विज्ञान एवं
प्रौद्योगिकी मंत्रालय
MINISTRY OF
SCIENCE AND
TECHNOLOGY
सत्यमेव जयते

WHITE PAPER

India's Geospatial Capacity Building Strategy

Vision 2030 and Beyond



Department of Science and Technology, Government of India
NATIONAL GEOSPATIAL PROGRAMME

New Delhi | October 2026

विज्ञान एवं
प्रौद्योगिकी मंत्रालय
MINISTRY OF
SCIENCE AND
TECHNOLOGY
सत्यमेव जयते

WHITE PAPER

India's Geospatial Capacity Building Strategy

Vision 2030 and Beyond

Department of Science and Technology
Government of India
National Geospatial Programme Division

New Delhi | October 2026

Suggested citation

Department of Science and Technology (2026), White Paper on Geospatial Capacity Building, New Delhi: National Geospatial Programme Division, Department of Science and Technology, Government of India.

सत्यमेव जयते
प्रो. उमेश वी. वाघमारे
Prof. Umesh V. Waghmare

सचिव
भारत सरकार
विज्ञान एवं प्रौद्योगिकी मंत्रालय
विज्ञान एवं प्रौद्योगिकी विभाग
Secretary
Government of India
Ministry of Science and Technology
Department of Science and Technology



19th October, 2026

FOREWORD

India's geospatial landscape has been substantially reshaped over the past five years. The opening of the space sector in 2020, the liberalisation of geospatial data guidelines in 2021, and the National Geospatial Policy 2022 have together removed longstanding restrictions on the creation, access and use of spatial data. The Policy sets out a clear direction: an integrated national geospatial data ecosystem, a national digital twin, and the routine use of spatial intelligence across governance and economic activity.

The enabling conditions are now largely in place. India operates one of the world's significant Earth observation programmes. National platforms and data infrastructure are being established. PM GatiShakti has demonstrated the value of spatially coordinated planning at scale. The National Education Policy 2020 provides the flexibility required to introduce geospatial content across levels of education.

What remains is human capacity, and it is here that the constraint is most acute. The applications of the Geospatial technology depend on trained professionals across a wide range of institutions - central and State departments, urban and rural local bodies, universities, and industry. At present, the supply of such professionals is well below what the Policy targets require, and the institutional arrangements to produce them at scale do not yet exist. Technology can be procured; capability must be built, and it is built slowly.

This White Paper addresses that requirement directly. It sets out a structured framework for geospatial capacity building in India, covering policy architecture, education and skilling, and institutional partnerships. It identifies current gaps, proposes a phased approach with defined targets, and specifies the governance and monitoring arrangements needed to implement it.

The Department commends this White Paper to Ministries, State Governments, academic institutions and industry, and looks forward to their participation in taking its recommendations forward.

V. Umesh

(Umesh V. Waghmare)

सत्यमेव जयते

Dr. Manoranjan Mohanty
Scientist 'G' & Head
Nano and Advanced Materials &
National Geospatial Programme Divisions



भारत सरकार
विज्ञान और प्रौद्योगिकी मंत्रालय
विज्ञान और प्रौद्योगिकी विभाग
टेक्नोलॉजी भवन, नया महरौली मार्ग,
नई दिल्ली–110016
Government of India
Ministry of Science and Technology
Department of Science and Technology
Technology Bhavan, New Mehrauli Road
New Delhi – 110016.
Tel.: 011-26516076
E-mail : mohantym@nic.in
Website: www.dst.gov.in

MESSAGE

India's geospatial landscape is evolving rapidly, driven by advances in Earth observation, geospatial technologies, digital infrastructure and emerging applications across sectors. The National Geospatial Policy 2022 provides a clear direction towards strengthening India's geospatial ecosystem and building the capabilities required to support its effective implementation.

The United Nations Integrated Geospatial Information Framework (UN-IGIF) provides an important reference for strengthening national geospatial capacity. Its nine Strategic Pathways cover governance and institutions, policy and legal frameworks, financial models, data, innovation, standards, partnerships, capacity and education, and communication and engagement. India has made significant progress across several of these areas. The National Geospatial Programme has also supported capacity-building initiatives through training programmes, open learning resources, online course content, spatial thinking activities in schools, and engagement with universities and other institutions.

At the same time, the growing use of technologies such as Geo-AI, digital twins, LiDAR, hyperspectral sensing and advanced Earth observation requires continuous development of skills and institutional capabilities. Training capacity, curricula, faculty development and linkages between education, training and employment need to evolve in line with these emerging requirements.

This White Paper presents a structured framework for strengthening geospatial capacity building in India. It brings together education, training, professional development, institutional partnerships and emerging technology capabilities, with defined targets, institutional responsibilities and mechanisms for monitoring progress.

The objective is to support the development of a skilled and future-ready geospatial workforce and to strengthen the capacity of institutions across the country. The National Geospatial Programme Division looks forward to the continued participation and collaboration of Central and State Government institutions, academic and technical institutions, industry, research organisations and other stakeholders in taking forward this important national endeavour.

Mohanty

(Dr. Manoranjan Mohanty)

Committee Mandate and Deliberations

The Committee was constituted to provide expert guidance and review inputs for the development of the White Paper on Geospatial Capacity Building in India. The Committee's deliberations focused on identifying existing gaps in geospatial education, training and institutional capacity, and on developing actionable strategies for strengthening capacity building in alignment with the National Geospatial Policy 2022.

The Committee brought together experts and representatives from government, academia, research institutions and industry, including the National Geospatial Programme (NGP), Indian Institute of Space Science and Technology (IIST), Bharati Vidyapeeth Institute of Environment Education and Research (BVIEER), IIT Bombay and industry. The discussions drew upon earlier brainstorming sessions and consultations with stakeholders involved in geospatial education, training, research and applications.

The Committee deliberated on a Pan-India and inclusive approach to geospatial capacity building, with particular emphasis on reaching underserved and geographically remote regions. It considered capacity building requirements across different learner groups and disciplines, including school students, graduates, professionals and persons seeking livelihood opportunities. The Committee also emphasised the need for multidisciplinary training, including applications of geospatial technology, image processing and emerging technology areas.

A key area of deliberation was the development of a modular and flexible training and certification framework, combining online theoretical learning with practical training at designated centres and competency-based assessment. The Committee also emphasised stronger engagement with NCERT, UGC, AICTE, the Association of Geospatial Industries (AGI), State Remote Sensing Centres and other relevant stakeholders to support national-level implementation.

The Committee further stressed the importance of a detailed gap analysis, evidence-based planning, faculty and trainer inputs, open-source and indigenous geospatial technologies, industry linkages, and effective monitoring of outcomes. It recommended wider stakeholder participation and a multidisciplinary and inclusive approach so that the benefits of geospatial capacity building reach different sections of society.

The deliberations and recommendations of the Committee, together with inputs received through stakeholder consultations and brainstorming sessions, informed the strategic framework, education and skilling pathways, institutional partnerships, implementation and roadmap presented in this White Paper.

Acknowledgements

The National Geospatial Programme Division, Department of Science and Technology, places on record its appreciation of the individuals and institutions whose contributions have shaped this White Paper.

Dr Manoranjan Mohanty, Head, National Geospatial Programme Division, provided vision and direction throughout the process. Dr Shubha Pandey, Scientist E, Member Secretary of the Expert Committee, anchored the preparation of the White Paper to programme priorities, national requirements and in alignment with the National Geospatial Policy 2022 (NGP) and through holding several in-person/ online discussions with relevant experts. Shri Ankur Mehta, Scientist B, as Convener of the Expert Committee, and subsequently Shri Rakesh Kumar, Scientist B, National Geospatial Programme Division, coordinated the meetings and consultations of the Committee.

The Institute of Environment Education and Research, Bharati Vidyapeeth (Deemed to be) University, Pune, serves as the Programme Management Unit for the DST National Geospatial Capacity Building Programme and has drafted this framework under the leadership of Prof. Shamita Kumar. The Department acknowledges her contribution in designing the analytical framework, leading the institutional assessment, convening stakeholder consultations, and coordinating the document through successive rounds of review.

The Department gratefully acknowledges the Chairman and members of the Expert Committee for Capacity Building and Training on Geospatial Science and Technologies (reconstituted on 30 January 2025), listed in Appendix C, for their guidance, expert inputs, and detailed review of the framework. The Department places on record its appreciation to Dr Y.V.N. Krishna Murthy, Chairman of the Committee, Prof. K.C. Tiwari, Prof. Bharat Lohani, Dr Pennan Chinnasamy, Shri Rahul Nayar, Dr V.S.S. Kiran, Dr Diksha Rajput, Prof. Aparna Pandey and Shri Varun Kumar for their valuable contributions to the development and review of the White Paper. Their inputs were particularly valuable in shaping the phasing, targets, institutional arrangements, capacity building priorities, and implementation mechanisms proposed in this document.

The Department also acknowledges the participants in the round tables, stakeholder consultations, and the Ideation Workshop/Brainstorming held during the preparation of the White Paper, including representatives of Central and State Government departments, universities and technical institutions, industry associations, research organisations, schools, and civil society. Their experience, perspectives, and constructive feedback contributed significantly to strengthening the analysis and recommendations. A fuller account of the consultations and a list of participating experts and stakeholders are provided in Appendix B.

The Department also acknowledges the Indian Institute of Remote Sensing (IIRS), National Remote Sensing Centre (NRSC), Survey of India, State Remote Sensing and Application Centres, National Council of Educational Research and Training (NCERT), and Association of Geospatial Industries (AGI) for their valuable data, institutional insights, and inputs. The Department further appreciates Bharati Vidyapeeth (Deemed to be) University for its institutional support to the Programme Management Unit.

The Department expresses its sincere appreciation to all experts, institutions, stakeholders, and colleagues who contributed their time, knowledge, and insights to this endeavour.

Contents

Foreword iii

Message from the Head iv

Committee Mandate and Deliberations v

Acknowledgements vi

Executive Summary 1

The Challenge 1

Strategic Framework: Three Integrated Pillars 1

Pillar 1: Policy Architecture for Capacity Building 2

Pillar 2: Education and Human Capital Development 2

Pillar 3: Innovation Ecosystem and Strategic Partnerships 2

Strategic Implementation Roadmap 2

Key Enablers for Success 4

Anticipated National Transformation 4

Call to Collective Action 4

Section 1: Introduction: Empowering India through Geospatial Capacity Building 6

1.1 Introduction: Empowering India through Geospatial Capacity Building 6

1.2 Purpose of the White Paper: Strengthening Geospatial Capacity Building in India 7

1.3 Vision 2030: A Geospatially Empowered India 9

Section 2: Geospatial Capacity Building Landscape Analysis 12

2.1 Learning from the World, Leading at Home: Geospatial Capacity Building Landscape 12

2.2 India's Evolving Geospatial Capacity Building Ecosystem 15

2.3 Enabling Local Governance through National Geospatial Initiatives 22

Broader Significance for Capacity Building 23

1. State-Level Geospatial Governance Initiatives 23

2. State Level Geospatial Capacity Building Institutions 24

Section 3: Multilevel Capacity Building Framework 27

3.1 The Three Pillar, Multilevel Approach 27

3.2 Pillar 1: Policy Architecture for Capacity Building (Systemic Level) 28

3.3 Pillar 2: Education and Human Capital Development (Institutional Level) 31

3.4 Pillar 3: Innovation Ecosystem and Strategic Partnerships (Institutional Level) 35

Section 4: Pathways for Inclusive Geospatial Education 41

4.1 Foundational Pathway: Spatial Thinking from Primary to Higher Education 41

4.2 Professional Development Pathway: Sector Specific Training and Certification 43

4.3 Digital Learning Pathway: MOOCs, Online Modules, and Flexible Credentials 45

4.4 Experiential Learning Pathway: Summer Schools, Innovation Challenges, and Applied Projects 46

4.5 Innovation and Entrepreneurship Pathway: From Learning to Market 48

4.6 Community Engagement Pathway: Citizen Science and Participatory Mapping 49

Section 5: Monitoring, Evaluation & Accountability Framework 52

5.1 Monitoring Framework Overview 52

5.2 Pillar 1 KPIs: Policy Architecture and Enabling Infrastructure 52

5.3 Pillar 2 KPIs: Education and Human Capital Development 53

5.4 Pillar 3 KPIs: Innovation Ecosystem and Strategic Partnerships 54

5.5 Phase-wise Implementation Milestones and Targets 56
5.6 Data Collection and Management Systems 57
5.7 Evaluation Framework and Reporting Cycles 57
5.8 Long-term Impact Metrics 58
5.9 Risk Management and Early Warning System 59
5.10 Sustainability and Continuous Improvement 59
5.11 Conclusion 59

Section 6: Governance, Coordination, and Institutional Mechanisms 60
6.1 Three-Tier Governance Structure 60
6.2 RACI Matrix (Roles & Responsibilities) 60
6.3 Coordination Mechanisms 61

Appendix A: Detailed Budget Allocation and Cost Framework 63
Table A.1: Comprehensive 4-Year Budget Allocation (₹ Crore) 63
Table A.2: Centre of Excellence Establishment Phasing 65
Table A.3: Training Target Distribution (35,000 Professionals) 65
Table A.4: High-Performance Computing Infrastructure (₹60 Crore) 66
Table A.5: Staffing Model (Based on 7th Pay Commission) 67
Table A.6: Financial Sustainability Trajectory 68
Table A.7: Cost Efficiency Analysis 68

Appendix B: Stakeholder Consultation Summary **69**
List of Participants 76

Appendix C: Constitution of the Expert Committee for Capacity Building and Training on Geospatial Science and Technologies **78**

Appendix D: Glossary of Technical Terms **79**

Appendix E: References **82**

India's Geospatial Capacity Building Strategy: Vision 2030 and Beyond

Executive Summary

India stands at a transformative juncture where geospatial technologies can revolutionise governance, development, and innovation. The National Geospatial Policy (NGP) 2022 recognises that realising this vision requires systematic capacity building across systemic, institutional, and individual levels. This white paper presents a strategic roadmap to expand access to geospatial capacity building, develop a robust talent pipeline, and position India to emerge as a global leader in geospatial capabilities by 2030.

"Access. Cost. Curricula. Awareness. Without addressing these gaps, India risks falling short of its digital transformation and sustainable development goals."

Executive Summary

BOX 1: VISION 2030: GEOSPATIAL CAPACITY BUILDING AT SCALE

Ambitious Targets

- Train 35,000 geospatial professionals by 2030
- Establish 15 regional geospatial research and training hubs
- Integrate geospatial curricula in 5,000 higher education institutions
- Estimated investment: ₹200 crore over four years

Expected Returns

- 30% improvement in public service delivery and environmental planning
- 10x expansion in institutional geospatial readiness
- 70% improvement in geospatial literacy across participating sectors

Source: National Geospatial Policy 2022 targets, DST-NGP strategic framework, stakeholder consultations (2023-2025). Compiled by BVIEER, 2025. Note: Targets represent Phase I-IV cumulative achievements (2026-2030) and reflect realistic capacity building milestones aligned with NGP 2022 sectoral priorities.

The Challenge

Despite India's technological prowess, significant capacity gaps persist. Only ~150 of India's 44,000+ higher education institutions offer geospatial programmes, creating an acute shortage of trained professionals. Critical barriers include limited access to quality data and training infrastructure, high technology costs, fragmented educational frameworks, and insufficient awareness among policymakers and citizens. Without addressing these gaps, India risks falling short of its digital transformation and sustainable development goals.

Strategic Framework: Three Integrated Pillars

The capacity building strategy is built on three interdependent pillars that will be implemented simultaneously across all phases to ensure comprehensive transformation:

Pillar 1: Policy Architecture for Capacity Building

Establish comprehensive policy frameworks aligned with international standards, including national training standards, professional certification mechanisms, dedicated funding allocations, and performance measurement systems. Create enabling regulatory environments that promote open data access, interoperability, and strategic cross-sector collaboration.

Pillar 2: Education and Human Capital Development

Embed spatial thinking across all educational levels from foundational to advanced specialisations. Develop standardised, competency-based curricula emphasising experiential learning and real-world applications. Establish comprehensive faculty development programmes, inclusive scholarship schemes, and continuous professional development pathways. (Kerski, 2008) (Kumar et al., 2014)

Pillar 3: Innovation Ecosystem and Strategic Partnerships

Foster strategic collaboration among government agencies, academic institutions, industry leaders, and civil society organisations. Leverage public-private partnerships to scale infrastructure, co-develop training programmes, and accelerate innovation. Support interdisciplinary research, startup incubation, and knowledge exchange platforms.

Strategic Implementation Roadmap

The implementation strategy adopts an integrated approach where all three pillars are advanced simultaneously in each phase, ensuring that policy frameworks, educational programmes, and innovation partnerships develop in tandem to create a cohesive geospatial capacity building system.

Table 1: Phase-wise implementation of Vision 2030 for Geospatial Capacity Building Programme

Phase	Policy Architecture For Capacity Building	Education & Human Capital Development	Innovation Ecosystem & Partnerships
Phase I Foundation *2026-27*	National geospatial training standards and accreditation frameworks Open data policies (free access to foundational datasets) Coordination mechanisms with NGP Performance measurement frameworks	5 centres established 10,000 trained Curriculum frameworks Digital training platform launch	Tech partnerships International MoUs Industry advisory councils National awareness campaigns launched with partnerships
Phase II Expansion *2027-28*	Professional certification programme Quality assurance State and Agency partnerships for localised engagement Fully operationalise certification system	10 centres total (5 new established) 10,000 trained (20,000 cumulative) 1,500 institutions integrated Geospatial merit scholarship launched All centres active as research hubs	PPP framework for co investment in training infrastructure Applied Research projects addressing sectoral challenges Startup incubation in established centres Scale partnerships Establish tech transfer mechanisms Create regional innovation clusters around Centres of Excellence
Phase III Excellence *2028-29*	Policy review & refinement based on assessments International collaborations and national knowledge exchange frameworks Statutory recognition for professional credentials	15 centres complete 10,000 trained (30,000 cumulative**)** 3,500 institutions integrated Advanced specialisations launched	Centres demonstrate revenue generation, research productivity and innovation outputs Centres offer consultancy services Employment pathways with industry established International collaboration programmes
Phase IV Sustainability *2029-30*	Permanent institutional mechanisms for continuous capacity building established Sustainable funding models Long-term governance structures for ensuring programme continuity and evolution	5,000 trained (35,000 total achieved) 5,000 institutions complete Impact evaluation conducted Autonomous operations established Lifelong learning frameworks	Financial sustainability achieved Enduring PPP models India positioned as global excellence hub

Source: UN Integrated Geospatial Information Framework (UN-IGIF) pathways, DST-NGP implementation experience (2013-2025), stakeholder consultations (2023-2025). Compiled by BVIEER, 2025. Note: Phase-wise targets reflect evidence-based scaling trajectories validated through pilot programmes and international best practices.

Key Enablers for Success

- Coordinated Implementation: Simultaneous advancement of all three pillars ensuring policy, education, and innovation develop synergistically
- Stakeholder Engagement: Active participation from government, academia, industry, and civil society throughout implementation
- Quality Assurance: Rigorous standards, continuous evaluation, and performance benchmarking against international best practices
- Inclusive Access: Targeted interventions ensuring equitable participation across geographic, gender, and socioeconomic dimensions
- Adaptive Management: Regular assessment and course correction based on emerging needs and technological evolution

Anticipated National Transformation

By 2030, India will possess a geospatially empowered workforce capable of leveraging spatial intelligence for evidence-based policymaking and planning. Enhanced institutional readiness will enable seamless geospatial data integration across government, industry, and civil society. Stronger cross-sector partnerships will accelerate innovation and expand capabilities. These transformations will measurably enhance urban planning efficiency, agricultural productivity, disaster management effectiveness, natural resource conservation, and governance transparency, thus contributing directly to India's Digital India Mission, PM GatiShakti initiative, and Sustainable Development Goals commitments.

"In India, technology is not an agent of exclusion. It is an agent of inclusion."

Hon'ble Prime Minister of India
At the Second United Nations World Geospatial Information Congress, Hyderabad, 2022

Call to Collective Action

This white paper provides a comprehensive, evidence-based framework to transform India's geospatial capacity from aspiration to institutional reality. Success requires unified commitment from all stakeholders: government must prioritise strategic investments and enabling policies; educational institutions must champion excellence; industry must co-invest in workforce development; civil society must drive grassroots adoption. With coordinated action across all three pillars, India can establish global leadership in geospatial capabilities, converting spatial data into actionable intelligence, technical expertise into national competitive advantage, and technological potential into inclusive, sustainable progress for all citizens.

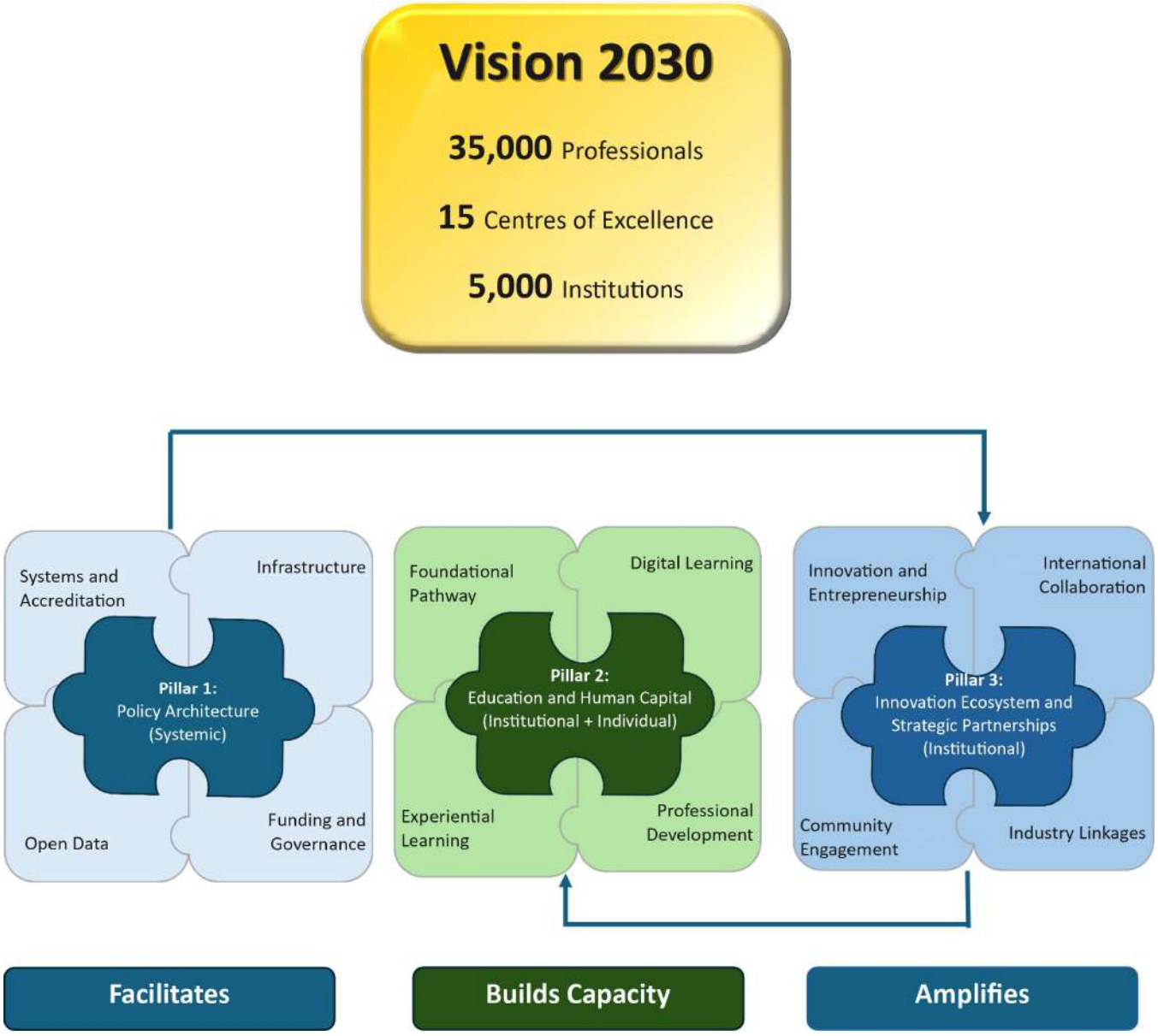


Figure 1: Vision 2030 Targets and the Three Pillars of Geospatial Capacity Building

Section 1: Introduction: Empowering India through Geospatial Capacity Building

1.1 Introduction: Empowering India through Geospatial Capacity Building

Geospatial technologies have emerged as a transformative force, reshaping how countries plan, govern, and innovate. In India, they hold immense potential to address critical challenges ranging from infrastructure development and natural resource management to disaster response and inclusive governance. They underpin key national priorities including the Digital India Mission, GatiShakti initiative, and Sustainable Development Goals (SDGs). Recognising this strategic importance, India's National Geospatial Policy (NGP) 2022 charts an ambitious path to mainstream geospatial technologies across all sectors of the country's development agenda.

