

# GEOSPATIAL STRATEGY FOR NEW INDIA

*Maps are not driving just apps today; they are driving economies too*

*National Think Tank on Geospatial Strategy for New India*



# Foreword

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Innovations in technology such as miniature sensors, Cloud and Artificial Intelligence, duly augmented by delivery platforms like small satellites and drones, have made geospatial data “by default” in our daily lives. Today, what excites me the most is the fact that location offers the much needed fourth pillar (along with AI, IoT and Big Data) to the Fourth Industrial Revolution, enabling disruptive innovations and driving smart solutions for the future generations who are facing challenges of growing consumerism and depleting resources. All this makes it all the more important to observe, monitor and manage our Planet Earth in real time.

The ‘Geospatial Way’ is the future and probably the most efficient and effective way to collect, process and utilize information in the overall Global Development Agenda. It is a given today that integrated geospatial infrastructure and knowledge platforms have direct correlation with human development and quality of life. The Geospatial Readiness Index has clearly indicated that countries which have better geospatial institutional infrastructure and policies also have a higher level of adoption of geospatial technology, and have benefitted across almost every walk of socio-economic activities, furthering their mission of sustainable development.

India houses 20% of the world’s population. It is the world’s third largest economy on PPP, but is ranked 60th in the World Economic Forum’s Global Competitiveness Index of 148 countries. In the past few years, we have been striving towards developing fundamental and essential infrastructure and facilities for citizens. Under the New India Vision, the government is addressing core issues like water, health, education, sanitation, housing and infrastructure for all. Leveraging the power of geospatial information and technologies will only help the country address its multi-dimensional goals of financial growth combined with sustainable development faster.

A National Geospatial Infrastructure and Knowledge Platform, comprising comprehensive and updated information about the natural, human, industrial and community resources of the country, would not only serve as an instrument of effective planning, implementation and monitoring of national programs, but also provide the foundation for good governance, innovation, entrepreneurship and knowledge economy. Although there has been great amount of awareness about geospatial technology in India, fragmented and isolated approaches have been obstructing growth of the geospatial industry in the country and its subsequent role in national development.

Geospatial Media facilitated the formation of the Non-Executive Think Tank on ‘Geospatial Strategy for New India’ under the chairmanship of Padma Shri Dr B.V.R. Mohan Reddy, duly supported and guided by other eminent members representing the entire geospatial ecosystem in India.

The Think Tank held several meetings in the past one year and deliberated on emerging technology trends/innovations, and estimated potential value and role of geospatial industry in building a ‘New India’. It also suggested strategies and mechanisms towards building an integrated geospatial infrastructure and knowledge platform that would facilitate greater adoption and utilization of the technologies in national development programs. The Think Tank believes that a National Geospatial Infrastructure and Strategy will serve as one of the important pillars of New India by making significant contribution in overall planning, implementation and monitoring of national programs.

I am excited to present this document which encapsulates the discussions of these meetings and the suggestions of the esteemed members. It also showcases the value and potential of geospatial technologies in India’s growth and development, and gives a strategic direction towards its mainstreaming for easier and greater adoption, while leaving to the government the broader vision of how these strategies have to be implemented on the ground.

I would also like to add that at a recent high-level meeting organized by the Prime Minister’s Science, Technology and Innovation Council on November 19 on Geospatial Infrastructure, it was unanimously agreed that an independent and autonomous agency be created at the highest level to give policy directions and act as a collaborative entity for the entire industry. Those views and suggestions have also been incorporated in this document.

To remain competitive in this digital era, India needs to leverage the power of geospatial. An Integrated National Geospatial Strategy will only help us reach there. At the same time, such an integrated and comprehensive approach would help improve productivity and bring higher returns on national investments, while strengthening and expanding the overall size of the Indian geospatial industry which would add significant societal and economic value in itself.

I would also like to take the opportunity to thank the esteemed members of the Think Tank for sharing their incredible experience, knowledge, virtue and supervisory guidance in shaping this endeavor.

**Sanjay Kumar**

Convenor, National Think Tank on Geospatial Strategy for New India  
CEO, Geospatial Media and Communications

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# INTRODUCTION

## GEOSPATIAL INFRASTRUCTURE FOR DATA ECONOMY

The past decade has witnessed unprecedented technological advancements. Technologies like Cloud, mobile, Internet, and Internet of Things (IoT) have led to data explosion and analytics. It is estimated by IBM that 90% of the world's data has been created in the last two years. This comprises largely of unstructured data, generated by transactions, logs, records, social media, audio, visual and video consumption. New data sources are added every day, resulting in valuable data ecosystems for governments and businesses alike.

The availability of such large amounts of data has given rise to a **Data Economy**, which is thriving on analytics and value derived from these varied data sources. This data economy is supported by a converged **Digital Infrastructure**, which ensures seamless storage and exchange of data through communication systems.

**Converged infrastructure** groups multiple components like servers, data storage devices, networking equipment and software for information infrastructure management, automation and orchestration into a single optimized system. Such converged infrastructure enables organizations to centralize the management of resources, consolidate systems, increase resource-utilization rates and lower costs. It fosters these objectives by implementing pools of hardware, storage and data resources that can be shared by multiple applications and managed in a collective manner using policy-driven processes. Such digital infrastructure lends for seamless data exchange, access and use, thereby enhancing productivity in public and private sectors, boosting innovation and data utilization.

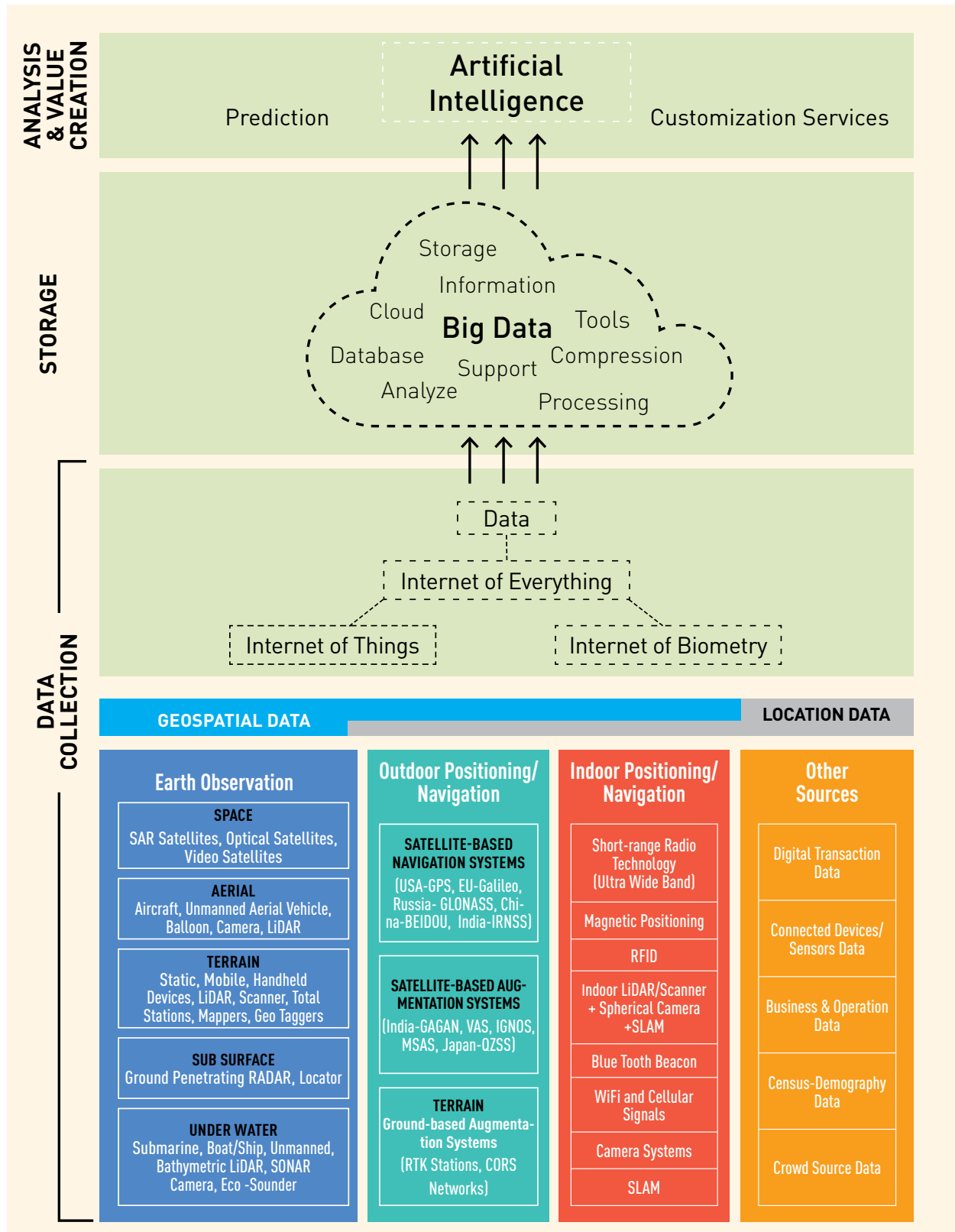
Given that **80% of all data has a spatial component**, a foundational component of the **Data Infrastructure** also includes the geospatial data infrastructure. Geospatial data provides the critical 'where' or location component to any data or system. Geospatial Data not only serves as an infrastructure, but as a knowledge source and a service provider for the country.

For a country like India that seeks to become a USD 5 trillion economy by 2024, leveraging the digital transformation by establishing a digital data infrastructure and geospatial data infrastructure are non-negotiable.

Qualitative geospatial infrastructure will help the country to address its multi-dimensional goals of building a "Swachh, Swasth, Shikshit, Sampann, Saksham and Surakshit Bharat by 2022". To achieve these goals, the government needs to adopt a **Whole-of-Government** approach to build and maintain the geospatial data infrastructure, while leveraging the capabilities of the private sector in producing real-time data for co-creating the geospatial infrastructure.

In order to achieve this vision, India needs an **Integrated National Geospatial Strategy** that synergizes efforts of different agencies responsible for creation of integrated geospatial infrastructure and use of geospatial data to support national goals.

## GEOSPATIAL DATA IN INDUSTRY 4.0



# GEOSPATIAL INFORMATION INFRASTRUCTURE

## FOR SOCIETY AND ECONOMY

### 2.1 Everything happens somewhere

The significance of 'place' has been well recognized by our ancestors — for ages maps have been used for defence, trade, navigation, land and resource management, infrastructure planning and administration. People have been making decisions based on knowledge of the environment provided by maps, hence, the better the maps, the better the decisions.

With the evolution of technology, the face and form of maps have also changed. Nowadays, digital geospatial information provides far more value for societal, economic and environmental use than just a simple map, and serves as an essential national information resource. It provides an integrating underpinning 'location' reference frame that enables government systems and services, and national development initiatives. With the development of mobile devices and telecommunications infrastructure, its use is also increasing in business services provided by companies like Uber, Airbnb, Amazon, etc.

Geospatial Information is nothing but a digital version of the physical world in which all human, economic and environmental activities take place, and without which a digital economy is not possible. Geospatial information is presented in many forms and mediums including maps, satellite imagery and aerial photography.

Geospatial information and related location-based services silently extend value and benefit to all sections and stakeholders, including citizens, communities, businesses, governments and others on a daily basis by providing the digital connection between a place, its people and their activities. It is also used to model and portray the impact of the past, the present and the likely future.

Geospatial information is a nation's 'digital currency' for evidence-based decision-making. As already established, it is a critical component of national infrastructure and knowledge economy that provides a

### APPLICATION AREAS OF GEOSPATIAL INFORMATION





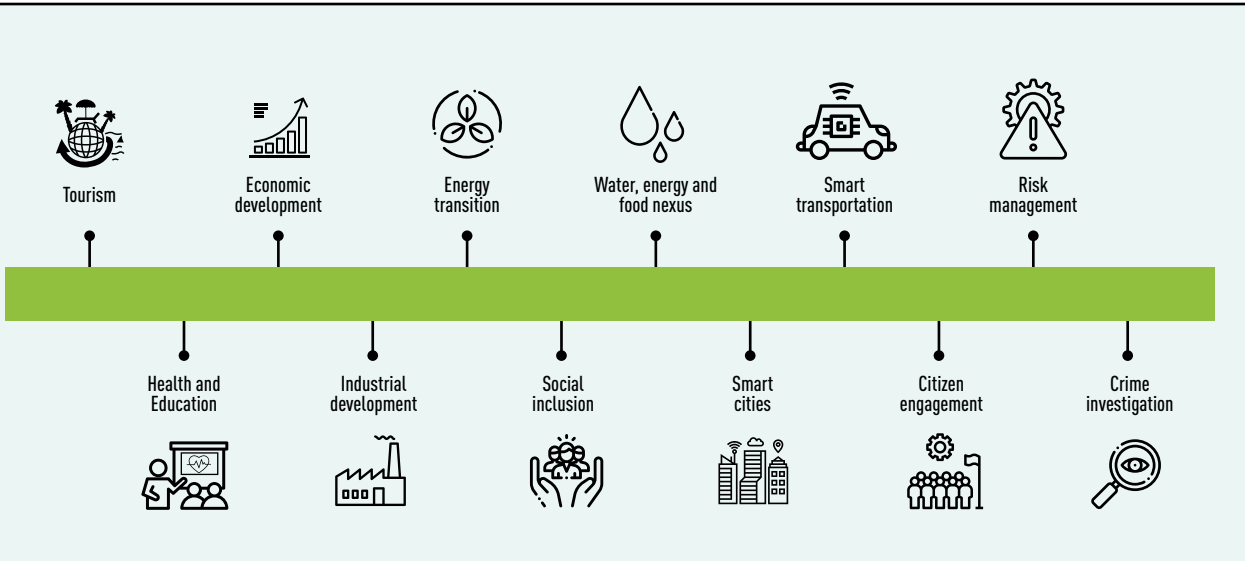
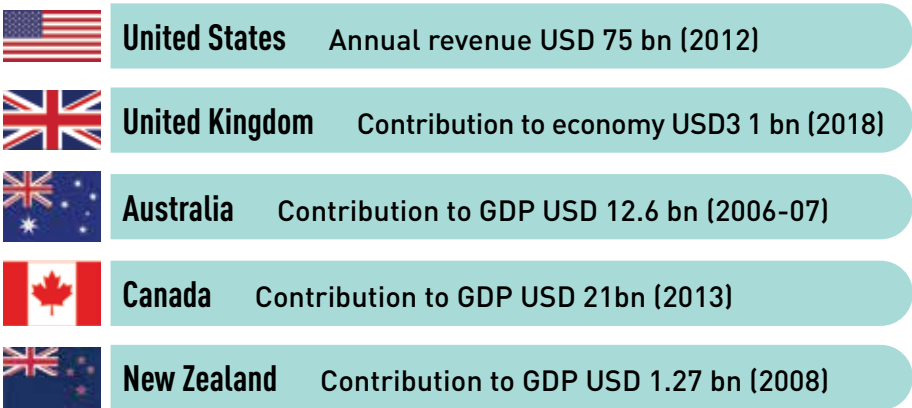
nation’s blueprint of what happens where, and the means to integrate a wide variety of government services that contribute to economic growth, national security, sustainable social development, environmental sustainability and national prosperity. All governments, both at the national and local levels, hold considerable quantities of geospatial information and location data, for example databases of schools and school performance, flood risk data and mobile phone ownership data. However, this information is often not up to date, or of sufficient quality for effective decision-making. In contrast, a geospatially enabled nation is one that shares, integrates and uses a wide range of data to achieve social, economic and environmental benefits. This use and associated benefits extend across governments, businesses and citizens, and from national to city and small community levels. Geospatial information is the underpinning infrastructure for all these applications.

