

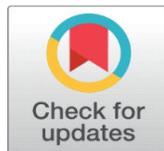
INDIAN GEOSPATIAL EDUCATIONAL ECOSYSTEM: A NEW HORIZON IN NEP FRAMEWORK

Dr. Druheen Chakraborty ¹  , Swadhin Tantubay ²  , Manasi Chattaraj ³  

¹ Assistant Professor of Geography, Bankura Christian College, Bankura, West Bengal

² SACT, Department of Geography, Bankura Christian College, Bankura, West Bengal

³ Research Scholar, Department of Geography, Bankura University, Bankura, West Bengal



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Corresponding Author

Dr. Druheen Chakraborty,
druheengeobcc@gmail.com

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ABSTRACT

Geospatial technology plays a crucial role towards addressing many challenges of the modern century. Realizing its significance, India has been working to foster a vibrant geospatial ecosystem. The National Education Policy (NEP) 2020 emerges to strengthen digital geospatial literacy by giving fresh impetus to this endeavor through its focus on incorporating technology-enabled learning and spatial thinking in education. This article evaluates the state of the geospatial educational ecosystem of India, as well as the new opportunities and challenges of NEP 2020 and approaches to create a new horizon of geospatial education.

Keywords: Curriculum Reform, Digital Literacy, Geospatial Education, Spatial Intelligence

1. INTRODUCTION

Geospatial Education Ecosystem (GEE) refers to a total framework of '3i's- instruments, institutions, and implementations- that provides students with the knowledge, skills, and tools to understand and utilize geospatial technologies [Moore et al. \(2016\)](#). GEE is drastically transforming technology-based society to knowledge-based society providing personalized education to strengthen capacity

and preparing digitally literate human resources [Mukul and Büyüközkan \(2023\)](#). The main goal of GEE in India is to promote the geospatial technologies and develop geospatial skills and economic spatial thinking, emphasizing integrated geospatial technologies like Remote Sensing (RS), Geographic Information System (GIS), Global Positioning System (GPS) etc. In India, various geospatial courses are being offered from the school level to higher education levels to enhance geospatial literacy, strengthen digital economy, strengthening public services, improving infrastructure, and improvements contributing to national security [Chaudhari et al. \(2023\)](#). This must be linked with the NEP 2020 aim of holistic learning, infusion of technology- and future-ready workforce development. Strengthening GEE is crucial to meet the targeted Sustainable Development Goals, and the National Geospatial Policy (NGP) of India, 2022 is a step forward towards achieving these goals. In order to meet the criteria and credentials of growing global geospatial job sectors, India needs a strong GEE, that will enable new generations to harness geospatial technology for personal development and the nation's advancement.

2. HISTORY OF GEOSPATIAL EDUCATIONAL ECOSYSTEM IN INDIA

The history of the Indian geospatial educational system is very old, but at the early phase, the scope and access of geospatial technologies were very limited. Only a few governmental and non-governmental organizations had the access to use these technologies due to a lack of proper geospatial educational infrastructure. But the increasing importance and demand of geospatial technologies in this country has led to rapid growth of GEE, especially after the introduction of [NEP \(2020\)](#). Indian GES gets a boost at the beginning of the 21st century with intervention from the Government of India through the establishment of a national task force and the introduction of [NGP \(2022\)](#) for the development of a strong GEE in India. The brief history of the Indian geospatial educational ecosystem is given in [Table 1](#).

Table 1

Table 1 History of Geospatial Education System in India	
Time period	Major geospatial educational development
1950-1990	<ul style="list-style-type: none"> i. Establishing NRSC, Hyderabad, IIRS ii. ISRO started training program in RS and GIS
1990-2010	<ul style="list-style-type: none"> i. Development of GIS software (ArcGIS, ERDAS etc.) ii. Establishment of NSDI, DST iii. Many universities started offering academic training and certification courses in geospatial technologies and geoinformatics iv. Started National Geospatial program (2005) v. Opensource GIS software available
2010-till now	<ul style="list-style-type: none"> i. Development of Artificial Intelligence (AI), Machine Learning (ML), Internet of Things (IOT), Fuzzy Techniques ii. Incorporating GES as an integral part of NEP (2020) iii. Emphasizing on Drone based mapping and geospatial data analysis iv. Introducing National geospatial policy (2022) ESRI, National Map policy, Promoting online education platform