India's commitment to geospatial advancement is evident in recent policy initiatives, most notably the National Geospatial Mission announced in Union Budget 2025-26 with an allocation of ₹100 crore. This mission aims to develop foundational geospatial infrastructure and data, modernise land records, and enhance urban planning capabilities. However, infrastructure investments risk underutilisation without parallel investments in human capital. While high-resolution mapping, satellite systems, and data platforms are being deployed, the critical bottleneck lies in capacity building – the systematic development of skills, institutions, and enabling frameworks required to effectively leverage these technologies. Currently, only ~150 of India's 44,000+ higher education institutions offer geospatial programmes, creating an acute shortage of trained professionals across government, industry, and civil society who can harness the full potential of initiatives like the National Geospatial Mission. (Ministry of Education, 2022)

"Infrastructure investments risk underutilisation without parallel investments in human capital."

Section 1.1

This commitment builds upon a foundational vision articulated in 2015, when the Prime Minister convened a brainstorming session with ISRO and Line Ministries at Vigyan Bhawan, New Delhi. Widely regarded as a turning point, this meeting established the principle of democratising space and geospatial technologies across all sectors of government, leading to every Ministry and Department adopting space-based applications. This strategic directive laid the conceptual foundation for subsequent policy frameworks including the unlocking of the space sector for private participation in 2020, liberalised geospatial data guidelines in 2021, and ultimately the National Geospatial Policy 2022.

Central to addressing this gap is geospatial capacity building – a multidimensional process that strengthens capabilities at the systemic, institutional, and individual levels. It involves equipping individuals with relevant technical skills, empowering institutions to deliver quality geospatial education and services, and establishing enabling policies and infrastructure that support widespread adoption and innovation. The NGP 2022 identifies policy alignment, education, and innovation as foundational pillars for this transformation. The aim is to ensure that

geospatial expertise is not concentrated in elite institutions but distributed across India's geographically and socio-economically diverse regions, making spatial intelligence accessible to planners, administrators, entrepreneurs, and communities nationwide.

This capacity building imperative is particularly urgent given India's scale and complexity. With 28 States and 8 Union Territories, diverse ecosystems, rapid urbanisation, and ambitious development goals, India requires a geospatially literate workforce at all levels – from village panchayats using mapping tools for local planning to central ministries integrating spatial analytics into national policy. Without systematic capacity building, even the most sophisticated geospatial infrastructure will fail to deliver its transformative potential. The National Geospatial Mission's foundational data and infrastructure, for instance, will achieve maximum impact only when accompanied by a workforce trained to interpret, analyse, and apply geospatial intelligence in decision making. Conversely, strategic investments in human capital can create a multiplier effect, where trained professionals not only utilise existing systems but also drive innovation, entrepreneurship, and continuous improvement in geospatial applications.

This white paper presents a comprehensive roadmap to bridge India's geospatial capacity gap by 2030, complementing infrastructure initiatives like the National Geospatial Mission with targeted investments in human capital development. By outlining strategic interventions across policy, education, and innovation pillars, this framework ensures that India's geospatial sector develops in a balanced way. It will ensure that world class infrastructure is matched by world class expertise, creating a sustainable foundation for spatial technologies to become integral to India's development trajectory.

"Without systematic capacity building, even the most sophisticated geospatial infrastructure will fail to deliver its transformative potential."

Section 1.1

1.2 Purpose of the White Paper: Strengthening Geospatial Capacity Building in India

Building on the infrastructure investments outlined in the National Geospatial Mission and the policy direction established by the National Geospatial Policy 2022, this white paper addresses the critical human capital dimension of India's geospatial transformation. It presents a comprehensive, action-oriented framework to systematically develop the skilled workforce, institutional capabilities, and enabling policy environment required to maximise returns on India's geospatial investments.

The document serves three primary audiences: policymakers responsible for national capacity building initiatives; educational institutions seeking to integrate geospatial curricula; and industry and civil society organisations committed to workforce development and innovation. By providing clear implementation roadmaps, resource requirements, and success metrics, this framework enables coordinated action across all stakeholder groups.

1.2.1 Strategic Approach and Methodology

This framework is grounded in international best practices, particularly the United Nations Integrated Geospatial Information Framework (UN-IGIF), which

provides evidence-based guidance for national geospatial capacity development, while being specifically adapted to India's unique context, priorities, and institutional setting through extensive stakeholder consultations. (UN-GGIM, 2018, 2020a, 2020b)

An ideation workshop convened by BVIEER and DST-NGP on 10 January 2023 (Appendix B) brought together 34 key stakeholders representing the full spectrum of India's geospatial community: government agencies including Survey of India and NCERT, state-level institutions such as State Remote Sensing Applications Centres, industry representatives from the Association of Geospatial Industries (AGI), academic institutions, research organisations, and civil society groups. Stakeholders provided critical inputs on capacity building needs across the 14 sectoral themes identified in the National Geospatial Policy 2022, workforce development requirements at different skill levels, integration pathways for geospatial technologies in school curricula and undergraduate programmes, mechanisms for industry-academia collaboration, and alignment with national initiatives including the PM Karmayogi programme. The Karnataka State Council for Science and Technology (KSCST), for example, contributed insights on state capacity building models, including K-GIS training programmes. AGI emphasised the urgent need for industry-ready professionals, proposing short-term startup mentoring programmes and structured interaction mechanisms between academic institutions and enterprises. UGC and AICTE perspectives informed recommendations for geospatial curriculum integration across higher education and technical institutions. These consultations, detailed in Appendix B, directly shaped the three-pillar framework structure, the emphasis on multilevel capacity building from schools to doctoral programmes, the establishment of Centres of Excellence, and the integration of open-source technologies and emerging domains like AI-ML within training programmes.

"The framework was shaped by the people who will use it."

The framework is structured around three interdependent strategic pillars, each essential to creating a sustainable geospatial capacity building system. This multilevel approach has been validated in the Indian context through evaluations of urban development schemes, which demonstrate that effective capacity building requires simultaneous interventions at systemic, institutional, and individual levels to ensure sustainable adoption of geospatial technologies (Das et al., 2018). It also aligns with Strobl's (2019) conceptualisation of the geospatial capacity building ecosystem, which emphasises that developing 'brainware for spatial data infrastructure' requires coordinated interventions across systemic enablers, institutional capabilities, and individual competencies.

Pillar 1: Policy Architecture for Capacity Building

Establishes comprehensive policy frameworks including national training standards, professional certification mechanisms, open data access policies, and strategic funding allocations. This pillar creates the enabling regulatory and institutional environment for systematic capacity development at scale.

Pillar 2: Education and Human Capital Development

Develops standardised, competency based geospatial curricula spanning all educational levels, from spatial thinking in schools to advanced professional specialisations. Includes faculty development programmes, experiential learning models, scholarship schemes for inclusive access, and continuous professional development pathways to create a sustainable talent pipeline responsive to evolving technological and sectoral needs.

Pillar 3: Innovation Ecosystem and Strategic Partnerships

Builds collaborative models bringing together government agencies, academic institutions, industry leaders, and civil society organisations to co-develop training programmes, share infrastructure, support applied research, and create sustainable demand for geospatial expertise. This pillar ensures capacity building initiatives remain relevant, innovative, and connected to real-world applications.

These three pillars are designed to be implemented simultaneously and synergistically, not sequentially, recognising that policy frameworks, educational programmes, and innovation partnerships must develop in tandem to create a coherent system where India's geospatial infrastructure investments achieve their full transformative potential.

1.2.2 Scope and Ambition

"Investing in people is how governance, planning and services improve."

This white paper outlines a four-year strategic roadmap (2026-2030) to train 35,000 geospatial professionals, establish 15 strategically located Centres of Excellence, and integrate geospatial curricula across 5,000 higher education institutions nationwide. With a proposed investment of ₹200 crore over four years, the framework demonstrates how systematic human capital development can deliver measurable improvements in governance, planning, and service delivery across sectors.

The subsequent sections detail implementation strategies for each pillar, resource requirements, institutional mechanisms, success metrics, and risk mitigation approaches, providing a comprehensive blueprint for stakeholders to translate India's geospatial policy vision into institutional reality.

1.3 Vision 2030: A Geospatially Empowered India

1.3.1 India's Geospatial Future in 2030

By 2030, India envisions a geospatial sector where spatial thinking is embedded across all levels of education, governance, and innovation, where every district has access to trained geospatial professionals, where local elected representatives use spatial data for evidence based decision making, where students from rural schools to premier universities learn to think spatially, and where startups and established enterprises alike leverage geospatial technologies to create solutions for India's development challenges.

This vision transforms geospatial capacity from a niche technical capability concentrated in a few institutions into a widely distributed competency

supporting India's Digital India, Atmanirbhar Bharat, and Sustainable Development Goals.

It envisions a future where:

- 35,000 professionals across government, industry, academia, and civil society are trained in geospatial technologies, contributing to sectors from agriculture and disaster management to urban planning and public health.
- 15 regional Centres of Excellence provide equitable geographic access to world class geospatial training, research, and innovation support across India's diverse regions, from the Himalayas to coastal zones, from northeastern states to central India.
- 5,000 higher education institutions, including universities, colleges and vocational training institutes, integrate geospatial thinking into their curricula, creating a sustainable pipeline of spatial literacy from foundational education through professional specialisation.
- School-to-career pathways enable students to progress from spatial thinking activities in primary education through undergraduate and postgraduate specialisations to doctoral research and professional careers, with multiple entry and exit points accommodating diverse backgrounds and aspirations.
- Grassroots geospatial capacity empowers Gram Panchayats, NGOs, community organisations, and local leaders to use spatial data for participatory planning, resource management, and citizen engagement, making geospatial technologies tools for inclusion rather than elite expertise.

This Vision 2030 represents phase wise targets of a longer transformation, a realistic, evidence based first step that builds the institutional infrastructure, trainer network, and policy frameworks necessary for subsequent scaling. It aligns with the National Education Policy 2020's emphasis on multidisciplinary learning and skill development, the National Geospatial Policy 2022's commitment to democratising spatial data, and the National Geospatial Mission's infrastructure investments. (Ministry of Education, 2020)

The transformation from India's current state, where geospatial capacity is fragmented, concentrated, and insufficient to this vision of distributed, equitable, and scaled capacity will require coordinated action across policy, institutions, and individuals. The roadmap presented in this white paper details how India can systematically bridge this gap, converting the constraint of limited human capital into the strategic asset of a geospatially empowered nation.

BOX 2: VISION 2030 AT A GLANCE

CURRENT STATE (2025)

- ~150 institutions offering geospatial programmes (<0.4% of higher education)
- ~500 postgraduate geospatial professionals annually
- Fragmented training initiatives, no coordinated national framework
- Limited undergraduate and doctoral programmes
- Geographic clustering in urban centres, elite institutions

↓ TRANSFORMATION ↓

VISION 2030 (Targets)

- 5,000 institutions integrating geospatial curricula
- 35,000 professionals trained across all sectors
- 15 regional Centres of Excellence providing equitable access
- Coordinated national framework with quality standards
- School-to-career pipeline from spatial thinking to specialisation
- ~1,500 expert trainers developed annually

KEY ENABLERS

- Investment: ₹200 crore over four years (2026-2030)
- Policy alignment: NEP 2020 + NGP 2022 + National Geospatial Mission 2025
- Multilevel approach: Systemic, Institutional, Individual capacity building

EXPECTED OUTCOMES

- Transition from capacity constraint to strategic asset
- Equitable distribution of geospatial expertise across regions and sectors
- Foundation for scaling beyond 35,000 in subsequent phases
- Maximised returns on National Geospatial Mission infrastructure investments

Source: AISHE 2021-22 (higher education data), institutional surveys (2023-2024), DST-NGP training records (2013-2025). Compiled by BVIEER, 2025. Note: Current state figures represent conservative estimates; actual numbers may vary due to informal training programmes not captured in official databases.

The proposed investment of ₹200 crore over four years (2026-2030) supports training 35,000 professionals, establishing 15 Centres of Excellence, and developing digital infrastructure. Detailed cost allocations are provided in Appendix A.

To chart a path toward this vision, we must first understand India's current geospatial capacity in depth, examining both the progress achieved and the persistent gaps that must be addressed. Section 2 provides this comprehensive assessment, grounding our strategic recommendations in empirical evidence while drawing lessons from successful international models.

Section 2: Geospatial Capacity Building Landscape Analysis

2.1 Learning from the World, Leading at Home: Geospatial Capacity Building Landscape

Section 1 outlined India's vision for a geospatially empowered future. Realising this vision requires a clear assessment of the current situation. Understanding both the foundations already built and the gaps that must be urgently addressed is critical. This section situates India's progress within the context of successful international frameworks (2.1), conducts a detailed analysis of India's existing capacity building ecosystem (2.2), and examines how national geospatial initiatives are already enabling local governance (2.3). Together, these subsections provide the empirical foundation for the strategic framework presented in Section 3.

2.1.1 Benchmarking Global Practice: What India Can Learn

Around the world, geospatial capacity building has emerged as a critical enabler for sustainable development. Several international programmes provide proven models from which India can draw inspiration, especially in areas like open access, cross-sector collaboration, and integration of geospatial data into decision making.

One leading example is **SERVIR-HKH**, a collaboration between NASA, USAID, and ICIMOD, which delivered satellite-based Earth observations to support environmental monitoring and decision making in the Hindu Kush Himalaya region. Through technical training, workshops, and research partnerships, SERVIR-HKH empowered scientists, institutions, and policymakers to use geospatial tools for addressing pressing challenges such as glacier retreat, flood risk, and forest degradation. Its multi stakeholder approach and emphasis on region specific applications offer a valuable model for India's own mountainous and ecologically sensitive zones. (Bajracharya et al., 2021; USAID, 2024; LaConte et al., 2021)

Another example is **USAID's Geospatial Strategy**, which integrated geospatial data into global development programmes across sectors. USAID focused on long-term capacity building by training government officials, project managers, and civil society stakeholders in geospatial data management, visualisation, and analytics. Its commitment to embedding geospatial intelligence into project design, monitoring, and evaluation aligned strongly with India's goals of democratising geospatial data and enhancing transparency through open data initiatives.

The European Union's **Copernicus Programme**, implemented with the European Space Agency, offers a third benchmark in capacity building through open access, high resolution satellite data. Copernicus supports scientists, urban planners, and environmental authorities across Europe and beyond in applying geospatial insights for climate adaptation, land use monitoring, and natural resource

management. Its model of freely available, high quality geospatial data combined with institutional capacity building demonstrates how open data can fuel innovation and evidence-based policy. (European Commission, 2024)

In addition to operational data platforms and training, both **NASA and the European Space Agency (ESA)** have established pioneering education programmes that cultivate geospatial awareness from school to research levels. NASA's Earth Science Education Program engages students, educators, and citizen scientists through initiatives such as interactive satellite data portals, teacher fellowships, and student led research challenges like the GLOBE Program (Global Learning and Observations to Benefit the Environment). It focuses on building capacity not only in technical knowledge but also in spatial thinking, inquiry-based learning, and community driven science (Činčera et al., 2019; ESA, 2024). Professional development approaches, particularly NASA's evidence-based STEM workshop model emphasising hands-on, inquiry driven learning (LaConte et al., 2021), offer proven frameworks for high impact capacity building that India can adapt to its geospatial education initiatives.

Similarly, ESA's Education Office runs structured programmes such as Earth Observation for Secondary Schools and ESA Academy, which offer hands on toolkits, classroom ready lesson plans, and in-depth university level training on remote sensing and GIS applications. ESA also supports international student competitions, data challenges, and virtual learning labs, making geospatial science exciting and accessible to young learners across Europe and beyond (Strobl, 2019).

Beyond operational data platforms and technical training, international experience increasingly emphasises spatial citizenship, the empowerment of citizens with geospatial competencies to participate meaningfully in democratic processes and community development (Gryl et al., 2010; Gryl and Jekel, 2012; Gryl et al., 2013; Schulze et al., 2014). This approach recognises that geospatial literacy extends beyond technical proficiency to encompass critical spatial thinking, ethical use of geomedia, and capacity for civic engagement (De Luca et al., 2014). Goodchild's (2007) foundational work on volunteered geography demonstrated that citizens equipped with basic geospatial tools can function as active data contributors rather than passive consumers, transforming the relationship between communities and spatial information systems.

European initiatives have successfully integrated these concepts into secondary education curricula, moving geoinformation from specialised technical training to foundational competency for 21st century citizenship (De Miguel and Donert, 2014; Donert, 2014; Jekel et al., 2012). Regional capacity building programmes, such as those implemented across the Black Sea catchment for GEOSS and INSPIRE, demonstrate that multistakeholder partnerships combining technical infrastructure with systematic training can achieve sustainable geospatial capacity at scale (Giuliani et al., 2013).

While India has made initial progress in school-level geospatial education (Pandey, 2016), systematic adoption of these international best practices, particularly the spatial citizenship framework and participatory mapping approaches can accelerate the mainstreaming of geospatial competencies across educational levels and empower grassroots communities to leverage spatial intelligence for local development priorities.

Key Learnings for India

1. Open Data and Platform Development

- Promote open-access geospatial data and invest in user-friendly national platforms that mirror the transparency and accessibility of the EU's Copernicus programme.
- Leverage platforms like Bhuvan, IIRS e-learning platform and DST-IGET not just for data delivery, but as interactive educational and learning tools.
- Develop and maintain platforms for multidata, multidiscipline research and applications.

2. Regional Relevance and Multi-Sector Integration

- Encourage regional and problem specific collaborations (as in SERVIR-HKH) to address India's ecological and social diversity.
- Embed geospatial thinking into development programmes across sectors by integrating spatial data into planning, monitoring, and evaluation, following the USAID model.

3. Inclusive and Scalable Training

- Scale training beyond technical specialists to include policymakers, educators, NGO workers, and grassroots leaders, promoting widespread geospatial literacy.
- Identify government mechanisms that can aid training and collaborate.

4. Education and Workforce Pipeline

- Invest in a multilevel geospatial education pipeline, from primary schools to postgraduate research.
- Integrate spatial thinking into school level STEM education using inquiry-based learning, project kits, and citizen science
- Develop structured teacher training programmes with fellowships, curriculum linked resources, and support for pedagogical innovation.
- Identify mechanisms to promote mentors at training events, to make it sustainable.
- Use competitions, gamified learning, and student driven projects to engage youth and link learning with real world geospatial applications.

By internalising these global lessons, India can strengthen its capacity building system and accelerate the adoption of geospatial tools for national progress. These international models provide proven pathways that India can adapt and scale. SERVIR-HKH's regional approach informs India's proposed network of 15 regional centres; USAID's long-term capacity building validates India's focus on

sustained professional development; Copernicus' open data model reinforces India's NGP 2022 principles; and NASA/ESA's education programmes inspire India's school-to-research pipeline strategy. With these global lessons in mind, we now examine India's current capacity building efforts in detail.

2.2 India's Evolving Geospatial Capacity Building Ecosystem

India's geospatial education and training system has evolved significantly over the last two decades, transitioning from discipline-specific courses in remote sensing and surveying to a multi-institutional network integrating technology, governance, and applications. This system comprises three primary components: formal academic programmes, structured government led capacity building initiatives, and open-source outreach models.

2.2.1 Formal Academic Programmes

Geospatial science is taught across universities, engineering institutes, and agricultural and environmental colleges, though penetration remains severely limited. As shown in Box 3 below, India's massive higher education system of over 44,000 institutions offers geospatial programmes in only approximately 150 institutions, representing less than 0.4% of the total. These programmes are predominantly concentrated in postgraduate and engineering levels, particularly in IITs, NITs, specialised institutions such as the Indian Institute of Remote Sensing (IIRS), and select central and state universities.

"Geospatial education starts too late and reaches too few."

The distribution of programmes reveals a significant structural imbalance: merely 10 undergraduate programmes (B.Sc./B.Tech.) compared to 103 master's level programmes (M.Sc./M.Tech.), 55 doctoral research programmes, and 63 postgraduate diploma or certificate courses. Distance education options remain minimal, with only 8 institutions offering remote learning despite India's geographic spread. This concentration at advanced levels creates major entry barriers for foundational geospatial literacy and constrains workforce pipeline development. (Ministry of Education, 2024)

BOX 3: GEOSPATIAL EDUCATION CURRENT LANDSCAPE

Metric	Current Status
Total higher education institutions	44,000+
Institutions offering geospatial programmes	~150
Share of geospatial programmes	<0.4% of higher education
Bachelor's programmes	10
Master's programmes	103
PhD programmes	55
PG Diplomas	63
Distance education institutions	8
Annual Output (Key Institutions)	
IIRS graduates (2023-24)	631 students
IIRS certificate courses	461 participants
NRSC specialised courses	18 courses (2023)
NIGST trainees	1,000+ annually

Source: AISHE 2021-22, National Remote Sensing Centre (2024), institutional capacity surveys conducted by BVIEER (2023-2024), DST-NGP institutional mapping. Compiled by BVIEER, 2025.
Note: Metrics represent formal geospatial programmes only; excludes short-term workshops and informal training.

"Students can map a disaster and learn a profession at the same time."

2.2.2 Government-Led Capacity Building Initiatives

Complementing formal academic programmes, several national agencies have established structured training initiatives that provide focused, application-oriented capacity building. These programmes, detailed in Box 4, demonstrate varying approaches to scale and specialisation.

DST National Geospatial Programme (NGP) has been the principal driver of multilevel capacity building. Between 2013 and 2025, DST supported 166 national-level summer and winter schools and over 30 specialised workshops, training more than 5,000 unique participants, all faculty members and working professionals, making it the only programme in India to exclusively target this group (Department of Science and Technology, 2024a). Each three-week school combines classroom instruction, laboratory sessions, and field-based projects at an average cost of ₹11 lakh per programme, while three-day thematic workshops average ₹4 lakh. The DST-IGET digital portal provides open courseware and assessment tools to extend reach. (Department of Science and Technology, 2024a)

Following the devastating 2013 Uttarakhand floods, the Department of Science and Technology initiated MANU (Map the Neighbourhood in Uttarakhand), a pioneering crowdsourced disaster assessment programme that engaged college students from hill universities and institutes in systematic field surveying. Students used mobile mapping applications developed by NRSC to document damage to buildings, roads, bridges, and infrastructure across the Char-Dham areas covering approximately 8,000 sq. km. IIRS and Survey of India provided

capacity building to field teams, demonstrating how student engagement in real-world disaster response can simultaneously address urgent mapping needs while building geospatial competencies. The programme exemplifies participatory mapping and the potential for student-led contributions to disaster management and recovery planning (National Remote Sensing Centre, 2013). **ISRO-IIRS** demonstrates the power of technology enabled learning, with outreach programmes reaching an extraordinary 156,262 participants in 2023-24 through MOOCs and online initiatives (Indian Institute of Remote Sensing, 2024). This is complemented by its national Nodal Centre network focusing on remote sensing applications and satellite data interpretation.

ICAR integrates geospatial applications in precision agriculture through its 700+ Krishi Vigyan Kendras, training approximately 1,000 participants annually. **AICTE's ATAL Academy** runs periodic five-day faculty development courses in the online mode (more theory and application based), while **CSSTEAP** at IIRS trained 388 international participants in 2023-24, positioning India as a regional capacity building hub (Indian Institute of Remote Sensing, 2024).