*[Adapted from Integrated Geospatial Information Framework, UN-GGIM and The World Bank, 2018)].*

## 2.2 Value to economy

It is estimated that the value derived for the global economy through geospatial was USD 2,210 billion in 2017<sup>38</sup>. However, the total contribution is considered to be several times higher, since the exponential benefits of spatial dimension being realized by citizens globally are difficult to measure. Today, geospatial sector is adding substantial value to countries in terms of economic output and social good by making updated and accurate data easily accessible.

### GEOSPATIAL TECHNOLOGY AND VALUE IMPACT TO ECONOMY<sup>3-7</sup>

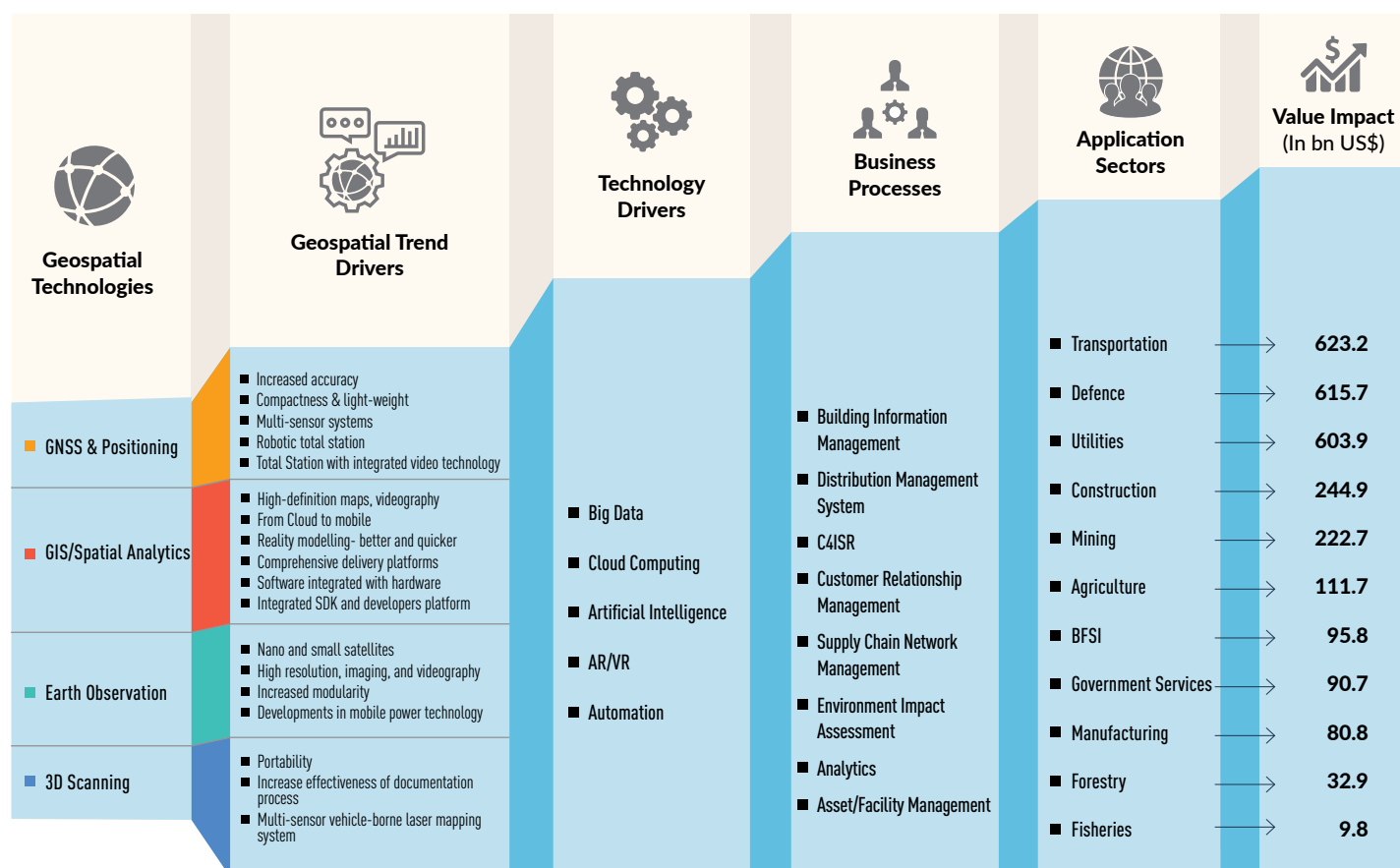


## 2.3 Value impact application wise

As the geospatial industry continues to grow and gets embedded in various business processes such as Business Information Management, C4ISR, Supply Chain Management Network, Environment Impact Assessment, Facility Management, among others, its adoption in the key economic sectors continues to grow. Leveraging on spatial information, various traditional and emerging geospatial applications are improving the efficiency and productivity of these segments. These applications are finding varied use in Transportation, Construction, Mining, Agriculture, Utilities, Government and other sectors, thus generating huge value impact for economies worldwide.

With geospatial analytics being used globally for informed decision-making, location analytics becoming pervasive in day-to-day activities, and satellite imagery being used extensively for disaster risk mitigation and climate risk management, the geospatial market continues to grow. However, what remains hidden is the substantial economic impact the technology generates, because it is difficult to calculate.

### CREATING HIGH VALUE IMPACT



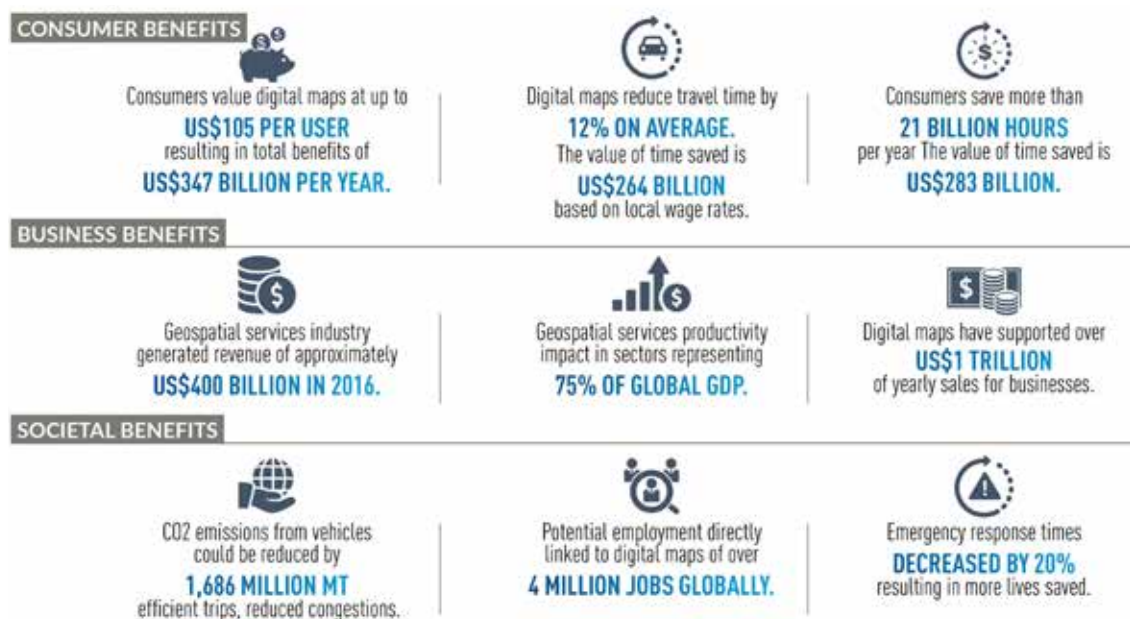
Source: GeoBuiz Report 2018<sup>38</sup>



## 2.4 Economic impact of geospatial services

Digital maps are significantly impacting our lives. They have become powerful tools for policymakers as well as businesses. As per a 2017 AlphaBeta Report on the economic impact of geospatial services, digital maps have supported roughly USD 1 trillion in sales by businesses. The benefits that geospatial services extend to the community can best be categorized into consumer benefits, business benefits and societal benefits.

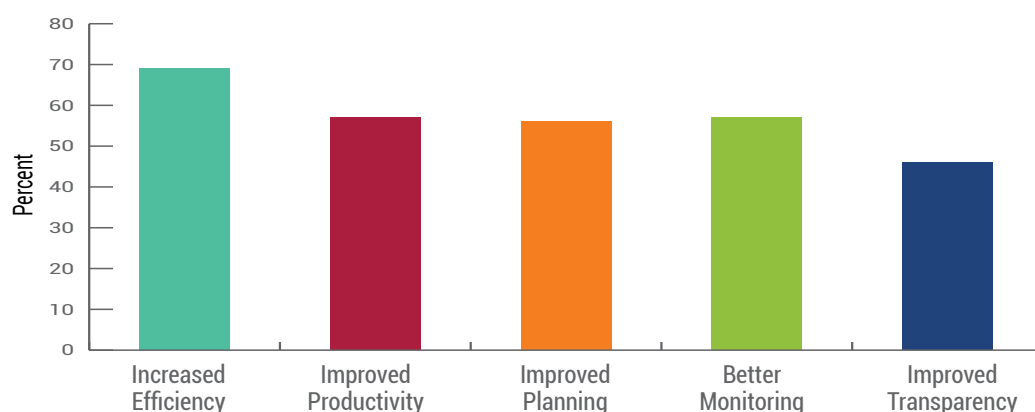
### GLOBAL ECONOMIC IMPACT OF GEOSPATIAL SERVICES DURING 2016



Source: AlphaBeta Report 2017<sup>8</sup>

Geospatial technologies considerably reduce the time it takes to complete the project and improve the customer service. For long, businesses have viewed the improvement in productivity that comes from implementing geospatial technology as a way to beat the competition and increase bottom line. Governments have also adopted geospatial technologies in projects that require accountability. Geospatial's ability to integrate databases and visualize the spatial relationships between various components encourages partnerships and data sharing.

### BENEFITS OF GEOSPATIAL TECHNOLOGY



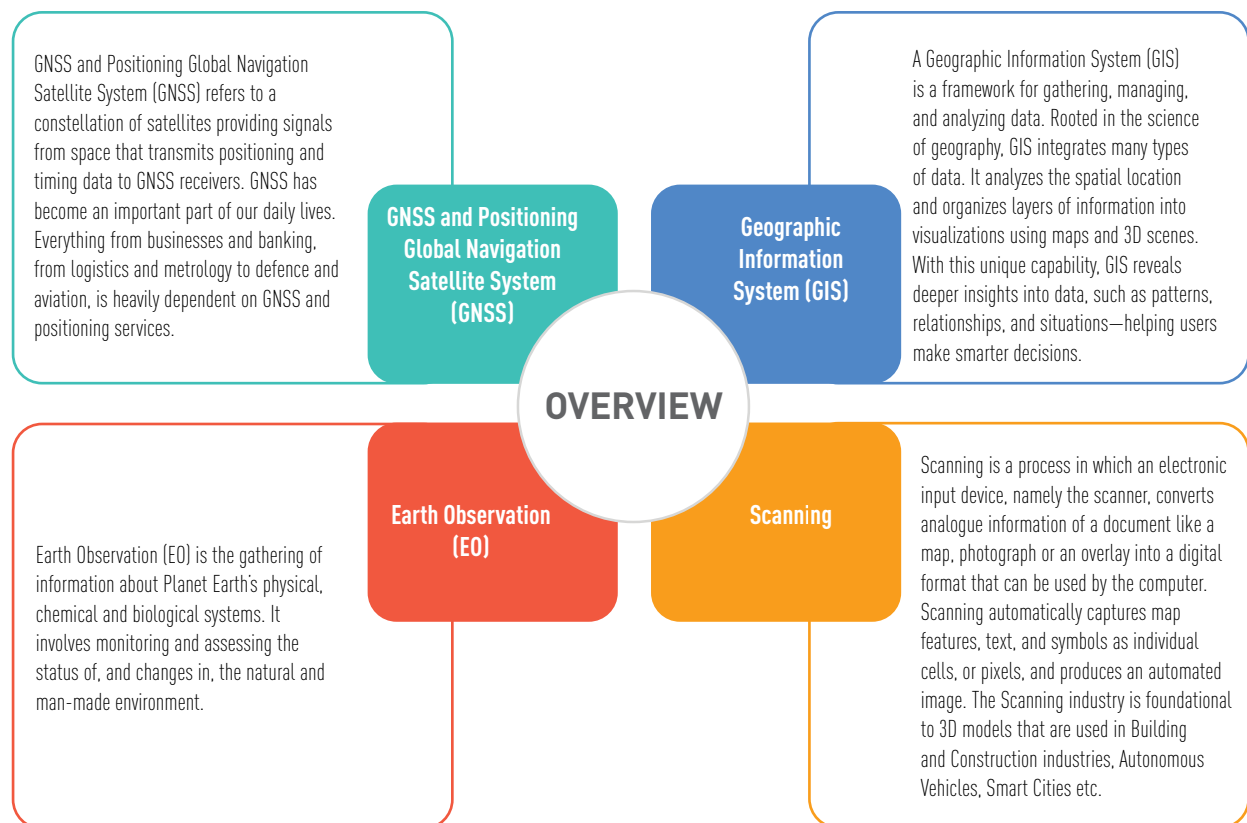
Source: GeoBuiz Report 2017<sup>39</sup>

# GEOSPATIAL INDUSTRY OVERVIEW

## ELEMENTS, SIZE AND VALUE

### 3.1 Industry ecosystem

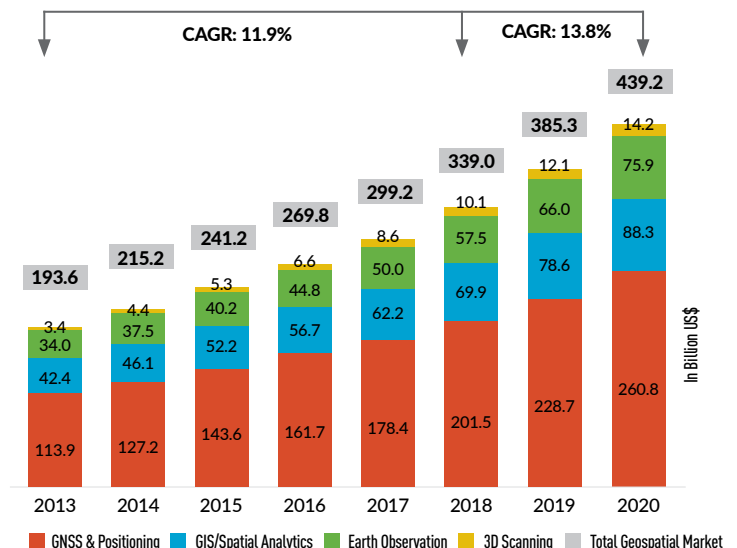
The geospatial industry value chain commences with the capturing or sourcing of a wide range of geospatial data and its precise position on Earth, above surface, below surface, under water and indoors. The spatial data (images, point clouds, geospatial and location data) captured through sensors is processed and integrated with other spatial and non-spatial datasets to render the required map content and spatial and location analytics. The geospatial technology ecosystem is a complex entity with multiple interactive components. These technologies have evolved over many years and are broadly segmented into four categories: GNSS and Positioning, GIS and Spatial Analytics, Earth Observation and 3D Scanning.



