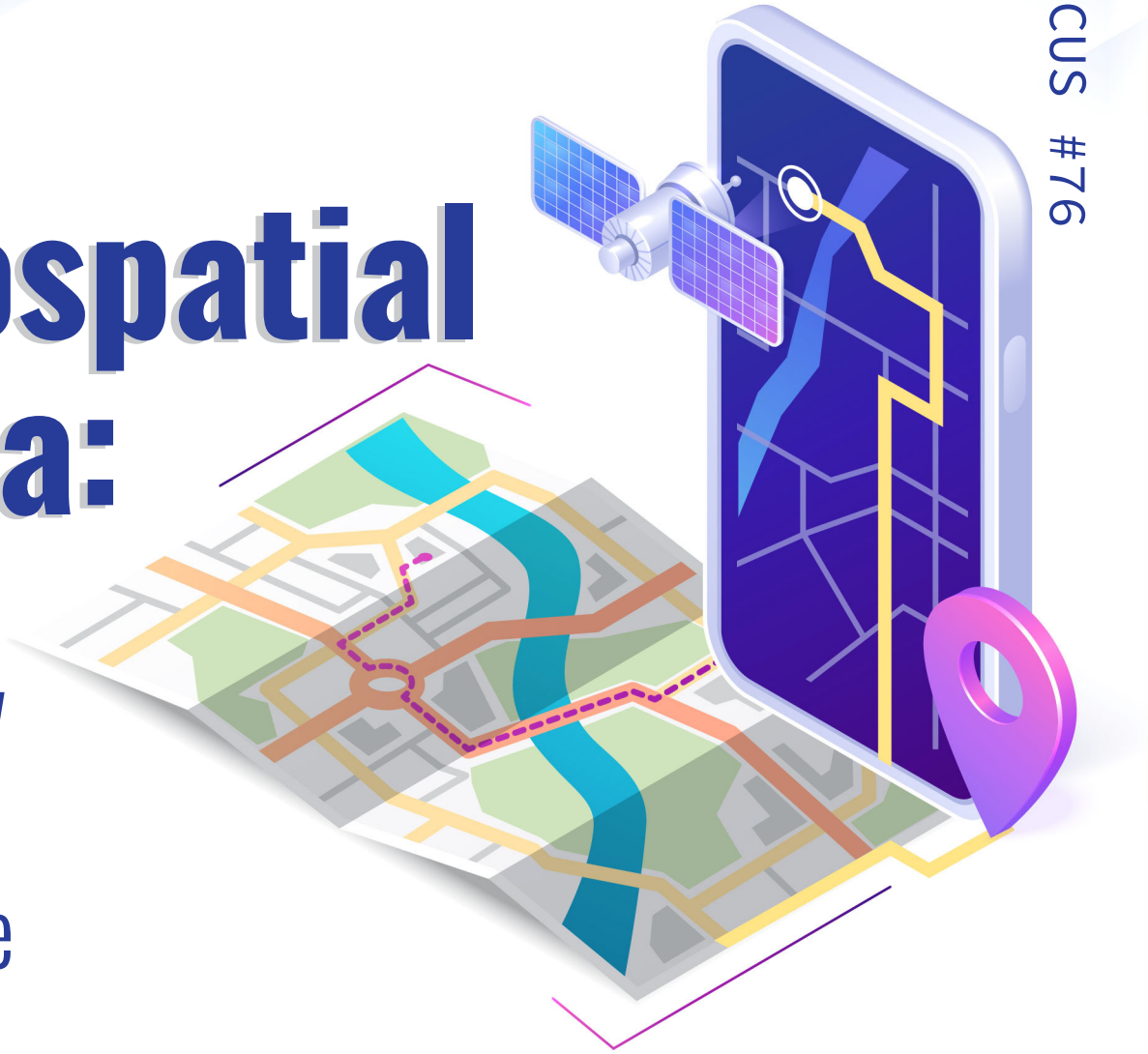
VISIONIAS
INSPIRING INNOVATION

WEEKLY FOCUS #76

Geospatial Data:

Driving the new age of Defense



INTRODUCTION

In the digital era, geospatial technologies are revolutionizing the economy. From navigating public transport to tracking supply chains and planning efficient delivery routes, the digital services built on geospatial data have quietly become part of daily life and commerce.

