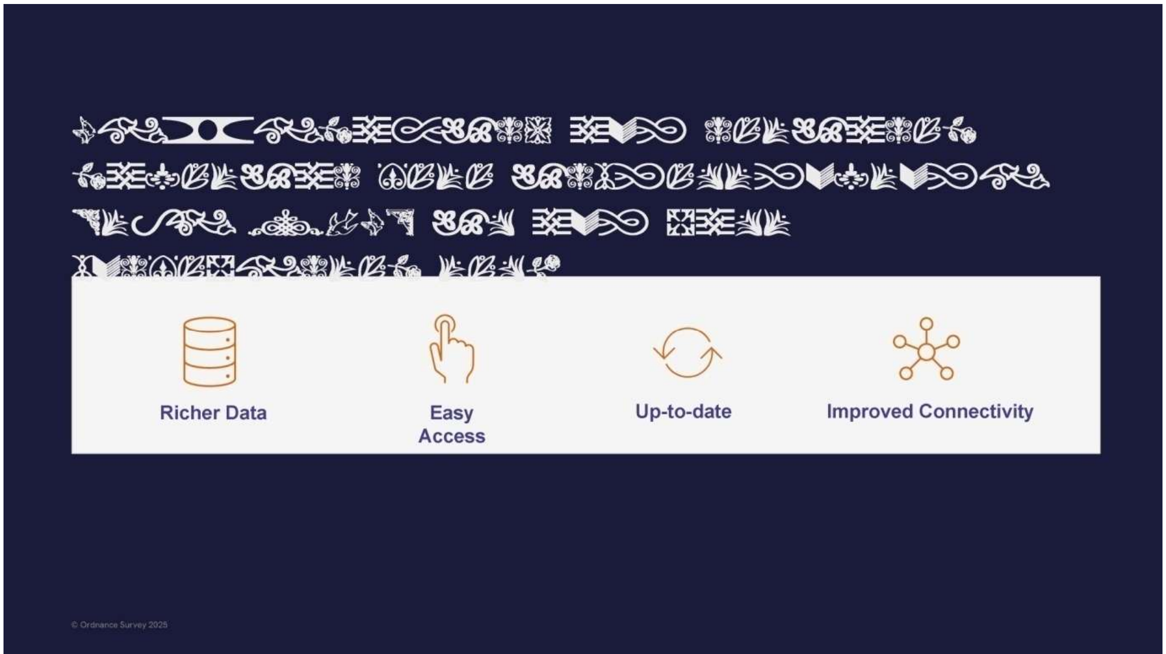
The UK's Association for Geographic Information - a member driven organisation, recently published a strategic foresight report for the industry.

THE 2030 AGI FORESIGHT THEMES

1. **DATA IN THE WORLD OF GEOSPATIAL:** THE NEXT TRANSFORMATION
2. **ARTIFICIAL INTELLIGENCE IN GEOSPATIAL:** PROMISE, PERIL AND THE PATH FORWARD
3. **INTEROPERABILITY AND INFRASTRUCTURE IN GEOSPATIAL:** EVOLUTION OVER THE NEXT FIVE YEARS
4. **THE GREAT SKILLS SHIFT:** HOW GEOSPATIAL EDUCATION MUST EVOLVE FOR AN EMBEDDED FUTURE
5. **COLLABORATION IN GEOSPATIAL:** EVOLUTION AND FUTURE TRAJECTORIES
6. **EARTH SYSTEMS EVOLUTION:** THE GEOSPATIAL-DIGITAL TWIN NEXUS TRANSFORMING CLIMATE, FINANCE AND CONSTRUCTION

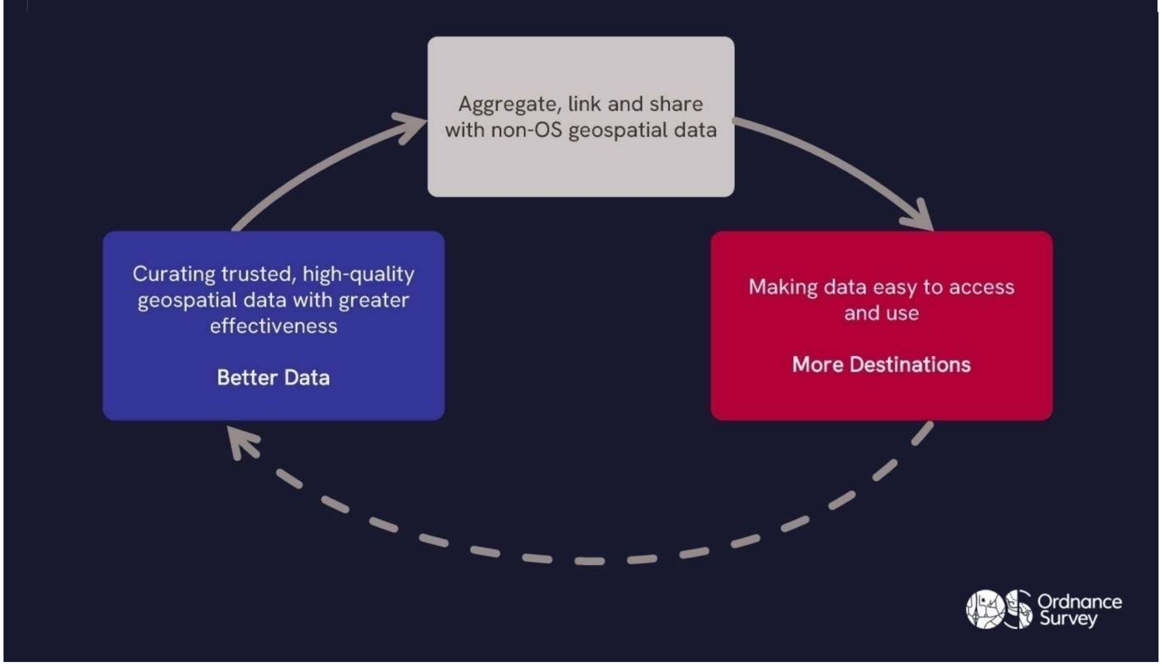

Ordnance Survey is **Great Britain's** national mapping service
▪ Established over 230 years ago
▪ Trusted source of geospatial data
▪ Supporting infrastructure, public services, and innovation
▪ Leading a national ecosystem of partners and customers
▪ Collaborating globally
© Ordnance Survey 2025