## 3.2 Global geospatial market size

Geospatial industry is among the fastest growing industries globally and is helping translate innovation into business practices in multiple sectors. Geospatial technology, which was earlier associated with just mapping, is today pushing industrial processes, offering immense value in terms of enhancing productivity, cost effectiveness, transparency, safety and project management.

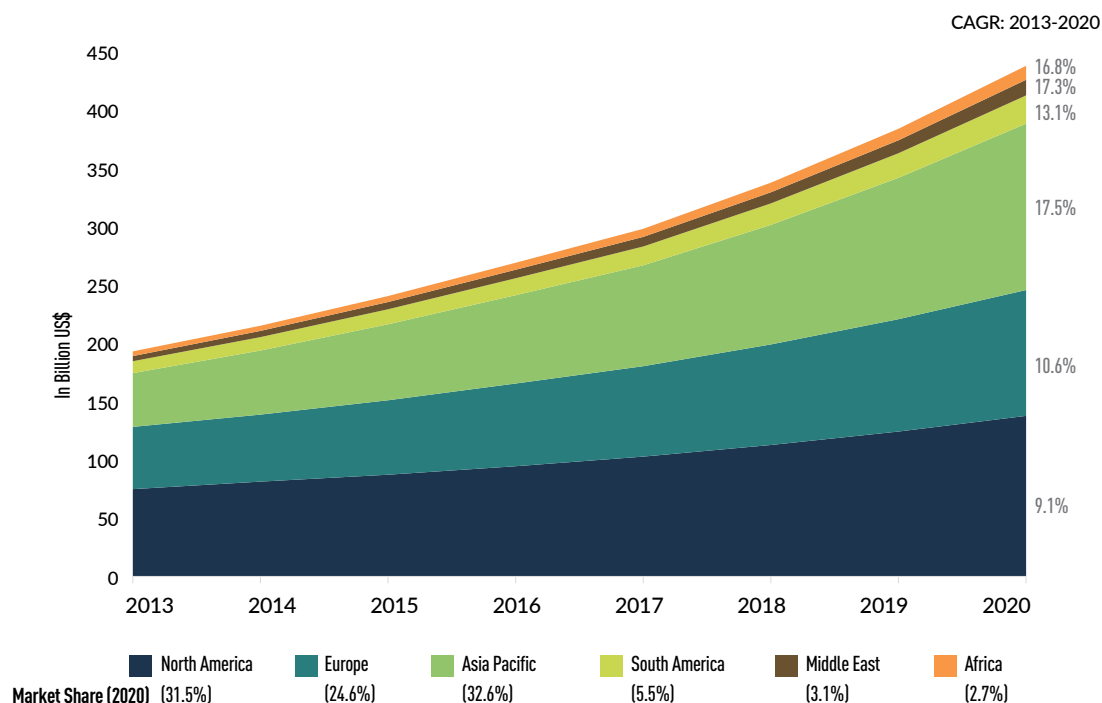
The global geospatial market is growing steadily. In 2018, the market was worth USD 339 billion and is forecast to grow to USD 439.2 billion by 2020, at a CAGR of 13.8%<sup>9</sup>.



Source: GeoBuiz Report 2018<sup>38</sup>

## 3.3 Regional market size

As the global geospatial industry continues to gain relevance and maturity, the overall market is expected to grow at a high rate during the forecast period. The Asia-Pacific region is the fastest growing for the geospatial industry, with an estimated market share of 30.3% of the global geospatial market share. Of the Asian countries, India and China are third and fourth, respectively on the list. These two Asian powerhouses, coupled with other APAC economies, will surely make the region the growth center in times to come<sup>9</sup>.



Source: GeoBuiz Report 2018<sup>38</sup>

# GEOSPATIAL TECHNOLOGY MATURITY ASSESSMENT



Source: Future Technologies review; PUBLIC and The UK Geospatial Commission, 2018<sup>37</sup>



# NEW INDIA VISION

## CONTEXT AND ROADMAP

### 4.1 The India growth story

India, the world's third largest economy on purchasing power parity, ranks 60th out of 148 countries in the World Economic Forum's Global Competitiveness Index, indicating that there is greater potential waiting to be unlocked. With slowing growth and the need to bolster investor confidence, India faces the key challenges of urbanization, health, sanitation, connectivity, water scarcity and transparency. Challenges of this complexity and magnitude require a collaborative approach involving political, administrative and business leaders, members of civil society and academia, youth groups and social entrepreneurs.

#### TRANSPORT CONNECTIVITY

- India's transport demand has grown by almost 8 times since 1980, which is more than any other Asian economy<sup>10</sup>
- The average speed of vehicles in some metros is as low as 17 km/h<sup>11</sup>
- An estimate of the economic loss due to congestion in the four metro cities is over USD 22 billion annually<sup>12</sup>

#### NEED

The action-agenda is advocated around four key pillars — Connect Bharat; Optimize travel footprint; Promote seamless, cooperative transport; and Adopt green modes and technologies

#### WATER SCARCITY

- 18% of the world's population resides in India, and it only has access to 4% of usable water sources<sup>13</sup>
- 163 million Indians lack access to safe drinking water<sup>14</sup>
- Delhi and 21 other cities in India would run out of groundwater by 2020<sup>15</sup>

**NEED** For water conservation, minimizing wastage and ensuring equitable distribution of water resources across and within states

#### TRANSPARENCY

- India is at 78th position out of 175 countries, according to the 2018 Corruption Perceptions Index by Transparency International

**NEED** To enhance the processes and systems of public bodies. It is established that ICT in e-governance delivery model leads to the administration assuming greater responsibility, which makes its activity more transparent



#### URBANIZATION

- Urban population accounts for 27.78% of the total population. While the total population increased by 21.34% between 1991 and 2001, urban population grew by 31.36% during this same period<sup>16</sup>
- This has greatly increased housing issues: with overcrowded cities, many people are forced to live in unsafe conditions

**NEED** To safeguard environment and resources which will require innovative models of urban development and infrastructure

#### HEALTH

- India accounted for 34% of the global tuberculosis burden and 26% of premature mortality<sup>19</sup>
- The country stands to lose \$6.15 trillion due to non-communicable diseases and mental disorders by 2030<sup>20</sup>

**NEED** To identify trends and improve services, track infectious diseases

#### SANITATION

- According to Census 2011, only 32.7% of rural households had access to toilet facilities<sup>21</sup>
- Lack of sanitation facilities leads to groundwater contamination and pathogen contamination leads to diarrheal diseases, resulting in malnutrition, stunting and death

**NEED** To identify and implement the right way to provide 1.2 billion Indians with a clean environment

#### EDUCATION, SKILLS AND ENTREPRENEURSHIP

- In GER (gross enrollment ratio) in higher education, India (25.8%) is below the world average of 33% and that of countries such as Brazil (46%), Russia (78%) and China (30%)<sup>16</sup>
- Only 5.4% of the workforce has undergone formal skill training, as compared to 68% in the UK, 75% in Germany and 96% in South Korea<sup>17</sup>

**NEED** To create infrastructure, trained faculty, curriculum and skills to create innovation ecosystem that suit the needs of Industry 4.0



India has designed a vision to change, and emerge as a nation driven by technology. To realize its dream, the country has designed the 'New India' vision to transform the nation by 2022 through an agenda of reforms in ten interconnected areas. This will also help drive India to its goals of shared prosperity by 2030 and a more competitive economy. Geospatial and other emerging technologies like Artificial Intelligence, Internet of Things, Machine Learning, among others, will play a key role in achieving these targets.

### Vision 2022<sup>21</sup>

- Poverty free India by 2022
- Efficient, transparent and accountable governance
- By 2022, provide a strong foundation for clean, inclusive, sustained and sustainable growth for the next three decades
- Ensure maximum employment creation, codification of labour laws to be completed
- India open to business, ideas to be global manufacturing hub
- Doubling of farmers' income
- Development of 100 smart cities till 2022
- National waterways development plan envisages to develop six national waterways integrating them seamlessly with the national transportation grid
- Holistic highway development/improvement initiative
- Connecting all villages with habitations over 500 with all-weather roads
- Housing for All by 2022 under Pradhan Mantri Awas Yojana (PMAY) scheme
- Electricity for all houses by 2022;
- Target of 100 GW of solar power by 2022
- First Bullet train by 2022

### VISION 2030<sup>22-34</sup>

- Build next-generation infrastructure in all sectors comprising roads, railways, seaports, airports and inland waterways together with social infrastructure.
- Build a Digital India that reaches every corner of the economy and every citizen.
- Clean & Green India to focus on Electric Vehicles and renewable energy, thus reducing import dependence and increasing energy security
- Expanding of rural industrialization using modern industrial technologies, based on the 'Make in India' approach, using grassroot MSMEs and startups across the country.
- Clean Rivers with safe drinking water to all Indians using micro-irrigation techniques.
- Exploitation of the Blue Economy, to ensure better standards and quality of life for a large number of people living in the coastal areas.
- Become the global launch-pad of satellites and placing an Indian astronaut into space by 2022
- Self-sufficiency in food and improving agricultural productivity with an emphasis on organic food.
- A healthy India, with a distress-free and comprehensive wellness system for all.
- Minimum Government, Maximum Governance with proactive, responsible, friendly bureaucracy and electronic governance.

## 4.2 Strategy for New India

'Strategy for New India @ 75', a vision document from the Niti Aayog, captures three key messages.

- **Development as a mass movement**, in which every Indian recognizes his role and also experiences the tangible benefits accruing to her in the form of better ease of living.
- **Embracing new technologies fostering innovation and upskilling** will ensure that the development strategy employed helps achieve broad-based economic growth and balanced development across all regions and states and across sectors.
- The strategy when implemented, will bridge the gap between public and private sector performance. There is a **focus on putting a 'development state' in place** of the 'soft state' that this government had inherited. In this context, the government has focused on the efficient delivery of public services, rooting out corruption and black economy, formalizing the economy and expanding the tax base, improving the ease of doing business, nursing the stressed commercial banking sector back to a healthy state, and stopping leakages through direct benefit transfers and widespread use of the JAM trinity.

# INDIA'S GEOSPATIAL MARKET

## RIDING ON NATIONAL DEVELOPMENT PROGRAMS

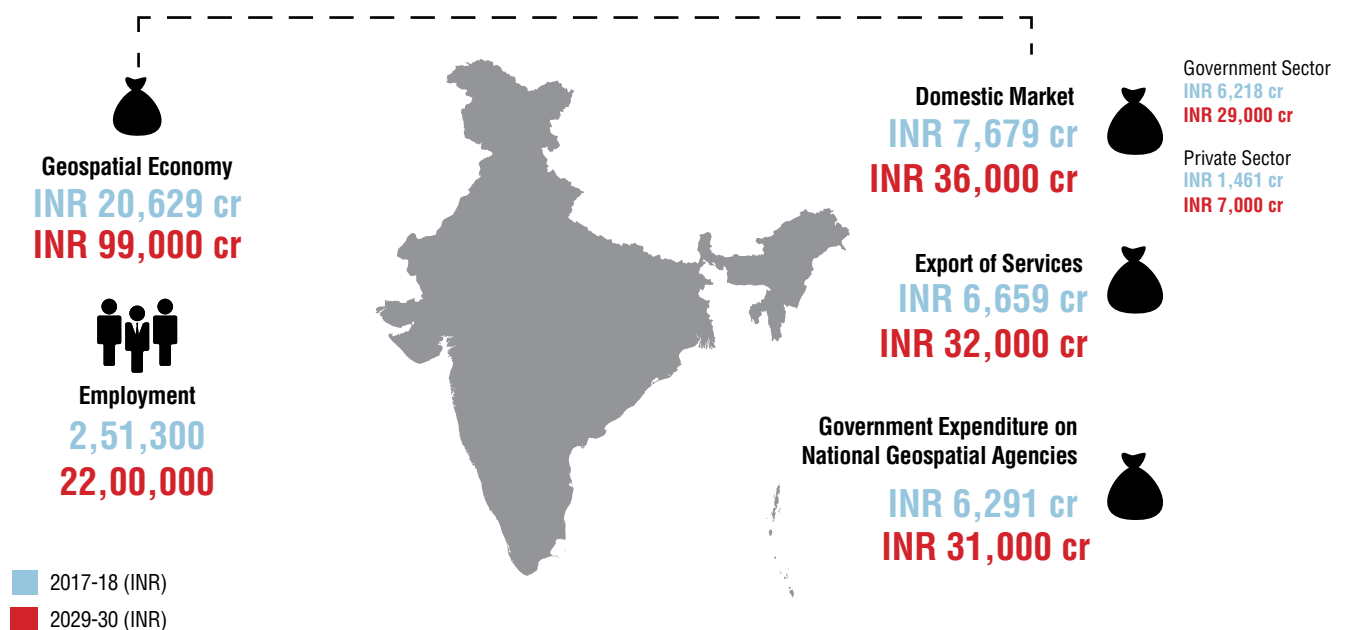
The Indian geospatial economy is valued at INR 20,629 crore (USD3.07 billion) and employs over 251,000 people across the country. A comprehensive study, the Indian Geospatial Economy (IGE) Report 2018 by Geospatial Media and Communications finds that the Indian geospatial market is currently valued at INR 7,679 crore and is pegged to grow at 13.8% CAGR between FY 2017-18 and FY 2020-21<sup>2</sup>.

### 5.1 Key growth drivers

The growth driver for geospatial market in India is the thrust provided by the **central and state government programs** for developing a robust physical infrastructure, effective governance delivery including e-governance and digital economy initiatives, integrated programs on urban and rural development such as Smart Cities, AMRUT, RURBAN clusters, National Hydrology Project (NHP) and integrated projects like Bharatmala and Sagarmala.

Geospatial data and information and its adoption has so far been a direct beneficiary of the **advancements in Information and Communication Technologies (ICT)** as it rides conveniently on the matured digital ecosystem and digital infrastructure to deliver value to government, businesses as well as consumers/ citizens.

Another major contributor to the growth is the export market. India is a paradise for **outsourcing of services and R&D**. Organizations consider India as the primary destination for outsourcing. Outsourcing of services or software development to India means lower costs, higher software quality, no communication



Source: India Geospatial Economy report -2018<sup>2</sup>

barriers and a huge talent pool. Globally, it is now being driven by process transformation, analytics and automation. Most of the big Location Analytics players are gradually embracing platform-based solutions and services models. India's share in the global data analytics outsourcing is nearly 70%, which shows its analytics capabilities.