Globally, the ecosystem utilizing geospatial data grew out of cartography and imagery analysis and was initially developed by governments for military and strategic purposes. This indicates the invaluable role geospatial data and its associated technology have played in security operations. This role has further magnified with significant advancements in capture technologies, enhanced accessibility of geospatial data and the emergence of the new age of defence and warfare. Hence it warrants a closer examination of questions like- what is geospatial data and its associated technologies? What measures have been taken in India to develop its geospatial capabilities? What significance does it hold in national security? What restricts India from fully utilizing its potential for National security? And, what more can be done further for enhancing India's capabilities to utilize geospatial data for national security?

What is geospatial data and what are its technological applications?

Geospatial data is data about **objects, events, or phenomena that have a location on the surface of the earth.** The **location may be static** in the short-term (e.g., the location of a road, an earthquake event, children living in poverty), or **dynamic** (e.g., a moving vehicle or pedestrian, the spread of an infectious disease).

Geospatial data often combines 3 types of information:

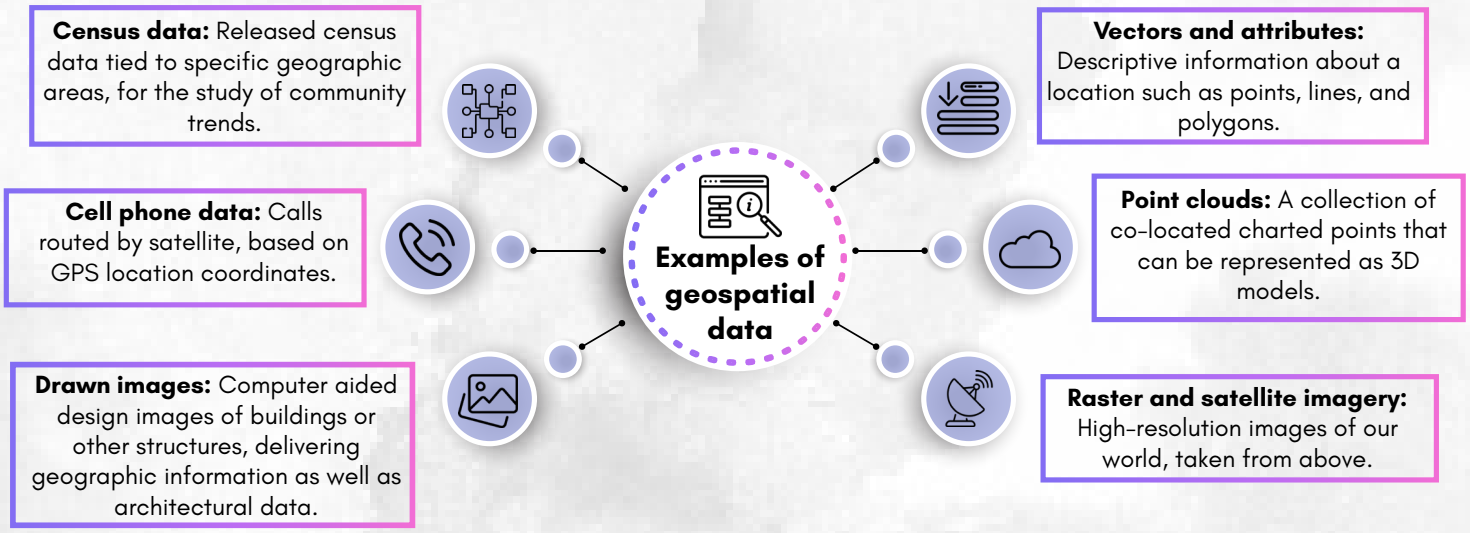
- **Location information** (usually coordinates on the earth),
- **Attribute information** (the characteristics of the object, event, or phenomena concerned) and
- **Temporal information** (the time or life span at which the location and attributes exist).

Sources of Geospatial data: In present times, techniques of capturing geospatial data have significantly expanded to include –

- **Photogrammetry** (technique that uses photographs for surveying and mapmaking) using manned/unmanned aerial vehicles, terrestrial vehicle-mounted Mobile Mapping systems,
- **Light Detection and Ranging** (LIDAR) tech,
- **Radio Detection and Ranging (RADAR)** Interferometry,
- **Satellite-based remote sensing,**
- **Mobile phone sensors**, etc.

Did you know?