Operation Dronagiri, launched in 2024 as a pilot project under the National Geospatial Policy 2022, demonstrates the transformative potential of integrating geospatial data and drone technology across key sectors including agriculture, livelihoods, logistics, and transport. Operating through Geospatial Innovation Accelerators at IIT Kanpur, IIT Bombay, IIM Calcutta, and IIT Ropar, the programme showcases practical applications of geospatial technologies through the Geospatial Data Sharing Interface (GDI) platform. The initiative builds institutional capacity by engaging academic institutions, government agencies, startups, and businesses in collaborative use-case demonstrations across five states in its first phase (Department of Science and Technology, 2024b).

National Disaster Management Authority (NDMA) conducts specialised training-cum-workshop programmes on 'Application of GIS in Disaster Management' for state officials, Union Territories, and National Disaster Response Force (NDRF) personnel, focusing on developing skills for effectively utilising geo-information tools for disaster preparedness, response, and recovery through the National Institute of Disaster Management (NIDM). These programmes cover critical applications including flood inundation mapping using satellite imagery and UAV data, earthquake vulnerability assessment, cyclone track prediction and impact modelling, and rapid damage assessment using drone-based surveys. Experts from NDMA, IIRS, National Spatial Data Infrastructure (NSDI), and academic institutions provide hands-on training on web-based GIS services for integrated disaster management platforms. NIDM, as the designated capacity building arm under the Disaster Management Act 2005, conducts comprehensive courses on inclusive disaster risk management, incorporating geospatial data analysis as a core competency for disaster management professionals (National Disaster Management Authority, 2018; National Institute of Disaster Management, 2025).

2.2.3 Open-Source Outreach Models

The FOSSEE GIS Project at IIT Bombay represents India's largest open-source geospatial outreach initiative. Since 2020, it has engaged over 103,000 participants, including 18,670 between 2023 and 2025, across universities and colleges in 26 states and 5 union territories. Through Mapathons, Hackathons, internships, and open-source tool adoption programmes using QGIS and GRASS

GIS, FOSSEE focuses on software literacy and awareness creation. While reaching primarily college students and faculty, its format emphasises exposure rather than intensive technical training, complementing the structured, domain-intensive programmes offered by DST and ISRO. (IIT Bombay, 2024)

2.2.4 School-Level Geospatial Education: Building the Foundation

NCERT has pioneered GIS integration in India's school curriculum since 2000 (NCFSE-2000). Since 2008, it has conducted national-level training programmes, both physical and virtual for Geography teachers across Central and State government as well as private schools. In 2015, 'School Bhuvan-NCERT', an e-learning portal, was developed with NRSC-ISRO to promote geospatial skills among learners and continues to be updated to align with curricular needs (Pandey, 2011, 2012, 2016; NRSC/ISRO and NCERT, 2024).

Portal analytics for School Bhuvan–NCERT show sustained traffic through the 2025–26 academic cycle, with monthly page views ranging from approximately 85,000 to over 450,000. As these figures record page views rather than unique users, they indicate continued engagement with the platform rather than the size of the user base. (NCERT, 2026)

Recognising that geospatial capacity building must begin at the foundational level, several initiatives have emerged to integrate spatial thinking and GIS into school education. Bharati Vidyapeeth (Deemed to be) University, Pune, in partnership with DST, has developed India's most extensive school geospatial programme, spanning 150 schools across 13 states. This initiative focuses on building spatial thinking capabilities among students through project-based learning and real-world applications. In 2022, the programme's impact was showcased at the Second United Nations World Geospatial Information Congress (UNWGIC), Hyderabad, where 18 schools presented projects demonstrating how spatial thinking can be applied to localise Sustainable Development Goals (SDGs) at the community level (details available on the DST-IGET website: dst-iget.in; Department of Science and Technology, 2022; Press Information Bureau, 2022). This international validation at the Second UNWGIC established this model as a scalable framework with national potential for systematically integrating geospatial thinking into India's school education system. Currently, 306 teachers and educators have been trained at intensive workshops and more than 4,000 students are actively engaging with spatial thinking projects. (Bharati Vidyapeeth (Deemed to be) University, 2024a, 2024b)

"The surest way to close the skills gap is to start in school."

While ESRI India operates a limited programme, the BVIEER-DST initiative represents the most scaled effort to systematically integrate geospatial thinking into Indian school education. These programmes are critical for building a pipeline of spatially literate citizens and creating early awareness about geospatial careers, addressing the capacity gap at its source rather than attempting remedial training at higher education levels.

BOX 4: NATIONAL TRAINING INITIATIVES

Initiative	Focus	Reach	Format	Distinctive Strength
DST-NGP	Structured capacity building, pedagogy, governance	5,000+ (2013-25) 306 school teachers trained 150 schools across 13 States 4,000+ students engaged in spatial thinking projects	3-week schools & short courses School level training programmes	Interdisciplinary, policy-linked, hands-on, intensive Two-day workshops for school teachers followed by implementation in schools Multiplier effect: trained teachers deliver spatial thinking projects to successive student cohorts India's only sustained multi-week intensive programme, combining classroom instruction, laboratory sessions and field projects, and the only one targeting faculty and working professionals exclusively
ISRO-IIRS	Remote sensing & applications	156,262 (2023-24)	Online & blended	Massive scale through MOOCs
ICAR	Precision agriculture, resource mapping	~1,000/year	Workshop	Field-oriented, sector specific
AICTE ATAL	Faculty development in GIS	Several hundred/batch	FDP modules (1 week)	Technical education institutional focus
FOSSEE GIS (IIT Bombay)	Open-source awareness & software literacy	103,000+ (2020-25)	Mapathons & hackathons	Large higher-ed outreach, open-source promotion
CSSTEAP	International training	388 (2023-24)	Online & offline	Regional leadership
NCERT	School level GIS	3.05 million portal page views (cumulative to April 2026)	Online (School Bhuvan)	Integration with school curriculum, aligned at national level

(Source: DST-NGP Annual Reports (2013-2025), IIRS Annual Report 2023-24, NRSC capacity building data, ICAR/AICTE institutional records, FOSSEE programme reports and School Bhuvan–NCERT portal analytics, April 2025–April 2026, provided by NCERT, 2026. Compiled by BVIEER, 2026. Note: Reach figures represent unique participants, except for the NCERT row, which records portal page views; some individuals may have attended multiple programmes.)

2.2.5 Current Workforce Estimates and Training Coverage

India's geospatial workforce presents a complex picture requiring careful interpretation. The National Geospatial Task Force (2013) identified fewer than 15,000 formally trained geospatial specialists (Government of India, 2013).

By 2021, UN-GGIM Asia-Pacific's Geospatial Strategy for National Development reported approximately 470,000 people employed in the broader geospatial industry. However, this larger figure encompasses software developers, surveyors, support technicians, and allied services, not exclusively professionals with formal academic training in geospatial science. A disaggregated count of formally trained specialists remains unavailable, highlighting the urgent need for standardised workforce classification.

BOX 5: WORKFORCE PROFILE

Metric	Status
Formally trained specialists (2013)	<15,000
Broader geospatial workforce (2021)	~470,000 (includes allied services)
Projected requirement (2030)	250,000-300,000 trained professionals
Skill distribution	Majority in basic GIS; advanced AI/ML analytics rare

(Source: Geospatial World, 2022; Government of India, 2013)

"India has the data. What it lacks are the people trained to use it."

2.2.6 Infrastructure and Institutional Capacity

India has established robust geospatial data infrastructure through coordinated initiatives. The Geospatial Data Promotion and Development Committee (GDPDC) under DST provides strategic direction for the National Geospatial Mission. This builds upon platforms including Bhuvan (ISRO's geoportal), Bharat Maps (NIC's GIS platform), and the National Spatial Data Infrastructure (NSDI) framework. State initiatives like Kerala's KSDI and Karnataka's KSSDI demonstrate successful regional models. (ISRO, 2024)

However, training infrastructure lags substantially behind data infrastructure. Regional training centres, virtual laboratories, and cloud-based learning environments remain fragmented. Among the geospatial institutions identified in Box 3, only select IITs, NITs, and specialised centres possess dedicated remote sensing laboratories with modern equipment. This disparity creates a critical bottleneck: excellent data resources exist, but insufficient trained professionals can leverage them effectively.

BOX 6: INFRASTRUCTURE STATUS

Component	Current Status
Data infrastructure	Bhuvan, NRSC archives, NSDI operational
Regional training hubs	Not yet established
Cloud-based learning platforms	At pilot stage
Institutional labs with modern equipment	Limited to a few institutions, mostly in urban areas
Training infrastructure coordination	Fragmented and uneven

Source: NRSC institutional data, ISRO annual reports, Survey of India databases, DST-IGET portal statistics. Compiled by BVIEER, 2025. Note: Status reflects operational capabilities as of 2024-25; ongoing infrastructure developments may alter these baselines.

2.2.7 Critical Capacity Gaps: Assessment and Projections

The National Geospatial Task Force Report (2013) projected India would require 250,000-300,000 trained professionals by 2030 (Government of India, 2013). Despite growth in the broader workforce, the gap in formally trained specialists capable of leveraging advanced spatial analytics, AI/ML integration, and emerging technologies persists. This white paper's Vision 2030 targets, outlined in Box 7, represent a critical first phase in systematically addressing this deficit through a phased approach building sustainable infrastructure while creating immediate impact.

BOX 7: VISION 2030 TARGETS – PHASE WISE (2026-2030)

Target	Objective
Trained professionals	35,000
Regional Centres of Excellence	15 strategically located hubs
Institutional reach	From 150 to 5,000 institutions
Expert trainers annually	~1,500
Investment requirement	₹200 crore over four years
Policy alignment	NEP 2020 + NGP 2022 + National Geospatial Mission

Source: National Geospatial Policy 2022 framework, DST-NGP strategic modelling, UN-IGIF capacity benchmarks, stakeholder consultations (2023-2025). Compiled by BVIEER, 2025. Note: Targets represent cumulative achievements across all pillars by end of Phase IV (2029-30).

"India can transform geospatial capacity from constraint to strategic asset."

Section 2.2.7

Achieving these targets demands coordinated interventions: expanding institutional reach by over 30-fold, developing expert trainers to create cascading effects, establishing comprehensive digital infrastructure, and harmonising efforts with national policy frameworks. The 15 regional centres will provide strategic coverage across India's 36 states and union territories, ensuring equitable access while maintaining quality.

The evidence presented reveals a sector with remarkable achievements, FOSSEE reaching over 103,000 participants, mostly students, IIRS engaging 156,262 through digital platforms, yet facing critical structural challenges. The contrast between 44,000+ higher education institutions and geospatial programmes in merely 150 highlights the scale of transformation required. By advancing policy architecture, educational programmes, and innovation partnerships as detailed in subsequent sections, India can transform geospatial capacity from constraint to strategic asset.

The proposed roadmap provides an evidence-based pathway to empower stakeholders from grassroots users to national decision-makers with the spatial intelligence capabilities essential for development, governance, and global competitiveness.

2.3 Enabling Local Governance through National Geospatial Initiatives

The gaps identified in Section 2.2 might suggest a bleak picture. However, India's geospatial capacity building efforts are not merely aspirational. They are already producing measurable impact where policy meets practice. Two flagship national programmes, Yuktdhara and SVAMITVA, demonstrate how geospatial platforms can simultaneously deliver governance outcomes and build capacity at the grassroots level. These examples provide a proof of concept for the scaled approach proposed in this white paper.

These systems extend the use of geospatial technologies to the grassroots level, enabling evidence-based decision-making, transparency, and capacity building among Panchayati Raj Institutions (PRIs).

CASE STUDY BOX 1: YUKTDHARA GEOSPATIAL PLANNING PORTAL

Transparent Rural Development through Geospatial Technology

A detailed case study published by Geospatial World (2023) demonstrates how Yuktdhara has improved transparency and planning efficiency across rural India. The portal enables Gram Panchayats to visualise completed works and identify gaps in physical infrastructure, thereby reducing duplication and leakage. (Geospatial World, 2023)

In Nashik district, Maharashtra, an academic study found that use of Yuktdhara helped map regional disparities in asset creation under MGNREGA, improving equitable resource allocation. States such as Uttar Pradesh have now decided to make Yuktdhara mandatory for plan preparation from April 2026. (Patil et al., 2024)

Impact Highlights:

- 2.65 lakh Gram Panchayats covered
- 6.13 crore assets geo-tagged
- Enhanced monitoring, transparency, and accountability at village-planning level
- Nationwide training of Panchayat functionaries through hands-on GIS use

Key Insight: These metrics confirm that Yuktdhara functions not only as a planning platform but also as a large-scale geospatial capacity building tool embedded within government systems.

CASE STUDY BOX 2: SVAMITVA SCHEME

Revenue Mobilisation and Local Governance

District-level documentation from the Ministry of Panchayati Raj (2024b) records that after the completion of SVAMITVA mapping, a Gram Panchayat in Maharashtra observed a **16% increase in property-tax collection**

following the identification of ownership of previously unrecorded vacant plots.

An official e-book, *Empowerment through Ownership – SVAMITVA Scheme*, provides several such examples where Panchayats leveraged accurate land records for infrastructure planning and local revenue generation (Ministry of Panchayati Raj, 2024a; Development Monitoring and Evaluation Office, 2023; Press Information Bureau, 2025).

Impact Highlights:

- 3.20 lakh villages surveyed
- 2.42 crore property cards issued
- 16% increase in property-tax collection reported in a Gram Panchayat in Maharashtra
- Enhanced credit access and rural financial inclusion
- Strengthened data-driven local governance

According to the Government of India, the potential economic impact of SVAMITVA through land-asset monetisation is estimated at USD 1.162 trillion (≈ ₹96 lakh crore). While these macro-level projections require further validation, they highlight the transformative potential of geospatial infrastructure in unlocking rural wealth and institutional strengthening. (IMPRI India, 2025)

Broader Significance for Capacity Building

Both Yuktdhara and SVAMITVA illustrate how national geospatial programmes contribute directly to human and institutional capacity building. They create an experiential learning environment for government officials, engineers, and community members. They build institutional capability at the Panchayat level for data management, planning, and monitoring. They enhance public awareness and data literacy, both of which are cornerstones of a geospatially enabled society.

While direct financial RoI metrics remain under documentation, the systemic gains in terms of improved governance, transparency, and participatory decision making reflect a significant return on national investment in geospatial infrastructure.

1. State-Level Geospatial Governance Initiatives

Beyond national programmes, several states have pioneered their own geospatial land record systems, demonstrating diverse applications of digital technology in governance and capacity building.

Karnataka's Bhoomi project, launched in 2000, was India's first comprehensive land records digitisation initiative. By 2002, the project had successfully computerised all 20 million land records belonging to 6.7 million landowners across 176 talukas. This pioneering effort trained thousands of revenue officials in digital record management and established a replicable model for other states. (Government of Karnataka, 2002)

Kerala's Ente Bhoomi, part of the Integrated Land Information Management System (ILIMS), represents the next generation of land governance platforms. The Digital Resurvey Mission uses Continuously Operating Reference Stations (CORS), with 28 stations covering over 80% of the state, along with drones and advanced survey instruments. As of 2025, over 300 digitally surveyed villages have been integrated into the platform, with plans to cover all 1,666 villages. The single window portal integrates revenue, registration, and survey services, enabling real time land parcel map updates. Kerala's success has attracted interest from Assam, Puducherry, and Rajasthan, positioning it as a national benchmark for digital land governance. (Government of Kerala, 2024)

Both initiatives demonstrate how state level implementation can drive technological innovation, build technical capacity among government officials, and create scalable models for national replication.

2. State Level Geospatial Capacity Building Institutions

Beyond land records digitisation, specialised state level institutions have emerged as Centres of Excellence for geospatial capacity building, training government officials, and supporting multiple sectors through applied geospatial technology.

Haryana Space Applications Centre (HARSAC), established in 1986 and operational since 1988, represents India's early commitment to state level geospatial capacity building. Located at CCS Haryana Agricultural University in Hisar, HARSAC has embedded GIS across all aspects of governance in Haryana's 44,212 sq km area. Its crop management solution, part of the OneMap Gurugram Portal, enables real-time monitoring of agricultural production across the state through mobile GIS applications. Field surveys conducted by students not only generate accurate agricultural data but simultaneously build geospatial skills among youth, making them employment ready. The Centre provides technical training to thousands of government officials annually in GIS, UAV mapping, and remote sensing applications. HARSAC's work spans disaster management, illegal construction monitoring, land category information systems, and agricultural resource management, demonstrating the multiplier effect of a well-resourced state geospatial institution. (HARSAC, 2024)

Bhaskaracharya National Institute for Space Applications and Geo-informatics (BISAG-N), Gujarat, has evolved from a state agency (established as RESECO in 1997) to a national institution under the Ministry of Electronics and Information Technology in 2020. This elevation reflects BISAG-N's exceptional capacity building impact and scalability potential. The institute trains over 600 students annually from diverse backgrounds: water resources, urban planning, computer engineering, agriculture, and remote sensing. BISAG-N has signed MoUs with over 40 universities nationwide, bridging academic training with industry requirements through internships and specialised programmes. (BISAG-N, 2024)

BISAG-N's capacity building contributions extend far beyond Gujarat. The institute contributed over 1,450 GIS layers to the PM GatiShakti National Master Plan (as of March 2023), improving inter-ministerial coordination on infrastructure. It supports multiple states – Odisha, Maharashtra, Gujarat, and Jammu & Kashmir – in creating geospatial technology 'Centres of Excellence'. Through its SATCOM network, BISAG-N operates over 20 satellite communication classrooms and 51

DTH educational channels (including 16 under VANDE Gujarat), delivering remote education to underserved areas. During COVID-19, the institute delivered over 200 hours of teaching per week to rural Gujarat, Jammu & Kashmir, and tribal areas of Chhattisgarh. In August 2023, BISAG-N partnered with the Comptroller and Auditor General of India to provide geospatial audit tools, training CAG officials in satellite data analysis and AI-powered infrastructure monitoring.

These state level institutions demonstrate a crucial capacity building model: embedded within government systems, they simultaneously deliver operational geospatial services while training the next generation of professionals. Their success validates the white paper's recommendation for regional Centres of Excellence that combine service delivery, training, and innovation.

BOX 8: NATIONAL AND STATE GEOSPATIAL GOVERNANCE INITIATIVES

Programme/Institution	Coverage	Key Outcome	Capacity Building Impact
Yuktdhara (National)	2.65 lakh Gram Panchayats	6.13 crore assets geo-tagged	Hands-on GIS training for Panchayat functionaries
SVAMITVA (National)	3.20 lakh villages	2.42 crore property cards issued	16% revenue increase; enhanced data literacy among PRIs
Karnataka Bhoomi	20 million land records, 6.7 million landowners, 176 talukas	All land records computerised by 2002	Revenue officials trained in digital land record management
Kerala Ente Bhoomi (ILIMS)	300+ villages digitised; targeting all 1,666 villages	28 CORS stations covering 80% of state; integrated portal	Survey officials trained in RTK, drones, GIS; replicable model for other states
Haryana HARSAC	44,212 sq. km coverage; 206 completed projects	Crop management, OneMap Gurugram, land records digitisation	M.Tech programme (since 2009); 6-week summer training; student field surveys build GIS skills
BISAG-N (National, Gujarat)	Multi-state support; 40+ university MoUs nationwide	1,450+ GIS layers in PM GatiShakti; CAG geospatial auditing partnership	600+ students trained annually; supports 4 state Centres of Excellence; 51 DTH educational channels

Source: Karnataka Bhoomi project documentation, Haryana HARSAC institutional reports, Gujarat BISAG-N annual reports, PM GatiShakti National Master Plan data. Compiled by BVIEER, 2025.
Note: Examples represent best-practice models for state-level geospatial implementation.

The landscape analysis in Section 2 has demonstrated both promise and gaps. Section 2.2 identified critical shortfalls in India's capacity building infrastructure, while Section 2.3 has showcased how national programmes (Yuktdhara, SVAMITVA), state land record systems (Karnataka Bhoomi, Kerala Ente Bhoomi),

and specialised capacity building institutions (HARSAC, BISAG-N) are already producing tangible governance outcomes and building technical capacity at scale. These examples prove that geospatial technology can transform governance, but they also reveal the challenge: such initiatives remain isolated successes rather than systematic, nationwide capacity building.

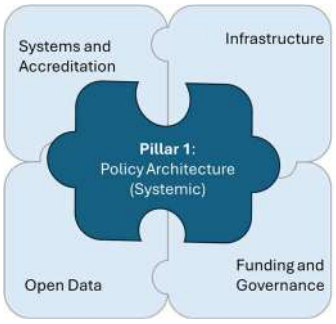
To address these multidimensional challenges, India requires a structured framework that operates simultaneously at three levels: creating enabling policy environments (systemic level), strengthening educational and training institutions (institutional level), and equipping individuals with skills and competencies (individual level). Section 3 presents this comprehensive Multilevel Capacity Building Framework.

Section 3: Multilevel Capacity Building Framework

To address the challenges outlined in Section 2 and realise the vision set forth in the National Geospatial Policy (NGP) 2022, India requires a structured, inclusive, and multilevel approach to capacity building. This framework is built on three interdependent strategic pillars – Policy Architecture, Education and Human Capital Development, and Innovation Ecosystem and Strategic Partnerships. They operate across systemic and institutional levels to enable individual capacity building. The framework aligns closely with international standards such as the United Nations Integrated Geospatial Information Framework (IGIF) and aims to bridge gaps in access, awareness, and application across sectors.

3.1 The Three Pillar, Multilevel Approach

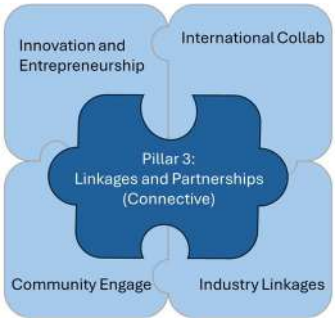
India's capacity building strategy recognises that sustainable transformation requires simultaneous action across three strategic pillars, each operating at different levels of the geospatial system:



Pillar 1 · systemic level



Pillar 2 · institutional level



Pillar 3 · institutional level

Pillar 1: Policy Architecture for Capacity Building operates primarily at the systemic level, creating the enabling environment through supportive policies, governance mechanisms, and technical infrastructure. This pillar ensures that the 'rules of the game' facilitate rather than hinder geospatial adoption, education, and innovation.

Pillar 2: Education and Human Capital Development operates at the institutional level, strengthening the organisations – universities, training academies, research centres, schools, and sectoral institutes – that deliver geospatial education, conduct research, and develop applications. Strong institutions translate systemic enablers into accessible learning opportunities and applied research.

Pillar 3: Innovation Ecosystem and Strategic Partnerships operates at the institutional level, building collaboration among government agencies, academic institutions, industry leaders, and civil society organisations. This pillar leverages partnerships to scale infrastructure, co-develop training programmes, and accelerate innovation.

Together, these three pillars create the foundation for individual capacity building, equipping students, professionals, educators, and citizens with the knowledge, skills, and competencies needed to effectively use geospatial technologies in their respective domains. This is where capacity building becomes tangible, through education, training, hands-on experience, and continuous learning.

Significance of the multilevel approach

Each pillar reinforces the others in a continuous feedback loop: Systemic policy reforms (Pillar 1) enable institutions to establish programmes and access resources; Strong institutions (Pillars 2 & 3) produce skilled individuals who drive innovation and application; Empowered individuals, in turn, advocate for better policies, strengthen institutions, and contribute to systemic improvements.

Without attention to all three pillars simultaneously, capacity building efforts risk remaining fragmented, unsustainable, or inaccessible to key stakeholder groups. For example, training individuals without reforming restrictive data policies or building institutional infrastructure results in skill atrophy and limited real world application. Similarly, creating excellent infrastructure without developing educators and curricula leaves the system underutilised.

This framework provides policymakers, educational institutions, and development practitioners with a roadmap for coordinated action. This ensures that investments in geospatial capacity building are strategic, inclusive, scalable, and aligned with India's national development goals.