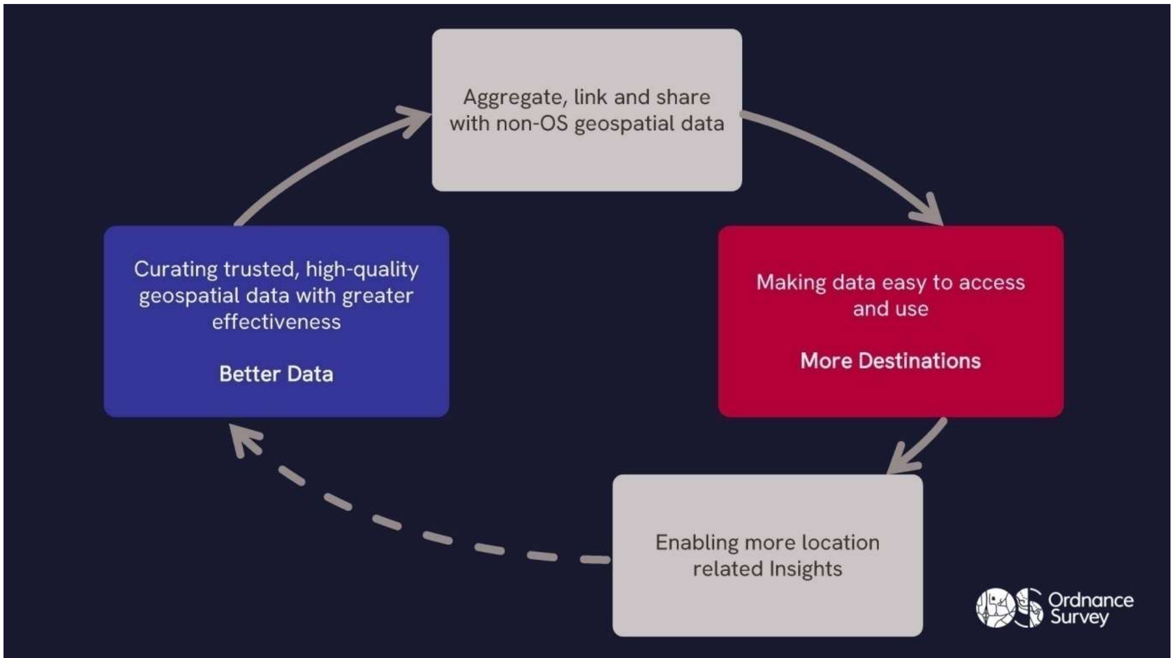

Strategy of an NMA
Curate trusted, high-quality geospatial data with greater effectiveness
Better Data
Make data easy to access and use
More Destinations
Ordnance Survey

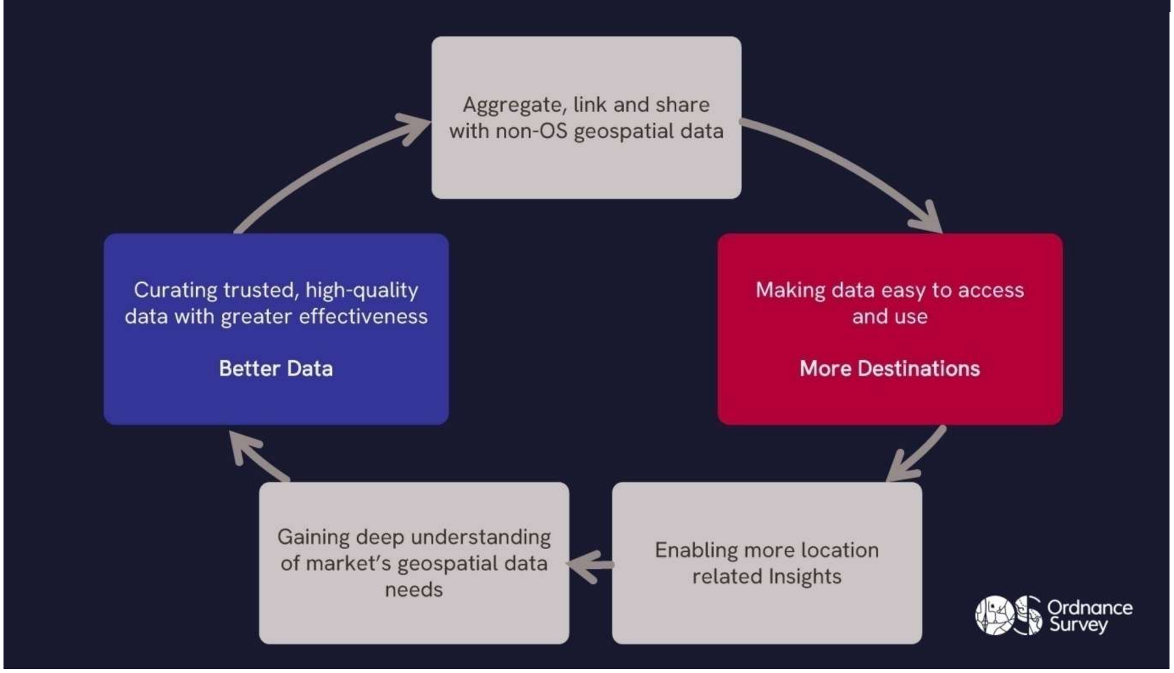

Richer Data
Easy Access
Up-to-date
Improved Connectivity
© Ordnance Survey 2025


The
AUTHORITATIVE DATA
that that unlocks the geography of Great Britain as the foundation to national data infrastructure
© Ordnance Survey
LAND USE
ADMINISTRATIVE & STATISTICAL UNITS
ADDRESS
LAND
TRANSPORT
BUILDINGS
WATER
STRUCTURES
GEOGRAPHICAL NAMES


Innovation in action
Real-time property data via OS NGD
Data fusion for better insights
AI-enhanced feature extraction and updating
International geospatial infrastructure for resilience and digital governance
Digital twins for smarter cities
The most advanced map of GB —built for everyone
ROUTING OPTIMISATION
© Ordnance Survey


Aggregate, link and share with non-OS geospatial data
Curating trusted, high-quality geospatial data with greater effectiveness
Better Data
Making data easy to access and use
More Destinations
Ordnance Survey


Aggregate, link and share with non-OS geospatial data
Making data easy to access and use
More Destinations
Enabling more location related Insights
Curating trusted, high-quality geospatial data with greater effectiveness
Better Data
Ordnance Survey


Aggregate, link and share with non-OS geospatial data
Making data easy to access and use
More Destinations
Enabling more location related Insights
Gaining deep understanding of market's geospatial data needs
Curating trusted, high-quality data with greater effectiveness
Better Data
Ordnance Survey

Interoperability by design

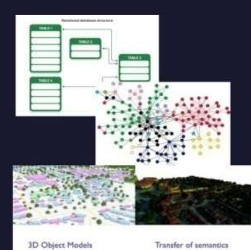
- → **Global Standards Driving Interoperability:** OGC, ISO Standards and Internal Data Discovery.
- → **National Geographic Database (NGD)** designed for **API-first delivery**.
- → **Feature-based data model** for flexible integration.
- → **Open APIs** and **Data Hub** provide interoperable access for developers and partners.