LIDAR and **RADAR** technology are quite similar to each other. They make use of the principle of **reflection of waves** for the detection of an object and for estimating the distance. While LIDAR is based on light beams, RADAR is based on radio waves.



Prominent technological applications of geospatial data:

- **Geospatial information systems (GIS):** It is a computer-based system that captures, stores, manages, analyses, and displays geographic data. It provides a way to overlay different layers of data.
- **Navigation systems:** These systems used radio waves on the land, sea, and air to determine the exact location, time, and velocity irrespective of weather conditions. For example, Global Positioning System (GPS) of USA.
- **Digital Cartography:** It is the process by which a collection of data is compiled and formatted into a virtual image.
- **Geospatial analytics:** It is used to add timing and location to traditional types of data and to build data visualizations. These visualizations can include maps, graphs, statistics and cartograms that show historical changes and current shifts and provide additional context for a more complete picture of events.

In Conversation!

How is geospatial data different from other types of data?

Vinay: *Hey Vini! How are you coming to class today?*

Vini: *I'm taking a cab. Let me share my location with you.*

Vinay: *Okay. It is so amazing how far technology has come that we can track our exact locations. I wonder how our locations are deciphered?*

Vini: *Well Vinay, it is the geospatial data which helps in finding these locations.*

Vinay: *Okay. But what exactly is geospatial data? And how is it any different from normal data?*

Vini: *Geospatial data is primarily related to a specific location on the Earth's surface. In comparison, other types of data are usually independent of geographic location. For example, your height is a data, which has nothing to do with any location.*

Vinay: *Okay. So non spatial data usually describes 'what' and geospatial data contains information about 'where'.*

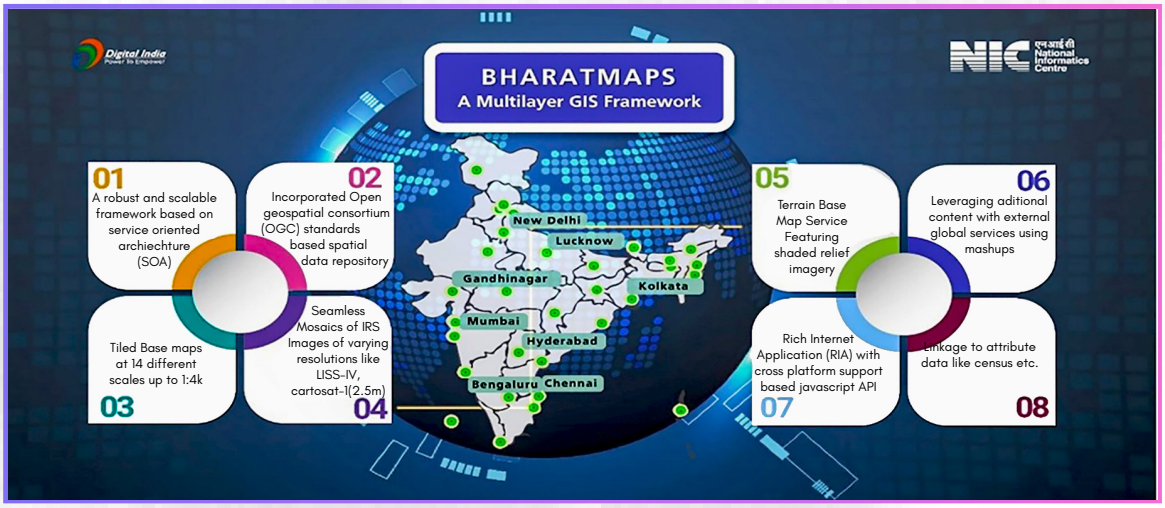
Vini: *Exactly. Maps, photographs, satellite images, scanned images of roads and rivers etc. are all examples of geospatial data.*

Vinay: *Thanks for explaining Vini!*

What measures have been taken in India to develop its geospatial capabilities?

Numerous governmental efforts have been undertaken to make India a **Geospatial enabled nation:**

- **Earth Observation Satellites:** India has one of the largest constellations of remote sensing satellites in operation, with varieties of instruments flown onboard these satellites to provide necessary data in a diversified spatial, spectral and temporal resolutions.
  - The most recent **radar-imaging satellite- EOS-04**, launched by the Indian Space Research Organisation (ISRO), is designed to provide high-quality images under all weather conditions.
- **Establishment of dedicated institutions** like- **Indian Institute of Remote Sensing,** a constituent unit of the ISRO, **National Center of Geo-Informatics (NCG),** GIS based decision support system platform, under National e-Governance Division (NeGD), etc.
- **National Spatial Data Infrastructure:** It has been implemented as a network of spatial data nodes established in various data-providing agencies in central and state governments towards improving access to geospatial data by all stakeholders.