3.2 Pillar 1: Policy Architecture for Capacity Building (Systemic Level)

The first pillar focuses on establishing the systemic foundation, i.e., the enabling environment of supportive policies, governance mechanisms, and technical infrastructure that makes it possible for a wide range of stakeholders to access, use, and benefit from geospatial tools and data. Without systemic readiness, even the most well-designed training programmes or academic courses may struggle to scale or sustain impact. India's strategy at this level aims to align with global best practices while addressing the country's unique developmental and governance needs.

3.2.1 Policy Alignment and Standardisation

The National Geospatial Policy (NGP) 2022 provides the overarching framework for systemic capacity building by promoting open access to data, reducing regulatory friction, and encouraging inter agency and cross sectoral coordination. Its alignment with the United Nations' Integrated Geospatial Information Framework (IGIF) supports the development of interoperable, standardised data systems that are essential for training, collaboration, and innovation across institutions. (Bureau of Indian Standards, 2025)

Standardisation and creation of Standard Operating Procedures (SOPs) is especially critical for capacity building because it ensures that educators, researchers, and professionals across the country are working with consistent formats and tools. This, in turn, facilitates knowledge sharing, curriculum development, and skill mobility across regions and sectors.

Key policy actions include:

- *Development of national geospatial training standards and accreditation frameworks that define competency levels and learning outcomes across educational stages*
- *Establishment of professional certification mechanisms that provide recognised credentials for geospatial professionals*
- *Implementation of open data policies ensuring free access to foundational geospatial datasets for educational and research purposes*
- *Creation of interoperability standards that enable seamless data exchange and tool integration across platforms*

"India currently lacks a central mechanism for geospatial capacity building governance to align priorities, standardise programmes, and avoid duplication."

Section 3.2.2

These policy foundations ensure that geospatial capacity building is not fragmented across isolated initiatives but rather forms part of a coherent national system aligned with international best practices.

3.2.2 Governance and Coordination Mechanisms

A well-defined governance and regulatory framework is essential to enable and sustain geospatial capacity building at scale. Governance in this context refers not only to managing geospatial data and infrastructure, but more importantly, to coordinating training, education, and skill development efforts across ministries, institutions, and sectors.

India currently lacks a central mechanism for geospatial capacity building governance to align priorities, standardise programmes, and avoid duplication. The Department of Science and Technology (DST), through the National Geospatial Programme (NGP), is well positioned to take on this coordinating role.

As a national convener, DST-NGP can:

- *Connect technical agencies (ISRO, NRSC, Survey of India), universities, training providers, and regulators (UGC, AICTE, NCERT)*
- *Ensure coherence with the National Geospatial Policy 2022 and global frameworks such as IGIF*

- *Establish coordination mechanisms with the National Geospatial Mission (NGM) to align infrastructure investments with capacity building priorities*
- *Create performance measurement frameworks to track progress, identify gaps, and enable evidence-based policy adjustments*
- *Facilitate state and agency partnerships for localised engagement and regionally responsive training programmes*

Such coordination is critical to transforming fragmented efforts into a unified system where curricula, research, and training reinforce one another. A supportive regulatory environment is equally important. Clear protocols for data sharing, privacy, and ethical use help build trust and broaden participation from institutions, NGOs, and communities, ultimately expanding the reach and effectiveness of capacity building initiatives.

3.2.3 Infrastructure Development

Robust geospatial infrastructure is a foundational enabler of capacity building. Investments in satellite imaging systems, LiDAR, UAVs, and ground-based sensors expand India's ability to generate, manage, and share spatial data. Equally important are digital platforms such as Bhuvan and the DST-IGET portal, which serve not only as repositories of national datasets but also as core learning environments for students, researchers, and professionals.

Accessible, high-quality data and user-friendly interfaces allow learners to engage with real world geospatial applications, supporting hands on training, interdisciplinary research, and digital innovation. When such infrastructure is widely available and regularly updated, it ensures consistency and equity in the learning experience, whether in academic programmes, government training institutes, or grassroots community initiatives.

Key infrastructure priorities include:

- *Establishment and expansion of data platforms providing free access to foundational geospatial datasets*
- *Development of High-Performance Computing (HPC) hubs to process large geospatial datasets, supporting multiple users across research and application domains*
- *Creation of regional data centres that host locally relevant datasets accessible in rural and underserved regions*
- *Investment in digital training platforms that deliver interactive learning content, simulation environments, and project-based modules*
- *Deployment of cloud-based geospatial analytics infrastructure that reduces hardware barriers for smaller institutions and individual learners*

Infrastructure development must be strategically aligned with educational priorities. This ensures that learners at all levels have access to the tools, data, and computing resources necessary to develop practical geospatial competencies.

3.2.4 Quality Assurance and Dedicated Funding

Sustainable capacity building requires predictable funding streams and quality assurance mechanisms. Dedicated funding allocations ensure programme continuity, allow for long-term planning, and enable institutions to invest in faculty development, infrastructure, and research. Quality assurance frameworks, including programme accreditation, periodic evaluations, and standardised assessment tools, ensure that training outputs meet national and international standards.

> ***Policy mechanisms should include:***
>
> - *Establishment of dedicated budget lines for geospatial capacity building within national science and technology funding*
> - *Creation of merit-based scholarship schemes to expand access for students from underrepresented regions and communities*
> - *Development of quality assurance frameworks that evaluate training programmes against defined competency standards*
> - *Implementation of continuous review and refinement processes based on assessment data and stakeholder feedback*

Policy alignment, coordinated governance, infrastructure investments, and sustainable funding together form the systemic foundation for scaling geospatial capacity in India. With this enabling environment in place, the next step lies in strengthening the institutions that operationalise geospatial education and training.

The following sections explore how universities, research centres, sectoral academies, and partnership mechanisms can build on this foundation to deliver structured academic programmes, support applied research, and scale collaborative innovation in support of India's geospatial ambitions.

3.3 Pillar 2: Education and Human Capital Development (Institutional Level)

The second pillar focuses on strengthening the institutions that deliver geospatial education and training across all levels – from early spatial thinking in schools to advanced specialisations in universities, from vocational training institutes to professional development academies. While universities and research centres are central to academic training and knowledge generation, a wider network of institutions, including schools, teacher education centres, sectoral training academies, and digital learning platforms also play a crucial role. These institutions bridge the gap between systemic enablers and individual learners, translating infrastructure, policy, and standards into accessible and context specific learning pathways across sectors and levels. (Beetham and Sharpe, 2013)

3.3.1 Academic and Educational Institutions

Strengthening formal geospatial education across levels is central to institutional capacity building. While several universities offer postgraduate programmes in geoinformatics and remote sensing, undergraduate offerings remain limited, and existing curricula are often inconsistent or outdated.

To build a robust pipeline, institutions must develop structured, multilevel programmes that span foundational courses, undergraduate degrees, and advanced specialisations. Geospatial thinking should also be embedded across disciplines such as environmental studies, engineering, urban planning, public policy, and public health, ensuring that spatial literacy becomes a cross-cutting competency rather than a niche technical skill.

School Level Integration: At the school level, spatial concepts must be introduced early through interdisciplinary, project-based approaches. Institutions such as State Councils of Educational Research and Training (SCERTs), District Institutes of Education and Training (DIETs), and teacher training colleges need to be equipped with tools and pedagogical strategies to introduce basic geospatial concepts in classrooms. Programmes led by NCERT, Bharati Vidyapeeth and other agencies supported by DST and the Ministry of Education can help mainstream geospatial learning into school education.

Higher Education: Universities and colleges must establish undergraduate programmes in geoinformatics, expand postgraduate specialisations, and promote doctoral research in thematic areas aligned with national development priorities. Curriculum frameworks should define core competencies, such as spatial reasoning, map interpretation, GIS operations, spatial analysis, and remote sensing.

"Spatial literacy should be as basic as reading a map, for every student."

Key institutional actions include:

- *Establishment of geospatial Centres of Excellence across regions, providing leadership in curriculum development, research, and training*
- *Development of standardised, modular curriculum frameworks aligned with the National Credit Framework (NCrF) and compatible with international standards*
- *Integration of geospatial competencies into existing disciplinary programmes through electives, interdisciplinary courses, and project-based modules*
- *Creation of pathways for students to earn academic credit through diverse learning experiences, including MOOCs, internships, and community-based projects*
- *Implementation of certification programmes, short-term courses, and exchange visits to elite geospatial centres for student exposure and skills enhancement*

By 2030, the roadmap envisions curriculum integration in 5,000 institutions across India, ensuring that geospatial literacy becomes a foundational competency for millions of students.

3.3.2 Sectoral and Vocational Training Institutes

Sector specific academies, serving agriculture, forestry, disaster management, policing, urban planning, and rural development are well positioned to integrate domain relevant geospatial applications into their training curricula. These institutions can build practical capacities among mid-career professionals by offering modular or certification-based learning pathways tailored to sectoral needs.

Similarly, vocational institutions under the National Skill Development Corporation (NSDC) and Industrial Training Institute (ITI) systems can provide short term, job-oriented training in mobile mapping, GIS basics, drone operations, and remote sensing applications. These offerings are critical for expanding access to geospatial careers among learners from non-traditional academic backgrounds and underserved regions.

Institutional collaboration with organisations like ISRO, NRSC, and state geospatial centres can ensure that these training programmes are technically sound, regionally relevant, and scalable. As outlined in the implementation roadmap, professional certification programmes will be launched and fully operationalised in Phase II, with statutory recognition by Phase III.

3.3.3 Faculty and Educator Development

High quality geospatial education depends on well-prepared faculty across institutional levels. Many educators currently lack exposure to evolving geospatial tools, interdisciplinary applications, and experiential teaching approaches. Addressing this gap is critical to ensuring that the expansion of geospatial programmes is matched by instructional quality. Faculty development should be integrated into national teacher development initiatives such as the UGC's Malaviya Mission Teacher Training Programme (MMTTP). Through this framework, geospatial specific faculty enhancement programmes can be designed and delivered in partnership with DST-NGP.

> ***These programmes should include:***
>
> - *Training on practical geospatial tools, open-source platforms, and emerging technologies*
> - *Curriculum integration workshops that help educators embed spatial thinking across disciplines*
> - *Pedagogical innovations promoting hands-on, locally contextualised, and project-based learning*
> - *Collaborative research opportunities that connect faculty with national research priorities and industry applications*

This approach will ensure that geospatial teaching capacity is strengthened not just in technical institutions, but across universities, colleges, schools, and training institutions, creating a multiplier effect that scales educational impact.

3.3.4 Digital Learning Platforms and Flexible Learning Models

Digital platforms are key enablers of inclusive geospatial education, allowing learners to access high quality content flexibly and at scale. Massive Open Online Courses (MOOCs), self-paced training modules, and open-access content provide flexible learning opportunities for students, professionals, and self-learners across India's diverse geographic and socioeconomic contexts.

Platforms such as SWAYAM, the DST-IGET portal, and NSDC's e-learning portals can serve as central channels for delivering these resources, particularly when designed with localised content and accessible formats. Mobile friendly delivery, multilingual materials, and modular course structures enable learners to access high quality content on their own terms.

The implementation of the National Credit Framework (NCrF) offers a significant opportunity to broaden how geospatial learning is delivered and recognised within higher education. Under NCrF, students can earn formal academic credits not only through classroom instruction but also through diverse learning experiences, such as completing geospatial MOOCs, participating in internships, or contributing to community-based mapping and citizen science projects. (UGC, 2023)

To fully realise this potential, DST can collaborate with UGC, higher education institutions, and state education councils to design and validate credit bearing opportunities. A curated bank of projects, such as community-based mapping challenges, school-college collaboration initiatives, and localised spatial planning exercises, can be developed and published as credit-worthy, supervised, and assessable learning opportunities.

As outlined in the strategic roadmap, digital training platforms will be launched in Phase I, supporting the training of 10,000 individuals in the first year and scaling progressively to reach 35,000 trained professionals by Phase IV (2029-30).

Strengthening institutional capacity across this wider base, from schools and vocational centres to universities and digital platforms, is essential for a geospatially empowered India. When educational, technical, and training institutions are equipped and aligned, they serve as engines of geospatial awareness, innovation, and problem solving. Building on this foundation, the next pillar focuses on building innovation ecosystems and strategic partnerships that amplify institutional capacity and drive real world application.

3.3.5 Individual Capacity Building

Individual capacity building is the most direct layer of capacity development, ensuring that the broader framework of policy, infrastructure, institutions, and partnerships translates into real world competencies. Empowered individuals, students, professionals, educators, and citizens, are the ultimate measure of success for India's geospatial capacity building framework.

Individual capacity building encompasses multiple dimensions:

Education Pathways: Students at all levels, from primary school to doctoral research, gain exposure to spatial thinking and geospatial technologies through formal curricula, project-based learning, and experiential opportunities. The integration of geospatial competencies into degree programmes, supported by the National Credit Framework (NCrF), allows students to earn academic recognition for diverse learning experiences including MOOCs, internships, and community projects. (UGC, 2023)

Professional Training: Mid-career professionals across sectors, agriculture, urban planning, disaster management, environmental monitoring, public health, acquire sector specific geospatial skills through certified short-term training programmes, modular workshops, and online courses. These programmes enable professionals to integrate geospatial tools into decision-making, project monitoring, and operational workflows.

Flexible and Personalised Learning: Early career professionals, individuals in remote regions, and lifelong learners access geospatial competencies through self-paced, modular learning pathways: micro-credentials, MOOCs, and online

certification courses. Platforms such as SWAYAM, DST-IGET, and NSDC portals provide scalable, accessible alternatives to traditional classroom-based training.

Community Engagement: Citizens engage in everyday spatial thinking and participatory mapping through citizen science initiatives: tree mapping, village asset mapping, OpenStreetMap editing, disaster risk assessment. These activities strengthen spatial literacy, empower community-led development, and create inclusive data systems.

3.4 Pillar 3: Innovation Ecosystem and Strategic Partnerships (Institutional Level)

The third pillar focuses on fostering strategic collaboration among government agencies, academic institutions, industry leaders, and civil society organisations. While the first two pillars establish the policy environment and educational infrastructure, this pillar ensures that geospatial capacity building is dynamic, responsive to market needs, and deeply connected to real-world applications. By leveraging public-private partnerships (PPPs), supporting interdisciplinary research, and creating innovation hubs, India can accelerate technology transfer, scale solutions, and position itself as a global leader in geospatial innovation.

3.4.1 Research and Innovation Hubs

"Geospatial skills create value when they are built into products people use."

Institutions must serve not only as centres for education but also as hubs for applied geospatial research and innovation. Establishing thematic research centres in areas such as disaster risk reduction, climate resilience, water resource management, precision agriculture, urban planning, and sustainable development helps align academic inquiry with national priorities and sectoral challenges. These hubs should promote interdisciplinary collaboration, encourage faculty-student-industry linkages, and attract competitive research funding. By building a culture of inquiry and problem solving, institutions can serve as incubators for locally grounded, scalable geospatial solutions that address India's unique developmental challenges.

Critical to these innovation hubs is capacity building in emerging geospatial technologies that will define next-generation spatial applications. Digital Twins provide virtual replicas of infrastructure and urban systems for real-time monitoring and predictive scenario planning. Geo-AI automates feature extraction from satellite imagery, enables predictive modelling for land use change and disaster risk, and powers intelligent spatial decision support. LiDAR delivers high-precision 3D mapping for terrain modelling, infrastructure planning, forest biomass estimation, and coastal zone management. Space Geodesy through GNSS and CORS networks supports precise positioning, crustal deformation monitoring, and land subsidence tracking. Hyperspectral Remote Sensing across hundreds of spectral bands enables mineral exploration, precision agriculture, water quality monitoring, and environmental contamination assessment. Integrating these domains into research agendas and training programmes from Phase I will ensure India's geospatial workforce remains at the cutting edge of global technological advancement.

Realising the commercial and employment potential of geospatial capability requires connecting it to complementary assets across the wider technology stack – electronics, sensors, computing, artificial intelligence, and the industrial

applications enabled by these technologies. Value is generated not by geospatial technology in isolation but by its integration into products, services and systems that industry will pay for. This gap arises from the risks that attend technology development, product delivery, and market adoption, arising from constant innovation both in the underpinning knowledge bases and applications of such technologies.

Focused Research Organisations (FROs) represent an institutional category well positioned to make these connections. These centres, located at top-tier national institutes with demonstrated R&D excellence but operated by professional management teams with world-class qualifications and experience, concentrate on rapidly accelerating technology commercialisation in well-defined technology and application domains. They provide startups with specialised technical support to reduce technology development uncertainties; and actively-managed portfolios of industry partnerships, which unlock complementary assets that reduce product management uncertainties.

Crucially, FROs are now eligible to receive funds from the Government of India's recently launched ₹1 lakh crore Research, Development and Innovation Fund (RDIF), to finance technology startups. FROs are empowered to provide this funding from stages as early as Technology Readiness Level 4, on financing terms designed for the risks of early-stage, R&D-intensive technology commercialisation. RDIF is mandated to rapidly expand such financing through 2030, across technology and application domains. This provides Indian geospatial innovators with a national network dedicated, equipped, and resourced to integrate their technologies with startups and industry; and to scale their commercialisation across applications and markets.

Accordingly, the research and innovation hubs proposed under this framework should therefore be designed to interface directly with FROs rather than to operate in parallel with them. Three modes of engagement are envisaged.

First, a subset of the proposed Centres of Excellence, those located within or adjacent to FRO networks, should carry an additional innovation mandate, undertaking joint programmes in technology integration, startup engagement and industry-facing application development.

Second, all centres in the network should have access to FRO assets (including startup portfolios, industry relationships, and technical specialisation, all resourced with commercialisation-oriented talent pools, financed by RDIF). This would accelerate the development of – and access to – complementary technical, entrepreneurial, and business knowledge and skills, for geospatial innovators and researchers. This access could expand and deepen such skills across tiers of experience and seniority, via equivalents to the Knowledge Transfer Partnership programme pioneered in the United Kingdom, and structured arrangements for internships, mentorship, placement and joint innovation challenges. This would expand the benefits of these commercialisation-focused linkages, and the skill-sets that underpin them, to geospatial innovators beyond a few locations.

Third, the relationship should be understood as reciprocal: FROs and the startups they incubate require a supply of geospatially skilled personnel that does not presently exist at scale, and the capacity building network proposed here is the

mechanism by which that supply is created. Formalising this interface would strengthen industry–academia articulation, improve employment outcomes for trained professionals, and create the market signal necessary to attract students into geospatial disciplines.

Key strategies include:

- *Establishment of geospatial Centres of Excellence that serve as regional innovation hubs, combining research, training, and application development, with designated centres carrying an extended innovation and commercialisation mandate*
- *Creation of applied research projects that address sectoral challenges identified by government agencies, NGOs, and industry partners*
- *Development of technology transfer mechanisms that facilitate the commercialisation and scaling of research outputs*
- *Formalisation of partnerships with Focused Research Organisations, connecting geospatial capability with complementary technologies and providing the network with access to startup portfolios, industry relationships, and commercialisation expertise*
- *Establishment of structured mobility arrangements (internships, placements, mentorship, and knowledge transfer partnerships) linking geospatial researchers and trainees to startups and industry across the network*
- *Integration of startup incubation programmes within established centres, providing infrastructure, mentorship, and funding support for geospatial entrepreneurs*

As outlined in the implementation roadmap, all Centres of Excellence will transition to active research and innovation hubs by Phase II, demonstrating revenue generation, research productivity, and innovation outputs by Phase III.

3.4.2 Public-Private Partnerships (PPPs)

Public-private partnerships are critical to scaling geospatial capacity building beyond what government or academia can achieve independently. Industry partners bring technical expertise, infrastructure, market insights, and employment pathways that complement academic and policy efforts. PPPs can take multiple forms:

Co-investment in Training Infrastructure: Private sector partners can co-invest in establishing and operating training centres, providing hardware, software, datasets, and technical mentorship. This reduces public expenditure while ensuring that training reflects industry standards and workforce needs.

Curriculum Co-Development: Industry experts can collaborate with academic institutions to design curricula that balance theoretical knowledge with practical skills, ensuring graduates are job ready and aligned with evolving market demands.

Internship and Employment Pipelines: Structured partnerships create pathways for students to gain hands-on experience through internships, live projects, and

eventual employment, bridging the gap between education and workforce integration.

Technology Partnerships: Collaborations with technology providers (both domestic and international) enable institutions to access cutting-edge tools, cloud platforms, and analytics capabilities that would otherwise be cost-prohibitive.

The strategic roadmap envisions establishing PPP frameworks for co-investment in training infrastructure and scaling partnerships during Phase II, and achieving financial sustainability through enduring PPP models by Phase IV.

3.4.3 Industry Collaboration and Consultancy Services

As geospatial centres mature, they should transition from purely educational institutions to entities that offer consultancy services, applied research, and professional training to government agencies, private firms, and NGOs. This dual role not only generates revenue to support institutional sustainability but also ensures that academic research remains relevant and responsive to real world challenges.

Industry advisory councils can be established to guide curriculum development, identify emerging skill needs, and facilitate collaborative research projects. These councils provide a formal mechanism for ongoing dialogue between academia and industry, ensuring that capacity building efforts remain aligned with workforce demands and technological advancements.

By Phase III, Centres of Excellence are expected to demonstrate revenue generation through consultancy services, applied research contracts, and professional development programmes, contributing to their financial sustainability and reducing dependence on government funding alone.

3.4.4 International Collaborations and Knowledge Exchange

India's geospatial capacity building efforts can benefit significantly from international collaborations that bring global expertise, best practices, and technology access.

> ***Strategic partnerships with international organisations, universities, and geospatial agencies can support:***
>
> - *Faculty and student exchange programmes that expose Indian educators and learners to global practices and cutting-edge research*
> - *Joint research initiatives addressing transboundary challenges such as climate change, disaster resilience, and sustainable development*
> - *Technology transfer agreements that enable access to advanced tools, platforms, and datasets*
> - *Participation in global geospatial networks and capacity building forums, positioning India as both a learner and a leader in international geospatial education*

Memoranda of Understanding (MoUs) with international partners will be established in Phase I, with scaling of international collaboration programmes in Phase III. By Phase IV, India aims to be positioned as a global hub of geospatial excellence, contributing to capacity building efforts in other developing nations and actively participating in international geospatial governance.

3.4.5 National Awareness Campaigns and Community Engagement

Building a geospatially literate society requires broad based awareness campaigns that communicate the value of spatial thinking and geospatial technologies to diverse audiences – from policymakers and educators to entrepreneurs and citizens. Strategic partnerships with media organisations, civil society groups, and industry associations can amplify these awareness efforts.

National awareness campaigns launched in Phase I, supported by partnerships with industry and civil society, will focus on:

- *Demonstrating real-world applications of geospatial technologies in everyday life, from agriculture and disaster response to smart cities and environmental conservation*
- *Highlighting career opportunities in the geospatial sector and pathways for skill development*
- *Engaging policymakers and sectoral leaders in understanding the strategic value of geospatial capacity for national development*
- *Promoting citizen science initiatives and participatory mapping projects that democratise access to geospatial tools*

These campaigns lay the groundwork for broader societal engagement with geospatial technologies, creating demand for training programmes and promoting a culture of spatial literacy.

Cross institutional collaboration, strategic partnerships, and innovation ecosystems enhance the efficiency and reach of capacity building efforts. Joint programmes, shared infrastructure, faculty exchanges, and internship pipelines allow institutions to pool resources and extend impact. National programmes such as DST-NGP can act as conveners, supporting knowledge-sharing networks, enabling access to common platforms and datasets, and sustaining long-term partnerships between academia, government agencies, and private-sector actors. These collaborations ensure that geospatial learning and research are relevant, applied, and future ready.

By 2030, the strategic roadmap envisions training 35,000 individuals across these pathways, with formal geospatial education embedded in 5,000 institutions nationwide. This scaling of individual capacity, supported by systemic policies, strong institutions, and vibrant innovation ecosystems, will position India as a geospatially literate nation capable of leveraging spatial technologies for sustainable, inclusive development. The three-pillar framework – Policy Architecture, Education and Human Capital Development, and Innovation Ecosystem – operates across systemic and institutional levels to enable individual capacity building.