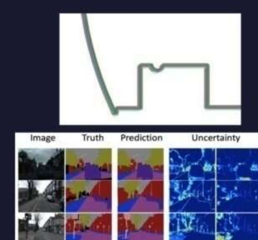
Solving some infrastructure challenges

Testing and assuring positional accuracy

Exploring and deriving data from new sources

Linking data from different sources to deliver new insight





Measuring and communicating uncertainty


Geospatial acts as a coordinate system for modern data infrastructures
Spatial backbone
Connectivity
Location insights
Dynamic
© Ordnance Survey 2025

Keeping Pace with Technological Advancements in the Geospatial Field

From Maps to National Decision Infrastructure

Dr. Roshan K. Srivastav

Associate Professor, IIT Tirupati
Project Director – Technology Innovation Hub (NM-ICPS)
Head – Geo-Intel Lab, IITTirupati National Innovation Foundation

What Does "Keeping Pace" Really Mean?

It is NOT merely

- Higher-resolution satellite data
- New sensors or platforms
- AI algorithms or cloud infrastructure
- Technology adoption alone

True progress REQUIRES

- Institutions evolving at technology's speed
- Platforms translating data into actionable decisions
- Workforce ready to absorb and apply advances
- Measurable governance outcomes

Critical Insight: If governance outcomes do not demonstrably improve, we are not truly keeping pace with technological advancement.

Why Keeping Pace Is Challenging Today

Speed Mismatch
Technology evolves exponentially faster than institutional systems can adapt

Decision Gap
Abundant data exists, but limited translation into policy impact and outcomes

Scale Barrier
Numerous successful pilots, but very few achieve scalable platform status

Skill Concentration
Expertise remains concentrated in pockets, not embedded across institutions

Fragmentation
Limited interoperability and coordination across departments and levels

> The real gap is no longer innovation — it is **institutionalisation** and systematic deployment.

Pillar 1: Geospatial Workforce

From GIS Users to Spatial Decision-Makers

Geospatial transformation is fundamentally **people-driven**. Every ministry, department, and governance unit now requires embedded geospatial capability.

Workforce must become

- Governance-ready and policy-aware
- Platform-literate across technologies
- Cross-disciplinary and collaborative

1 ❌ **Project-Based GIS Manpower**
Temporary consultants for specific tasks

2 ✅ **Embedded Geospatial Workforce**
Permanent institutional capability across levels

Foundational Truth: Human capital is the most critical geospatial infrastructure investment a nation can make.

Pillar 2: Foundational & PNT Infrastructure

Positioning, Reference Frames & Trust

Robust foundational infrastructure enables reliable, interoperable geospatial systems at national scale.

Core Components

- Geodetic reference frameworks (ITRF compatibility)
- CORS networks for continuous positioning
- NavIC & GNSS integration for sovereignty
- Precise timing and synchronisation systems

Critical Applications

- Autonomous drones and logistics operations
- Real-time infrastructure health monitoring
- Rapid disaster response coordination
- Strategic autonomy in positioning services

> Without reliable, accurate positioning infrastructure, digital governance systems remain fundamentally incomplete.

Pillar 3: GIS & Remote Sensing Platforms

From Static Maps to Operational Decision Systems

1. **Siloed Systems** — Fragmented departmental GIS implementations
2. **Shared Platforms** — Federated, interoperable national infrastructure
3. **Static Data** — Periodic maps and archived datasets
4. **Live Intelligence** — Real-time spatial decision support systems

Integrated Data Ecosystem

Satellite Data
Multi-sensor EO streams

Ground Surveys
Field validation & verification

Digital Twins
Dynamic urban & infrastructure models

Administrative Datasets
Census, land records, schemes

Next-generation GIS platforms transform isolated data into coordinated, evidence-based action across governance levels.

Pillar 4: AI & Machine Learning in Geospatial

Scaling Governance at National Level

National governance operates at **massive scale** — manual analysis cannot match the pace or scope required for effective decision-making.

Automated Feature Extraction

Rapid identification of infrastructure, land use, and built environment from imagery

Continuous Change Detection

Near real-time monitoring of urban growth, encroachment, and environmental shifts

Predictive Analytics

Forecasting spatial patterns for disaster risk, resource planning, and development

Decision Support at Scale

Automated insights for millions of locations, thousands of concurrent decisions

Core Principle: GeoAI is not about algorithmic sophistication for its own sake — it is about achieving **scalability** in governance decision-making.

Integration & Innovation Pipelines

From Pilots to Platforms

Federated Architecture

India requires **federated systems**, not monolithic centralised platforms.

Data must flow seamlessly across

- Central ministries and departments
- State government agencies
- District and local governance bodies
- Research and academic institutions

Structured Innovation Pipeline

1. **Problem Identification** — Real governance challenges
2. **Prototype Development** — Solution design & testing
3. **Pilot Deployment** — Field validation at scale
4. **National Scale-Up** — Institutionalised platform

Hackathons as governance instruments: Real problems, real datasets, real deployment pathways.

> Innovation creates tangible value only when it successfully reaches operational deployment and sustained usage.

What Can Be Done in the Next 24 Months?

A Doable National Roadmap

01

Identify Priority Use-Cases

Map high-impact geospatial applications across ministries and state departments

02

Create Reference Datasets

Develop standardised baseline data and development starter kits for rapid deployment

03

Standardise Interoperability

Establish APIs, data exchange protocols, and common technical standards

04

Build Workforce Pipelines

Continuous training programmes embedded across government, academia, and industry

05

Institutionalise Innovation Models

Systematic pathways from research prototypes to operational government platforms

Expected Outcomes

3×

Faster Adoption

Accelerated deployment timelines

60%

Reduced Duplication

Elimination of redundant efforts

10×

Measurable Impact

Quantifiable governance outcomes

Role of TIH & Geo-Intel Lab

A Cross-Cutting National Enabler

Technology Innovation Hub and Geo-Intel Lab function as a **translation and acceleration layer** connecting research, policy, and deployment.

Translation

Policy intent → deployable platforms and operational systems

Integration

GIS + RS + PNT + AI + Governance frameworks

Capacity Building

Workforce development across government, academia, startups

Acceleration

Pilots → scalable, sustainable national systems

Strategic Position: TIH under NM-ICPS enables Geo-Intel Lab to operate at the critical intersection of research excellence, governance needs, and deployment capability — essential for building national-scale geospatial systems.