- **Bharatmaps:** It is a GIS platform, established by National Informatics Centre (NIC) which depicts the core foundation data as an integrated multi-scale, multi-resolution base map service using reference data from various agencies.
- **Bhuvan portal:** It is the national Geo-portal developed and hosted by ISRO comprising Geo-Spatial Data, Services and Tools for Analysis with versatile features, like visualization of Satellite Imagery and Maps.
- **India's indigenous navigation system "NavIC" (Navigation with Indian Constellation):** It is designed to provide accurate position information service to users in India as well as the region **extending up to 1500** km from its boundary, which is its primary service area.
- **Development of Policy Framework to regulate Geographic Information:** It includes policies like-
  - **National map policy** which defines the scope, distribution, and access of India's topographic maps; **Remote sensing Data Policy** which defines the process for distribution of satellite imagery; **National Data sharing and Accessibility Policy** which declares open access to data generated through public funding etc.
  - **Guidelines for acquiring and producing Geospatial Data and Geospatial Data Services including Maps** were recently released for the Geo-Spatial Sector in India, to liberalise the sector.
- **Geospatial data gathering as a part of schemes:** Geospatial mapping is being undertaken under various initiatives like **PM Gati shakti-National Master Plan for multi-modal connectivity and SVAMITVA scheme** for developmental and planning purposes.

Key Features of Guidelines for acquiring and producing Geospatial Data and Geospatial Data Services including Maps

- **Introduction of a self-certification regime**
- **Relaxation of restricted areas:** Prohibition of mapping only for specific attributes of highly sensitive locations.
- **Specific permissibility for Indian Entities** for using geospatial data above a certain special accuracy; using specific technologies such as ground truthing and verification; and conducting activities such as street view surveying and surveying in Indian territorial waters.
- **Relaxation on export restrictions:** Export of maps with resolutions up to a 1:100 resolution permitted.
- **Open access to publicly funded data** for scientific, economic and developmental purposes.

As a result of these efforts, India's geospatial market in 2021 is estimated to be INR 14,050 crore and is predicted to **grow at a CAGR of 13.8% to INR 23,200 crore in 2025.** The defence and intelligence sector accounts for the largest share in this market which implies how vital geospatial data is for national security.

In Conversation!

Role of geospatial data in war events

Vinay: *Hi Vini! Do you know why 26th July is an important day for India?*

Vini: *Of course! On 26th July in 1999 we ousted Pakistan from India in Kargil. To commemorate this victory we observe Kargil Vijay Diwas each year on this date.*

Vinay: *Do you know that during this war we also moved towards having our own geospatial constellation of satellites to enhance national security?*

Vini: *I didn't know that. How?*

Vinay: *During the Kargil war USA denied India GPS data. It impacted the Indian army to plan attacks precisely.*

Vini: *Okay, so what is India doing to overcome such a situation in future?*

Vinay: *India came up with the idea of Navic-Navigation with the Indian Constellation. It allows Indian security agencies to obtain precise satellite imagery, reliable position, and navigation services.*

Vini: *Thanks a lot, Vinay. This was insightful.*

What significance do geospatial data and associated technologies hold in National security?

Geospatial technologies with their unique ability for acquisition, integration, and analysis of geographically referenced spatial information, can be extremely useful in India's security operations-

- **Strengthening India's intelligence architecture:** Geospatial data overlying on high resolution satellite images substantially enhances the precision and reliability of intelligence, surveillance, and reconnaissance activities.
  - Further, a techno-centric gathering of data overcomes limitations of classical methods of intelligence gathering by enabling day and night and all-weather surveillance activities.
- **Advancing situational awareness:** With its unique ability of real-time monitoring, geospatial data can provide actionable insights for quick and secure decision-making to handle critical insurgencies. Tactical deployment enabled by real time analysis of geospatial data acts as an effective tool for-
  - **Strengthening Border Security and Coastal Surveillance System**, e.g., Mapping of terrain and hotspots of border crossing.
  - **Preventing and/or disrupting potential internal and external security threats,** e.g., tracking infiltration and monitoring camps of terrorists, left wing extremists etc.
  - **Tracking and countering organized crimes** for example money laundering, and drug trafficking.
- **Supporting military operations:** Geospatial data plays a vital role logistically in the movement of troops, supplies, arms, and ammunition across the nation.
  - It also helps in developing tactical plans, exploring terrains virtually, and facilitating communication in remote areas during military operations.
- **Tackling new and emerging threats:** Geo-spatial analytics can help to predict and counter new threats like cyber-attacks, hybrid warfare, stealth weaponry etc. which endanger critical infrastructure of the nation. E.g., Perpetrators of Cyber-attacks can be traced by geolocating online information.