Source: Compiled by authors from Google, SOI, DST draft [policy \(2021\)](#)

3. GEOSPATIAL EDUCATIONAL ECOSYSTEM IN INDIA UNDER NEP

The New Education Policy (NEP) 2020 has a strong focus on developing and building up modern technology and promoting a multidisciplinary approach in every sector of education. This policy caters significant opportunity to strengthen and spread out the geospatial educational system in India. Here's how the NEP can contribute:

- 1) **Initial Geospatial Concept:** NEP promotes some basic concepts about geospatial technologies for school level students to prepare the base for a strong geospatial knowledge system.
- 2) **Geospatial Technologies in Higher Education:** NEP provides different types of courses of geospatial technologies in higher education studies in India. This structure of NEP encourages the students of various disciplines to explore the geospatial technologies and their applications in different respective fields. Colleges and universities across India offer specialized degree programs, minor courses, and electives in geospatial science, GIS, GPS, remote sensing and geoinformatics to cater to the growing demand for skilled professionals in the geospatial sector.
- 3) **Research – Innovation and Geospatial education:** Research and innovation is a major part of National education policy system and NEP support research and innovation in different fields. This can be utilized to promote research in geospatial technologies, focusing on areas like data analytics, AI, machine learning, and their applications in solving real-world problems. Collaboration between academia, industry, and government agencies can be fostered to promote research and development in geospatial technologies.
- 4) **Skill Development and Vocational Training:** The NEP emphasizes skill development and vocational training to increase employability. This can be more utilized if it is built with the short-term courses and certification programs in geospatial technologies for students and working professionals. These skill development Programme mainly focus on some specific geospatial skill like data acquisition, analysis, processing, and visualization using different geospatial software and tools.
- 5) **Online and Digital Learning:** Online and digital learning system are important educational platforms in the world. NEP also promote these types of digital platforms for education. The various online courses and tutorials are very helpful to spread out the geospatial educational system to the wider people and also easily acceptable for the wider audiences.
- 6) **Teacher Training and Capacity Building:** Capacity building together with teacher training stands as a central focus of the NEP. The training system can prepare teachers to use geospatial technologies while learning their relevant applications so they can implement them in their educational practice. Educational platforms including workshops, seminars, and online courses should be provided to teachers for improving their capabilities in geospatial technology.
- 7) **Collaboration and Internships:** Through its structure the NEP establishes collaboration between institutions of learning and industrial entities. Utilizing this provision will establish student internships at geospatial companies and organizations where students can gain field experience along with professional exposure. Educational institutions should invite

industry experts who will assist with developing the curriculum and teach courses to guarantee educational programs align with industry demands.

4. FRAMEWORK OF INDIAN GEOSPATIAL EDUCATIONAL ECOSYSTEM

The GEE in India puts together the institutions, programs, and initiatives involved in the process of education toward developing geospatial technical knowledge in India. The ecosystem shelters various educational institutions, research organizations, government policies, industry participation, and capacity-building programs. A more detailed structure of the Indian GEE is provided below:

4.1. EDUCATIONAL INSTITUTION

- 1) **Primary to High School Level:** Basic concept of geospatial technologies (RS, GIS, and GPS) have been introduced in school level education under NEP. It is also compulsory part of some subject like Geography, Environmental Science etc. of secondary and higher secondary education level.
- 2) **Colleges and Universities:** Offer various courses and programs in Geoinformatics and other related fields at various levels (B.Sc, Masters, diploma and doctoral).
- 3) **Specialized institute:** Special training program and research in geospatial technologies is provided by many specialized institutes like IIRS, NATMO, NIO etc.

4.2. GOVERNMENTAL PROGRAMS AND POLICIES

- 1) National Geospatial Program (NGP): Started in 2019. The main aim of this programs is to promote geospatial technologies and science, build up capacity and develop geospatial solutions.
- 2) [National Geospatial Policy \(2022\)](#): Provides the framework for the policy development to enhance geospatial technologies in India.
- 3) DST: Department of science and technology plays a vital role supporting and funding in geospatial education.
- 4) NSDI: The National Spatial Data Infrastructure provides various type of geospatial data for education and research, which is very helpful for the development of geospatial technologies in India [Acharya and Pandey \(2018\)](#).