GEOSPATIAL INTELLIGENCE AND APPLICATIONS LABORATORY (GEO-INTEL LAB), IITTNIF

Techonlogy Innovation Hub, IIT Tirupati
Advancing Spatial Intelligence and PNT Technologies for Innovation, Public Good & Digital Governance

KEY FOCUS AREAS

- GIS Applications
- Geophysical Exploration
- GNSS Reflectometry
- CORS
- VR/AR
- GDI Federated Node

ACTIVITIES/INITIATIVES

Vidya GIS
A national initiative to bring GIS into classrooms and empower with spatial thinking skills.

VIKAS
Bringing Business to Startups

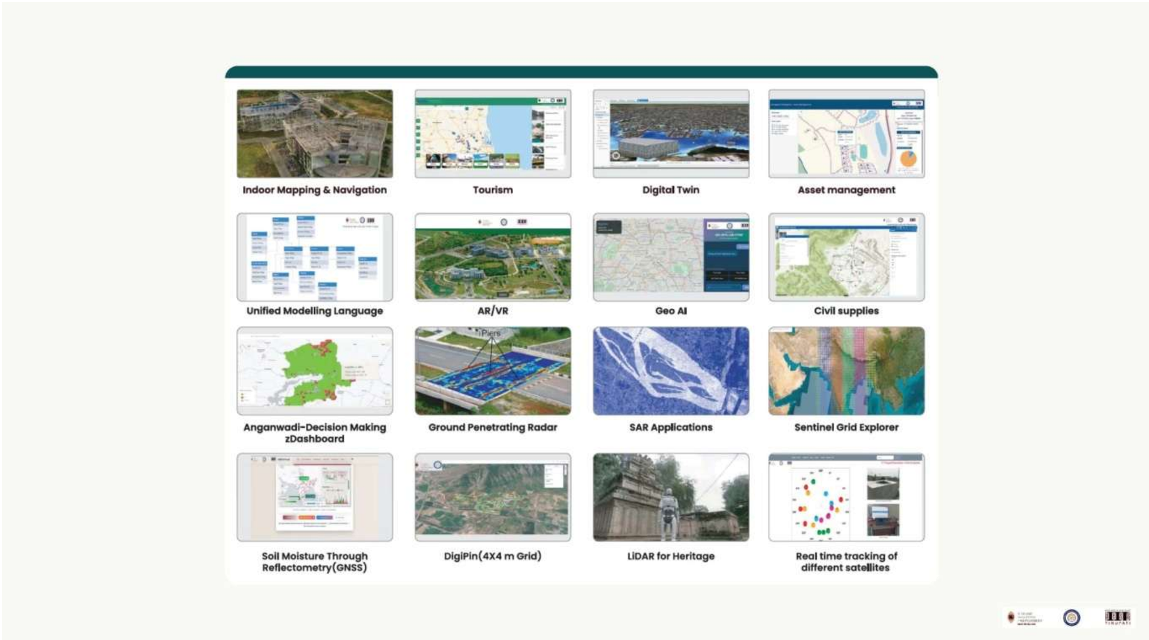
WINGS
Women in Navigation & Geospatial Solutions-Join to be a member

Academic Network

- **National SPIN Labs**
  SPIN Labs in academic institutes to foster innovation, support student startups, and build skills
  12 Partnering Institutions
  24+ Faculty | 100+ Students
- **Academic Network of Digital Twin**
  Virtual replicas enriched by geospatial data
- **Academic Network of NaVIC**
  Leveraging India's indigenous navigation system


60+ Platforms/Apps Onboarded
30+ Experts Onboarded
4+ Verticals
15+ Active Projects
50+ Partners & Collaborators
150+ Trained Professionals
4+ Professional Workshops
7+ Events/ Programs
1500+ Participants
200+ VIKAS
CENTERS/LABS
• PNT Lab - Safran India
• Center of Competence - Esri India
• Open Geospatial Consortium (OGC)
• CORS - Hyfix India
NATIONAL EVENTS/WORKSHOP
• Synthetic Aperture Radar • Research2Market
• Clear Skies Challenge- Ideathon & Hackathon
• NaVIC - The Game Changer • GeoCities
• Space Technologies and Applications- Ideathon & Hackathon
• Faculty Training Program on Geo-informatics and Applications
https://geo.intel.iittnif.com/ | Email: geo.intel@iittnif.com | Phone: +91-9154746805


KEY PARTNERS
FLAGSHIP PROJECTS
• Smart Tourism
• Digital Twin- Disaster Management
• LiDAR for Heritage
• Civil Supplies - Decision Making Dashboard
• Indoor Mapping & Navigation
• GNSS Reflectometry
• Geophysical Exploration
• Asset Management
• Space Archaeology
• Geodesy • Geo AI


Indoor Mapping & Navigation
Tourism
Digital Twin
Asset management
Unified Modelling Language
AR/VR
Geo AI
Civil supplies
Anganwadi-Decision Making zDashboard
Ground Penetrating Radar
SAR Applications
Sentinel Grid Explorer
Soil Moisture Through Reflectometry(GNSS)
DigiPin(4X4 m Grid)
LiDAR for Heritage
Real time tracking of different satellites


IIT Tirupati Navavishkār I-Hub Foundation
भारतीय प्रौद्योगिकी संस्थान तिरुपति
TIRUPATI
पंचायती राज मंत्रालय
Ministry of Panchayati Raj
NIC
National Informatics Centre
Geospatial Intelligence – Hackathon Challenge
Powered by: Geospatial Intelligence and Applications Laboratory, IITTNiF
A national-level innovation challenge focused on
AI/ML-based geospatial solutions for Smart Rural Planning, leveraging drone imagery and point-cloud data to support Digital Governance and Viksit Bharat 2047.

Closing Thought

> Keeping pace with technological advancements in geospatial is not about chasing technology trends.
> **It is about systematically building trusted platforms, institutional capacity, and decision systems that can serve India's governance needs for decades to come.**