Utilizing Geospatial data for managing disasters and reducing risk

Climate change is set to increase the severity and frequency of extreme weather events in India. In this scenario, effective disaster risk reduction becomes extremely important for securing national assets and protecting citizens. With respect to disaster management, geospatial data can play significant role in:

- **Risk reduction:** Analysing historical geospatial data to pinpoint hazards and evaluate the risks of potential emergencies or disasters.
- **Preparedness:** Tracking disasters like cyclones, forest fires etc.; enhancing efficiency of early warning systems; preparing evacuation plans and setting up safe shelters etc.
- **Response and rescue:** Understanding the scope of the damage, identifying locations of trapped or injured people etc.
- **Recovery:** Assessing damage; help in building resilient infrastructure by identifying potential hydrological/meteorological risks; etc.

- **Modernizing security operations:** Geospatial data in combination with other technologies like artificial intelligence and big data analysis holds immense potential in fields like-
  - **Crime prediction:** GIS can offer a visual representation of past criminal activities and help in predicting hotspots for crimes.
  - **Precision-guided munitions:** Geospatial intelligence and navigation systems are key to developing hi-tech weaponry like unmanned armed aerial/terrestrial vehicles, automated missiles etc. with capabilities for automatic target detection, intelligent manoeuvring etc.
- **Securing the vast Indian Ocean region:** Geospatial data can help in improving India's **Maritime Domain Awareness** capabilities by expanding the regional coverage and allowing maritime law enforcement agencies to monitor the maritime domain more comprehensively.
  - E.g., Incorporating geospatial information provides authorities with a deeper understanding of Indian ocean's physical environment and how maleficent actors like insurgent groups, human smugglers, and arms traffickers threaten security.

Build progressive defence & security partnerships: In the current digital age, sharing of geospatial data forms a crucial component of security partnerships. E.g., India signed the Basic Exchange and Cooperation Agreement for Geospatial Cooperation (BECA) with USA enabling deep military cooperation between the two countries.

Geospatial Knowledge for National Development

In addition to the military and law enforcement infrastructure, the national security of a country comprises many aspects including the **security of the society, environment, natural resources, energy, and national economy.** In this regard, geospatial data-based planning is increasingly being used for finding evidence-based solutions to social, economic, and environmental challenges.
Some examples have been listed below, where geospatial systems are playing or are expected to play a critical role in India's developmental efforts.

Sector	Applications of geospatial data	Examples in India
Agriculture	• Enabling precision farming techniques through real time crop monitoring. • Developing decision-support systems for crop insurance.	• **Pradhan Mantri Fasal Bima Yojana** promotes the use of geospatial data for various activities like qualitative crop loss and health assessment.
Natural Resource Management	• Hydrological mapping of water resources for integrated management. • Mapping potential oil and mineral exploration sites.	• **India-WRIS Web GIS** provides all water resources & related data and information in a standardized GIS format.
Infrastructure planning and development	• Identify issues like dangerous crossings, disaster resilience etc. • Find optimal locations. • Predict possible service disruptions and optimize maintenance. • Monitor development of new assets.	• **Gati shakti-National Master Plan for multi-modal** connectivity plans to use GIS based spatial planning and analytical tools. • **Yuktdhara portal** aims to facilitate planning of new MGNREGA assets using GIS based information.
Urban planning	• Examine and predict extent and patterns of urban growth. • Enable smart solutions like remote operation of utilities like traffic lights etc.	• **Smart Cities Mission** utilizes GIS datasets to build smart infrastructure.
Energy	• Utilities providers can analyse and optimize performance of power lines. • Wind and solar installations can analyze environmental conditions by pinpointing local assets.	• **NITI Aayog in collaboration with the Indian Space Research Organisation (ISRO)** has developed GIS enabled Energy Map of India to provide a comprehensive view of energy production and distribution in the country.
Health	• Building Disease surveillance systems for monitoring disease outbreaks, facilitating contract tracing, and evaluating the efficacy of interventions.	• Department of Science and Technology (DST), created an **Integrated Geospatial Platform** to help decision making during the current COVID-19 outbreak.