Each pillar reinforces the others in a continuous feedback loop: systemic policy reforms enable institutions to establish programmes and access resources; strong institutions produce skilled individuals who drive innovation and application; empowered individuals, in turn, advocate for better policies, strengthen institutions, and contribute to ongoing systemic improvements (Strobl, 2019).

Without attention to all three pillars simultaneously, capacity building efforts risk remaining fragmented, unsustainable, or inaccessible to key stakeholder groups. This framework, however, must ultimately serve a diverse range of users, each with distinct roles, learning needs, and entry points into India's geospatial sector.

Government officials require different competencies than school teachers; urban planners have different needs than grassroots leaders; entrepreneurs engage with geospatial technology differently than journalists or local elected representatives.

The following section outlines inclusive education pathways through which these varied stakeholder groups can access geospatial learning opportunities aligned with their specific contexts, career trajectories, and developmental needs. These pathways demonstrate how the three-pillar framework translates into actionable routes for individuals to acquire, apply, and advance their geospatial competencies throughout their lives.

Section 4: Pathways for Inclusive Geospatial Education

As geospatial technology becomes increasingly embedded in development planning, governance, disaster resilience, and environmental monitoring, the demand for geospatial literacy across India is growing rapidly. Meeting this demand requires an inclusive and lifelong learning pathway, one that builds spatial awareness early, supports academic and professional progression, and integrates real-world, community-based learning opportunities.

The three-pillar capacity building framework outlined in Section 3 creates multiple entry points and learning pathways for diverse stakeholder groups. Policy architecture (Pillar 1) establishes the enabling environment; educational institutions (Pillar 2) deliver structured learning; and innovation ecosystems (Pillar 3) provide applied, real-world opportunities.

This section outlines six interconnected pathways through which individuals, from school students to midcareer professionals, from grassroots leaders to entrepreneurs, can access geospatial education and training aligned with their specific contexts, career stages, and developmental needs.

Each pathway demonstrates how the three pillars work together to create accessible, relevant, and impactful learning experiences. The pathways are not mutually exclusive. Learners often engage with multiple pathways simultaneously or sequentially as they progress through their educational and professional journeys.

4.1 Foundational Pathway: Spatial Thinking from Primary to Higher Education

Building spatial thinking skills from a young age is foundational to developing geospatial literacy. This pathway spans from early childhood education through doctoral research, progressively deepening spatial competencies and technical skills at each educational level.

ENABLED BY
Pillar 2 (Education and Human Capital Development) with systemic support from Pillar 1 (Policy Architecture)

4.1.1 Primary and Secondary Education: Building Spatial Foundations

Integrating spatial concepts into primary and secondary education through subjects such as science, social science, mathematics, and environmental education helps students understand the spatial dimensions of everyday life and decision-making. Spatial thinking at this level involves understanding location, distance, direction, patterns, and relationships in physical and human geography.

Efforts by DST, including workshops for school teachers and support to State Councils of Educational Research and Training (SCERTs), aim to embed spatial thinking in pedagogical practice using age-appropriate tools and project-based activities. Programmes led by NCERT, supported by DST and the Ministry of Education, can help mainstream geospatial learning into school education through curriculum integration and teacher training.

India has taken important steps toward integrating geospatial education into formal school curricula, with CBSE introducing a structured Geospatial Technology curriculum for Class XI that covers GIS fundamentals, remote sensing, and spatial data applications (CBSE, 2024). However, translating this curriculum framework into widespread classroom implementation requires systematic teacher training, resource development, and institutional support as outlined in this capacity building strategy.

At the secondary level, introducing simple GIS tools, such as Bhuvan, Google Earth, QGIS, and mobile mapping applications and local mapping exercises helps build analytical and visual reasoning. Students can engage in projects such as mapping school surroundings, tracking local environmental changes, or analysing community resources, making spatial thinking tangible and locally relevant.

Special emphasis should be placed on utilising the 10-day 'bagless period' recommended under the National Education Policy 2020 (para 4.26), during which students in Grades 6–8 undertake experiential learning with local practitioners, to introduce hands-on spatial activities that spark curiosity and contextual understanding. Institutions such as District Institutes of Education and Training (DIETs) and teacher training colleges play a crucial role in equipping educators with the tools, pedagogical strategies, and confidence to introduce these concepts effectively (Ministry of Education, 2020; NCERT, 2023).

"Mapping the school neighbourhood is where spatial thinking begins."

4.1.2 Undergraduate Education: Building Technical Foundations

As students progress into higher education, structured programmes such as bachelor's degrees in geoinformatics, geography, environmental science, and spatial data science provide deeper theoretical and technical knowledge. However, geospatial literacy should not remain confined to specialised programmes, it must be embedded across disciplines.

Universities should:

- *Establish undergraduate programmes in geoinformatics and remote sensing, providing comprehensive technical training in GIS, spatial analysis, remote sensing, and spatial database management.*
- *Integrate geospatial competencies into existing disciplinary programmes through electives, interdisciplinary courses, and project-based modules in fields such as urban planning, environmental science, public policy, public health, agriculture, and civil engineering*
- *Develop modular curriculum frameworks aligned with the National Credit Framework (NCrF), allowing students to earn academic credits through diverse learning experiences including MOOCs, internships, and community projects (UGC, 2023)*
- *Create pathways for students to engage with real-world applications through live projects, fieldwork, and collaboration with government agencies and NGOs*

By Phase III of the implementation roadmap, curriculum integration is targeted across 3,500 institutions, rising to 5,000 by Phase IV. This scaling ensures that geospatial literacy becomes a cross-cutting competency rather than a niche technical skill.

4.1.3 Postgraduate and Doctoral Education: Specialisation and Research

Master's and doctoral programmes provide advanced specialisations in thematic areas such as disaster resilience, climate modelling, precision agriculture, urban analytics, and sustainable development. These programmes should align closely with national development priorities and sectoral challenges, ensuring that research contributes to applied solutions.

> ***Postgraduate education should emphasise:***
>
> - *Advanced technical skills in spatial modelling, machine learning for geospatial data, big data analytics, and cloud-based geospatial computing*
> - *Interdisciplinary research that addresses complex challenges requiring spatial analysis, such as climate change adaptation, water resource management, public health surveillance, and urban planning.*
> - *Collaboration with research and innovation hubs established under Pillar 3, connecting academic research with industry applications and policy needs*
> - *Publication and dissemination of research through national and international forums, contributing to India's knowledge leadership in geospatial science*

Doctoral scholars can also serve as facilitators in training programmes, providing technical support, mentoring undergraduate students, and contributing to curriculum development. This model, already employed in DST's summer and winter schools, creates a multiplier effect that extends the reach of capacity building efforts.

As the implementation roadmap envisions, advanced specialisations in geospatial domains will be established by Phase III, supported by research productivity and innovation outputs from Centres of Excellence.

4.1.4 Continuous Learning and Lifelong Pathways

Geospatial education should not end with formal degrees. Continuous learning pathways enable students and professionals to move from foundational education into advanced thematic areas as technologies evolve and sectoral applications expand. Alumni networks, professional associations, and digital platforms can support lifelong engagement with geospatial learning, ensuring that competencies remain current and relevant throughout professional careers.

4.2 Professional Development Pathway: Sector Specific Training and Certification

Professionals across sectors such as agriculture, urban planning, disaster management, environmental monitoring, public health, forestry, and policy require geospatial training that is closely aligned with the practical demands of their work. This pathway focuses on mid-career professionals who need to integrate geospatial tools into their existing roles and decision-making processes.

ENABLED BY
Pillar 2 (Education and Human Capital Development) in collaboration with Pillar 3 (Innovation and Partnerships)

4.2.1 Sectoral Training Academies

Sector specific institutions such as the National Institute of Disaster Management (NIDM), agricultural universities, police training academies, and urban planning institutes are well positioned to integrate domain relevant geospatial applications into their training curricula. These institutions can build practical capacities among mid career professionals by offering modular or certification-based learning pathways tailored to sectoral needs.

For example:

- *Agricultural extension officers can be trained in precision agriculture, crop health monitoring using remote sensing, and farm-level GIS for resource planning*
- *Disaster management professionals can acquire skills in risk mapping, early warning systems, vulnerability assessment, and real-time disaster response coordination*
- *Urban planners can learn spatial analytics for infrastructure planning, land use optimisation, public service delivery, and smart city applications*
- *Forest officials can be trained in forest cover mapping, biodiversity monitoring, fire risk assessment, and illegal encroachment detection*

Institutional collaboration with organisations like ISRO, NRSC, and state geospatial centres ensures that these training programmes are technically sound, regionally relevant, and scalable.

4.2.2 Professional Certification Programmes

As outlined in the implementation roadmap, professional certification programmes will be launched and fully operationalised in Phase II (2027-28), with statutory recognition by Phase III (2028-29). These certifications provide recognised credentials that validate geospatial competencies, support career advancement, and enhance professional credibility.

> ***Certification mechanisms should:***
>
> - *Define competency standards at multiple levels (foundational, intermediate, advanced) aligned with international frameworks*
> - *Establish assessment protocols that combine knowledge evaluation with practical skill demonstration*
> - *Gain recognition from professional bodies, regulatory agencies (UGC, AICTE), and industry associations*
> - *Create pathways for professionals to upgrade certifications as they acquire additional skills or move into specialised domains*

Certification programmes benefit both individuals, who gain formal recognition of their skills, and employers, who can confidently recruit and promote geospatially competent professionals.

4.2.3 Short Term and Modular Training

Not all professionals require comprehensive degree programmes. Short-term workshops, intensive boot camps, and modular online courses enable professionals to acquire specific geospatial competencies that are immediately

applicable to their work, such as mobile mapping, spatial data visualisation, drone-based surveying, or cloud-based GIS platforms.

These programmes should be:

- *Application-oriented, focusing on solving real-world problems rather than abstract technical skills*
- *Delivered in multiple formats such as in-person workshops, hybrid blended learning, and fully online modules, to accommodate diverse schedules and geographic locations*
- *Sector specific, using datasets, case studies, and tools relevant to participants' professional contexts*
- *Recognised under national frameworks, allowing professionals to earn credentials, continuing education units, or academic credit*

By Phase IV, the roadmap envisions training 35,000 professionals, with training delivered through 15 Centres of Excellence and partner institutions across India.

4.3 Digital Learning Pathway: MOOCs, Online Modules, and Flexible Credentials

Digital platforms are key enablers of inclusive geospatial education, allowing learners to access high quality content flexibly and at scale. This pathway serves students, professionals, and self-learners who require training opportunities that go beyond traditional classroom-based programmes, particularly those in remote or underserved regions, working professionals balancing jobs and learning, and lifelong learners seeking to acquire new skills.

ENABLED BY
Pillar 2 (Education and Human Capital Development) with infrastructure support from Pillar 1 (Policy Architecture)

4.3.1 MOOCs and Self-Paced Learning

Massive Open Online Courses (MOOCs), self-paced training modules, and open-access content provide flexible learning opportunities for diverse audiences. Platforms like SWAYAM offer foundational and advanced content on topics such as GIS, spatial data visualisation, remote sensing, and spatial statistics, tailored to Indian contexts and datasets.

The DST-IGET portal can also offer rich educational content supported with data and learning materials for developing hands-on skills in spatial thinking. Integration with the iGOT Karmayogi platform presents a strategic opportunity to embed geospatial capacity building within the Government of India's unified civil services training system. The DST-IGET portal can interface with iGOT Karmayogi to deliver domain-specific geospatial training modules to government officials across ministries, departments, and state agencies. This integration enables officials working in urban planning, agriculture, disaster management, environmental monitoring, and infrastructure development to access role-specific geospatial training aligned with their functional responsibilities. By leveraging Karmayogi's competency framework and digital credentialing system, geospatial training can be mapped to career progression pathways, making spatial literacy an integral component of professional development for India's 20 million government employees.

These platforms should provide:

- *Structured courses with clear learning outcomes, assessments, and certifications*

- *Interactive modules that allow learners to practise with real datasets and tools*
- *Multilingual content to expand accessibility across India's linguistic diversity*
- *Mobile-friendly formats that enable learning on smartphones, reducing hardware barriers*

For learners in remote, underserved, or working environments, e-learning platforms offer a vital bridge to geospatial literacy. As outlined in the roadmap, digital training platforms will be launched in Phase I (2026-27), supporting the training of 10,000 individuals in the first year.

4.3.2 Micro Credentials and Digital Badges

Micro credentials and digital badges validate learning outcomes from short courses, MOOCs, and skill specific modules. These credentials are stackable. Learners can accumulate multiple micro-credentials over time, eventually building toward more comprehensive certifications or degree equivalents.

Initiatives like micro credentialing and digital badges can validate learning outcomes and support mobility across academic and professional settings, in line with the National Credit Framework (NCrF). This flexibility is especially important for working professionals, mid-career transitions, and individuals who cannot commit to full-time degree programmes. (UGC, 2023)

4.3.3 Integration with the National Credit Framework (NCrF)

The implementation of the National Credit Framework (NCrF) offers a significant opportunity to broaden how geospatial learning is delivered and recognised within higher education. Under NCrF, students can earn formal academic credits not only through classroom instruction but also through diverse learning experiences, such as completing geospatial MOOCs on platforms like SWAYAM, participating in internships, or contributing to community-based mapping and citizen science projects. (UGC, 2023)

To fully realise this potential, DST can collaborate with UGC, higher education institutions, and state education councils to design and validate credit bearing opportunities. A curated bank of projects, such as community-based mapping challenges, school-college collaboration initiatives, and localised spatial planning exercises can be developed and published as credit-worthy, supervised, and assessable learning opportunities. These project templates would enable educators to recommend relevant activities and guide students in implementing them within academic frameworks.

By formalising such efforts under the NCrF, geospatial education can extend beyond traditional classrooms to become more applied, participatory, and nationally recognised as part of India's evolving education system.

4.4 Experiential Learning Pathway: Summer Schools, Innovation Challenges, and Applied Projects

Experiential learning is critical for applying geospatial knowledge to real world problems. This pathway emphasises hands-on, project-based learning that connects theoretical knowledge with practical application, enabling learners to develop problem-solving skills, technical proficiency, and collaborative capacities.

ENABLED BY

Pillar 2 (Education and Human Capital Development) in close collaboration with Pillar 3 (Innovation and Partnerships)

4.4.1 DST Summer and Winter Schools

DST's Level 1 and Level 2 Summer and Winter Schools introduce participants to foundational GIS and advanced thematic applications. These programmes combine lectures, hands-on labs, fieldwork, and collaborative projects, and have reached thousands of students, educators, and professionals across India.

Level 1 programmes focus on foundational skills such as introduction to GIS, map interpretation, spatial data collection, and basic spatial analysis. Level 2 programmes advance into thematic applications such as disaster risk assessment, climate modelling, agricultural monitoring, and urban analytics.

To enhance impact, these programmes should be:

- *More deeply embedded within academic calendars, recognised as part of formal curricula*
- *Formally recognised under Faculty Development Programmes of the UGC*
- *Expanded regionally to ensure equitable access across states and institutions*
- *Supported by institutions as part of structured learning pathways, with post-programme mentorship and project continuation*

By providing intensive, immersive learning experiences, summer and winter schools serve as catalysts for deeper engagement with geospatial technologies.

4.4.2 Geo Innovation Challenges and Hackathons

Innovation-driven competitions like the Geo Innovation Challenge encourage youth-led problem solving and geospatial entrepreneurship. Participants learn to develop scalable, real-world solutions, often guided by mentorship from academic and industry experts.

> ***These competitions should:***
>
> - *Source challenges from real sectoral problems identified by government agencies, NGOs, and industry partners*
> - *Provide mentorship, technical support, and access to datasets and tools*
> - *Connect top solutions with incubation support, funding networks, and pathways to implementation*
> - *Be institutionalised as annual events that create visibility, community, and career pathways for emerging professionals*

The GIS Mapathon, organised at FOSSEE, IIT Bombay, exemplifies project-based learning through mapathon competitions. These events engage students in collaborative problem-solving while contributing to public datasets and community knowledge.

As envisioned in the implementation roadmap, innovation challenges will be launched in Phase II, alongside startup incubation in centres.

4.4.3 Project-Based Learning and Internships

Real-world application is essential for building professional readiness in geospatial fields. Internships and project-based learning, whether with NRSC, IIRS, local governments, NGOs, or private firms, offer students and early-career professionals opportunities to apply geospatial tools in areas such as urban

mapping, agricultural monitoring, disaster response, and climate impact assessment.

These experiences bridge the gap between academic learning and workforce expectations, helping learners develop technical, analytical, and collaborative skills.

To operationalise this effectively, academic institutions should:

- *Institutionalise project-based modules within curricula, ensuring all students have access to applied learning opportunities*
- *Build structured partnerships with public agencies, research institutions, and civil society organisations to create internship pipelines*
- *Develop a national repository of approved project templates, facilitating consistent and scalable implementation*
- *Enable credit-bearing integration under frameworks like the National Credit Framework (NCrF), ensuring that internships and projects contribute to degree requirements* (UGC, 2023)

DST, in collaboration with UGC and sectoral ministries, can support this by facilitating partnerships, curating project templates, and enabling academic recognition. Such a coordinated approach will ensure that every learner has access to authentic, locally relevant geospatial learning opportunities that contribute to both personal development and community impact.

4.5 Innovation and Entrepreneurship Pathway: From Learning to Market

This pathway supports learners and professionals who want to translate geospatial knowledge into entrepreneurial ventures, innovative solutions, and market applications. It connects education with commercialisation, research with implementation, and academic knowledge with industry needs.

ENABLED BY
Pillar 3 (Innovation Ecosystem and Strategic Partnerships) with educational support from Pillar 2

4.5.1 Innovation Hubs and Startup Incubation

Innovation hubs supported by DST provide startups and early-stage entrepreneurs with infrastructure, mentorship, and funding to explore geospatial solutions. These hubs should be co-located with Centres of Excellence established under the capacity building framework, creating synergies between education, research, and entrepreneurship.

Regional geospatial innovation hubs can further strengthen these efforts by linking academic knowledge with market applications, investor networks, and government partnerships. As outlined in the roadmap, startup incubation programmes and regional innovation clusters around Centres of Excellence will be established by Phase II.

A significant opportunity for strengthening these hubs lies in partnership with Focused Research Organisations. As set out in Section 3.4.1, FROs combine demonstrated R&D capability with professional commercialisation management and actively-managed industry portfolios, and are now eligible for financing from the Research, Development and Innovation Fund. Innovation hubs established under this framework should draw on these assets rather than duplicate them, accessing FRO startup portfolios, industry relationships and technical specialisation to accelerate the movement of geospatial innovation from research

to market. For centres located within or adjacent to FRO networks, this relationship can extend to joint programming in technology integration and industry-facing application development.

Key services provided by innovation hubs include:

- *Infrastructure support: access to hardware, software, cloud computing, and datasets*
- *Mentorship from industry experts, academic researchers, and successful entrepreneurs*
- *Funding connections: linking startups with angel investors, venture capital, and government innovation funds*
- *Market access: facilitating pilot projects with government agencies, NGOs, and corporate partners*
- *Commercialisation linkages: structured access to Focused Research Organisation startup portfolios, industry partnerships, and technology transfer expertise*

4.5.2 Technology Transfer and Commercialisation

Research conducted in academic institutions and innovation hubs should have pathways to market. Technology transfer mechanisms including intellectual property management, licensing agreements, and industry partnerships enable the commercialisation and scaling of research outputs.

By Phase II, the roadmap envisions establishing formal tech transfer mechanisms that facilitate the movement of innovations from labs to real-world applications. This not only generates revenue for institutions but also ensures that research contributes to economic development and job creation.

4.5.3 Employment Pathways and Industry Integration

Strong linkages with industry ensure that geospatial education translates into employment opportunities. Industry advisory councils, established in Phase I, can:

- Guide curriculum development to ensure alignment with workforce needs
- Identify emerging skill requirements and technological trends
- Facilitate structured internship programmes and campus recruitment drives
- Support professional development through continuing education partnerships

By Phase III, Centres of Excellence should demonstrate established employment pathways with industry, consultancy service offerings, and revenue generation, contributing to financial sustainability and reducing dependence on government funding.

4.6 Community Engagement Pathway: Citizen Science and Participatory Mapping

Geospatial capacity building must reach beyond formal education to engage citizens in everyday spatial thinking and participatory mapping. This pathway democratises access to geospatial tools, empowering communities to contribute to local knowledge, planning, and development processes.

ENABLED BY

All three pillars working together: Pillar 1 (open data policies), Pillar 2 (training and awareness), and Pillar 3 (partnerships with NGOs and local governments)

4.6.1 Foundational Spatial Literacy for Citizens

Most people interact with spatial data in their daily lives, through navigation apps, public service delivery, or environmental issues. Yet many lack the basic skills to read or interpret maps meaningfully. Promoting geospatial awareness at the community level begins with building foundational skills such as map reading, location-based inquiry, and the use of simple tools like open-source mapping platforms.

Community-based training programmes, conducted through NGOs, local governments, and schools, can introduce:

- *Basic map literacy: understanding coordinates, scales, legends, and spatial relationships*
- *Use of simple mobile mapping tools for data collection*
- *Accessing and interpreting geospatial data relevant to local issues, such as infrastructure, environmental changes, or public services*

These foundational skills enable citizens to engage meaningfully with development processes and advocate for their communities using spatial evidence.

4.6.2 Citizen Science Initiatives

Citizen science initiatives such as tree mapping, open defecation-free (ODF) zone tracking, OpenStreetMap (OSM) editing, or village asset mapping offer hands-on ways for individuals and community groups to contribute to local knowledge and planning efforts.

These participatory activities not only strengthen spatial literacy but also empower citizens to engage with development processes, be it identifying missing amenities, tracking environmental changes, or contributing to disaster risk assessments. Schools, NGOs, local governments, and universities can play a key role in enabling such engagement by providing accessible training, mentorship, and tools.

Moreover, clarity on how citizens can take ownership of the data and the associated products formed can encourage greater participation in these activities. Ensuring that communities see tangible benefits from their contributions, such as improved public services, transparent governance, or environmental improvements, sustains engagement and builds trust.

4.6.3 Linking Communities with Institutions

A mutually beneficial model can be created by connecting NGOs and community groups with students and academic institutions. By sourcing real, on-ground challenges from NGOs and communities, and linking them to student-led projects, internships, and hackathons, both parties benefit: NGOs and communities gain practical solutions, while students gain applied experience.

This model, operationalised through structured partnerships under Pillar 3, can scale citizen engagement while providing meaningful learning opportunities for students. Local youth can also be trained as geospatial volunteers or data assistants to support Panchayats and local governments in managing and updating spatial data. This not only builds local data ownership and capacity but also creates livelihood opportunities.

Targeted capacity building workshops, interactive dashboards, and regular briefings tailored to local needs can build a culture of data-driven, transparent governance at the grassroots level. As part of a broader capacity building effort, citizen participation in geospatial projects promotes inclusion, transparency, and locally rooted data systems.

4.6.4 Geospatial Tools for Local Governance

Local elected representatives, including Sarpanches, municipal councillors, and MLAs, are uniquely positioned to harness geospatial data for planning local infrastructure, monitoring development schemes, and responding to community needs. However, many lack access to user-friendly tools or the support required to interpret and act on spatial data.

Training programmes should focus on tools like Gram Manchitra, the government's GIS-based planning platform for Panchayati Raj Institutions, which should be widely promoted and integrated into training programmes for local elected representatives. Interactive dashboards that visualise development schemes, resource allocation, and service delivery can make geospatial data accessible and actionable for grassroots leaders.

By empowering local governance with spatial tools and literacy, India can strengthen decentralised decision-making, enhance transparency, and ensure that development planning is responsive to community needs.

"Geospatial capacity is for every citizen, not only for specialists."

Together, these six pathways – Foundational Education, Professional Development, Digital Learning, Experiential Learning, Innovation and Entrepreneurship, and Community Engagement – create a comprehensive and inclusive geospatial education system. Each pathway demonstrates how the three-pillar capacity building framework translates into actionable routes for individuals to acquire, apply, and advance their geospatial competencies throughout their lives.