That is how geospatial becomes an enabler of *Viksit Bharat*

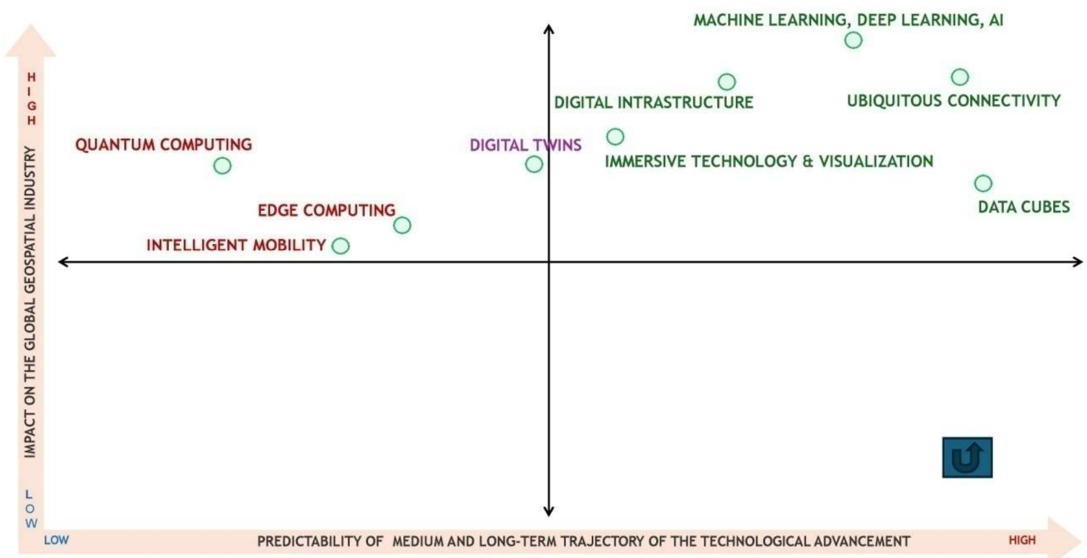
Dr. Roshan K. Srivastav
Geo-Intel Lab, IITTNiF | Technology Innovation Hub (NM-ICPS)

विज्ञान एवं प्रौद्योगिकी विभाग
DEPARTMENT OF
SCIENCE & TECHNOLOGY

भारतीय सर्वेक्षण विभाग
Survey of India
विज्ञान और प्रौद्योगिकी विभाग
Department of Science & Technology

Keeping Pace With Technological Advancement in Geospatial Domain

Presented by: Shri. Shailesh Kumar Sinha
Additional Surveyor General
Survey of India
Date: 17-12-2025, New Delhi



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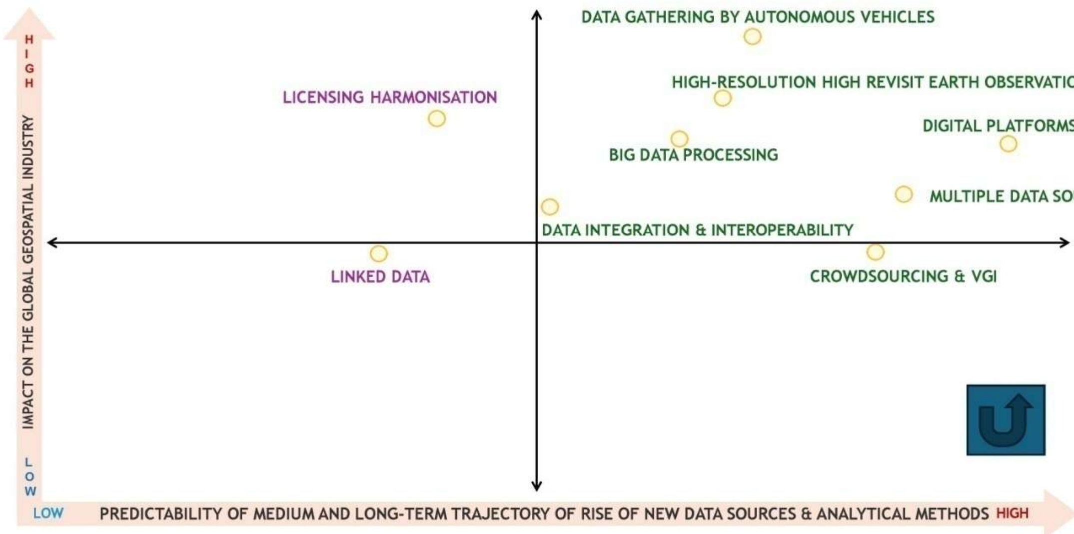
DATA GATHERING BY AUTONOMOUS VEHICLES
HIGH-RESOLUTION HIGH REVISIT EARTH OBSERVATION
LICENSING HARMONISATION
DIGITAL PLATFORMS
BIG DATA PROCESSING
MULTIPLE DATA SOURCES
DATA INTEGRATION & INTEROPERABILITY
LINKED DATA
CROWDSOURCING & VGI
HIGH
IMPACT ON THE GLOBAL GEOSPATIAL INDUSTRY
LOW
LOW
PREDICTABILITY OF MEDIUM AND LONG-TERM TRAJECTORY OF RISE OF NEW DATA SOURCES & ANALYTICAL METHODS
HIGH

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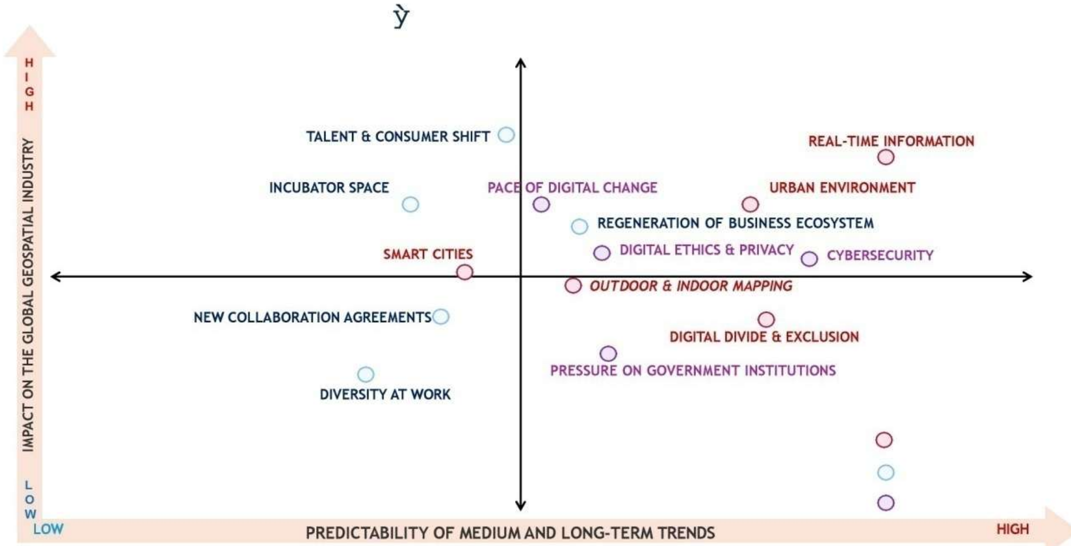
TALENT & CONSUMER SHIFT
REAL-TIME INFORMATION
INCUBATOR SPACE
PACE OF DIGITAL CHANGE
URBAN ENVIRONMENT
REGENERATION OF BUSINESS ECOSYSTEM
SMART CITIES
DIGITAL ETHICS & PRIVACY
CYBERSECURITY
OUTDOOR & INDOOR MAPPING
NEW COLLABORATION AGREEMENTS
DIGITAL DIVIDE & EXCLUSION
PRESSURE ON GOVERNMENT INSTITUTIONS
DIVERSITY AT WORK
HIGH
IMPACT ON THE GLOBAL GEOSPATIAL INDUSTRY
LOW
LOW
PREDICTABILITY OF MEDIUM AND LONG-TERM TRENDS
HIGH