## 5.2 India's geospatial readiness

The Countries Geospatial Readiness Index (CGRI)-2019, an assessment of the 'geospatial readiness' of 75 nations by Geospatial Media, has been done based on comprehensive evaluation of the five core pillars of the geospatial ecosystem, namely geospatial data infrastructure, policy framework, user adoption, institutional readiness and geospatial industry fabric.

There is close correlation between the leaders on the CGRI and those ranking high on development indices. Simply put, countries that are high in adoption of geospatial technologies stand to gain more than others in terms of contribution to GDP, standard of living for citizens and quality of infrastructure. For instance, US, UK, Germany, Singapore and The Netherlands rank among the top ten on CGRI.

The CGRI ranks India at the 25th place. India's ranking on these pillars and multiple sub-pillars which represent various subcomponents of the geospatial sector ecosystem provides ample insights on the need for an integrated approach from government and national geospatial agencies for a holistic development of the sector. While India's inability to fully harness the development and commercial opportunities is due to a combination of factors, the less-than-optimum role played by the national geospatial agencies is one of the key reasons.

Country	Countries Geospatial Readiness Index 2019	UNDP Human Development index 2018	WEF Global Competitiveness Report 2019	UN E-Gov Development Index 2018
US	1	13	2	11
UK	2	14	9	4
Germany	3	5	7	12
Netherlands	4	10	2	13
Canada	5	12	14	12
Denmark	6	11	10	1
China	7	86	28	65
Singapore	8	9	1	7
Belgium	9	17	22	27
Switzerland	10	2	5	15
India	25	130	58	96

CGRI is an index of 75 countries; UNDP Human Development Index ranks 189 countries; WEF Global Competitiveness Report 2019 ranks 140 countries; UN E-Government Development Index 2018 ranks 193 countries

# DOING BUSINESS IN INDIA

## THE GEOSPATIAL ADOPTION HURDLE

India has for long been using remote sensing and GIS and other geospatial technologies for planning and development. However, the renewed focus on big ticket infrastructure projects brings the focus back on updated maps and spatial technologies. In every major national program, including Digital India, Smart Cities, transportation and highway development, river linking, industrial corridors, smart power, and agriculture, geospatial technologies will play a critical role.

As with other countries, digitalization presents India with a rare opportunity to make swift economic progress all across. New-age technologies like IoT, Artificial intelligence, Cloud, Wireless & Broadband and Big Data are empowering the assimilation of spatial information into existing business processes. Analyzing data using Geographic Information system is becoming a critical core strategy for successful decision making in an increasingly competitive global economy,

However, there are some challenges that are unique to the Indian context.

While base data availability has improved in growth markets, the real challenge still lies in **generating a reliable base data** that is up-to-date and contextual. A case in point is the United States, where base data is maintained centrally by the government and is updated regularly. The information related to monsoon, acreage etc. is regularly shared with farmers and private sector. Similarly, in India, there is a pressing need for all of this data to be generated by various agencies to be unlocked and made accessible to the private sector, as this data forms the core for their innovation.

**The absence of a comprehensive policy** on the use of geospatial data and technologies had been the biggest contention for the country, more so with a number of old obsolete policies — restrictive and overrun by security concerns — hindering the efforts. There are a total of 17 national-level policies and rules, with four in draft stage, dealing with geospatial data, under as many as six ministries/departments. To facilitate wider and faster adoption of geospatial technologies it is necessary to revisit these policies

### THE MISSING LINKS



and evolve an integrated geodata policy which will satisfy development and civilian applications while at the same time address the national security concerns.

Realistically speaking, it may not be possible to bring all the geospatial-related policies under one umbrella. Even the National Geospatial Policy draft doesn't strike out any of the existing policies but is in "harmonization of these existing policies". However, they can surely be amalgamated into a maximum of two-three policies for ease of implementation.

There are **no clear-cut guidelines on data sharing**. So, when a department creates any data for its own use, despite the existence of the National Data Sharing and Accessibility Policy 2012, most of that lie in silos, because of the absence of one single platform, which can then be used by another department and put the value added data back into its source, which can further contribute in enriching this dataset.

In developed nations, there is a regulation under the free data sharing policy that mandates all government departments and public organizations to publish their datasets to a centralized authority, ensuring seamless access to standardized datasets. Likewise, it will help to have a national consortium for geospatial data in India with a charter to organize and maintain uniform, standardized seamless spatial data, which will also ensure easy access to the same set of data to every stakeholder.

Multiple agencies generating independent datasets without common guidelines are leading to problems of **data quality, authenticity, interoperability and convergence**. Often, no two datasets sit on each other. The need for an independent and autonomous agency to ensure the accuracy, standards and quality is felt more now than ever with the growth and reach of technology. A centralized agency on the lines of National Accreditation Bureau for Laboratories of Department of Science and Technology could be the answer, a mechanism which has worked well in other areas such as education.

**Absence of a single window clearance delays projects.** This again is majorly owing to the varied number of the departments controlling permission, and sensitivities associated with geospatial data. Involvement of so many different departments makes decision-making slow, and by the time the clearances are issued, changes in landscape are observed and the imagery data loses relevance, adversely affecting project implementation.

**Lack of CORS network:** CORS technology is rapidly becoming the preferred method for accurate 3D positioning across the world, and forms the basis for any Smart City agenda. It is in great demand among industries like surveying, navigation, construction, mining, precision agriculture and scientific research that require greater positional accuracy, as well as continuity of data. Geophysicists, meteorologists, atmospheric and ionospheric scientists also leverage CORS data for a wide variety of applications. Other popular user groups include surveyors, GIS users, and engineers. And with continuously evolving GPS technology, CORS facilities will have an even greater role to play in the future. Survey of India has started some work it since 2018, but in the absence of funding, it is likely to take a lot of time to cover the country.

**Capacity Building:** Lack of trained manpower poses a major hurdle in smooth implementation of projects, leading to loss of revenues and time. This issue is discussed in detail in the next chapter.

# GEOSPATIAL KNOWLEDGE DEVELOPMENT

## THE ISSUE OF CAPACITY BUILDING

Data accuracy is essential for ensuring optimum utility of geospatial technologies. Inaccurate data leads to huge financial losses, delay in project completion, leading to no benefits for the citizens.

However, there is a dearth of trained workforce in the Indian geospatial industry and inadequate supply. The problem is multi-pronged:

- Lack of enough trained resources to take up basic jobs like surveying
- Rapid technology advancements ensures that those who have obtained primary training are not equipped to operate latest tools
- The current workforce in geospatial industry is not equipped enough to train in emerging technologies like Artificial Intelligence, Machine Learning, etc.

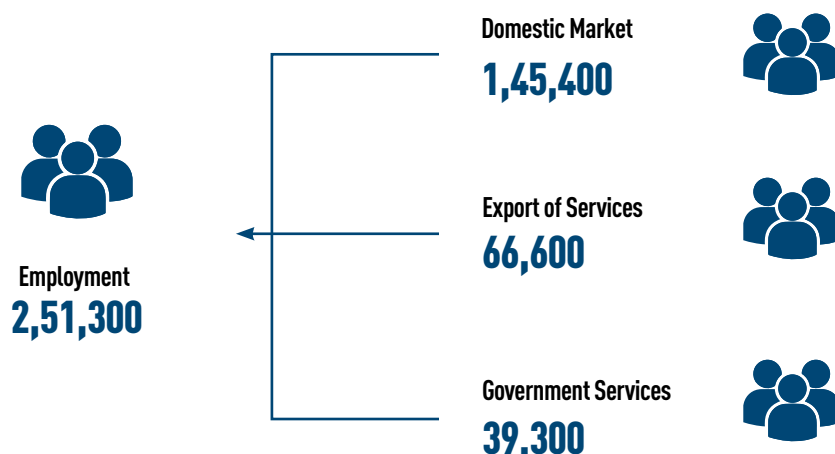
Indian geospatial sector currently employs 2.5 lakh people, out of which around 67,000 are engaged in exports-related services and around 40,000 are in government services.

There are enormous employment generation opportunities in India for rudimentary services such as surveying, map digitization, content development, APIs, data analysis, etc. This can be further illustrated by taking an example of a single national development project of DI-LRMP for one state of approximate 3 lakh sq. km.

An approximate number of skilled manpower required for DI-LRMP program for one state is 17,800. If the DI-LRMP Program is carried out at the national level, ~4, 00,000 approximate skilled manpower is essential. And as per the analysis in the table in next page, all national programs between 2019-2022 will require approximately ~12, 00,000 of skilled manpower.

The Skill Development Ministry has constituted a committee which is led by Survey of India in collaboration with Association of Geospatial Industries to set up a skill development council which will focus on developing capacities for assistant surveyors, surveyors and geospatial professionals. This will also help in filling up the demand of employment, and is expected to employ around 12-15 lakh people in the next five years.

### EMPLOYMENT WITHIN INDIAN GEOSPATIAL ECONOMY IN 2017-18



Source: India Geospatial Economy report 2018<sup>2</sup>

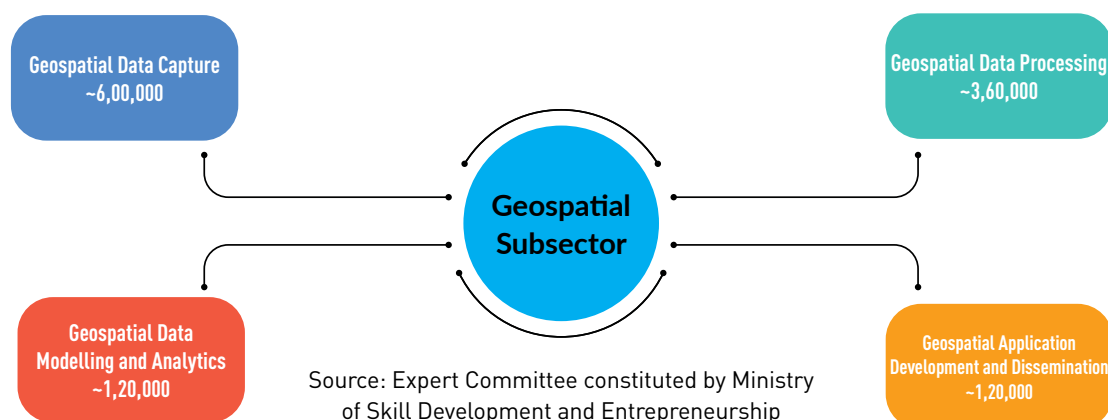


## SKILLED MANPOWER REQUIRED FOR DI-LRMP PROGRAM FOR ONE STATE

Sl.No	Description of Activity	Qty	Man days per each	Man months required	Skilled Man power required
1	Digitisation of existing cadastral maps and ROR attachment including updation of all mutation details	1.5 lakh maps	3 man days per map	18000 to be completed In 10 months	1800
2	Establishment of ground control points (All primary, secondary, tertiary points)	3 lakh sq km	points Approximate per day 2 per team of 2 people	12000 to be completed In 6 months	2000
3	Satellite Image processing, OEM creation, ortho rectification, superimposition of cadastral maps and digitisation for finalisation of boundaries	3 lakh sq km	Approximate 1 sq km per person per day	12000 man months to be completed In 6 months	2000
4	Filed survey for the plots where a discrepancy of more than 5% in area is detected	Approximate 50% of all plots	Approximate 30,00,000 Plots to be surveyed (Taking only about 25% of all plots)	120,000 man months Considering 2 plots per team with 2 people (To be completed in one year)	10,000
5	Printing, promulgation with all villages and finalisation	Approximate 75,000 Villages	300,000 man days	12000 man months (to be completed In one year)	1000
6	Mosaic of villages to form tehsils, and then state wide data	75,000 Villages	150000 man days	6000 man months (to be completed in 6 months)	1000
(Approximate no. of skilled man power required for DI-LRMP Project for one state)					17800

Source: Expert Committee constituted by Ministry of Skill Development and Entrepreneurship

On the other hand, geospatial subsector-wise analysis shows that 50%, 30%, 10%, and 10% skilled manpower is required for Geospatial Data Capture, Geospatial Data Processing, Geospatial Data Modelling and Analytics, and Geospatial Application Development and Dissemination respectively.



These statistics speak for themselves and emphasize on the chasm between demand and supply of skilled geospatial manpower. It also underscores the urgent need of geospatial skill-building initiatives, especially at mapping, surveying, processing, analytics and application level. Such high stakes riding on geospatial capacity and skill for national development, and its contribution to employment, mandate the need for quality check of data being produced and need for requisite manpower. There is a large pool of manpower whose employability and quality skills remain uncertified. Majority of human capacities in India are unemployable owing to low skill level. These skill gaps are also an indicator that the geospatial sector has huge untapped employment opportunities. Thus, we have to establish a Geospatial Skill Sector to cater to the rapidly growing demand of skilled manpower for successfully delivering various national development projects and to provide employment and growth opportunities to the people.

# GEOSPATIAL INFORMATION INFRASTRUCTURE

## FOUNDATIONAL TO NEW INDIA VISION

Integration of geospatial technology in the 'New India' vision will enable the development of applications that enable efficient workflows across industries. The technology promises rapid growth in some of the key sectors of the economy such as agriculture, health, education, housing, disaster management, environment and urban development, realizing the vision of a USD 5 trillion economy by 2025.

### 8.1 Role of geospatial technologies

Use of geospatial technology is becoming an important part of program monitoring, management and governance. It is a key enabler in policy planning, implementation and engagement with citizens. Governments and businesses are increasingly relying on geospatial technology to make decisions about investments and expenditure, in order to improve services to citizens / customers, be it tracking illegal construction, minimizing environmental damage or planning sustainable development. With various technological solutions at the core of India's vision, geospatial as an empowering technology has the potential to redefine paradigms for delivery of services.

The government has laid out integrated programs for digital empowerment and economy, Smart Cities, Urban Development, Rail, Road, Water and Air Transport Infrastructure, Water and Irrigation, health and Sanitation, Skill Development and Security and Safety Management to create a sustainable base for continuing this development in the next decade. Currently, the development agenda is based on five pillars.