What restricts India in fully utilizing the potential of Geospatial data for National security?

- **Access to comprehensive and accurate data:** Lack of accessibility to high-resolution data in a convenient format, prevents India to go beyond niche applications to mainstream applications in fields like local law enforcement.
- **Research outputs are usually stand-alone and lack unanimity:** The results are therefore not getting streamlined for national security concerns and fail to conform to specific requirements of departments like armed forces, police department etc.
- **Shortage of trained human resources in government agencies:** Working with raw geospatial data requires specialized knowledge and the application of advanced mathematics to conduct necessary tasks, such as geospatial alignment of data layers.
  - There is a need to apprise senior administrators and executives regarding the technology to enable the mainstreaming of Geo-Spatial technology.
- **Financial constraints:** Expenditure on salaries and pensions forms the largest portion of the defence budget which results in financial constraints in technological adoption and advancement in emerging and experimental fields like geospatial analytics.

Liberalization of geospatial data: Will it jeopardize national security?

- The recently released guidelines in India aim to build a more permissive regime for utilization of geospatial data by the private sector.
- The changes were welcomed by the Indian geospatial industry as they would make Indian companies more competitive in the global market, enhance investment in the sector and encourage new Start-ups and businesses.
- However, **liberalization of geospatial data has been accompanied by security concerns.** For instance, re-use or resale of geospatial data by entities revealing strategic assets and secure establishments can lead to its misuse by foreign agencies, terrorists etc.
- But it is also important to note that highly restrictive policies can curb innovation and growth of GI technology in the country, which in turn staggers technological growth in national security ecosystem as well.
- Thus, to keep in pace with ongoing global developments in defence technology, India needs to encourage **democratization of geospatial data** for development of indigenous GI industry – software, data, GIS applications etc. while also safeguarding its security interests.
- The current guidelines ensure this by creating a **'negative list of sensitive attributes'** that would require regulation before anyone can acquire or use such data.

- **Ensuring secure storage of geospatial data:** With increasing liberalization and commercialization of geospatial data and growing cyber-attack capabilities of adversaries, safe storage of geospatial data has become a concerning issue, given India's vulnerable digital ecosystem.
  - Geospatial data, particularly related to strategic resources, critical infrastructure and defence operations, in hands of anti-social actors and foreign agencies can have disastrous results.
- **Coordination issues:** Lack of clarity on data sharing and collaboration, especially with lower levels of governance, prevents utilization of existing geospatial information to tackle localized threats.
- **Privacy concerns:** The opportunities and benefits of using geospatial data for defence are often constrained by locational privacy and confidentiality.
  - When geospatial data is combined with technologies like face recognition algorithms, it can be possibly used to identify and survey individuals without their consent, leading to violation of fundamental right to privacy.
- **Lack of Indigenous software and hardware technology:** India is largely reliant on imports for geospatial equipment and software, which is not only financially unviable but raises concerns regarding data sovereignty.
- **Sheer volume of geospatial data:** Efforts to analyze massive amounts of data, especially to track potential security threats, have become more challenging in recent years due to a relative explosion of Internet of Things (IoT).

How can India strengthen its capabilities to utilize geospatial data for national security?

- **Bringing cohesiveness to the Geospatial sector:** This can be enabled by enhancing collaboration between government, academia, and industry working in the field of defence technology and creating a roadmap for service-level adoption of geospatial technology for the purposes of strengthening national security.
- **Awareness and capacity building:** There is a need to educate and build the capacity of decision-makers and users in order for them to better understand the use and application of geospatial technology.
- **Strengthening security of digital infrastructure:** The national cyberspace must be adequately protected against attacks to ensure safe storage of critical geospatial data.
- **Promote development of indigenous software and hardware:** Schemes and policies aimed at indigenisation of defence sector, like Innovations for Defence Excellence (iDEX), can be used to promote innovation specifically in the field of geospatial technologies.
- **Transforming higher education:** Research and education in specialised fields like Geo-informatics, big data analytics etc should be promoted to develop human resource.
  - A **sector skills council** can be developed under the aegis of the Association of Geospatial Industries (AGI) to provide certificate courses for various geospatial technologies and their applications.
- **Enhancing Coordination among agencies:** Secure data sharing platforms can enhance accessibility of available data and promote its utilization for innovative applications like crime prediction at local levels.
- **Creation of a dedicated department** and enhancing financial allocation for better utilization of geospatial data to develop hi-tech services and application in the field of defence.
- **Ensuring privacy of citizens:** The concerns of citizens can be addressed by including specific provisions regarding use of geospatial data by the government in Personal Data Protection Bill.