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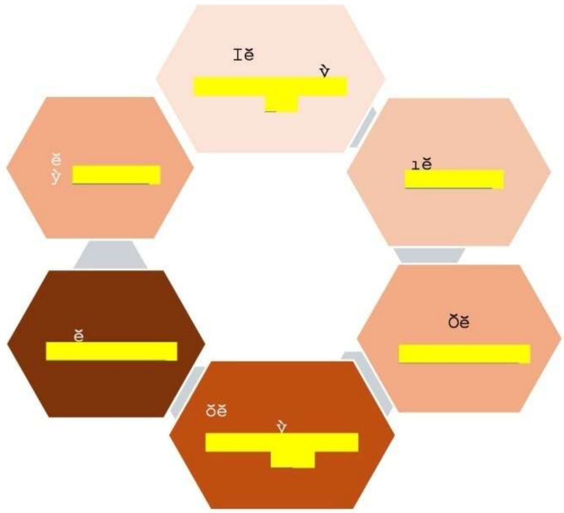

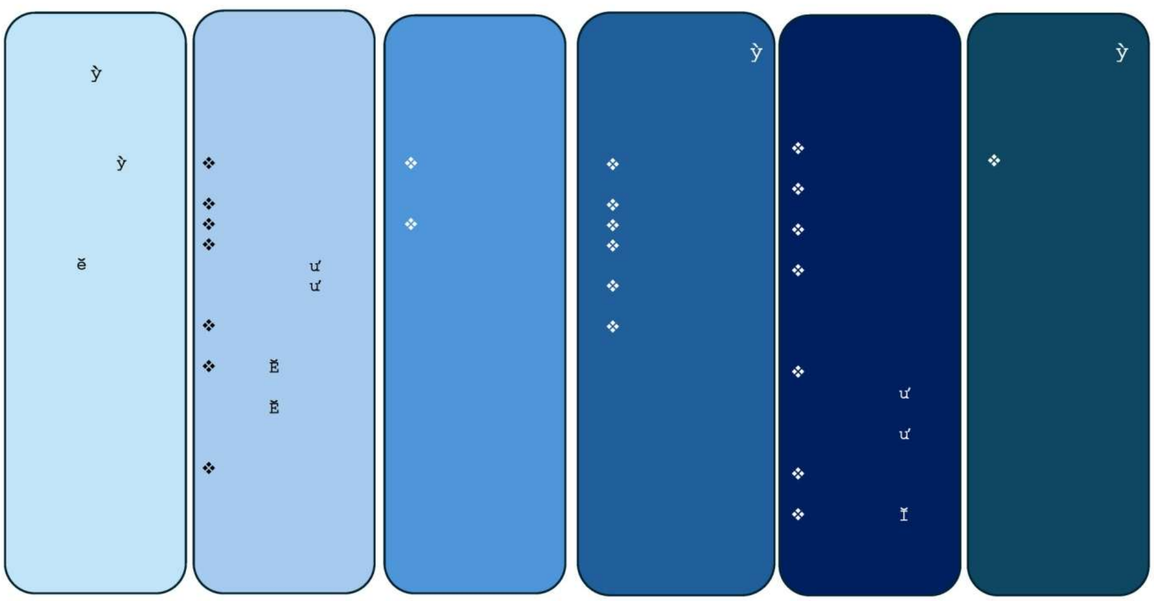


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Department of Science & Technology
THANK YOU..!!
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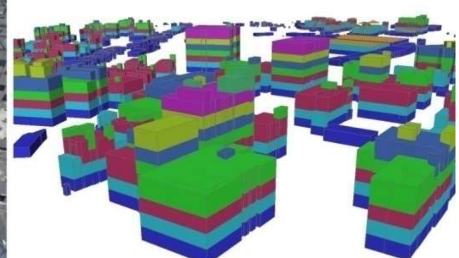