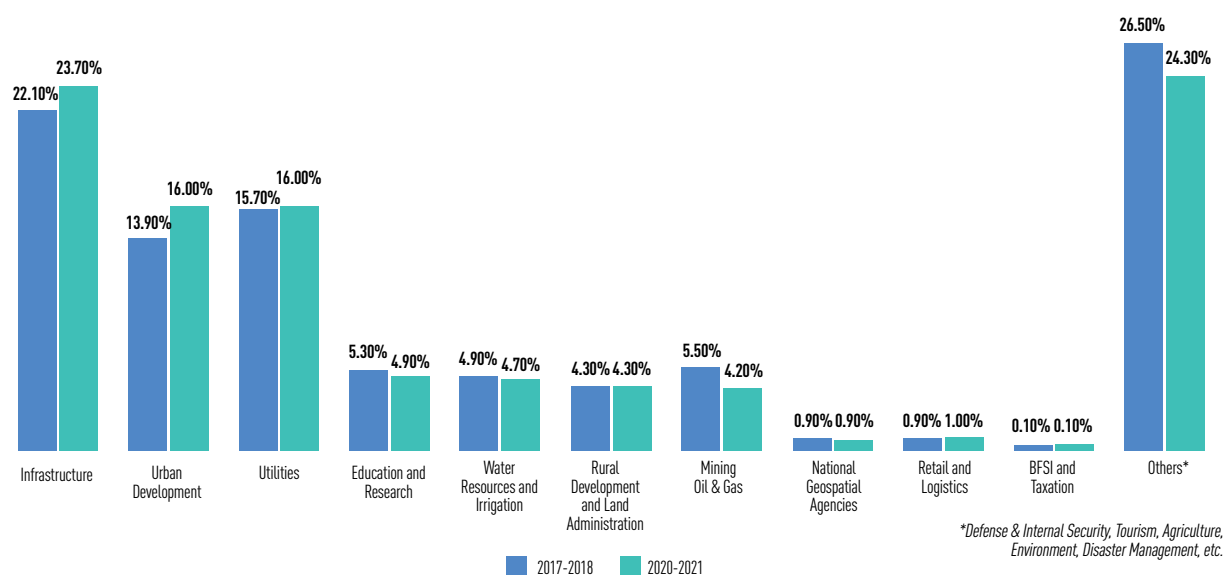
### 8.2 Key sectors using geospatial technology

In terms of end-use sectors (or application areas), the geospatial market of India is dominated by Infrastructure, Urban Development and Utilities. Together in FY 2017-18, these three sectors had an estimated market share of 22.1%, 13.9% and 15.7% respectively, representing nearly half of the total geospatial market of India<sup>2</sup>.

Mining, Education and Research, Water Resources and Irrigation sectors are the next three major user segments contributing nearly 5.5%, 5.3%, and 4.9% respectively in FY 2017-18. On growth terms, between FY 2014-15 and FY 2017-18, Land Administration and Rural Development sector has seen the highest growth rate of nearly 22.9% CAGR, followed by Infrastructure (19.2%), Retail and Logistics (18.0%) and Urban Development (14.7%)<sup>2</sup>.

Going forward, Urban Development, Infrastructure and Retail and Logistics are likely to be the fastest growing user segments.

## SECTORS FINDING HIGH GEOSPATIAL APPLICATION



Source: India Geospatial Economy 2018<sup>2</sup>

**The Niti Aayog, in its vision document Strategy for New India@75, acknowledges the relevance and importance of spatial data and framework in the country's growth and development.**

- *The absence of a modern spatial planning framework, public utility design standards and land titling in cities takes a huge toll on economic growth and productivity, environmental sustainability and living conditions in cities.*
- *Complete digitization of land records is a must for effective implementation of land leasing. Geo-tagging, along with location agnostic online registration of land records to generate updated land records, must be carried out.*
- *There is urgent need for a synchronous and modern national framework for the spatial planning of cities that replaces the current Urban Development Plans Formulation and Implementation (UDPFI) guidelines.*
- *While most states have started digitizing their records, all states must have digitized textual as well as spatial records so that they are easily available and verifiable.*
- *One of the key operational challenge areas in the Smart City Mission include the non-availability of a robust spatial plan as an overall framework within which smart city planning and implementation can happen. Spatial plans should provide for integrating land-use and transport planning to support more mixed-use development for enhancing economic activity, reducing commuting time and improving environmental quality.*
- *Municipal acts need to provide for a digital transformation roadmap for ULBs as a mandatory policy document, like spatial plans. This will also help build data observatories for multiple uses, including citizen engagement.*

## TOP 10 STATES IN TERMS OF UPTAKE (FY 2014-15 TO FY 2017-18)

S. No.	State	Market Share (%)
1.	Maharashtra	13.4%
2.	Karnataka	10.2%
3.	West Bengal	7.9%
4.	Uttar Pradesh	6.2%
5.	Delhi	5.9%
6.	Madhya Pradesh	5.3%
7.	Tamil Nadu	5.3%
8.	Rajasthan	5.0%
9.	Gujarat	4.8%
10.	Andhra Pradesh	4.7%

Source: India Geospatial Economy report 2018<sup>2</sup>

The geospatial technology uptake is yet to make sufficient inroads across all Indian states. At present, the deployment of such technologies is mostly confined to the states that are doing relatively well on the economic front and are taking well defined steps to integrate technology solutions for effective planning, execution and delivery of projects. For the rest of the states, use of geospatial technologies is primarily driven by central policy/scheme mandates.

### 8.3 Geospatial opportunity

The geographic approach benefits organizations of all sizes and in almost every sector or industry, and there is a growing interest in and awareness of its economic and strategic value. The benefits generally fall into five basic categories:

- Cost savings resulting from greater efficiency
- Informed decision making
- Improved communication
- Higher productivity
- Geographic management

Almost every integrated national program requires significant use of spatial data and analysis to enhance productivity, efficiency, transparency and monitoring. The next section takes a deeper look at the geospatial advantage in following areas:



Transport Infrastructure



Land, Rural Development and Agriculture



Water



Urban Development and Housing



Energy



Disaster management

# TRANSPORT INFRASTRUCTURE

**Surface transport:** Roads in India account for the lion's share in the movement of both passengers and freight. Driven by a rapidly growing economy, access to vehicle finance and improved road connectivity, the demand for mobility on roads has risen continuously, leading to a sharp rise in the number of road transport vehicles. The total number of registered vehicles in India increased from 58.9 million in 2001-02 to 182.4 million in 2012-13. However, access to and quality of public transportation needs improvement.

**Railways:** Despite extensive reach and substantial growth in freight load, the modal share of railways in the transportation of surface freight has drastically come down from 86.2% in 1950-51 to 33% in 2015, in part due to a shortfall in carrying capacity and lack of price competitiveness. IR's golden quadrilateral and its diagonals make up only 15% of the total route of the railways but it transports 52% of passenger traffic and 58% of total freight load. This underlines the high saturation and over-utilized capacity on popular routes.

**Civil aviation:** The civil aviation sector has been growing steadily – it contributed USD 8.9 billion to India's GDP in 2014 and supported 1.31 million direct, indirect and induced aviation jobs. The World Economic Forum's Global Competitiveness Report, 2018 ranks India 53rd out of 140 countries worldwide in air transport infrastructure. The Airport Authority of India (AAI) aims to make 250 airports operational across the country by 2020. The Ministry of Civil Aviation's regional connectivity scheme, UDAN, will promote balanced regional growth and make flying affordable for the population.

**Water transport:** India has a coastline spanning about 7,500 km, forming one of the biggest peninsulas in the world. Around 90% of India's external trade by volume and 70% by value are handled by ports. Twelve major ports and 205 non-major ports operate on India's coast. Yet, roads and railways continue to be the dominant modes for cargo movement. Despite being the most cost-effective and efficient mode, water transport accounted for only 6% of freight transport in India in 2016-17. Despite the number of rivers in India, inland water transport carries less than 2% of India's organized freight traffic and negligible passenger traffic. The Inland Waterways Authority of India is mandated to develop and maintain infrastructure for fairway, navigational aids and terminals.

*(Text adapted from India@75 by NITI Aayog<sup>21</sup>)*

## ESTIMATED BUDGET (FY 2019-20)

**INR 250,000 cr**  
(approx)

## GEOSPATIAL MARKET<sup>2</sup>

**FY 2017-18**  
**INR 1,690 cr**

—  
**CAGR**  
**16.9%**  
—

**FY 2029-30**  
**INR 9,415 cr**

## INITIATIVES

- Bharatmala phase 2
- PM Gram Sadak Yojana for state network
- National Highways Grid
- Setu Bharatam
- Industrial corridors
- UDAAN
- Jal Marg Vikas project
- Sagarmala
- High Speed Train Corridor
- Dedicated Freight Corridors

## GEOSPATIAL ADVANTAGE

- Better planning and improved decision making
- Efficient project execution, monitoring and maintenance
- Improved cost and time efficiency
- Increased productivity
- Real-time tracking of assets
- Seamless flow of information
- Clash detection and risk mitigation
- Better coordination and collaboration
- Better-designed projects

# LAND, AGRICULTURE AND RURAL DEVELOPMENT



**Land:** India is among the most land scarce countries in the world, as per the land-to-population ratio. Agriculture accounts for majority of land use, although the sector contributed only 17.45% of value added to GDP in 2015. There has been a steep decrease in the average farm size from 2.28 hectares (ha) in 1970-71 to 1.15 ha in 2010-11. The total recorded forest land in India is 76.4 million hectares, which is about 23.3% of the total geographical area. Even though India has more than 20% of its land under forest cover, Indian forests contribute only 6.4 % of the demand for wood. Property rights over forest lands can be strengthened. The enactment of the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights Act (FRA)), which recognizes individual as well as community rights over forests and allows local communities/gram sabhas to protect and manage their customary forests on a sustainable basis, is a step forward. At the same time, there is an urgent need to make land available to cater to the needs of a rapidly expanding economy and rising population with a focus on vertical development.

**Agriculture:** The current yield levels of a large number of crops are still significantly lower than the global average. Some of the main causes are low irrigation, poor quality seeds, knowledge gap, and lack of technological adoption. Also, more than 50% of cropped area is water stressed, and rainwater management practices and services constantly face a resource crunch. This hinders the capability of a cultivator to undertake multiple cropping, which further leads to inefficient utilization of land resources. Inefficient extension delivery systems have created wide yield gaps as well.

**Rural development:** In spite of rapid progress, rural India faces an infrastructure deficit. The government is working towards total village electrification and accelerating the pace of connecting habitations through the Pradhan Mantri Gram Sadak Yojana. The lack of an adequate and efficient cold chain infrastructure leads to massive post-harvest losses, estimated at INR 92,561 crore annually, in addition to affecting farm exports as well. Electronic national agriculture market (e-NAM) was launched in 2016 to create a unified national market. Till now, 479 *mandis* across 14 states and UTs have been integrated to the platform.

*(Text adapted from India@75 by NITI Aayog<sup>21</sup>)*

## ESTIMATED BUDGET (FY 2019-20)

**INR 250,000 cr**  
(approx)

## GEOSPATIAL MARKET<sup>2</sup>

**FY 2017-18**

**INR 1,488 cr**

—  
**CAGR**  
**13.7%**  
—

**FY 2029-30**

**INR 6,108 cr**

## INITIATIVES

- Digital Land Records Modernization Program
- MNREGA
- National Rurban Mission
- Pradhan Mantri Kisan Samman Nidhi Yojana (PM-Kisan)
- AGRI-UDAAN programme
- Pradhan Mantri Krishi Sinchai Yojana (PMKSY)
- Pradhan Mantri Fasal Bima Yojana
- National Programme on use of Space Technology for Agriculture (NPSTA)

## GEOSPATIAL ADVANTAGE

- Efficient spatial planning
- Records of rights
- Accurate assessment collection of land revenue
- Data shareability
- Monitoring and managing of farm operations
- Efficient management of resources and data
- Better weather forecasting reducing uncertainty for farmers
- Higher yield/ increased productivity
- Increased food security



# WATER RESOURCES MANAGEMENT

India is currently suffering from the worst water crisis in its history, and is ranked 120 among 122 countries in terms of water quality. Over 600 million people face high-to-extreme water stress, 75% of households do not have drinking water on premises and 84% rural households do not have access to piped water. By 2020, according to Niti Aayog, as many as 21 major cities of India will run out of water and face 'day zero'. Water resources are facing pressure due to population explosion, urbanization, rising demand for water from the agriculture, energy and industry sectors, pollution, inefficient use, poor management and poor institutional mechanisms. India is the world's top exploiter of groundwater — it extracts more groundwater than China and US combined (the second and third on the list). Several regions experience water scarcity due to the uneven distribution of water resources over space and time.

The government has launched programs for management of water resources, viz Pradhan Mantri Krishi Sinchayee Yojana (umbrella scheme for irrigation that prioritizes 99 major and medium irrigation projects for completion by December 2019); Namami Gange (clean and rejuvenate the River Ganga to maintain Aviral and Nirmal Dhara and ensure its ecological and geological integrity); and setting up desalination plants on the long coastline.

Among the major constraints for the sector are the huge gap between the irrigation potential created and utilized; absence of participatory irrigation management and non-alignment of cropping patterns to the agroclimatic zones; Easement Act, 1882, which grants groundwater ownership rights to the landowner; and subsidized pricing of water in various states.

The Clean Ganga mission needs to coordinate with the Ministry of Drinking Water, Supply and Sanitation for solid and liquid waste management in 1,600 gram panchayats. Also, there is an urgent need to revitalize, renovate and repair water bodies as well as develop recharging zones at identified places to make groundwater resources sustainable. Programs for smart water meters and tradable permits are crucial aspects to avoid water wastage as well as for use of recycled water.

*(Text adapted from India@75 by NITI Aayog<sup>21</sup>)*

## ESTIMATED BUDGET (FY 2019-20)

**INR 45,000 cr**  
(approx)

## GEOSPATIAL MARKET<sup>2</sup>

**FY 2017-18**  
**INR 379 cr**

—  
**CAGR**  
**11.90%**  
—

**FY 2029-30**  
**INR 1305 cr**

## INITIATIVES

- National Rural Drinking Water Program
- Jal Jeevan Mission
- National Water Informatics Centre
- National Hydrology Project
- Namami Gange Program
- Interlinking of river program
- National River Conservation Programme
- Water Resources Information System
- National Water Mission
- Ground Water Management and Regulation

## GEOSPATIAL ADVANTAGE

- Informed planning and policy formulation
- Real-time monitoring of water storage
- Identification of location of drinking water
- Identification of potential rain water harvesting
- Site suitability for rain water harvesting
- Providing decision support system
- Change detection of water bodies
- Improved predictive analysis of water resources
- Integrated Water Resources Management

# URBAN TRANSFORMATION AND SMART CITIES

India is urbanizing at an enormous pace and it is expected that by 2050, around half of the country's population would be residing in urban areas, needing sustainable infrastructure and services for enhanced quality of life. Such infrastructure and services can only be ensured through modern urban governance. Indian cities are in the process of modernizing their governance structures. The government has undertaken various initiatives focusing on tourism (HRIDAY - Heritage City Development and Augmentation Yojana), infrastructure (Housing for All, Smart Cities Mission, AMRUT - Atal Mission for Rejuvenation and Urban Transformation) and sanitation (Swachh Bharat Mission), among others. The current status of urban governance can be assessed through analyzing the constraints.

Smart Cities is an approach to urban development characterized by area-based development, efficient delivery of basic infrastructure and services in an equitable manner and citizens' participation. The Government of India has so far selected 99 cities with an outlay of INR 2.04 lakh crore. These cities have started implementing projects such as smart command and control centers, smart area-based development, smart roads, solar rooftops, intelligent transport systems and smart parks. These projects have the unique feature of integration between different infrastructural elements of the projects. As of 14 May 2018, projects worth INR 4,800 crore have been completed and works worth more than INR 20,000 crore are underway, as per the Ministry of Housing and Urban Affairs' Smart City MIS portal.