The pathways are designed to be flexible, interconnected, and mutually reinforcing. A school student engaging with spatial thinking in the Foundational Pathway may later participate in a Geo Innovation Challenge through the Experiential Pathway, pursue a professional certification through the Professional Development Pathway, and eventually launch a geospatial startup through the Innovation and Entrepreneurship Pathway. Similarly, a mid-career professional may engage with Digital Learning for skill upgradation while also contributing to Community Engagement through citizen science projects.

This diversity of pathways ensures that geospatial capacity building in India is not confined to a narrow pipeline of technical specialists but rather creates a broad-based, geospatially literate society capable of leveraging spatial technologies for sustainable, inclusive, and data-driven development. As outlined in the strategic implementation roadmap, these pathways will be progressively scaled from Phase I through Phase IV, ultimately training 35,000 individuals, embedding geospatial literacy in 5,000 institutions, and positioning India as a global hub of geospatial excellence by 2030.

Section 5: Monitoring, Evaluation & Accountability Framework

A robust monitoring and evaluation (M&E) framework is essential to track progress, measure impact, and ensure accountability throughout the implementation of India's National Geospatial Capacity Building Strategy. This section establishes a comprehensive system of Key Performance Indicators (KPIs), measurement methodologies, and evaluation mechanisms aligned with the three-pillar framework and four-phase implementation roadmap.

5.1 Monitoring Framework Overview

The monitoring framework operates at four levels:

Input Indicators	Process Indicators	Output Indicators	Outcome/Impact Indicators
Resources invested (funding, infrastructure, personnel)	Implementation activities and milestones achieved	Immediate deliverables (trained professionals, courses launched, partnerships formed)	Long-term effects on workforce capacity, economic contribution, and global competitiveness

All indicators are mapped to the three strategic pillars and tracked across the four implementation phases to ensure systematic progress measurement and timely course correction. (Source: UN-IGIF monitoring and evaluation guidelines, DST programme evaluation frameworks, international capacity building assessment models. Compiled by BVIEER, 2025. Note: Framework adapted from UN-IGIF Strategic Pathway 8 (Capacity and Education) monitoring principles.)

5.2 Pillar 1 KPIs: Policy Architecture and Enabling Infrastructure

Pillar 1 focuses on creating the systemic foundations, i.e., policy frameworks, standards, data infrastructure, and regulatory mechanisms, that enable large-scale capacity building. KPIs measure policy adoption, infrastructure accessibility, and systemic integration.

KPI Category	Indicator	Target & Measurement
Policy Framework	National Geospatial Policy adoption rate	**Target**: 100% compliance by all Union Territories and 80% of states by Phase III **Measurement**: Annual policy compliance audits
Standards & Certification	Number of accredited training institutions	**Baseline**: 150 institutions (2025) Target: 3,500 institutions by Phase III **Measurement**: Quarterly accreditation registry updates
	Professional certification uptake	**Target**: 25% of trained workforce certified by Phase III **Measurement**: Certification exam pass rates and renewals
Data Infrastructure	Open data accessibility score	**Baseline**: 40% datasets openly accessible (2025) **Target**: 90% by Phase III **Measurement**: Quarterly data portal analytics

Source: National Geospatial Policy 2022 compliance targets, DST-NGP institutional accreditation framework, stakeholder consultation outcomes (2023-2025). Compiled by BVIEER, 2025. Note: Baseline measurements reflect 2024-25 status; targets are cumulative phase-wise achievements.

5.3 Pillar 2 KPIs: Education and Human Capital Development

Pillar 2 measures the effectiveness of education programmes, training throughput, curriculum integration, and workforce skill development across formal and informal learning pathways.

KPI Category	Indicator	Target & Measurement
Training Output	Number of professionals trained annually	**Baseline**: ~5,000/year (2024-25) **Phase** I target: 10,000/year Phase II target: 10,000/year **Phase III target:** 10,000/year **Phase IV target:** 5,000/year **Cumulative target**: 35,000 by Phase IV **Measurement**: Training MIS dashboards (monthly)
	Training completion rate	**Target**: >85% completion rate across all programmes **Measurement**: Programme-wise dropout tracking
	Geographic diversity index	**Target**: Representation from all 28 states and 8 UTs by Phase II **Measurement**: State-wise enrolment data
Institutional Capacity	Number of operational Centres of Excellence	**Phase I**: 5 centres; Phase II: 10 centres (cumulative) **Phase III**: 15 centres (cumulative) **Measurement**: Centre activation and capacity utilisation reports
	Faculty development programmes completed	**Target**: Train-the-trainer programmes for 500 university faculty members by Phase III **Measurement**: Faculty training registry
Curriculum Integration	Universities with integrated geospatial curricula	**Baseline**: ~150 institutions (2025) **Target**: 3,500 institutions by Phase III; 5,000 by Phase IV **Measurement**: Curriculum audit submissions (AISHE Data)
	School-level programmes (students reached)	**Baseline**: 150 schools; 4,000+ students engaged in spatial thinking projects (~75,000 students enrolled in participating schools) (2025) **Target**: 1,000 schools; 500,000 students exposed to spatial thinking by **Phase III Measurement**: School participation database
Skills & Employability	Post-training employment rate	**Target**: >70% employed/self-employed within 6 months **Measurement**: 6-month and 12-month tracer studies
	Skills gap closure index	**Target**: Reduce skills gap from 85% to 50% by Phase IV **Measurement**: Annual industry needs assessment vs. training output

Source: AISHE baseline data (2021-22), DST-NGP training records (2013-2025), institutional capacity modelling, phase-wise scaling projections validated through stakeholder consultations. Compiled by BVIEER, 2025. Note: Training targets reflect 4-phase roadmap totalling 35,000 professionals (10,000+10,000+10,000+5,000).

5.4 Pillar 3 KPIs: Innovation Ecosystem and Strategic Partnerships

Pillar 3 tracks the development of innovation ecosystems, technology transfer, industry partnerships, and entrepreneurship outcomes that translate capacity building into economic and social impact.

KPI Category	Indicator	Target & Measurement
FRO Integration	Formal partnerships with Focused Research Organisations	**Phase I:** 2 partnerships; **Phase III:** 8 partnerships (cumulative) **Measurement**: Partnership agreements and joint activity records
	Centres operating with extended innovation mandate	**Target**: 4 centres co-located within or adjacent to FRO networks by Phase III **Measurement**: Centre designation records and annual review
	Joint technology-integration programmes with FROs	**Target**: 18 programmes by Phase III **Measurement**: Programme documentation and outcome tracking
	Knowledge transfer partnerships established	**Target**: 45 partnerships linking researchers to startups and industry by Phase III **Measurement**: Partnership registry and placement records
	Trainees placed in FRO-supported startups	**Target**: 400 placements by Phase IV **Measurement**: Placement tracking and six-month tracer study
Partnerships & Collaboration	Number of active industry partnerships (MoUs)	**Phase I:** 20 MoUs; **Phase III**: 100 MoUs (cumulative) **Measurement**: MoU registry with activity tracking
	Public-Private Partnership (PPP) projects launched	**Target**: 50 PPP projects operational by Phase II **Measurement**: PPP project monitoring dashboard
	International collaborations	**Target**: 15 bilateral/multilateral geospatial partnerships by Phase III **Measurement**: International MoU tracker and exchange programmes
Innovation & Entrepreneurship	Geospatial startups incubated	**Target**: 75 startups incubated by Phase III **Measurement**: Startup registry and survival rates (3-year tracking) including startups supported through FRO partnerships
	Patents and intellectual property created	**Target**: 50 patents filed by Phase III **Measurement**: Patent filing and commercialisation tracking
	Innovation challenges and hackathons conducted	**Target**: 20 national-level challenges by Phase III **Measurement**: Event participation and solution deployment rates
Technology Transfer	Technology adoption by government agencies	**Target**: 100 central/state agencies using geospatial tech by Phase III **Measurement**: Agency technology adoption surveys
	Community-based geospatial applications developed	**Target**: 50 citizen science/participatory mapping projects by Phase III **Measurement**: Project documentation and impact assessments

Source: Industry partnership benchmarks from DST-NGP collaborations, startup sector data from AGI, Research Development and Innovation Fund and Focused Research Organisation programme documentation, international collaboration models from UN-GGIM. Compiled by BVIEER, 2025. Note: Partnership targets based on progressive scaling from pilot phase (Phase I) to mature stage (Phase IV). FRO integration targets are indicative and subject to confirmation of institutional arrangements, and assume scaling in line with RDIF deployment through 2030.

5.5 Phase-wise Implementation Milestones and Targets

The following table consolidates key targets across all three pillars for each implementation phase, enabling systematic tracking of progress and early identification of delays.

Phase	Pillar 1 Milestones	Pillar 2 Milestones	Pillar 3 Milestones
Phase I 2026-27	• National standards finalised for certification of capacity building • Open data portal facilitated and publicised • Baseline capacity audit completed	• 5 Centres of Excellence operational • 10,000 professionals trained • Curriculum framework approved	• 20 industry MoUs signed • Technology partnerships established • PPP framework drafted • 2 FRO partnerships formalised • FRO engagement framework agreed
Phase II 2027-28	• Certification programme launched • 1,500 institutions accredited	• 10 Centres of Excellence operational • 20,000 cumulative trained • 500 schools participating	• 50 PPP projects operational • 50 startups incubated • 10 innovation challenges held • 5 FRO partnerships active • 2 centres operating with extended innovation mandate • Knowledge transfer partnerships initiated
Phase III 2028-29	• 3,500 institutions accredited • 90% data openly accessible • Policy compliance: 80% of States	• 15 Centres of Excellence operational • 30,000 cumulative trained • 1,000 schools, 500,000 students	• 100 industry MoUs active • 75 startups incubated • 50 patents filed • 8 FRO partnerships active • 4 centres with extended innovation mandate • 45 knowledge transfer partnerships established
Phase IV 2029-30	• Policy review and refinement • International harmonisation • Permanent policy mechanisms established • Continuous improvement cycle	• 5,000 trained (35,000 cumulative) • Advanced specialisations consolidated • Regional innovation clusters consolidated • Autonomous operations • Skills gap reduced to below 50% • 5,000 institutions integrated	• Revenue generation scaled up • Export services initiated • Sustainability mechanisms in place • 400 trainees placed in FRO-supported startups • FRO integration model institutionalised • Global excellence hub status • Self-sustaining ecosystem

Source: Strategic roadmap modelling based on DST-NGP implementation experience, UN-IGIF capacity building pathways, stakeholder-validated scaling trajectories. Compiled by BVIEER, 2025. Note: Milestones represent minimum targets; actual achievements may exceed these based on funding and institutional readiness.

5.6 Data Collection and Management Systems

Effective M&E requires robust data collection mechanisms. The strategy will implement the following systems:

5.6.1 Training Management Information System (MIS)

A centralised digital platform will capture:

- Learner enrolment, progress, and completion data
- Course feedback and satisfaction scores
- Faculty performance metrics
- Real-time dashboards for institutional administrators and policymakers

5.6.2 Institutional Accreditation Registry

A public-facing registry will maintain:

- Accreditation status of all training institutions
- Compliance with national standards
- Quality audit results
- Institutional capacity utilisation rates

5.6.3 Partnership and Innovation Tracking System

A dedicated platform will monitor:

- Active MoUs and partnership agreements
- Startup incubation and survival rates
- Technology transfer and commercialisation outcomes
- PPP project deliverables and financial performance

5.6.4 Tracer Study Mechanism

Longitudinal tracking of training outcomes through:

- 6-month and 12-month post-training surveys
- Employment status and salary progression
- Skills application in workplace settings
- Alumni network engagement

5.7 Evaluation Framework and Reporting Cycles

The M&E framework operates on three evaluation cycles:

5.7.1 Monthly Monitoring

Purpose: Track immediate outputs and identify operational issues

Focus: Training enrolment, completion rates, partnership activities

Reporting: Automated MIS dashboards accessible to programme managers

5.7.2 Quarterly Reviews

Purpose: Assess phase-wise progress against milestones

Focus: All KPIs across three pillars, budget utilisation, risk identification

Reporting: Comprehensive reports to steering committee with corrective action plans

5.7.3 Annual Evaluation

Purpose: Independent assessment of outcomes and impact

Focus: Long-term indicators (employment, skills gap closure, economic contribution)

Reporting: Public annual reports with policy recommendations

Methodology: Third-party evaluation, tracer studies, industry needs assessments

5.8 Long-term Impact Metrics

Beyond immediate outputs, the strategy will measure long-term impacts on India's geospatial sector and economy:

Impact Dimension	Indicator	Target by Phase IV
Economic Contribution	Geospatial sector GDP contribution	Increase from ₹49,900 crore (2023) to ₹80,000+ crore by 2030
	Employment generation	100,000 direct jobs + 200,000 indirect jobs
Workforce Capacity	Skills gap index	Reduce from 85% (2025) to <50% (2030)
	Certified professionals	25,000+ nationally certified geospatial professionals
Innovation Output	Geospatial startup base	75+ viable startups with 3-year survival rate >60%
	Patent portfolio	50+ patents filed, 20+ commercialised
Global Competitiveness	UN-GGIM capacity maturity rating	Advance from Level 3 to Level 4/5 (global leadership)
	International training exports	Provide training to 5,000+ international professionals
Social Impact	Government services improved	100+ agencies using geospatial tech for citizen services
	Community geospatial literacy	500,000+ students exposed to spatial thinking

Source: Geospatial sector economic projections (Geospatial World Reports, Task Force 2013), UN-GGIM Global Geospatial Information Management assessments, industry growth models from AGI. Compiled by BVIEER, 2025. Note: Economic targets based on compound annual growth rate (CAGR) projections validated through international geospatial market trends.

5.9 Risk Management and Early Warning System

The M&E framework includes a risk monitoring mechanism with the following early warning indicators:

- **Red Flag Indicators:** Training completion rates <75%, partnership MoU activation <50%, accreditation delays >3 months
- **Amber Alerts:** Phase-wise targets at 70-80% achievement, budget utilisation variance >15%, faculty shortage >20%
- **Mitigation Protocols:** Quarterly steering committee reviews for red flags, mid-course corrections for amber alerts, contingency fund allocation (10% of phase budget)

5.10 Sustainability and Continuous Improvement

Beyond Phase IV, the monitoring framework will transition to a continuous improvement cycle with:

- **Biennial National Geospatial Capacity Assessments** to update baselines and identify emerging skill requirements
- **KPI Refinement Process** with annual review and adjustment based on technology evolution and industry feedback
- **Benchmarking Studies** comparing India's progress against global leaders (USA, UK, Australia, Netherlands)
- **Open Data Publication** of all M&E results on a public portal to ensure transparency and stakeholder engagement

"Clear indicators turn the vision into results that can be checked."

5.11 Conclusion

This monitoring, evaluation, and impact assessment framework provides the essential infrastructure to ensure accountability, measure progress, and demonstrate value throughout the implementation of India's National Geospatial Capacity Building Strategy. By establishing clear KPIs mapped to the three-pillar framework, implementing robust data collection systems, and creating systematic evaluation cycles, this M&E framework transforms the strategic vision into measurable outcomes. The comprehensive approach, from monthly operational monitoring to long-term impact assessment, ensures that the initiative remains on track to achieve its ambitious goal of training 35,000 professionals, integrating geospatial curricula across 5,000 institutions, and positioning India as a global leader in geospatial capacity by 2030. (Strobl, 2019)

Section 6: Governance, Coordination, and Institutional Mechanisms

This section establishes the organisational framework for implementing India's National Geospatial Capacity Building Strategy.

6.1 Three-Tier Governance Structure

TIER 1: NATIONAL GEOSPATIAL CAPACITY BUILDING AUTHORITY		
Chair: Secretary, DST | Co-Chair: Secretary, DoS *Bi-annual meetings | Policy approval, Strategic direction, Resource allocation*		
▼		
TIER 2: NATIONAL STEERING COMMITTEE		
Chair: Head NGP (DST) | Members: ISRO, MoE, AICTE, UGC, Industry *Quarterly meetings | Implementation oversight, KPI monitoring, Budget management*		
▼		
TIER 3: OPERATIONAL BODIES		
Technical Advisory Board 15 members *Standards, Technology, Quality* **Bi-monthly**	**Programme Management Unit** Secretariat *Operations, MIS, Coordination* **NGP with a designated coordinating agency**	**CoEs** 15 nodes *Regional implementation* **Phased rollout**

Source: UN-IGIF governance frameworks, DST institutional models, stakeholder consultations on governance mechanisms (2023-2025). Compiled by BVIEER, 2025. Note: Three-tier structure designed to balance national coordination with operational flexibility.

6.2 RACI Matrix (Roles & Responsibilities)

R = Responsible | **A** = Accountable | **C** = Consulted | **I** = Informed

Activity	NGCBA	Steering	PMU	Tech Board	Institutions
Policy & framework development	A	R	C	C	I
Annual budget approval	A	R	C	I	I
Curriculum standards	A	C	C	R	C
Institution accreditation	I	A	R	C	I
Training delivery	I	I	A	C	R
MIS & data management	I	A	R	I	C
Industry partnerships	I	A	R	C	C
Quarterly monitoring	I	A	R	C	C
Annual evaluation	A	R	C	C	C

6.3 Coordination Mechanisms

Level	Mechanism	Frequency & Participants
Inter-Ministerial	JS-level committee for policy alignment and resource sharing	**Annual** | DST, DoS, MoE, MeitY, PMU
Centre-State	Regional coordination via CoEs for implementation support	**Bi-monthly** | PMU + CoEs
Public-Private	Industry forum for market needs, tech trends, partnerships	**Quarterly** | Steering + Industry
Academic Network	Centres of Excellence network for best practices sharing	**Monthly** | Directors + PMU
International	Bilateral/multilateral forums for knowledge transfer	**Annual** | NGCBA + Partners

This governance architecture ensures clear authority, efficient coordination, and effective implementation through structured decision-making, defined roles, and robust institutional support.

Appendices

Detailed tables, consultation records, committee composition, glossary and references that support this White Paper.

A Detailed Budget Allocation and Cost Framework

B Stakeholder Consultation Summary

C Constitution of the Expert Committee for Capacity Building and Training on Geospatial Science and Technologies

D Glossary of Technical Terms

E References

Appendix A: Detailed Budget Allocation and Cost Framework

The proposed investment of ₹200 crore over four years (2026-2030) represents a strategic allocation across all three pillars of the capacity building framework – Policy Architecture, Education & Human Capital Development, and Innovation Ecosystem & Partnerships. This appendix provides detailed cost breakdowns, phase-wise budget distribution, and financial sustainability projections. All cost estimates are based on DST-NGP programme actuals (2013-2025), institutional infrastructure benchmarks, and stakeholder consultations on resource requirements.

Table A.1: Comprehensive 4-Year Budget Allocation (₹ Crore)

Component	Year 1 2026-27	Year 2 2027-28	Year 3 2028-29	Year 4 2029-30	Total (₹ Crore)	% of Total	Details
1. CENTRES OF EXCELLENCE	**38**	**34**	**32**	**25**	**129**	**64.5%**	**15 Centres across India**
a) Computational Infrastructure	20	18	15	7	60	30%	HPC, GPU, digital twins, servers
GPU Clusters (Geo-AI)	8	7	6	3	24		NVIDIA A100/H100, 8-16 GPUs/centre
Virtual Training Servers	6	5	4	2	17		VMware/cloud, 50-100 VMs/centre
Digital Twin Infrastructure	4	4	3	1	12		Real-time rendering, IoT platforms
Storage & Data Systems	2	2	2	1	7		Petabyte storage, NAS/SAN
b) Physical Infrastructure	13	8	7	7	35	17.5%	Labs, equipment, facilities
Geospatial Labs & Equipment	7	4	4	3	18		Surveying, GIS workstations, UAVs
IT Infrastructure & Software	4	3	2	3	12		Licences, networking, cloud
Furniture & Facilities	2	1	1	1	5		Classrooms, meeting rooms
4-Year Operations	5	8	10	11	34	17%	1 Sci-E + 1 Sci-D per centre
Faculty Salaries	3	6	7	8	24		₹50L/yr × centres operational
Supporting Staff	1	1	2	2	6		Technical & admin staff
Utilities & Maintenance	1	1	1	1	4		Operations, fieldwork

Component	Year 1 2026-27	Year 2 2027-28	Year 3 2028-29	Year 4 2029-30	Total (₹ Crore)	% of Total	Details
2. TRAINING PROGRAMMES	**13**	**13**	**13**	**6**	**45**	**22.5%**	**35,000 professionals trained**
Short-term intensive (3-week)	5	5	5	3	18		10,000 participants @ ₹18,000 avg
Blended/online learning	4	4	4	2	14		15,000 participants @ ₹9,300 avg
Advanced specialisations	4	4	4	1	13		10,000 participants @ ₹13,000 avg
3. DIGITAL INFRASTRUCTURE	**5**	**4**	**2**	**1**	**12**	**6%**	**Platforms, MOOCs, integration**
National learning platform	2	2	1	0	5		DST-IGET enhancement
iGOT Karmayogi integration	2	1	0	0	3		API development, migration
MOOC content development	1	1	1	1	4		Video modules, assessments
4. SCHOLARSHIPS & INCLUSION	**2**	**2**	**2**	**2**	**8**	**4%**	**Access & equity support**
Merit-cum-means scholarships (Hackathons, National Events, etc)	1	1	1	1	4		1,000 scholars @ ₹40,000 over 4 yrs
Tier-2/3 institution support	1	1	1	1	4		Equipment, connectivity grants
5. CURRICULUM & STANDARDS	**2**	**2**	**1**	**1**	**6**	**3%**	**Multilevel frameworks**
Curriculum development	1	1	1	0	3		School to postgraduate
Faculty training programmes	1	1	0	1	3		Pedagogy, tools training
TOTAL	**60**	**55**	**50**	**35**	**200**	**100%**	

Note: Budget of ₹200 crore (₹50 crore/year average) represents less than 1% of DST's annual budget. Centres of Excellence allocation (64.5%) prioritises cutting-edge computational infrastructure essential for training in emerging technologies (Geo-AI, digital twins, LiDAR processing). Faculty costs based on 7th Pay Commission: Scientist E (₹28L/yr), Scientist D (₹22L/yr). Infrastructure investment front-loaded in Years 1-2; operational costs increase as centres become fully staffed.

Table A.2: Centre of Excellence Establishment Phasing

Phase	Year	New Centres	Cumulative Centres	Faculty Recruited	Infrastructure Investment	Operational Budget	Total Year Budget
Phase I	2026-27	5	5	10 (5 Sci-E + 5 Sci-D)	₹33 crore	₹5 crore	₹38 crore
Phase II	2027-28	5	10	10 (5 Sci-E + 5 Sci-D)	₹26 crore	₹8 crore	₹34 crore
Phase III	2028-29	5	15	10 (5 Sci-E + 5 Sci-D)	₹22 crore	₹10 crore	₹32 crore
Phase IV	2029-30	0	15	0 (all recruited)	₹14 crore	₹11 crore	₹25 crore
TOTAL		**15**		**30 (15 Sci-E + 15 Sci-D)**	**₹95 crore**	**₹34 crore**	**₹129 crore**

Note: Centres established in batches of 5 per year (Years 1-3). Infrastructure costs include both computational (GPUs, servers) and physical (labs, equipment). Operational costs cover salaries, utilities, and maintenance. By Year 4, all 15 centres are fully operational with complete staffing (30 scientific positions + 30 support staff).

Table A.3: Training Target Distribution (35,000 Professionals)

Training Type	Year 1 2026-27	Year 2 2027-28	Year 3 2028-29	Year 4 2029-30	Total Trainees	Avg Cost per Trainee
Short-term intensive (3-week)	2,500	2,500	2,500	2,500	10,000	₹18,000
Blended/online learning	4,500	4,500	4,500	1,500	15,000	₹9,300
Advanced specialisations	3,000	3,000	3,000	1,000	10,000	₹13,000
TOTAL TRAINED	**10,000**	**10,000**	**10,000**	**5,000**	**35,000**	**₹12,857**
Centres Operational	**5**	**10**	**15**	**15**		

Note: Overall average cost of ₹12,857 per trainee (₹45 crore ÷ 35,000) reflects lean but quality-focused training. Training delivery scales with centre availability: delivery is held at 10,000 per year through Phases I to III as centres come on stream, reducing to 5,000 in Phase IV as the programme transitions to its sustainability phase.