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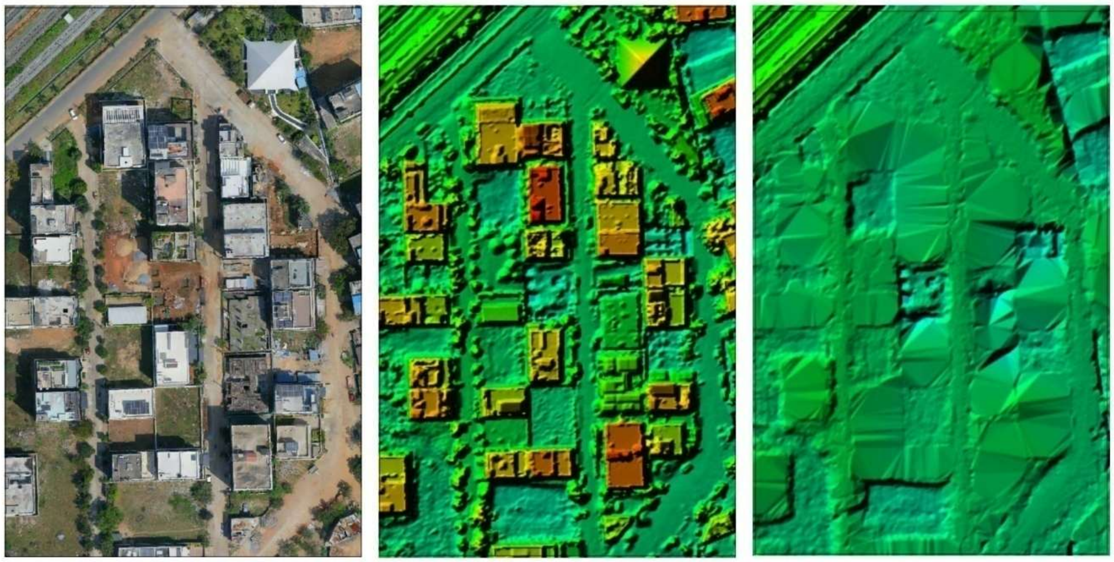
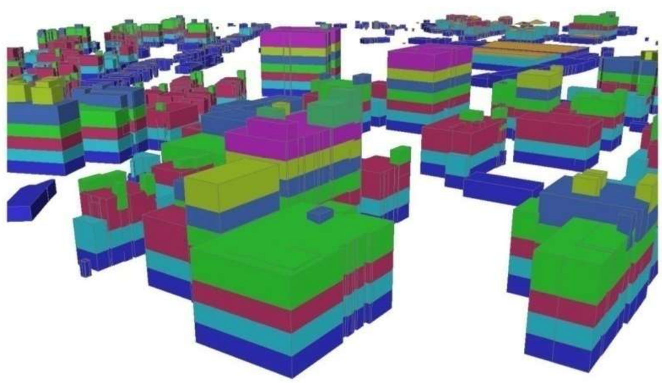
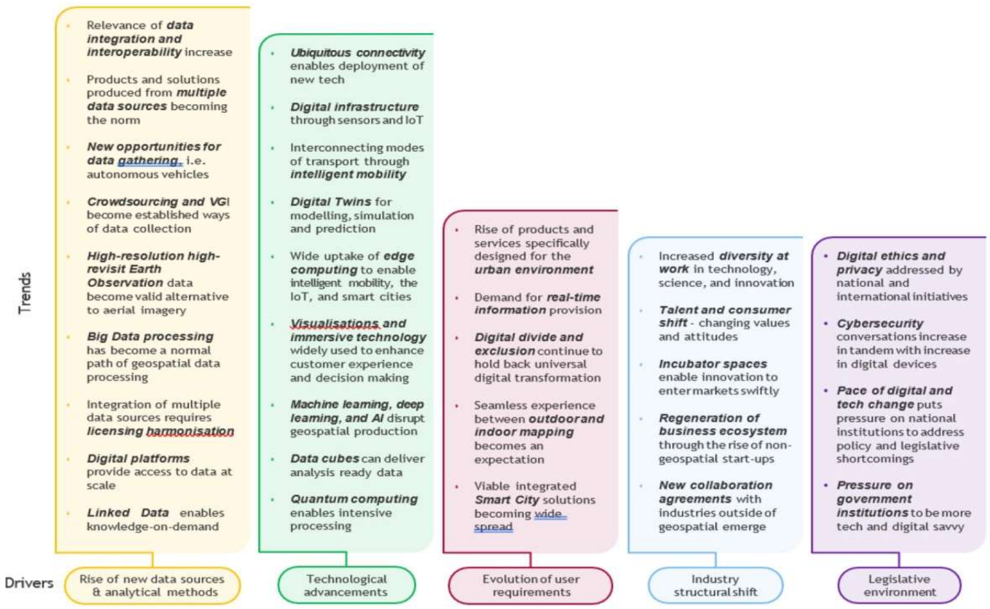
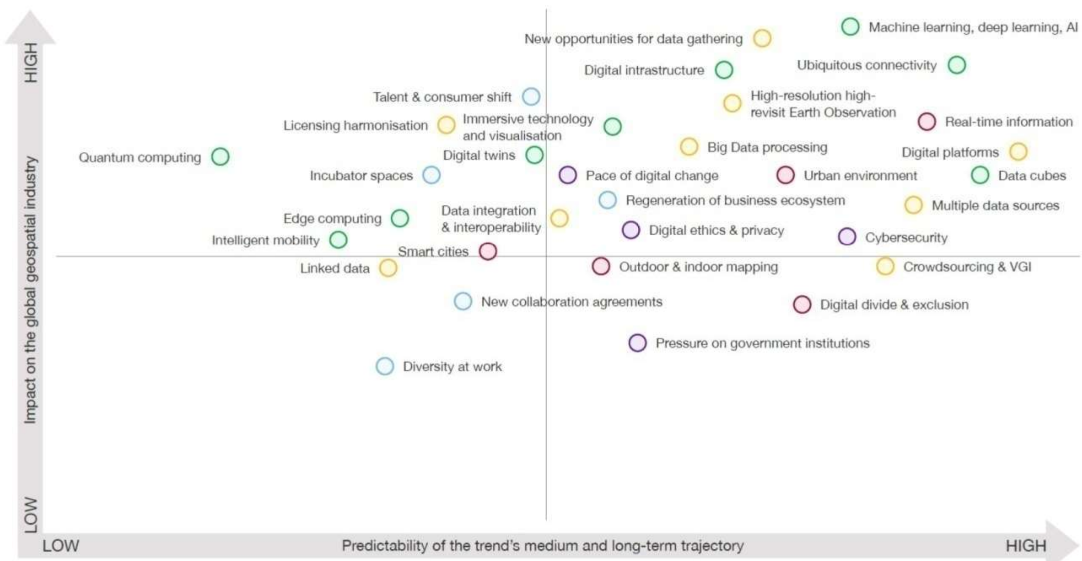





Trends
Relevance of data integration and interoperability increase
Products and solutions produced from multiple data sources becoming the norm
New opportunities for data gathering, i.e. autonomous vehicles
Crowdsourcing and VGI become established ways of data collection
High-resolution high-revisit Earth Observation data become valid alternative to aerial imagery
Big Data processing has become a normal path of geospatial data processing
Integration of multiple data sources requires licensing harmonisation
Digital platforms provide access to data at scale
Linked Data enables knowledge-on-demand
Ubiquitous connectivity enables deployment of new tech
Digital infrastructure through sensors and IoT
Interconnecting modes of transport through intelligent mobility
Digital Twins for modelling, simulation and prediction
Wide uptake of edge computing to enable intelligent mobility, the IoT, and smart cities
Visualisations and immersive technology widely used to enhance customer experience and decision making
Machine learning, deep learning, and AI disrupt geospatial production
Data cubes can deliver analysis ready data
Quantum computing enables intensive processing
Rise of products and services specifically designed for the urban environment
Demand for real-time information provision
Digital divide and exclusion continue to hold back universal digital transformation
Seamless experience between outdoor and indoor mapping becomes an expectation
Viable integrated Smart City solutions becoming wide spread
Increased diversity at work in technology, science, and innovation
Talent and consumer shift - changing values and attitudes
Incubator spaces enable innovation to enter markets swiftly
Regeneration of business ecosystem through the rise of non-geospatial start-ups
New collaboration agreements with industries outside of geospatial emerge
Digital ethics and privacy addressed by national and international initiatives
Cybersecurity conversations increase in tandem with increase in digital devices
Pace of digital and tech change puts pressure on national institutions to address policy and legislative shortcomings
Pressure on government institutions to be more tech and digital savvy
Drivers
Rise of new data sources & analytical methods
Technological advancements
Evolution of user requirements
Industry structural shift
Legislative environment