Significantly, the Niti Aayog has identified a robust spatial plan as an overall framework for smart city planning and implementation. It has said land titling in cities, digital master plan or a digital strategy and roadmap are fundamental to data-driven decision making for service delivery and resource sustainability in cities. Guaranteed land titling may also be evaluated to foster a transparent land market. India's future cities must be climate resilient, inclusive for urban poor and slum dwellers and encourage citizen participation. Decentralization and metropolitan governance; data observatories in partnership with civil society and quarterly city dashboard to provide a framework for data-driven decisions are also part and parcel of Smart Cities.

*(Text adapted from India@75 by NITI Aayog<sup>21</sup>)*

## ESTIMATED BUDGET (FY 2019-20)

**INR 48,000 cr**  
(approx)

## GEOSPATIAL MARKET<sup>2</sup>

**FY 2017-18**  
**INR 1,067 cr**

—  
**CAGR**  
**16.2%**  
—

**FY 2029-30**  
**INR 5,564 cr**

## INITIATIVES

- Pradhan Mantri Awas Yojana - Urban
- Smart City Mission
- Atal Mission for Rejuvenation and Urban Transformation (AMRUT)
- Heritage City Development and Augmentation Yojana (HRIDAY)
- Metro rail projects
- Swachh Bharat Mission - Urban
- Sustainable Urban Transport Project (SUTP)
- Deendayal Antyodaya Yojana
- National Urban Livelihoods Mission
- Jawahar Lal Nehru National Urban Renewal Mission

## GEOSPATIAL ADVANTAGE

- Improved decision-making in cities
- Informed city planning and inclusive growth
- Monitoring of programs
- Urban sprawl change detection
- Increased resource efficiency
- Connected systems enable seamless flow of information
- Uninterrupted services to citizens
- Less downtime of infrastructure

# POWER



Coal dominates India's energy scene with a 49.6% share, followed by oil (28%), biomass (11.6%), gas (7.3%), renewable and clean energy (2.2%) and nuclear energy (1.2%). It is the world's third largest energy consumer. On energy supply, India is still heavily reliant on petroleum imports to meet its requirements. In the coal sector, the government permitted commercial mining in 2018. Furthermore, power sector companies, especially state government utilities, continue to face financial woes. Interestingly, India has surplus power generation capacity, but lacks adequate distribution infrastructure.

The government's ongoing energy sector policies aim "to provide access to affordable, reliable, sustainable and modern energy". At the convergence of its domestic goals and the Global Development Agenda, it also intends to make 24x7 power availability to all by 2019. The special focus on clean and green power entails achieving 175 GW of renewable energy generation capacity by 2022. The target is also to reduce imports of oil and gas by 10% by 2022-23, thus increasing energy security. The plan also entails continuing to reduce emission intensity of GDP in a manner that will help India achieve the intended nationally determined contribution target of 2030.

Among the biggest constraints for the power sector are old inefficient plants; lack of focus and investments in energy efficiency; inability of regulatory commissions to fully regulate discoms; unmetered power supply to agriculture; unreliable supply and load shedding; and inability of states to invest in system improvements. Land for coal mining becoming a major issue which is also hurting the power sector.

Smart grid and smart meters should be one of the primary areas of investment going forward, if India has to ensure energy efficiency. Since free power to agriculture sector is a drag on the economy, there should be focus on use of renewable power, an upfront subsidy per acre of land through direct benefit transfer for farmers as well as 100% metering, smart meters, and metering of electricity supplied to agriculture.

*(Text adapted from India@75 by NITI Aayog<sup>21</sup>)*

## ESTIMATED BUDGET (FY 2019-20)

**INR 20,000 cr**  
(approx)

- Make 24x7 power available to all by 2019.
- Achieve 175 GW of renewable energy generation capacity by 2022.
- Reduce imports of oil and gas by 10% by 2022-23.
- Continue to reduce emission intensity of GDP in a manner that will help India achieve the intended nationally determined contribution target of 2030.

## INITIATIVES

- One Nation One Grid
- National Smart Grid Mission
- Ultra Mega Power Projects (UMPPs)
- Restructured Accelerated Power Development and Reforms Programme (R-APDRP)
- Pradhan Mantri Sahaj Bijli Har Ghar Yojana
- Deen Dayal Upadhyay Gram Jyoti Yojana (DDU-JY)
- Integrated Power Development Scheme (IPDS)
- Ujwal Discoms Assurance Yojana (UDAY)
- Green Energy Corridor Project
- National Solar Mission
- National Policy on Biofuels

## GEOSPATIAL ADVANTAGE

- Improved decision making
- Better management of assets and complex operations
- Effective planning of transmission and distribution requirements
- Transmission line route alignment
- Improved customer services
- Efficient project management
- Higher transparency
- Better network monitoring
- Reduced network downtime
- Improved efficiency

# DISASTER MANAGEMENT



India is quite prone to natural disasters like floods, earthquakes, cyclones, and tsunamis. As compared to the developed West, which is adequately equipped to withstand environmental disruptions, countries like India and China will bear the brunt of disasters caused by rising sea levels and increased emissions. Temperatures in three Indian cities — Chennai, Mumbai and Delhi — have spiked steadily in the past 50 years. In Chennai, it has risen by 0.9 degree Celsius since 1960-70. This rise in temperatures has led to higher incidences of natural disasters — storms, floods and droughts<sup>35</sup>.

Large-scale development without proper disaster risk assessment has increased the risk of losses from disasters. In the 1900s, natural disasters affected a million people. While now 596 million people are being affected, which is almost half of India's population. The cost of the damages has also shot up. In the current decade, damages caused due to natural disasters are expected to reach USD53.6 billion - from USD19.9 billion in the last decade<sup>35</sup>.

A study released by the UN Office for Disaster Risk Reduction shows that between 1998 and 2017, India has been among the top five countries with absolute economic losses of about USD79.5 billion. The global losses stand at about USD3 trillion in the last two decades, with US topping the list at USD945 billion. The government intends to set up national-level disaster database by 2020<sup>36</sup>.

## ESTIMATED BUDGET (FY 2019-20)

**INR 578 cr**  
(approx)

## AIM

**Make India disaster resilient, achieve substantial disaster risk reduction, and significantly decrease the losses of life, livelihoods, and assets by maximizing the ability to cope with disasters.**

### Prime Minister's 10-Point Agenda On Disaster Risk Reduction

- All development sectors must imbibe the principles of disaster risk management.
- Work towards risk coverage for all-starting from poor households to SMEs to multi-national corporations to nation states.
- Encourage greater involvement and leadership of women in disaster risk management.
- Invest in risk mapping.
- Leverage technology to enhance the efficiency of our disaster risk management efforts.
- Develop a network of universities to work on disaster issues.
- Utilize the opportunities provided by social media and mobile technologies.
- Build on local capacity and initiative.
- Opportunity to learn from a disaster must not be wasted.
- Bring about greater cohesion in international response to disasters.

## INITIATIVES

- National Cyclone Risk Mitigation Project
- Aapda Mitra – Scheme for training volunteers
- School Safety Project
- National Disaster Management Services (NDMS) Pilot Project

## GEOSPATIAL ADVANTAGE

- Enhanced decision making
- Hazard zone mapping
- Improved mitigation strategies
- Improved resource allocation
- Enhanced situational awareness
- Preparedness for disasters
- Early warning of disaster event
- Improved relief management, rescue operations`

# GEOSPATIAL STRATEGY

## FOR ACHIEVING NEW INDIA VISION

With the advent of the Fourth Industrial Revolution, geospatial technologies have assumed a greater significance in steering future course of growth. Together with IT and engineering technologies, geospatial can ensure all round sustainable development. This can be achieved by ensuring the accuracy and availability of geospatial data to an even greater extent, thereby making it more efficient.

### 9.1 Mission, vision and principle

#### Mission

To provide leadership to the geospatial industry through formulation of policies, standards and coordination, to steer the industry towards shared goals, minimize conflicts and disruptions, promote and assist innovation in the geospatial sector for leveraging its potential to develop sustainable solutions for social, economic and environmental issues.

This entails creation of a secure geospatial information network in India with physical infrastructure that makes data available, accessible, exchangeable and usable for the people to ensure:

- Safety and security of India; and
- Inclusive and information-driven and innovation-driven economy.

To realize this vision, the government has to play a leadership role in facilitating a conducive environment for development and maintenance of geospatial information and its adoption in all development programs.

The strategy lays down the purpose, principles, goals and implementation plan required to achieve the vision detailed.

#### Purpose

- Evolve an approach in order to dovetail the specifics of geospatial information infrastructure of the country with the requirements of industry and the needs of the government;
- Provide the requisite architecture for effective leadership for managing geospatial information;
- Encourage public investment in geospatial infrastructure; and
- Ensure availability of reliable and accurate geospatial data to all.

#### Key principles

- Standardization of geospatial information with scope for necessary customizations;
- Simplifying access to geospatial information to ensure that it is easy to understand, integrate, interpret and use;
- Unrestricted flow of relevant geospatial information within suitable financial models to facilitate the government's access for public good; and
- Adequate security and protection for geospatial data within the purview of national security, sovereignty and privacy policy.

## 9.2 Strategic goals

### Governance

- Establish appropriate governance structure to regulate and optimize benefits from geospatial resources in public and private sectors.

### Data

- Ensure capturing, protection, preservation and maintenance of fundamental geospatial datasets and networks, and prescribe guidelines for non-fundamental geospatial data for improving government, business and community decisions by transforming data capabilities and supporting a data-enabled economy.

### Innovation

- Create an innovation-driven geospatial economy with inbuilt capacities to churn out customized and improved solutions for suitable monetization of technologies that lead to higher productivity and competitiveness for the industry.

### Policy

- Ensure an enabling policy architecture for communities and businesses for ease of access to geospatial information and ensure that it can be used by different governmental agencies for multiple purposes.

### Operational Excellence

- Deliver better services, solutions and outcomes that benefit citizens.

### Knowledge platform

- Create a knowledge platform that will enable real-time information flow.



## 9.3 Geospatial infrastructure

### Mapping infrastructure

The Survey of India shall continue to provide user focused, cost effective, reliable and quality geospatial data, information and intelligence for meeting the needs of national security, sustainable national development, and new information markets.

Prepare topographic maps of different scales. There is an urgent need to develop a strategy for completion of large scale maps for entire country through private partnerships and other available mechanisms. Such an initiative will bridge important gaps in policy planning and execution of development programs.

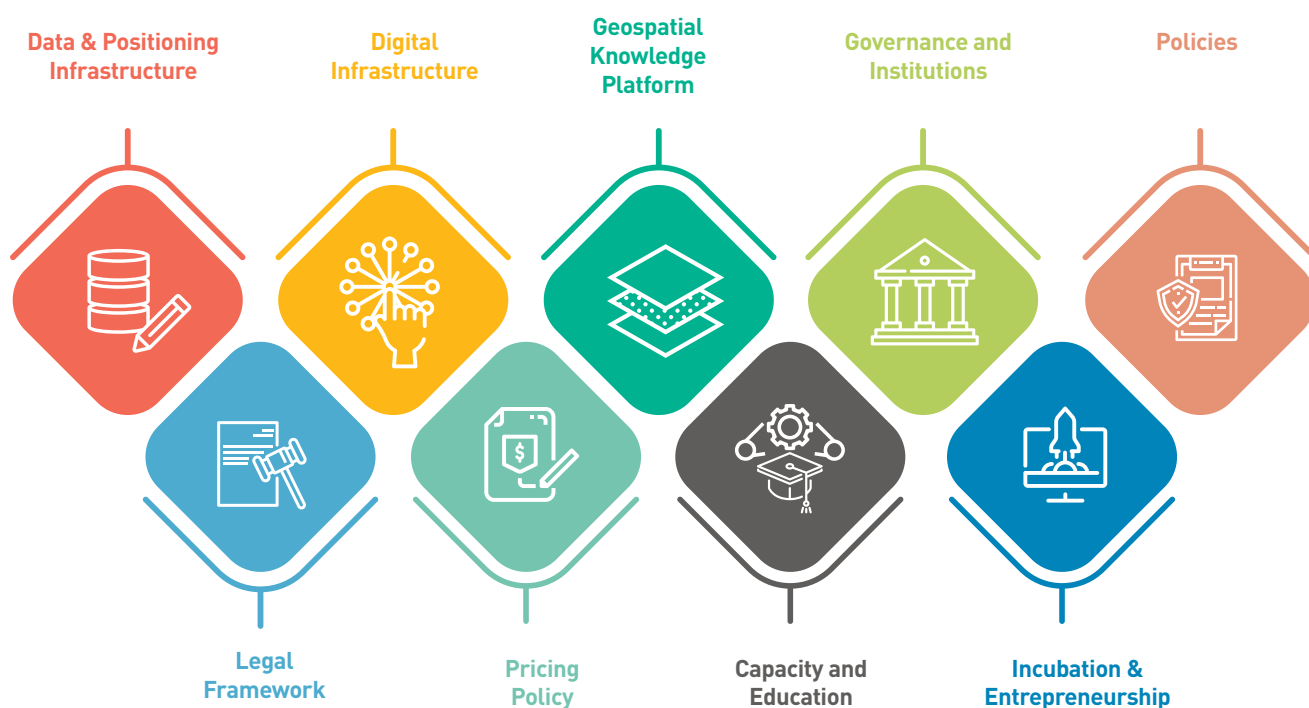
Geodetic surveys to be carried out to provide the most accurate type of control points for efficient surveying. SOI shall provide geomagnetic data to various scientific agencies and carry out gravity observations which play an important role in R&D and scientific exploration.

### Positioning infrastructure

Given the growing importance of precise location in a data economy, there is an urgent need to establish nationwide GNSS CORS infrastructure network. This network will fulfil the need for instantaneous, reliable and fit-for-purpose access to position and timing information that will enable a variety of scientific, civil, and commercial applications across the Indian landscape and its maritime jurisdictions.



## ELEMENTS OF STRATEGY



In view of its strategic importance, India needs to develop a network of 4,000 CORS stations. While Survey of India has already started some work in this direction, a collaborative approach is required to deliver this infrastructure to cater to the high initial cost involved in setting up of the system.

In order to encourage the penetration of IRNSS in services, the strategy should be to encourage the implementation and usage of IRNSS in the larger domain of public services. This can include transportation services. In addition, states can be encouraged to use IRNSS receivers as part of their public transportation systems such as buses and emergency services, among others.

Such measures will be key in achieving volumes for manufacturers and service providers to support users at reasonable cost. A systematic identification of projects under each department and ministry and also a charter for usage at various state government levels will ensure that IRNSS usage kicks off with a broad scope of integration into major civilian services. This will put the usage of the navigation constellation on course for commercial/consumer electronics, extension of similar services to other SAARC nations and expansion of the footprint of the constellation in the future.

### Earth observation infrastructure

India now ranks amongst a handful of nations that have credible capabilities in the field of space technology and has had a great legacy of using space-based technologies for nation building. Since its establishment in 1969, ISRO has been guided by a set of mission and vision statements covering both the societal objectives and the thrust areas. The Indian remote sensing program was guided by a vision to focus on use of space-based imagery for a slew of national demands, ranging from weather forecasting, disaster management and national resource mapping and planning.