CONCLUSION

The changing global security scenario and rapid technological developments in the past two decades have altered the nature of conflict. Geospatial information is thus valuable for understanding and better assessment of security management to save lives, properties and establishments of communities for future economic stability. The need of the hour is to empower citizens and enterprises to create, access and use geospatial data and information for addressing developmental needs of the country while also safeguarding its security interests.

TOPIC AT A GLANCE

Geospatial data

- Data about objects, events, or phenomena that are located on the earth's surface.
- Captured using **photogrammetry, LIDAR, RADAR, satellite-based remote sensing etc.**
- **Prominent technological application of geospatial data:** Geospatial information systems (GIS), Navigation systems, Digital Cartography, and Geospatial analytics.

Combines 3 types of information

- **Location information** (usually coordinates on the earth)
- **Attribute information** (the characteristics of the object, event, or phenomena concerned)
- **Temporal information** (the time or life span at which the location and attributes eist).

India's steps to develop its geospatial capabilities

- **Building a constellation of Earth Observation Satellites.**
- **Establishment of dedicated institutions** like- Indian Institute of Remote Sensing, National Center of Geo-Informatics (NCG) etc.
- **National Spatial Data Infrastructure, Bharatmaps** platform and **Bhuvan portal.**
- **India's indigenous navigation system "NavIC" (Navigation with Indian Constellation)** designed to provide accurate position information service to users in the region extending up to 1500 km from India's boundary.
- **Policy Framework to regulate Geographic Information:** National map policy, Remote sensing Data Policy, National Dara sharing and Accessibility Policy and the recent **Guidelines for acquiring and producing Geospatial Data and Geospatial Data Services including Maps.**
- **Geospatial data gathering as a part of schemes** in initiatives like PM **Gati shakti and SVAMITVA**

Significance of geospatial data in National security

- **Enhancing the precision and reliability of intelligence, surveillance, and reconnaissance activities.**
- **Advancing situational awareness** for quick and secure decision-making to handle critical insurgencies.
- **Supporting military operations** in logistics management, developing tactical plans, exploring terrains virtually, etc.
- **Tackling new and emerging threats** like cyber- attacks, hybrid warfare etc
- **Modernizing security operations:** E.g.,Crime prediction and precision-guided munitions.
- **Securing the vast Indian Ocean region** by improving India's Maritime Domain Awareness capabilities.
- **Build progressive defence & security partnerships:** E.g., BECA with the USA.

Challenges in utilizing Geospatial data for National security

- **Access to comprehensive and accurate data.**
- **Research outputs are usually stand-alone** and lack unanimity.
- **Shortage of trained human resources in government agencies.**
- **Financial constraints** in technological adoption and advancement in emerging and experimental fields like geospatial analytics.
- **Ensuring secure storage of geospatial data,** given India's vulnerable digital ecosystem.
- **Coordination issues** due to lack of clarity on data sharing and collaboration with lower levels of governance.
- **Lack of Indigenous software and hardware technology.**
- **Privacy concerns:** Lack of locational privacy and confidentiality in India.
- **Difficulties in processing sheer volume of geospatial data.**

Way forward

- **Bringing cohesiveness to the Geospatial sector** enabled by enhancing collaboration between government, academia, and industry.
- **Awareness and capacity building** among decision-makers and users.
- **Strengthening the security of digital infrastructure.**
- **Promote the development of indigenous software and hardware.**
- **Promoting education in specialised fields** like Geo-informatics, big data analytics etc.
- **Enhancing Coordination among agencies** like state police, defence, and intelligence bureau.
- **Creation of a dedicated department** and enhancing financial allocation for better utilization of geospatial data.
- **Ensuring the privacy of citizens.**