HIGH
LOW
Impact on the global geospatial industry
Predictability of the trend's medium and long-term trajectory
New opportunities for data gathering
Machine learning, deep learning, AI
Digital intrastructure
Ubiquitous connectivity
Talent & consumer shift
High-resolution high-revisit Earth Observation
Licensing harmonisation
Immersive technology and visualisation
Real-time information
Quantum computing
Digital twins
Big Data processing
Digital platforms
Incubator spaces
Pace of digital change
Urban environment
Data cubes
Regeneration of business ecosystem
Multiple data sources
Edge computing
Data integration & interoperability
Digital ethics & privacy
Cybersecurity
Intelligent mobility
Smart cities
Linked data
Outdoor & indoor mapping
Crowdsourcing & VGI
New collaboration agreements
Digital divide & exclusion
Pressure on government institutions
Diversity at work

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Purpose: Define what is acceptable geospatial data

- Geodetic framework & Co0:ordinate Reference System
- 14 Fundamental Theme schemas (ORI/Elevation/Other Themes)
- ***Spatial Data Models:*** *Vector (simple + topological)/Raster / multidimensional cubes/Network models/Parcel fabrics)*
- ***Semantic & Logical Layer:*** *Feature catalogues/Ontologies/Controlled vocabularies/Linked data models (URIs)*
- ***Standards Stack:*** *ISO 191xx/OGC /BIS standards including Metadata*
- **Custodianship & authority rules**

(Precedes all, Applies across data lifecycle, Design Time)

I

Data Acquisition : Capture raw spatial observations

- **Aerial Systems:** Manned aircraft/ Drones (UAVs) equipped with cameras, LiDAR (Terrestrial & Bathymetric) , Sensors
- **Satellites:** Earth Observation (Optical, SAR, Multispectral, Hyperspectral), Positioning (GNSS, VLBI, DORIS, SLR).
- **Ground-based:** Surveying (CORS/GNSS-rovers, Total Stations,), Terrestrial Laser Scanning, Mobile Mapping Systems (on vehicles/Backpack), IoT sensors.
- **Crowdsourced & Volunteered Geographic Information (VGI):** Geo-Platforms enabling Crowd-Sourcing , OpenStreetMap, Social Media geotags, Smartphone Data

Output: Raw imagery, Point Clouds, Ground-truth data , sensor readings.

Data Processing: Convert raw data into usable datasets

- **Photogrammetric processing:** Orthorectification, radiometric & geometric correction, Tiling/Mosaicing, DSM/DEM generation.
- **Feature Extraction:** Automatically or manually Digitization for Vector Layers
- **Remote Sensing :** Classification (land use/cover), change detection, indices calculation (NDVI for vegetation)
- **Advanced Analytics:** Machine Learning, Deep Learning, Computer Vision for Automated Featu Extraction

Output: Structured geospatial datasets (vector/raster), 3D models , thematic layers, maps, analytical reports. Technically correct datasets but **Not yet authoritative**

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Data Ingestion & Conformance Validation: Enforce models & standards. **This is where "Quality as per Model & Standards" happens**. Only compliant data enters national systems.

Ingestion = validation + governance + onboarding

- CRS & Datum Checks
- Schema Validation
- Resolution & accuracy class validation
- Metadata & Lineage checks
- Topology & rule validation
- Versioning & authority tagging

Technology Stack: Apache NiFi/ GDAL + PROJ/ PostGIS/GeoServer/ GeoNetwork/ RBAC

Storage & Data Management: Secure, authoritative data custody

- National repositories (foundational)
- Thematic repositories
- Version control
- Archival & disaster recovery

Technology Stack: Spatial databases (PostGIS), cloud platforms, Data Lakes.

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Integration & Interoperability: Make data discoverable & usable

- Metadata catalogues and Registry
- Open data : OGC Services/ APIs
- Linked data : Cross-theme integration
- Federation of central & state data
- Access control & licensing

Output: Accessible, curated, integrated , fit-for-purpose geospatial data repositories.

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Analytics, Modelling & Intelligence: Create insights

- Spatial analytics, Simulations, Predictive Analysis, Digital twins, AI/ML on geospatial data

Visualisation, DSS & Applications : User-friendly maps , Apps, Enable decisions & services, Dashboards, 3D Visualization, Command & control systems, Planning tools, Citizen & enterprise applications

Sectoral Usage: Realise socio-economic value

- Land administration, Urban planning, Infrastructure, Agriculture, Disaster management, Environment

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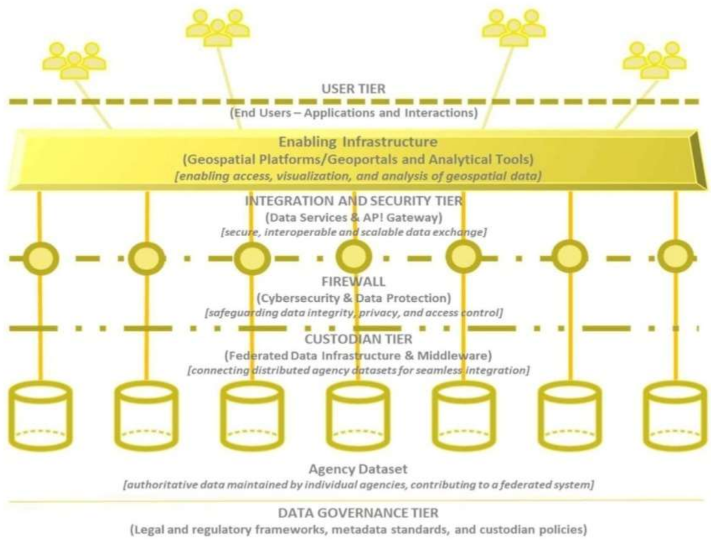
Change Detection, Updates & Legal Validation

- ORI-based change detection
- Field verification
- Administrative / legal approval

Loops back to Acquisition

Reuses same models & standards



- **User Tier:** Provides access to the data and geospatial services through a geoportal.
- **Application Tier:** Provides the tools to visualize, download and search for geospatial data.
- **Security Tier:** Provides data security and access authentication.
- **Core Services Tier:** Provides the data catalogue and metering services that manage usage and payment services.
- **Integration Tier:** Links the application tier to the virtual data stores.
- **Custodian Tier:** Enables custodians to upload data so that it is available to users.

- The geospatial value chain is a comprehensive framework that describes the flow of data and value from raw data collection to end-user applications across sectors.

- It is often visualized as a multi-stage pipeline, transforming raw spatial data into actionable intelligence.

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Department of Science & Technology

The modern geospatial value chain is a dynamic, interconnected, and increasingly democratized ecosystem. It's no longer linear but a value circle, where user feedback drives new data needs. The power lies in integrating the chain—from ubiquitous sensing (acquisition) to AI-powered analytics—to create spatial intelligence that is embedded directly into the decision-making workflows of virtually every sector of the economy.

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