Table A.4: High-Performance Computing Infrastructure (₹60 Crore)

Infrastructure Component	Per Centre (₹ Crore)	For 15 Centres (₹ Crore)	% of HPC Budget	Capability Enabled
GPU Clusters (Geo-AI)	1.6	24	40%	Deep learning, image classification, ML training
Virtual Training Servers	1.1	17	28%	50-100 concurrent VMs, remote lab access
Digital Twin Infrastructure	0.8	12	20%	Real-time city models, IoT integration
Storage & Data Systems	0.5	7	12%	Petabyte storage, satellite data archives
TOTAL HPC	**4.0**	**60**	**100%**	

Note: HPC infrastructure (₹60 crore = 30% of total budget) positions India at the cutting edge of geospatial technology. GPU clusters enable Geo-AI and machine learning applications. Virtual servers provide 24/7 remote access for students across India. Digital twin systems allow realistic simulations. This computational backbone is essential for training in emerging technologies and differentiates these centres from traditional GIS labs.

Table A.5: Staffing Model (Based on 7th Pay Commission)

Position	Per Centre	All 15 Centres	Annual Salary (₹ Lakh)	Annual Cost/Centre (₹ Lakh)	Role
Scientist E (Level 13)	1	15	28	28	Centre Director/Head
Scientist D (Level 12)	1	15	22	22	Faculty/Trainer
Technical Officer	1	15	7	7	Lab support, IT
Administrative Assistant	1	15	5.5	5.5	Office management
TOTAL per Centre	**4**	**60**		**62.5**	
Annual salary cost at full strength (15 centres)				938	₹9.4 crore/year
4-Year salary cost (centres phased 5/10/15/15)					₹28.1 crore
Utilities & maintenance (4 years)					₹4 crore
TOTAL 4-YEAR OPERATIONS					**₹32.1 crore**

Note: Salaries based on 7th Pay Commission for central government scientific positions. Each centre employs four staff (1 Scientist E, 1 Scientist D, 1 technical officer, 1 administrative assistant), giving a total workforce of 60 positions across 15 centres. Salary cost per centre is ₹62.5 lakh per year. Because centres are established progressively (5, 10, 15, 15), the four-year salary cost is calculated on 45 centre-years rather than 60. The total of ₹32.1 crore sits within the ₹34 crore provided under 4-Year Operations in Table A.1, the difference providing headroom for annual increments and dearness allowance revisions. These four positions are additional to the existing faculty and infrastructure of the host institution. Centres are established within institutions that already hold relevant departmental capacity, and the DST-funded posts provide dedicated geospatial leadership and technical support rather than the full teaching complement. Training delivery draws on host faculty, visiting experts and industry trainers alongside the resident staff.

Table A.6: Financial Sustainability Trajectory

Year	Public Investment (₹ Crore)	Revenue Generated (₹ Crore)	Net Cost (₹ Crore)	Self-Sufficiency Ratio	Cumulative Net Cost
Year 1 (2026-27)	60	0	60	0%	60
Year 2 (2027-28)	55	3	52	5%	112
Year 3 (2028-29)	50	8	42	16%	154
Year 4 (2029-30)	35	12	23	34%	177
4-YEAR TOTAL	**200**	**23**	**177**	**12% avg**	
Post-2030 (annual)	**25**	**30**	**+5 surplus**	**120%**	**Self-sustaining**

Note: Revenue sources: consultancy services (60%), professional training fees (25%), research contracts (15%). Centres begin generating modest revenue from Year 2 onwards. By 2031 (Year 5), centres achieve self-sustainability with revenue exceeding operational costs. Conservative revenue projections reflect realistic ramp-up period.

Table A.7: Cost Efficiency Analysis

Metric	DST-NGP Actual (2013-2025)	Proposed Framework (2026-2030)	Change/Comment
Cost per 3-week intensive	₹11 lakh/programme (35 participants)	₹6.3 lakh/programme (35 participants)	43% reduction via scale
Cost per participant (intensive)	₹31,000	₹18,000	42% reduction
Overall cost per trainee	Not applicable	₹12,857 (all modalities)	Lean & efficient
Annual budget requirement	₹8-10 crore/year	₹50 crore/year	5x scale increase
Trainees per year	~1,200-1,500	8,000-10,000	7x capacity increase
Cost per Centre of Excellence	Not applicable	₹8.6 crore (4 years)	New infrastructure

Note: Despite a 5x budget increase (₹50 crore/year vs ₹8-10 crore/year), the framework delivers 7x capacity increase through economies of scale, digital platforms, and distributed centre model. Per-trainee costs are 42% lower than DST-NGP actuals. Investment in HPC infrastructure (₹60 crore) is a transformational addition not present in previous programmes.

Appendix B: Stakeholder Consultation Summary

Minutes of the Ideation Workshop/Brainstorming for charting the future course of Geospatial Capacity Building through the National Geospatial Programme (NGP) of the Department of Science and Technology, Government of India held virtually on Tuesday 10 January 2023, 10.00-13.00 hrs

An online Ideation Workshop/ Brainstorming was held with invited stakeholders from academia, industry, government, research as well as civil society organisations on Tuesday 10 January 2023 from 10.00 to 13.00 hrs. This workshop aimed at addressing the following:

1. Who are the stakeholder groups that are now generated by the National Geospatial Policy?
2. What are the capacity building needs of these stakeholders?
3. How can it be addressed through the DST-NGP's Geospatial Capacity Building Programme through short term, medium term and long term action plans?

Dr Shubha Pandey, Scientist and Member Secretary, while welcoming the participants, provided an overview of manpower requirements as outlined in the MHRD Task Force report 2013, which cites that there is a lack of geospatial experts at the higher level. She mentioned that only 22% of Indian Universities offer doctoral programmes in Geospatial Science and Technology compared to 80% in International Universities. Only 70 universities in the country offer Master's courses and 05 Universities offer Undergraduate programmes. The NGP-DST thus initiated the capacity building programme at Level 1 (basic) and Level 2 (advanced) a decade back. Two years ago, a Geo-Innovation Programme to harness the ideas from youth was initiated. She further mentioned that in light of the National Geospatial Policy 2022, there is a need for standardisation of curriculum at college level along with skill development and industrial training as well as initiating programmes at the school level. She hoped that the Brainstorming may bring certain action points for implementation by the division.

Mr Sunil Kumar, JS (Admin) and Head NGP, while welcoming the participants, mentioned that the NGP 2022 has just been notified which is a good start but also a great responsibility. The liberating nature of the NGP 2022 in terms of data will help move the industry that was restricted by various restrictions in the earlier modifications in policy. He mentioned that the present NGP 2022 is highly liberal and very comprehensive in addressing all aspects of Geospatial sector. He felt that the policy deregulated the sector, and provided the Geospatial community with an opportunity to actually set up building blocks to be able to realise the vision of the Geospatial community. He opined that while there are many aspects which needed funds, strategies, etc. there are also several challenges in bridging infrastructural gaps, as well as those related to skill and Enterprise development. He felt that each statement in the policy requires a deeper discussion and designing of actionable points to address and achieve the goals of the policy. He requested all participants to come out with actionable points addressing challenges and gaps which are bottlenecks in the growth of the Geospatial industry. Further, Surveyor certification and registration has not been addressed sufficiently. The mechanism to notify and register the traditional Surveyors/ Drone Surveyors for making the DPRs should be done through certification programmes with special capacity building programmes to be designed for this.

Dr D. Dutta, Adviser and Head SEED Division of DST, mentioned that this brainstorming was the first baby step towards enacting the policy. He mentioned that in the last four to five years, the Government focused on Geospatial Science and Technology by making the technology a catalyst for the GatiShakti Programme as well as several other flagship programmes. The government's Atmanirbhar Bharat Programme, the National Education Policy 2020 and now the National Geospatial Policy (NGP) 2022 have contributed a conducive environment for the growth of this sector. While elaborating on the NGP 2022 he mentioned that the policy focuses on catalysing the ecosystem by focusing on various components besides igniting a

geospatial spark in young minds and promoting spatial thinking as a competency and attempting to integrate the Geospatial Skill Council with the National Skills Qualifications Framework (NSQF). Strong industry linkages for providing training inputs and placements to complete the lifecycle will be needed. The level 1 capacity building programme of the NGP-DST addresses the formal education element as mentioned in the IGIF, while the level 2 capacity building programme addresses the professional training element. NCERT had a big role to play in initiating this technology at the school level, and he looked forward to generating actionable points through this brainstorming meet. According to him, one of the next immediate steps would be to initiate dialogue with all the training institutions including UGC and AICTE and expand the scope of the existing geospatial capacity building of the DST.

Prof. Shamita Kumar, Principal, Bharati Vidyapeeth Institute of Environment Education and Research (BVIEER), Pune, and National Coordinator, Programme Management Unit (PMU), National Geospatial Programme, Department of Science and Technology (NGP-DST) , thanked all the participants for sending their suggestions in response to a background note and questionnaire circulated earlier (summarised at the end of this Appendix). She mentioned that this policy forms the backbone of systemic capacity building with the NGP-DST programme contributing to the capacity building at the individual level. Both of these jointly contribute to institutional capacity building. The experience of the NGP-DST programme shows the immense lack of awareness of the use of this technology beyond the current stakeholders which at the present moment form a small fraction of users. The global IGIF programme has capacity building as one of its strategic pathways. The four elements within this strategic pathway are Awareness, Formal Education, Professional Training and Entrepreneurship. These four elements are required to develop and strengthen the knowledge, competencies, skills, instincts, abilities, processes, and resources that governments, organisations, communities and individuals require to utilise geospatial information for decision-making and service delivery. The experience with the NGP-DST geospatial capacity building programme has shown that operationalising the awareness pillar is key to unlocking the potential of the other pillars.

She further added that the side event with school students held at the Second UNWGIC has demonstrated the immense possibilities of inculcating spatial thinking into school curricula through projects. This will have immense spillover effects in the coming years if initiated now through generating interest among youth that will form the backbone of the future geospatial ecosystem. There is an immense need to build awareness about this technology among the civil society organisations, a very large proportion of whom have no knowledge of its use in their regular workflow. Industry has its own capacity building programmes but academia needs to feed into this through updated curriculum and relevant skills and competences that can be brought about through deeper engagement with industry. With NEP as an enabling educational policy, there is a huge opportunity to introduce multidisciplinary and interdisciplinary teaching-learning with respect to geospatial technologies. There is an urgent need to engage with the UGC and AICTE in light of the new national education policy; mentoring support through a mentor matching process as initiated in South Africa can be set up; initiate a national event for students for garnering interest in the field; initiate master training through the SCERTs in collaboration with the NCERT.

Major General (Dr) R Siva Kumar (Retd) emphasised the need to align the geospatial capacity building programme to the goals mentioned in the National Geospatial Policy (NGP) 2022, for 2025 and 2035. He mentioned that NGP 2022 aims for *Atmanirbharta* and focuses on empowering citizens. He suggested that promoting geospatial technologies among communities, especially through the DST-SEED programme, may pay rich dividends. He suggested: a capacity building programme for initiating entrepreneurship for start-ups; a dedicated social media team for promoting geospatial technology should be set up by the DST; integrating geospatial into computer science departments at universities and ensuring that geospatial should not be a separate subject but integrated into the curriculum at the school level wherever relevant along with initiating programmes targeting school students and village youth in local languages.

Shri S.K. Sinha (SOI), while referring to the milestones and targets in NGP 2022 gave the following

suggestions: identify capacity building requirements in the 14 sectoral themes and agencies mentioned in NGP 2022; programmes addressing capacity building in preparation of DPR; geo-enabling other IT sectors is essential and collaboration between all training institutions is to come up with a joint National Skills Qualifications Framework (NSQF); developing an NSQF for the geospatial sector similar to the IT sector that enabled India to be a leader in the IT sector.

Shri Vishnu Chandra emphasised the need for establishment of the National geospatial technology and services capacity building grid to permit all stakeholders to publish their curriculum courses, case studies and connect this to the government's Karmayogi system to enhance capacity building on science technology services and enterprise; ensure adequate funding for the geospatial capacity building activities; design generic awareness as well as domain and technology specific programmes; set up skill certification programmes and capacity building programmes for village heads including capacity to use Gram Manchitra. NIC must be a part of the NGP 2022 and other capacity building committees.

Dr G.P. Obi Reddy suggested the establishment of a regional task force on geospatial capacity building; establishing Centres for Excellence in emerging domain areas as well as thematic areas; exploring the possibility of integrating geospatial with other trending technologies like AI within curriculum and higher-level training programmes; capacity augmentation for developing quality data; strategy for reaching out to school students and youth.

Dr Aparna Pandey (NCERT) stated that NCERT through the geography subject at Higher Secondary stage has included knowledge of geospatial technologies. She suggested: integration of the concepts of geospatial technology with other subjects rather than only geography as a spatial thinking approach is more appropriate at the school level; upscaling through online mode of training and following the protocol of training programmes such as NISHTHA; development of material in regional languages; popularisation of geospatial as a tool that can be used by teachers of various subjects.

Dr H. Hemanth Kumar suggested that geospatial should be included in all other domains and hence geospatial should be a course in every undergraduate/postgraduate programme in the country as an elective course; conduct one day awareness or three to five days' workflow capacity building programmes for building a geospatial action plan within organisations.

Shri Rajesh Mathur provided an overview of the geospatial pyramid where at the bottom of the pyramid are programmers who are often fresh graduates, while the middle of the pyramid is populated by the system handlers who conceptualise and design enterprise system as well as build it and at the top of the pyramid are programme managers who create a vision for deployment of geospatial technology in various organisations. While the skill-set of people at the bottom of the pyramid is taken care of through the boot camps in the industry, the challenge is getting the right people at the mid-level and the top level. At the top are decision makers including senior bureaucrats etc who approve budgets and hence need to have an understanding of the geospatial domain for the organisation for achievement of organisational goals while at the middle of the pyramid are people who deploy this technology. Every Ministry has its own training institutions for its officers and DST needs to engage with them to conduct programmes useful for their workflow. Possibility of organising one day workshop in collaboration with the Lal Bahadur Shastri National Academy of Administration (LBSNAA), Mussoorie, and other training institutions for bureaucrats should be explored. Curriculum review and upgradation should go hand in hand with updating teachers' capacity. All courses of Geospatial must have an IT component; similarly, IT courses must have a Geospatial component. A Geospatial knowledge network with material, MOOCs, etc. may be created.

Dr Shirish Ravan mentioned that as the National Geospatial Policy liberates data and more data is available from drones and EO satellites, capacity building in developing new applications as well as methods of analysing using AI/ ML etc. should be explored. Capacity building should also focus on open-source geospatial software. Promotion of the technology among end users at large, as a

continuous programme, is needed for successful implementation of NGP 2022, along with upgradation of the teaching learning process, not only to build capacity but also to compete with foreign universities that will be established in India shortly.

Prof. Bharat Lohani expressed the need for core professionals in the geospatial sector within the pyramid as people who understand the complete pyramid are needed urgently in the country. He suggested initiation of four year undergraduate courses in geospatial science and technology that can foster the development of indigenous technology; setting up a National Geospatial University that is a hub for all aspects of this technology; establish Centres of Excellence in Hyperspectral, LiDAR, etc. within existing suitable institutions; initiate a geospatial data site where all possible data are uploaded in a time series opening it to both national and international students for fostering collaborations; mentoring and networking opportunities for startups should be provided.

Dr Seema Jalan suggested that as the reach of schools, technical institutions, colleges and universities is the largest, cascading effects will be seen by focusing on capacity building in this sector; awareness at top level is needed to develop a vision for implementation of the NGP 2022 and utilising the DST's geospatial capacity building initiatives; representatives of UGC, MHRD, AICTE must be a part of geospatial capacity building committees as well as of the NGP 2022; training can be made part of regulatory requirements for future promotions etc., through collaboration with the UGC; allotting credits for teachers for attending these training programmes in collaboration with UGC, AICTE, etc and introduce geospatial technology as elective at the undergraduate and postgraduate level as well as vocational courses; development of selected institutions as nodal institutions for training; setting up a national pool of experts who can teach virtually; training in local languages; L1 and L2 programmes have been meaningful due to the IGET portal and MOOCs and YouTube videos can be added.

Mr Siljo V.K. while describing the data collection workflow followed by MOSPI mentioned the following challenges being faced by them: dissemination of geotagged information; capacity building of all officers at MOSPI; though new personnel are being trained, there is a need for training top officers in drawing inferences from geospatial data; challenges are also faced in dissemination of sensitive unit level data and there is thus a need for training on working with aggregated and disaggregated geospatial data. He further mentioned that capacity building at MOSPI is executed through the Statistical Institute for Asia and the Pacific (SIAP), which has developed self-paced modules as well as facilitated live training programmes.

Shri Prashant Mittal mentioned that the PM Karmayogi programm e is being used by DoPT and others for training for officers. The DST Geospatial Programme could interface with this to integrate geospatial capacity building. He further mentioned that data privacy is a concern and thus mechanisms for addressing this in analysis must be built into the capacity building programmes. Further, there is a need to have clarity on the body to be approached for conflict resolution in implementation of the NGP 2022. BISAG's expertise in the capacity building programmes should be explored.

Shri Pranit Mehta suggested that the short-term capacity building programmes for startups through interactions with like-minded mentors or networks could be initiated; mentoring of the incubation is needed by industry mentors; in the long term a structured process for interaction with academic and other enterprises through DST facilitation is required.

Shri Sunil Kumar, Head-NGP thanked everyone for their active participation and interest in the Geospatial Capacity Building programme. He requested the participants to share their inputs via email on short term, medium term and long term actionable points on which NGP-DST should take action in the light of the Policy 2022 to enable DST to embark on new programmes.

The Brainstorming ended with thanking all the participants for their active participation.

Based upon the discussions held and inputs received, details of the recommended key actionable points for short-term, mid-term and long-term are as follows:

Short Term (06 months to 01 Year)	**Mid Term** (01 Year to 03 Years)	**Long Term** (03 Years to 05 Years)
• Awareness creation – Short videos on relevant portals and social media for use cases of Geospatial Technologies including spatial thinking at school level – Stakeholder meetings (Knowledge Institutions etc) – Promotion through DST-SEED Division – Geospatial Hackathons • Development of National Capacity Building Framework • Development of a programme for promotion of Geospatial Thinking at early stage – Introduction of Geospatial Science, Technology and Solutions at School level via relevant exercises, and master trainings – NCERT in collaboration with State S&T Councils may develop pilot projects to initiate spatial thinking in school students – Training workshop for SCERTs in collaboration with NCERT • Developing a Geospatial Knowledge Network/portal for connecting all the relevant stakeholders (Government, Academia, Start-ups) in terms of course curriculum, Case studies etc. It may be integrated with other relevant portals e.g. Mission Karmayogi, UGC, AICTE and other associated education systems at Central and State level • Align with UGC refresher Course and AICTE for credits of DST training (initiated earlier by NGP-DST but needs to be followed up) • Training of Trainers (ToT) • Focused meetings with Universities, National Training Institutions for integrating Geospatial Trainings • Conducting a National Event for promotion of Geospatial sector involving College/University/School etc • Collaboration with Industry for faculty and personnel from Government Refresher Courses for training on the latest geospatial technologies and their adoption. These courses should also facilitate academia-industry collaboration.	• Designing of Teacher Training programmes for in-service teachers of schools and Colleges at a large scale (NCERT-NISHTHA model may be adopted) • CoE at selected specific Universities/organisations for specific thematic areas as well as in cross cutting domains (Climate Change Informatics, Infrastructure with Digital twins etc.) • Geospatial Thinking as a core course (via AICTE, UGC, Min. of Education) • Development of Education material in regional languages • Offer degree in Geospatial Technologies as a dual degree under UGC's Dual Degree Programme • Design of generic and domain specific training programmes as well as technology focused programmes • Virtual training platforms through DST-IGET portal • Design and set-up Training for Trainers (Educators, NGOs, Government) • Conducting Regular Geospatial Hackathons • Introduction of Geospatial modules in State Administrative Training Institutes and LBSNAA, Mussoorie • Continuation of setting up the Geospatial Skill Development Council • Preparation of joint NSQF through collaboration of all training Institutes • Develop mechanism for Start-up–Academia collaboration including internships and mentoring (matchmaking portals) • Developing unified portal with job opportunities in Geospatial Sector to attract young minds	• Initiation of four year undergraduate programme in Geospatial Science and Technology • Continuation of setting up of Geospatial Skill Development Council

Short Term (06 months to 01 Year)	**Mid Term** (01 Year to 03 Years)	**Long Term** (03 Years to 05 Years)
• Development of Modules for advanced learning in Geospatial (Integration with AI and other frontier technologies) along with introducing demand driven modules • Mechanism for Certification of Surveyors to develop quality DPR/reports • Setting up of Geospatial Test Data Sites • Setting-up Geospatial Incubation Cells in Universities with Mentoring Support (for Entrepreneurship) • Awareness creation – Supply–Demand Assessment / Stakeholder Mapping • Geospatial Skill Gap Analysis for setting up Geospatial Skill Council		

Results from the questionnaire circulated among the stakeholders. Responses were received from 33 key stakeholders drawn from Government, Corporates, Academia, Research Institutions and Civil society.

1. Which new domains (thematic as well as technological) need to be addressed in future geospatial capacity building programmes?

- Cloud based GIS, IoT and Sensors, LIDAR, AI/ML in RS-GIS, DL/ML, Big Data, Blockchain; Hyperspectral; Photogrammetry, Drone image analysis/ applications
- Priority sectors as in the NGP 2022
- SDGs and ESG; Sustainable Cities
- Citizen centric service delivery
- Entrepreneurship and skill development
- Benchmark data creation
- Standardisation of the curriculum
- Spatial thinking for school students and youth

2. What modes of awareness can be used to enhance the utility of geospatial technologies among all sections of society?

- Lectures via YouTube/TV
- Visual and social media
- Community activities
- Outreach and awareness programmes
- Institutional Visits for the public
- Development of citizen friendly geospatial products
- Hackathons
- National Geospatial Event for youth
- Certifications via digital platforms
- Workshop & seminars for advocacy amongst policy makers
- Focus meetings
- Multi-disciplinary syllabus at university level and schools

3. What should be the duration of the capacity building programmes?

Answers here ranged from 1 day to 3-5 days, 21 days to weekend programmes and blended programmes.