The need of the hour is to shift the focus from being providers of data to value added products and services. This includes generation of user-oriented products, new software tools and uninterrupted services.

A plan has to be formulized for building high-resolution satellite constellations to provide data with high

revisit, establishing ground infrastructure for data acquisition, processing, generation of data products and reliable dissemination mechanisms. Constellation of microwave SAR satellites, high-resolution panchromatic and multispectral remote sensing data with quick turn-around-time is the need of hour.

### Sectoral geospatial infrastructure

Understanding the critical importance and value of geospatial data and technologies in an organization, a vision and plan for their ongoing management and future use is essential in major sectors of the government. For instance, recently the Ministry of Road Transport and Highways established a geospatial cell for single window, full spectrum, multidisciplinary geospatial capabilities. An independent sectoral geospatial strategy will help in better utilization of geospatial information for planning and project deliveries to ensure social and inclusive growth in line with the development philosophy of the government. Under this, each key ministry should work towards establishing its own geospatial cell with a strategic plan to encompass governance, infrastructure, software, resourcing, training and education and public access. The strategic plan should cover the following aspects:



### Subsurface infrastructure

The subsurface or underground is an incredibly complex environment which holds the vital functions of water and energy supply, communication systems, sewers and drainage. With increasing pressure on land and a drive for compact, resource-efficient cities, we see more urban development underground, such as metro networks. Knowledge of the subsurface is, thus, the key to build efficient cities and infrastructure. One of the main issues across the world is that urban designers till sometime back were not used to considering the subsurface in their urban development work. While there exists some data about underground infrastructure in Indian cities, much of it is fragmented (they have been generated by individual players like the municipality laying drainage pipes, the telecom or a gas pipeline player laying their connections), and most often not updated. With advancements in technologies and miniaturization of sensors, and the speed of urbanization and infrastructure in the country, there needs to be a concrete strategy for mapping the subsurface infrastructure in cities in 3D format, and collating or updating data in cases where it has already been done once.

### Thematic geospatial information

The designated thematic geospatial agencies like NATMO, Forest Survey of India, Geological Survey of India, Soil and Land-use Survey are responsible for conducting survey and assessment of national resources, providing specific geographical/environmental information and data sets, representation, scrutiny and certification of national interests of geospatial domain in their respective work areas. Together with other related entities, these agencies play a crucial role in augmenting the usage of geospatial data and information for social and economic development. Data acquisition, updation and maintenance of thematic

maps/layers will be the responsibility of the respective thematic mapping organization.

### **Hydrographic data**

The quantity of information generated by survey sensors for ocean and coastal zone mapping has reached the Big Data age influenced by the variety of survey sensors available today, high data resolution, commercial availability, as well as an increased use of autonomous platforms. The number of users of sophisticated survey information is also growing with the increase in data volume leading to a greater demand and broader use of the processed results, which includes marine archeology, disaster response, and many other applications.

While the Indian Naval Hydrographic Department is the nodal agency for Hydrographic surveys and Nautical charting in India, there are other organizations — both government and private — who collect information about the water bodies in India. All this data needs to be standardized and integrated to ensure availability of accurate and up-to-date navigational products to mariners, as also provide hydrographic services to national and international agencies and Public as well as Private Sector Undertakings.

## **9.4 Digital infrastructure**

In the digital era, with the advent of Big Data, Internet of Things and Artificial Intelligence, there is a requirement higher computing power, data storage and communication network speed for various applications of digital infrastructure like smart cities, smart healthcare, smart retail and intelligent transportation. Digital infrastructure is also critical for delivery of services to remote areas.

Building enabling physical infrastructure requires significant upfront and ongoing investment for maintenance and upgradation. The Ministry of Electronics and Technology (MeitY) has to maintain an information technology infrastructure to support geospatial data and its management and other geospatial data-related activities. MeitY will also study investigate ways to take advantage of cloud computing and storage and provide leadership and guidance around the computing paradigm, required hardware/software for AI-based processing to catalyze its use within industry and government.

MeitY should also build a robust geospatial innovation ecosystem in India comprising of startups, innovators, enterprises and the government, with focus on solving real-world challenges by utilizing geospatial technologies along with emerging technologies like IoT, AI, Data Science, Big Data, AR/VR, Machine Learning, robotics.

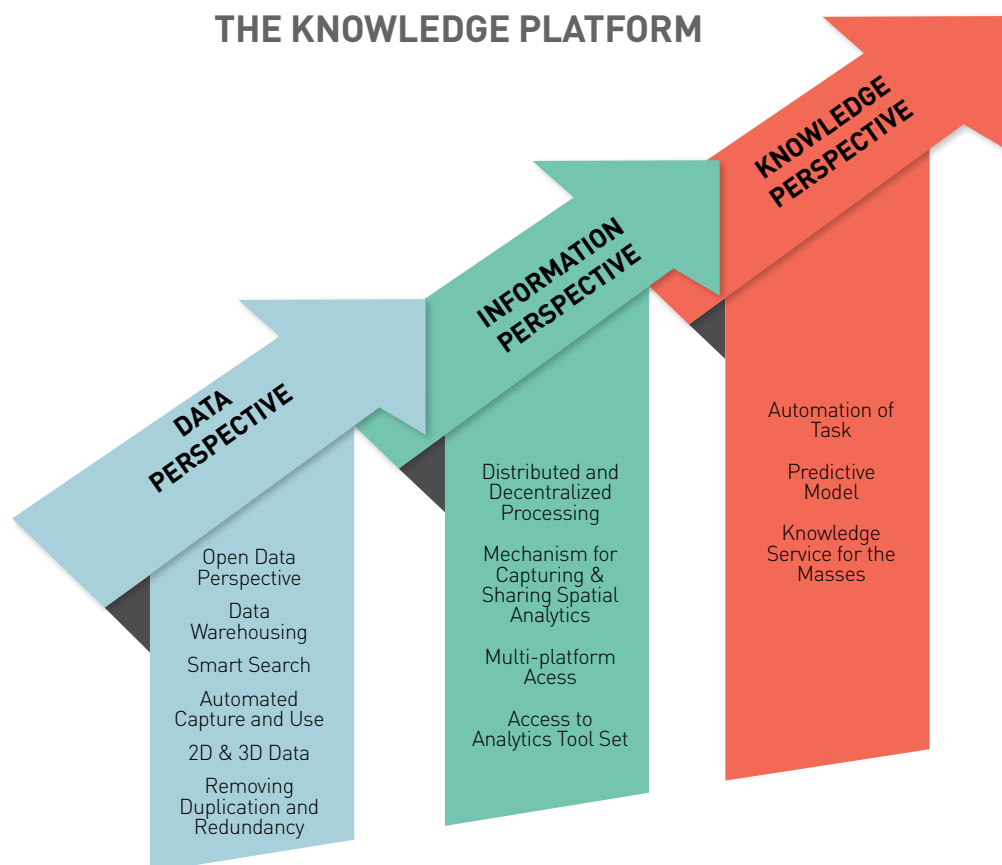
The National Informatics Centre with its vast experience in the domain shall be the technology think-tank and technology partner of the government. It shall play a key role in designing and developing the core information assets of the nation.

## **9.5 Integrated GeoHub and knowledge platform**

Enabled by advances in ICT infrastructure and digital technologies, gains in computation and data storage capacities to manage large volumes of different spatial and non-spatial datasets through standardization and interoperability, avoiding duplication and enhanced knowledge sharing in a networked environment. These initiatives at the national and state levels have evolved since 2000, primarily led by the Department of Science and Technology, various state governments, geo-portals like 'Bhuvan' by the National Remote Sensing Centre; 'Bhukosh' by Geological Survey of India. There is an urgent need for an integrated system/platform that has a network of data, analytics, expertise that assist people, whether individually or in collaboration, to integrate spatial knowledge into everyday decision-making and in support of the emerging digital economy and the rise of spatially-aware and equipped citizens.

The new platform will help in exploring, visualizing, downloading and analyzing geospatial data. This can analyze and combine data layers using maps, as well as develop new web and mobile applications. This

## THE KNOWLEDGE PLATFORM



Sharing	Significant time and effort saved through improved access, sharing and collaboration on data curation; analytics; broader inclusion of domain experts in collaborative teams leads to more effective use of spatial data; reliance on spatial data increased, driving increased productivity.
Versatility	Comprehensive spatial data available for decisions across all areas of government and industry analytics, including incorporation of 3D and 4D, dynamic, sensor-based, multisource imagery, IoT data reflecting physical measurements and crowdsourced data intimating human judgments and views
Process	Increased integration of analytics and business workflows; protection from adverse effects of data misapplication; increased confidence in data and analytics; range and use of spatial data in the marketplace increased. Increased confidence in automated information and knowledge creation.
Usability	More real-time usable, mobile, graphical and natural language interfaces; increase user base for spatial data, thus increasing efficiency; evidence-based decision-making supported by data and predictive analytics; time and costs of searching for data and using sub-optimal data and analytics reduced. Fast, efficient and cost effective spatial processes incorporated into workflows.

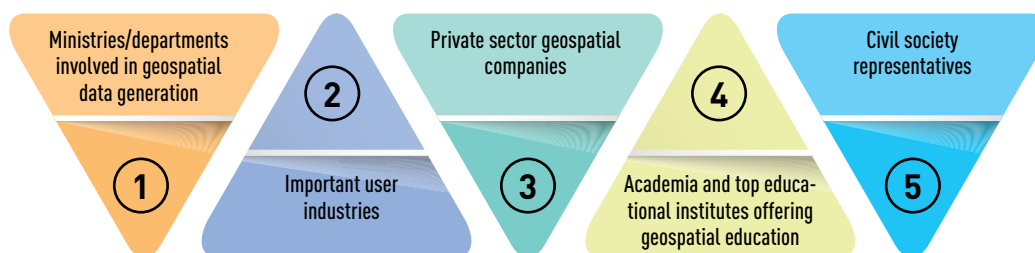
would be a decentralized system wherein department and business functions manage their geospatial data, systems and resources independently.

Building such a platform will result in a diverse and yet collaborative information management environment working at once and in partnership with many data providers facilitating establishment of a knowledge-focused environment for customized and real-time decision-making and drive new knowledge-based activities such as smarter transportation networks, responsive and resilient cities, and intelligent infrastructure planning. In other words, there will be complete synergy between all the participants in such a network.

## 9.6 Governance and institutions

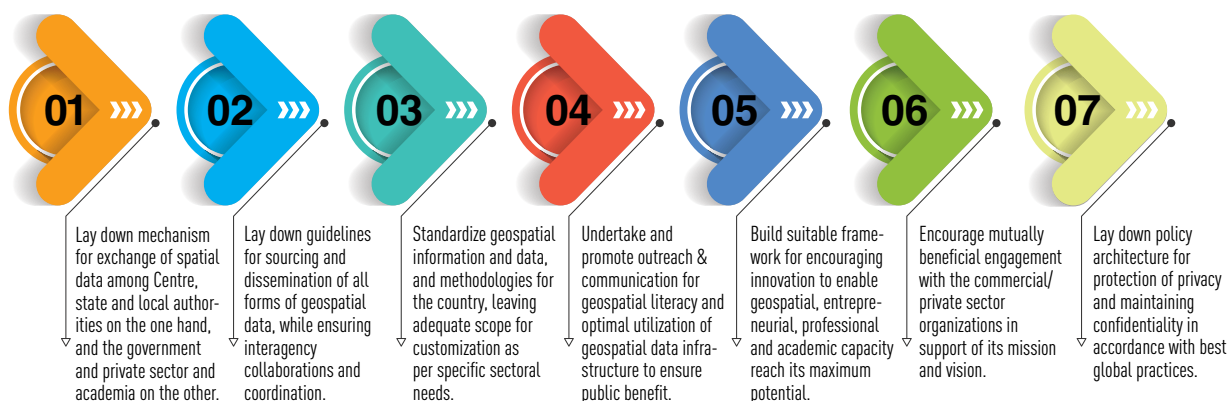
The growing importance of geospatial data and technologies and the widespread reach of assorted applications offer tremendous global economic opportunities. There is a dire need for an independent central geospatial agency for harnessing the potential of geospatial data and developing nation-wide capability to tap future opportunities. It would be a non-partisan and autonomous body under the Prime Minister Office or Niti Aayog.

The membership of the agency would include people from different areas of expertise such as:



The agency would be responsible for shaping India's national geospatial strategy, and will also act as the vanguard of all public sector data in India. Additionally, it will also constantly explore new opportunities for a convergence of benefits that will boost growth and productivity. It will actively work with various government departments and other public sector organizations that are looking at policies pertaining to geospatial planning, environment, drones, construction innovations, or simply the use of geospatial for more efficient decision-making.

### PRIMARY RESPONSIBILITIES



## 9.7 Data policy

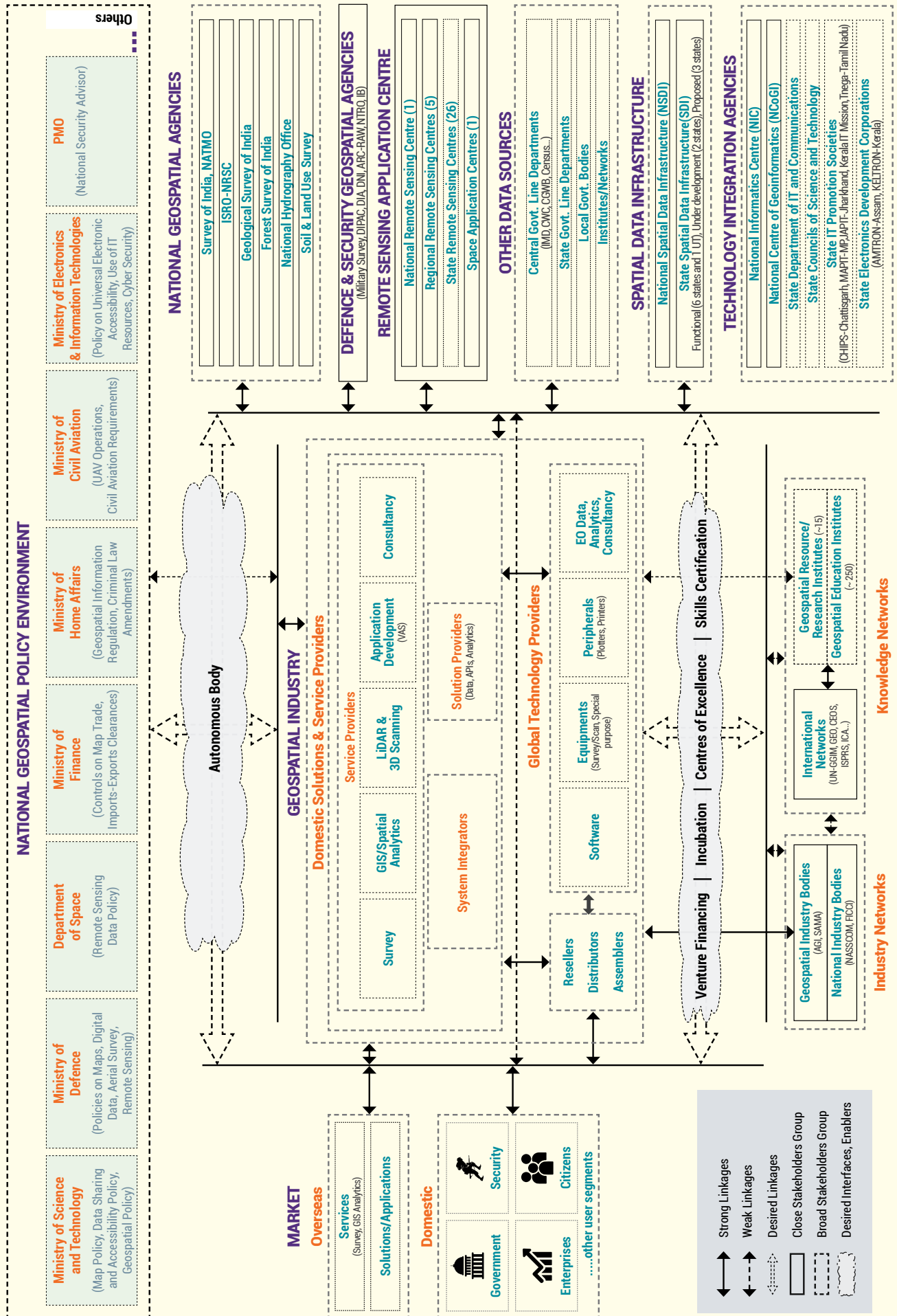
### Data acquisition and management

- Data acquisition and maintenance will be the responsibility of the respective national mapping and thematic mapping organizations for their dataset which will be shared with the Integrated Geospatial Knowledge Platform.
- Data will be updated periodically by the lead custodian agency corresponding to the data theme.

### Data dissemination and access

To foster an environment of innovation, data should have minimum restrictions while respecting privacy, national security and commercial confidentiality. However, due to the sensitive geo-political position of the country, different users like security agencies, lateral government agencies, research and academia, industry etc. should have different levels of permission and access to data in terms of areas, resolutions and data themes. These limitations to be pre-defined by the policy for the various categories of access.

# Indian Geospatial Sector: Proposed Landscape



**(A) Open access:** This data must be published in a readily usable format, with a license that permits anyone to access, use and share it. In order to promote the optimum utilization of geospatial information, all data up to 1m resolution should be made free and open access.

**(B) Registered access:** Automatic registered access: Under this type of access, users will register and get a user ID and password which will be used to gain access to data.

**(C) Authorized registered access:** Under this type of access, user details will be verified before giving access to data. The authorization will be for a limited period and select datasets. The access to the data could be exclusively meant for government purposes or data available at a cost for businesses and citizens.

**(D) Restricted access:** Users will have to submit a form detailing their need for the data and the activities they plan to use it for, and user details will be verified before giving access to data. The authorization will be for a limited period and select datasets. Different users like security agencies, lateral government agencies, research and academia, industry etc. will have different levels of permission and access to data in terms of areas, resolutions and data themes.

## 9.8 Legal framework

The integrated geospatial policy should be inclusive of provisions under which any violations of the National Geospatial Policy would entail disciplinary measures such as blacklisting, cancellation of business licenses and registration of criminal cases as per the provisions of the law. However, it is recommended that the policy also mandates the rules and regulation under the cyber law in India.

### Data sovereignty

If India's economic, social and political interests in the emerging data economy are to be effectively secured, its 'data sovereignty' has to be at the core while participating in the global digital economy.

- Mandate data sovereignty and localization in the country for investigative and national security reasons.
- Harmonize geospatial law and policy with the evolving legal framework and jurisprudence relating to sovereignty, privacy and data protection in India.

### IPR

The policy will be inclusive of Intellectual Property Rights (IPR). However, it will not be applicable in all contexts. For example, since the data will be available for free access, legality of IPR cannot be implemented in this case. However, IPR may be implemented in context to sensitive and non-sharable data that geospatial data generating agencies will enlist within three months from the issue of this policy. It is recommended that in case of IPR, the policy identifies and defines the need and the areas where it is implementable.

### Liability

Liability in geospatial data is complicated by the virtue of its multiple usages, integration with other technologies and data and use of multiple software. Each application of geospatial technology to a specific use may require integration of different types of data from multiple sources, re-assessing the attributes, etc. All these actions may add to some level of errors. The same data may run through different software for different purposes. Hence, legal questions surrounding liability for geospatial data is extremely complex, especially in a changing technological environment.

### Data security and protection

A data security and protection framework to be drafted based on technology agnosticism, controller accountability, structured enforcement and deterrent penalties. The National Geospatial Data Policy should be inclusive of unauthorized access and misuse of geospatial data. Violation of data protection through illegal copy of data, tampering and forgery, exposure of privacy information etc. will clearly be documented.

The issues of data protection by ensuring that core data protection and security principles to be addresses without affecting the core philosophy of 'data for all'.



## **Licensing**

Authorization policy will be enforced to specify 'who' can access 'what' and 'how', and the legal policy will be framed against violation of authorization of data access. Some high precision data is permitted to be used by military or government agencies only and users not having authorization will not have access to it. The policy should also address violation of rules set for such data access and licensing.

## **Privacy**

Geospatial data security has become one of the main areas of research all around the world. As geospatial data is important and confidential, privacy as well as security of this data is of main concern. The integrated geospatial policy, therefore, needs to identify and design security and privacy policy for geospatial data.

## **9.9 Pricing policy**

Maps up to 1:25,000 and 1m resolution imagery should be made freely available.

The rate sheet against high resolution data types should be finalized along with the lead data custodian agencies.

## **9.10 Capacity and education**

To support an environment that will enable entrepreneurial, industrial, academic and professional capacity building in the sector which will lead to knowledge and economic enhancement.

To help create an innovation ecosystem following three processes to be initiated.

**A. Creation of infrastructure:** The government will facilitate in development of physical and digital infra- structure through public private partnerships.

**B. Professional training:** Develop a cadre of geospatial professionals across India from a wide variety of backgrounds and application areas through professional training programs and regional training centers; establish certified qualifications for geospatial professionals through professional accreditation programs in collaboration with the Ministry of Skill Development.

**C. Formal education:** Realizing the importance of geospatial education, the Ministry of Human Resources Development had constituted a National Task Force on Geospatial Education (NTFGE) in 2013 under the chairmanship of Dr. K. Kasturirangan, a member of Planning Commission and former Chairman of ISRO. The key projects suggested by the National Task Force on geospatial education were: School Geospatial Education Project (SGEP) – led by the Department of School Education, MHRD; Geospatial University Networking Project (GUNP) – led by the Department of Higher Education, MHRD; Geospatial Training and Outreach Project (GTOP) – led by DST; and Indian Institute on Geospatial Technology.

## **9.11 Incubation and entrepreneurship**

To develop incubation models to support private-public entrepreneurship across various sectors in India, it is important to enable successful geospatial and ICT entrepreneurs to establish their tech labs in the facilities provided by the government and regional incubation centres to encourage successful technology incubators and accelerators to expand their incubation labs all over the country.



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## References

1. <http://ggim.un.org/meetings/GGIM-committee/8th-Session/documents/Part%201-IGIF-Overarching-Strategic-Framework-24July2018.pdf>
2. Indian Geospatial Economy Report 2018 - <https://geobuiz.com/india-geospatial-economy-report/>
3. <https://www.bcg.com/documents/file109372.pdf>
4. [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/733864/Initial\\_Analysis\\_of\\_the\\_Potential\\_Geospatial\\_Economic\\_Opportunity.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/733864/Initial_Analysis_of_the_Potential_Geospatial_Economic_Opportunity.pdf)
5. [https://www.computerworld.com.au/article/208938/landmark\\_study\\_qualifies\\_economic\\_benefits\\_spatial\\_information](https://www.computerworld.com.au/article/208938/landmark_study_qualifies_economic_benefits_spatial_information)
6. [https://cutaactu.ca/sites/default/files/final\\_cuta-economicbenefitsoftransit-finalreportsept2010.pdf](https://cutaactu.ca/sites/default/files/final_cuta-economicbenefitsoftransit-finalreportsept2010.pdf)
7. <https://www.geospatialworld.net/article/economic-value-of-geospatial-data-the-great-enabler/>
8. The Economic Impact of Geospatial Services 2017 - [https://www.alphabeta.com/wp-content/uploads/2017/09/GeoSpatial-Report\\_Sept-2017.pdf](https://www.alphabeta.com/wp-content/uploads/2017/09/GeoSpatial-Report_Sept-2017.pdf)
9. GeoBuiz 2019 Report - <https://geobuiz.com/geobuiz-report-2019/>
10. World Bank Database, retrieved 15th January 2018
11. <https://www.financialexpress.com/auto/car-news/time-spent-in-cabs-goes-up-as-averagespeed-of-cars-down-by-3kmh-bengaluru-hyderabad-delhi-worst-hit/1001845/>
12. BCG Uber report, 2018
13. <https://thewaterproject.org/water-crisis/water-in-crisis-india>
14. "Water quality of Ground Water - 2008". Open Government Data (OGD) Platform India
15. NITI Aayog (June 2018). "Composite Water Management Index"
16. UNESCO, 2013
17. National Skill Development Policy 2015 – framework document
18. <https://data.gov.in/keywords/urban-population>
19. Global Burden of Disease 2016, Institute of Health Metrics and Evaluation
20. <https://economictimes.indiatimes.com/news/economy/finance/india-to-lose-over-4-58-trillion-to-non-communicable-diseases/article-show/45050924.cms>
21. India @ 75, NITI Aayog 2018 - [https://niti.gov.in/writereaddata/files/Strategy\\_for\\_New\\_India.pdf](https://niti.gov.in/writereaddata/files/Strategy_for_New_India.pdf)
22. <https://www.indiabudget.gov.in/>
23. <https://sustainabledevelopment.un.org/content/documents/15836India.pdf>
24. [https://niti.gov.in/writereaddata/files/Strategy\\_for\\_New\\_India.pdf](https://niti.gov.in/writereaddata/files/Strategy_for_New_India.pdf)
25. <https://www.indiatoday.in/india/story/narendra-modi-s-6-biggest-challenges-1536512-2019-05-28>
26. <https://www.mapsofindia.com/my-india/society/current-major-issues-in-india?subscribe=success#512>
27. <https://www.indiatoday.in/news-analysis/story/why-this-economic-slowdown-is-serious-1580824-2019-08-14>
28. <https://www.downtoearth.org.in/news/economy/india-s-unemployment-rate-doubled-in-two-years-soe-in-figures-64953>
29. <http://ficci.in/spdocument/20195/FICCI-GT-Empowering-India-through-Geospatial-Technologies.pdf>
30. <https://www.files.ethz.ch/isn/154067/PrabhuBrief.pdf>
31. [https://energypedia.info/wiki/India\\_Energy\\_Situation#Key\\_Problems\\_of\\_the\\_Energy\\_Sector](https://energypedia.info/wiki/India_Energy_Situation#Key_Problems_of_the_Energy_Sector)
32. <http://amrut.gov.in/upload/newsrelease/5d3e9da5b8de4Minutes%20of%2022nd%20Apex%20Committee.pdf>
33. <https://www.indiatoday.in/india/story/narendra-modi-s-6-biggest-challenges-1536512-2019-05-28>
34. <https://pib.gov.in/budgetfornewindia/#gallery02>
35. The Climate Solution: India's Climate Change Crisis and What We Can Do About It - Mridula Ramesh
36. Economic losses, poverty & disasters: 1998-2017 - UN Office for Disaster Risk Reduction
37. [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/827507/Final\\_Version\\_-\\_Future\\_Technologies\\_Review.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/827507/Final_Version_-_Future_Technologies_Review.pdf)
38. GeoBuiz 2018 Report - <http://geobuiz.com/geobuiz-2018-report.html>
39. GeoBuiz 2017 Report

## Further Reading

1. [http://ggim.un.org/meetings/GGIM-committee/8th-Session/documents/E-C20-2018-7-Add\\_1-Global-fundamental-geospatial-datathemes.pdf](http://ggim.un.org/meetings/GGIM-committee/8th-Session/documents/E-C20-2018-7-Add_1-Global-fundamental-geospatial-datathemes.pdf)
3. [http://ggim.un.org/meetings/GGIM-committee/8th-Session/documents/E-C20-2018-7-Add\\_1-Global-fundamental-geospatial-datathemes.pdf](http://ggim.un.org/meetings/GGIM-committee/8th-Session/documents/E-C20-2018-7-Add_1-Global-fundamental-geospatial-datathemes.pdf)
4. [http://proceedings.esri.com/library/userconf/proc11/papers/3323\\_50.pdf](http://proceedings.esri.com/library/userconf/proc11/papers/3323_50.pdf)
5. [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/734331/Geospatial\\_Commission\\_call\\_for\\_evidence\\_2018.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/734331/Geospatial_Commission_call_for_evidence_2018.pdf)
6. <https://ec.europa.eu/digital-single-market/en/policies/building-european-data-economy>
7. <https://geospatial.sg/wp-content/uploads/2018/07/Singapore-Geospatial-Master-Plan.pdf>
8. [https://jecc.ac.in/documents/Kerala\\_Technology\\_Startup\\_Policy.pdf](https://jecc.ac.in/documents/Kerala_Technology_Startup_Policy.pdf)
9. [https://mhrd.gov.in/sites/upload\\_files/mhrd/files/RportNTFGE2013.pdf](https://mhrd.gov.in/sites/upload_files/mhrd/files/RportNTFGE2013.pdf)
10. <https://theodi.org/wp-content/uploads/2018/11/2018-11-ODI-Geospatial-data-infrastructure-paper.pdf>
11. <https://www.cnbc.com/2019/01/16/fourth-industrial-revolution-explained-davos-2019.html>
12. <https://www.cyberlawsindia.net/cyber-india.html>
13. <http://www.businessworld.in/article/After-Vision-New-India-Modi-Govt-Unveils-Vision-2030/01-02-2019-166713/>
14. <https://theoptimist.news/vision-for-new-india-through-use-of-gis-technology/>
15. <https://www.geoplatform.gov/wp-content/uploads/2018/05/geospatial-platform-roadmap-v4-final.pdf>
16. <https://www.fgdc.gov/organization/steering-committee/meeting-minutes/october-2011/geospatial-platform-fact-sheet.pdf>
17. <https://www.crcsi.com.au/assets/Program-3/CRCsi-Towards-Spatial-Knowledge-Whitepaper-web-May2017.pdf>
18. <https://www.tandfonline.com/doi/full/10.1080/10095020.2017.1325612>
19. <https://www.industry.gov.au/data-and-publications/australias-tech-future/digital-infrastructure/why-does-digital-infrastructure-matter>
20. [https://www.avendus.com/encrypted\\_pdf\\_path/img\\_5b0bffa967c0f8.06574817\\_Global%20Outlook%20on%20Analytics%20Industry.pdf](https://www.avendus.com/encrypted_pdf_path/img_5b0bffa967c0f8.06574817_Global%20Outlook%20on%20Analytics%20Industry.pdf)





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