List of Participants

1.	Shri Sunil Kumar	JS (Admin.) & Head-National Geospatial Programme, GOI
2.	Dr D. Dutta	Adviser DST and Head SEED, Department of Science and Technology (DST)
3.	Shri S.K. Sinha	Dy. Surveyor General Policy & Planning, Survey of India
4.	Dr Shubha Pandey	Scientist E, NGP-DST
5.	Mr S. K. Pani	Deputy Secretary, SMP-DST
6.	Maj. Gen. (Retd) Dr R. Siva Kumar	Former Head, NRDMS, DST
7.	Dr A.K. Rai	Assistant Professor, Grade-I, Centre for Ocean, River, Atmosphere and Land Sciences (CORAL), IIT Kharagpur
8.	Dr Areendran Gopala	Director, Remote Sensing and GIS, WWF India, New Delhi
9.	Dr G.P. Obi Reddy	Principal Scientist, Division of Remote Sensing Applications, NBSS&LUP, Nagpur
10.	Dr Jaya Sreevalsan Nair	Associate Professor, International Institute of Information Technology, Bangalore
11.	Dr Hemanth Kumar H.	Executive Secretary in Karnataka State Council for Science & Technology (KSCST), Bangalore
12.	Prof. Shamita Kumar	Professor and Principal, Bharati Vidyapeeth Institute of Environment Education and Research (BVIEER), Bharati Vidyapeeth (Deemed to be) University, Pune; National Coordinator, Programme Management Unit (PMU), National Geospatial Programme, Department of Science and Technology (NGP-DST)
13.	Prof. K.C. Tiwari	Professor and Head, Multidisciplinary Centre for Geoinformatics, Delhi Technological University, New Delhi
14.	Shri Vishnu Chandra C	Former DDG & HoG, GIS Division, NIC
15.	Ms Megha Dutta	Director - Market Development at Association of Geospatial Industries (AGI)
16.	Dr Aparna Pandey	Professor, Geography, NCERT, New Delhi
17.	Shri Rajesh Mathur	Advisor, Esri India Technologies Ltd.
18.	Dr A.M. Ramiya	Associate Professor, Department of Earth and Space Sciences, IIST, Trivandrum
19.	Ms Sanjana Binwal	Partnership Manager: APAC, Humanitarian OpenStreetMap Team, Bengaluru

20.	Dr Seema Jalan	Head of Department, Geography, Mohanlal Sukhadia University Udaipur
21.	Dr VSS Kiran	Founder & CEO - GARUDALYTICS
22.	Shri Venu Panjarla	Open Data Consultant to Government of Telangana
23.	Shri Pranit Mehta	VP - Business Development - GalaxEye
24.	Shri Sushil Srivastav	Scientist/Engineer-H & Chief General Manager (Regional Centres), National Remote Sensing Centre
25.	Mr Siljo VK	Deputy Director General, Social Statistics Division, National Statistical Office, Ministry of Statistics and Programme Implementation, New Delhi
26.	Dr Prabhati Mahapatra	Block Education Officer and Acting Principal, Govt H.S. Medical Campus, Berhampur, Odisha
27.	Dr Bharat Lohani	Associate Professor Department of Civil Engineering IIT Kanpur
28.	Prof. Surya Prakash	Professor and Head of the Geo-Meteorological Risks Management Division and the CBRN, Industrial and Cyber DRR Division at NIDM
29.	Shri Prashant Mittal	SC-G NIC/MeitY, MD NICSI
30.	Dr Shirish Ravan	Former Head, UN-SPIDER Beijing Office, United Nations Office for Outer Space Affairs (UNOOSA)
31.	Ms Amruta Kar	Marketing Executive at Vassar Labs
32.	Shri Satej Panditrao	Technical Manager · Association of Geospatial Industries (AGI)
33.	Ms Samruddhi Patwardhan	Research Associate, Programme Management Unit (PMU), National Geospatial Programme, Department of Science and Technology (NGP-DST), BVIEER, Pune
34.	Dr Madhurima Dey	Research Associate, Programme Management Unit (PMU), National Geospatial Programme, Department of Science and Technology (NGP-DST), BVIEER, Pune

Appendix C: Constitution of the Expert Committee for Capacity Building and Training on Geospatial Science and Technologies

The Expert Committee for Capacity Building and Training on Geospatial Science and Technologies was reconstituted by Office Order dated 30 January 2025 (File No. NRDMS/11/1848/011), National Geospatial Programme Division, Department of Science and Technology. Its composition is given below.

1.	**Dr Y.V.N. Krishna Murthy**	Distinguished Scientist, ISRO; formerly Scientific Secretary, ISRO, and Director, National Remote Sensing Centre	**Chairman**
2.	**Prof. K.C. Tiwari**	Professor, Department of Civil Engineering, Delhi Technological University, Delhi	Member
3.	**Prof. Bharat Lohani**	Professor, Department of Civil Engineering, Indian Institute of Technology Kanpur	Member
4.	**Prof. Shamita Kumar**	Professor and Principal, Bharati Vidyapeeth Institute of Environment Education and Research (BVIEER), Bharati Vidyapeeth (Deemed to be) University, Pune; National Coordinator, Programme Management Unit (PMU), National Geospatial Programme, Department of Science and Technology (NGP-DST)	Member
5.	**Dr Pennan Chinnasamy**	Associate Professor, and Professor-in-charge / Director, Rural Data Research and Analysis (RuDRA) Lab, Indian Institute of Technology Bombay	Member
6.	**Shri Rahul Nayar**	Senior Fellow, Foundation for Advancing Science and Technology, New Delhi	Member
7.	**Dr V.S.S. Kiran**	Founder and Chief Executive Officer, Garudalytics	Member
8.	**Dr Diksha Rajput**	Joint Secretary, University Grants Commission, New Delhi	Member
9.	**Representative**	All India Council for Technical Education	Member
10.	**Prof. Aparna Pandey**	Representative, National Council of Educational Research and Training, New Delhi	Member
11.	**Shri Varun Kumar**	Representative, National Institute for Geo-Informatics Science and Technology (NIGST), Survey of India	Member
12.	**Representative**	Association of Geospatial Industries (AGI), India	Member
13.	**Dr Shubha Pandey**	Scientist E, National Geospatial Programme Division, Department of Science and Technology, New Delhi	**Member Secretary**
14.	**Shri Ankur Mehta**	Scientist B, National Geospatial Programme Division, Department of Science and Technology, New Delhi	**Convener**

Appendix D: Glossary of Technical Terms

AICTE – All India Council for Technical Education

AISHE – All India Survey on Higher Education

AI/ML – Artificial Intelligence / Machine Learning

AMRUT – Atal Mission for Rejuvenation and Urban Transformation

ATAL – AICTE Training and Learning (Academy)

BISAG-N – Bhaskaracharya National Institute for Space Applications and Geo-informatics

BVIEER – Bharati Vidyapeeth Institute of Environment Education and Research

CAG – Comptroller and Auditor General of India

CBSE – Central Board of Secondary Education

CoE – Centre of Excellence

CORS – Continuously Operating Reference Stations

CSSTEAP – Centre for Space Science and Technology Education in Asia and the Pacific

DIETs – District Institutes of Education and Training

DoS – Department of Space

DST – Department of Science and Technology

DTH – Direct to Home (satellite television)

ESA – European Space Agency

FDP – Faculty Development Programme

FOSSEE – Free and Open Source Software for Education

FRO – Focused Research Organisation

GDPDC – Geospatial Data Promotion and Development Committee

GEOSS – Global Earth Observation System of Systems

GIS – Geographic Information System

GLOBE – Global Learning and Observations to Benefit the Environment

HARSAC – Haryana Space Applications Centre

HKH – Hindu Kush Himalaya

HPC – High Performance Computing

ICAR – Indian Council of Agricultural Research

ICIMOD – International Centre for Integrated Mountain Development

IGIF – Integrated Geospatial Information Framework

IGET – India Geospatial Education and Training

IIRS – Indian Institute of Remote Sensing

IITs – Indian Institutes of Technology

ILIMS – Integrated Land Information Management System

INSPIRE – Infrastructure for Spatial Information in Europe

ISRO – Indian Space Research Organisation

ITI – Industrial Training Institute

KPIs – Key Performance Indicators

KSDI – Kerala Spatial Data Infrastructure

LiDAR – Light Detection and Ranging

M&E – Monitoring and Evaluation

MeitY – Ministry of Electronics and Information Technology

MGNREGA – Mahatma Gandhi National Rural Employment Guarantee Act

MIS – Management Information System

MoE – Ministry of Education

MOOCs – Massive Open Online Courses

MoUs – Memoranda of Understanding

NASA – National Aeronautics and Space Administration (USA)

NCERT – National Council of Educational Research and Training

NCrF – National Credit Framework

NDMA – National Disaster Management Authority

NEP – National Education Policy

NGCBA – National Geospatial Capacity Building Authority

NGM – National Geospatial Mission

NGOs – Non-Governmental Organisations

NGP – National Geospatial Policy / National Geospatial Programme

NIC – National Informatics Centre

NIDM – National Institute of Disaster Management

NIGST – National Institute for Geo-Informatics Science and Technology

NITs – National Institutes of Technology

NRSC – National Remote Sensing Centre

NSDC – National Skill Development Corporation

NSDI – National Spatial Data Infrastructure

NSQF – National Skills Qualifications Framework

ODF – Open Defecation Free

OSM – OpenStreetMap

PM – Prime Minister

PMU – Programme Management Unit

PPP/PPPs – Public-Private Partnership(s)

PRIs – Panchayati Raj Institutions

QGIS – Quantum Geographic Information System (open-source GIS software)

RACI – Responsible, Accountable, Consulted, Informed (matrix)

RDIF – Research, Development and Innovation Fund

RoI – Return on Investment

RS – Remote Sensing

RTK – Real-Time Kinematic (surveying)

SCERTs – State Councils of Educational Research and Training

SDGs – Sustainable Development Goals

SDI – Spatial Data Infrastructure

SERVIR – Regional Visualization and Monitoring System (NASA-USAID programme)

SOPs – Standard Operating Procedures

STEM – Science, Technology, Engineering, and Mathematics

SVAMITVA – Survey of Villages and Mapping with Improvised Technology in Village Areas

SWAYAM – Study Webs of Active Learning for Young Aspiring Minds

UAV/UAVs – Unmanned Aerial Vehicle(s) / Drones

UGC – University Grants Commission

UN-GGIM – United Nations Committee of Experts on Global Geospatial Information Management

UN-IGIF – United Nations Integrated Geospatial Information Framework

UNWGIC – United Nations World Geospatial Information Congress

USAID – United States Agency for International Development

UTs – Union Territories

Appendix E: References

Bajracharya, B., Thapa, R.B. and Matin, M.A. (eds.) (2021) Earth Observation Science and Applications for Risk Reduction and Enhanced Resilience in Hindu Kush Himalaya Region: A Decade of Experience from SERVIR. Springer and ICIMOD.

Beetham, H. and Sharpe, R. (eds.) (2013) Rethinking Pedagogy for a Digital Age: Designing for 21st Century Learning. Abingdon: Routledge.

Bharati Vidyapeeth (Deemed to be) University (2024a) IGET India Geospatial Education Initiative. Institute of Environment Education and Research, Pune. Available at: https://dst-iget.in/iget-india-geospatial-education/ (Accessed: 22 October 2025).

Bharati Vidyapeeth (Deemed to be) University (2024b) Spatial Thinking Workshops: Catalyzing Geospatial Capacity Building for SDG Localization. Institute of Environment Education and Research, Pune. Available at: https://dst-iget.in/spatial-thinking/ (Accessed: 22 October 2025).

Bharati Vidyapeeth Institute of Environment Education and Research (2023) 'Minutes of the Ideation Workshop/Brainstorming for charting the future course of Geospatial Capacity Building through the National Geospatial Programme (NGP)', Stakeholder Consultation Workshop, 10 January 2023, Virtual. Department of Science and Technology, Government of India.

BISAG-N (2024) Bhaskaracharya National Institute for Space Applications and Geo-informatics – Academy for Geo-informatics: Education, Research and Training Facilities. BISAG-N, Ministry of Electronics and Information Technology, Government of India, Gandhinagar. Available at: https://bisag-n.gov.in/ (Accessed: 22 October 2025).

Bureau of Indian Standards (2025) Compendium of Geospatial Information Standards. Geospatial Information Sectional Committee (LITD 22), Bureau of Indian Standards, New Delhi. Available at: https://www.services.bis.gov.in/ (Accessed: 22 October 2025).

CBSE (2024) Geospatial Technology Curriculum for Class XI. Central Board of Secondary Education, New Delhi. Available at: https://cbseacademic.nic.in/web_material/Curriculum24/SrSec/818-GEOSPATIAL_TECHNOLOGY_XI.pdf (Accessed: 22 October 2025).

Činčera, J., Kroufek, R., Marková, K., Křepelková, Š. and Šimonová, P. (2019) 'The GLOBE program: what factors influence students' and teachers' satisfaction with science education', Research in Science & Technological Education, 39(2), pp. 245–261. doi: 10.1080/02635143.2019.1687441.

Das, S., Raju, P.L.N. and Nongkynrih, J.M. (2018) 'An evaluation of multi tier approach towards capacity building and institutional strengthening through application of geo spatial technology in purview of AMRUT scheme', The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XLII-5, pp. 15-19. doi: 10.5194/isprs-archives-XLII-5-15-2018

De Luca, N., Jekel, T. and Ferber, N. (2014) 'Spatial citizenship education – empowering citizens with geo-media', in INTED2014 Proceedings, pp. 1618-1627.

De Miguel, R. and Donert, K. (eds.) (2014) Innovative Learning Geography in Europe: New Challenges for the 21st Century. Newcastle: Cambridge Scholars Publishing.

Department of Science and Technology (2022) 'Students showcase their spatial thinking in localising SDGs', Press Release, 11 October. Available at: https://dst.gov.in/students-showcase-their-spatial-thinking-localising-sdgs (Accessed: 22 October 2025).

Department of Science and Technology (2024a) National Geospatial Programme (erstwhile NRDMS). Ministry of Science and Technology, Government of India, New Delhi. Available at:

https://www.dst.gov.in/ministry/our-division/details/national-geospatial-programme-ngp-MDM0czMtQWa (Accessed: 22 October 2025).

Department of Science and Technology (2024b) Operation Dronagiri: Pilot Project under National Geospatial Policy 2022. Ministry of Science and Technology, Government of India, New Delhi. Available at: https://dronagiribharat.com/ (Accessed: 9 February 2026).

Development Monitoring and Evaluation Office (2023) Analysis of SVAMITVA Scheme: Successes and Way Forward. NITI Aayog, Government of India. Available at: https://dmeo.gov.in/article/analysis-svamitva-scheme-successes-and-way-forward (Accessed: 23 October 2025).

Donert, K. (2014) 'Digital Earth – Digital World: strategies for geospatial technologies in 21st century education', in Muñiz Solari, O., Demirci, A. and Schee, J. van der (eds.) Geospatial Technologies and Geography Education in a Changing World: Geospatial Practices and Lessons Learned. Advances in Geographical and Environmental Sciences. Tokyo: Springer Japan, pp. 195-209.

ESA (2024) ESA Education. Available at: https://www.esa.int/Education (Accessed: 23 October 2025).

European Commission (2024) Copernicus: Europe's Eyes on Earth. European Union Earth Observation Programme, Brussels. Available at: https://www.copernicus.eu/en (Accessed: 22 October 2025).

Geospatial World (2022) Geospatial Artha Report 2022: Indian Geospatial Economy. Noida: Geospatial Media and Communications. Available at: https://geospatialworld.net/consulting/reports/artha-report-2022/ (Accessed: 28 October 2026).

Geospatial World (2023) 'Satellite/GIS-powered GeoMGNREGA – Yuktdhara Portal for Transparent Rural Development', Geospatial World, Noida. Available at: resource.geospatialworld.net (Accessed: 22 October 2025).

Giuliani, G., Ray, N. and Lehmann, A. (2013) 'Building regional capacities for GEOSS and INSPIRE: a journey in the Black Sea catchment', International Journal of Advanced Computer Science and Applications, 3(3), pp. 19-27.

Goodchild, M.F. (2007) 'Citizens as sensors: the world of volunteered geography', GeoJournal, 69(4), pp. 211-221.

Government of India (2013) Report of the National Task Force on Geospatial Education. New Delhi: Ministry of Human Resource Development, Government of India. Available at: http://mhrd.gov.in/report-national-task-force-geospatial-education (Accessed: 23 October 2025).

Government of Karnataka (2002) Bhoomi: Computerisation of Land Records in Karnataka. Revenue Department, Government of Karnataka, Bengaluru.

Government of Kerala (2024) Ente Bhoomi: Integrated Land Information Management System (ILIMS). Revenue and Survey Departments, Government of Kerala, Thiruvananthapuram.

Gryl, I. and Jekel, T. (2012) 'Re-centring geoinformation in secondary education: toward a spatial citizenship approach', Cartographica: The International Journal for Geographic Information and Geovisualization, 47(1), pp. 18-28.

Gryl, I., Jekel, T. and Donert, K. (2010) 'GI and spatial citizenship', in Learning with GeoInformation V, pp. 2-11.

Gryl, I., Schulze, U. and Kanwischer, D. (2013) 'Spatial citizenship: the concept of competence', in Vogler, R., Car, A., Strobl, J. and Griesebner, G. (eds.) Creating the GI Society. Berlin: Wichmann, pp. 282-293.

HARSAC (2024) Haryana Space Applications Centre: Geospatial Services, Training and Applications for Haryana State. HARSAC, Department of Science and Technology, Government of Haryana, Hisar. Available at: https://harsac.org/ (Accessed: 22 October 2025).

IIT Bombay (2024) FOSSEE GIS: Free and Open Source Software for Education – Geospatial Initiatives. FOSSEE Project, Indian Institute of Technology Bombay, Mumbai. Available at: https://gis.fossee.in/ (Accessed: 28 October 2026).

IMPRI India (2025) 'SVAMITVA Scheme: From Ground Governance to Ownership', IMPRI Impact and Policy Research Institute, New Delhi. Available at: impriindia.com (Accessed: 22 October 2025).

Indian Institute of Remote Sensing (2024) Academic and Training Programmes. IIRS/ISRO, Department of Space, Government of India, Dehradun. Available at: https://www.iirs.gov.in/academic-and-training-programmes (Accessed: 22 October 2025).

ISRO (2024) Bhuvan: Indian Geo-platform of ISRO. National Remote Sensing Centre, ISRO, Department of Space, Government of India, Hyderabad. Available at: https://bhuvan.nrsc.gov.in/ (Accessed: 22 October 2025).

Jekel, T., Koller, A. and Strobl, J. (2012) 'Austria: links between research institutions and secondary schools for geoinformation research and practice', in Milson, A.J., Demirci, A. and Kerski, J.J. (eds.) International Perspectives on Teaching and Learning with GIS in Secondary Schools. Dordrecht: Springer Netherlands, pp. 27-36.

Kerski, J.J. (2008) 'The role of GIS in Digital Earth education', International Journal of Digital Earth, 1(4), pp. 326–346. doi: 10.1080/17538940802420879.

Kumar, P., Siddiqui, A., Gupta, K., Jain, S. and Krishna Murthy, Y.V.N. (2014) 'Capacity building through geospatial education in planning and school curricula', The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XL-8, pp. 1253-1259. doi: 10.5194/isprsarchives-XL-8-1253-2014.

LaConte, K., Mitchell, B., Shupla, C., Liston, C. and Fitzhugh, G. (2021) 'Lessons Learned from NASA STEM Workshops for High-Impact Professional Development', Public Library Quarterly, 41(2), pp. 144–160. doi: 10.1080/01616846.2021.1875805.

Ministry of Education (2020) National Education Policy 2020. Government of India, New Delhi. Available at: https://www.education.gov.in/nep/about (Accessed: 22 October 2025).

Ministry of Education (2022) All India Survey on Higher Education (AISHE) 2021-22. Department of Higher Education, Government of India, New Delhi. Available at: https://aishe.gov.in/ (Accessed: 22 October 2025).

Ministry of Education (2024) All India Survey on Higher Education (AISHE) Portal. Government of India. Available at: https://aishe.gov.in/ (Accessed: 23 October 2025).

Ministry of Panchayati Raj (2024a) Empowerment through Ownership – SVAMITVA Scheme (e-book). Government of India, New Delhi. Available at: svamitva.nic.in (Accessed: 22 October 2025).

Ministry of Panchayati Raj (2024b) SVAMITVA Scheme: Survey of Villages and Mapping with Improvised Technology in Village Areas. Government of India. Available at: https://svamitva.nic.in/ (Accessed: 22 October 2025).

National Disaster Management Authority (2018) 'NDMA holds workshop on application of GIS in Disaster Management', Press Release, Ministry of Home Affairs, Government of India, New Delhi. Available at: https://pib.gov.in/Pressreleaseshare.aspx?PRID=1546753 (Accessed: 9 February 2026).

National Institute of Disaster Management (2025) Official Website. Ministry of Home Affairs, Government of India, New Delhi. Available at: https://nidm.gov.in/ (Accessed: 9 February 2026).

National Remote Sensing Centre (2013) Map the Neighbourhood in Uttarakhand (MANU): Crowdsourced Disaster Damage Assessment Programme. NRSC/ISRO, Department of Space, Government of India, Hyderabad. Available at: https://bhuvan.nrsc.gov.in/ (Accessed: 9 February 2025).

National Remote Sensing Centre (2024) Training Planning & Coordination Division - Courses Overview. NRSC/ISRO, Department of Space, Government of India, Hyderabad. Available at: https://www.nrsc.gov.in/Courses_Overview (Accessed: 22 October 2025).

NCERT (2023) National Curriculum Framework for School Education 2023. NCERT, Ministry of Education, Government of India, New Delhi.

NCERT (2026) School Bhuvan–NCERT Portal Analytics, April 2025–April 2026. Unpublished data provided by the National Council of Educational Research and Training, New Delhi.

NCFSE (2000) National Curriculum Framework for School Education 2000. National Council of Educational Research and Training, New Delhi.

NRSC/ISRO and NCERT (2024) School Bhuvan: Geospatial Platform for Educational Learning. National Remote Sensing Centre and National Council of Educational Research and Training. Available at: https://bhuvan-app1.nrsc.gov.in/mhrd_ncert/ (Accessed: 22 October 2025).

Pandey, A. (2011) 'Role of GIS in School Geography', Journal of Indian Education, XXXVII(3), pp. 112-117. New Delhi: NCERT. ISSN 0972-5628.

Pandey, A. (2012) 'GIS in Indian School Curriculum', Geospatial World. Available at: https://geospatialworld.net/article/gis-in-indian-school-curriculum/ (Accessed: 22 October 2025).

Pandey, A. (2016) 'School Bhuvan NCERT Bhusthanik portal – Vidyalayon me aadhuniktam taknik dwara bhugol ki khojparak shiksha', Bhartiya Aadhunik Shiksha, 37(1), pp. 73-79. New Delhi: NCERT. ISSN 0972-5636.

Patil et al. (2024) Use of Yuktdhara in MGNREGA Planning: Case Study of Nashik District, Maharashtra. American Journal of Rural Development, 13 (1): 12-20. pubs.sciepub.com

Press Information Bureau (2022) 'Students showcase their spatial thinking in localising SDGs – Special Event at Second UNWGIC', Ministry of Science and Technology, Government of India, New Delhi, 11 October. Available at: https://pib.gov.in/PressReleasePage.aspx?PRID=1866543 (Accessed: 22 October 2025).

Press Information Bureau (2025) 'Budget and Progress under SVAMITVA Scheme', Ministry of Panchayati Raj, Government of India, New Delhi. Available at: static.pib.gov.in (Accessed: 22 October 2025).

Schulze, U., Gryl, I. and Kanwischer, D. (2014) 'Spatial citizenship: creating a curriculum for teacher education', in Vogler, R., Car, A., Strobl, J. and Griesebner, G. (eds.) Geospatial Innovation for Society. Berlin: Wichmann, pp. 230-241.

Strobl, J. (2019) 'The geospatial capacity building ecosystem - developing the brainware for SDI', in Sustainable Development Goals Connectivity Dilemma: Land and Geospatial Information for Sustainable Development. 1st edn. Boca Raton: CRC Press, pp. 213-219.

UGC (2023) National Credit Framework (NCrF): Report of the High-Level Committee. University Grants Commission, New Delhi. Available at: https://www.ugc.gov.in/pdfnews/4299434_NCrF-Report.pdf (Accessed: 22 October 2025).

UN-GGIM (2018) Integrated Geospatial Information Framework (IGIF) - Part 1: Overarching Strategic Framework. United Nations Committee of Experts on Global Geospatial Information Management. Available at: https://ggim.un.org/meetings/ggim-committee/8th-session/documents/part%201-igif-overarching-strategic-framework-24july2018.pdf (Accessed: 22 October 2025).

UN-GGIM (2020a) IGIF Implementation Guide - Part 2. United Nations Committee of Experts on Global Geospatial Information Management. Available at: https://ggim.un.org/UN-IGIF/part2.cshtml (Accessed: 22 October 2025).

UN-GGIM (2020b) Strategic Pathway 8: Capacity and Education - Implementation Guide. United Nations Committee of Experts on Global Geospatial Information Management. Available at:

https://ggim.un.org/UN-IGIF/documents/SP8_Capacity_and_Education_Refined.pdf (Accessed: 22 October 2025).

USAID (2024) SERVIR Program: Connecting Space to Village. Washington, DC: United States Agency for International Development.



विज्ञान एवं
प्रौद्योगिकी मंत्रालय
MINISTRY OF
SCIENCE AND
TECHNOLOGY

Department of Science and Technology

Government of India

NATIONAL GEOSPATIAL PROGRAMME DIVISION

Technology Bhavan, New Mehrauli Road
New Delhi – 110016
www.dst.gov.in

October 2026