4.3. RESEARCH AND DEVELOPMENT

- 1) **ISRO:** Indian Space Research Organization play a vital role in the development of geospatial technologies in India, especially in RS and satellite imagery analysis [Rao et al. \(2016\)](#). ISRO also collaborate with different educational institutions and provides research funding and shares various types of geospatial data .
- 2) **IIRS:** Indian Institute of Remote Sensing established in 1966, provides training, education and research in RS and GIS applications, all these are very crucial for the geospatial technologies development [Raju and Gupta \(2012\)](#), [Turkar et al. \(2019\)](#).

- 3) **NRSC:** National Remote Sensing Centre is an agency under ISRO, which facilitates the use of RS data for geospatial educational purpose [Ghosh et al. \(2018\)](#), [Nayak \(2020\)](#).

4.4. TRAINING AND CERTIFICATION PROGRAMME

- 1) NGP and other organizations conduct various workshops, seminars and training programs for enhancing the skill and knowledge about geospatial technologies in India.
- 2) Students and other professionals are trained by standard RS and GIS software like ArcGIS, QGIS, Mapinfo, ERDAS imagine, AutoCAD etc. for geospatial technology development, culture and modeling.

4.5. COLLABORATION AND PARTNERSHIP

- 1) **Public-private Partnership:** Many private companies collaborate with different institutions and agencies to develop industry relevant geospatial educational programs. ESRI India, Trimble Leica Geo-Ecosystem etc. offer various training program and certificate course in RS and GIS.
- 2) **International Collaboration:** Indian government actively collaborates with some famous global organizations such as European space agency, NASA, UNESCO and world bank in joint geospatial data projects and for enhancing research in geospatial education system [Gupta et al. \(2016\)](#).

4.6. ONLINE TRAINING PLATFORMS

- 1) Various government department and agencies conduct online seminars, workshops, training program to enhance the geospatial technological skills of the students and professionals.
- 2) Some government e-learning platform such as SWAYAM offer online courses on geospatial technology, which plays an important role in fostering geospatial education to a broad spectrum of learners.

5. OPPORTUNITIES OF GEOSPATIAL EDUCATION ECOSYSTEM IN INDIA

The introduction of GEE has opened a plethora of opportunities in different sectors of education and industry, some of which are listed below:

- 1) **Urban Planning and Development:** Geospatial technologies play a very crucial role in urban development and planning by providing standardized spatio-temporal data necessary for infrastructure development, land use planning [Tao \(2013\)](#), traffic management [Mohtich et al. \(2023\)](#), waste disposal [Doorga et al. \(2022\)](#), [Chattaraj et al. \(2025\)](#), etc.
- 2) **Education and Research:** Geospatial technology can enhance and upgrade the teaching-learning experiences providing a blended mode of education and research incorporating both online and offline methods and resources [Lee \(2023\)](#). The data accessibility issues have been greatly solved, global geospatial data have become available at fingertip, which has strengthened

research and education in India [Naik et al. \(2013\)](#), [Dasgupta \(2017\)](#), [Singh et al. \(2024\)](#).

- 3) **Environmental Management and Sustainability:** Environmental management and sustainability greatly benefits from geospatial education Programme in India. Geospatial data and technologies is very helpful for monitoring and identifying the vulnerable area, analyzing the climate change pattern, managing ecosystem, determine disease hotspots [Ganguly et al. \(2025\)](#) and devise strategies for sustainable development practice [Chakraborty and Jha \(2011\)](#), [Das et al. \(2020\)](#), [Koul et al. \(2024\)](#).
- 4) **Economic Growth and Job Opportunities:** Geospatial data and technologies build up opportunities for innovation and economic growth and opens broad avenues for various information-technology based jobs for youth of India [Nagavi et al. \(2024\)](#).
- 5) **Skill Development for Remote and Backward Areas:** Geospatial data and technologies is very effective for the skill development in remote and backward region of India [Kumar \(2022\)](#). Training at local level especially rural and remote area can help build capacity in data analysis and improving local governance by using geospatial data [Remilla and Kishore \(2018\)](#), [Thakur et al. \(2018\)](#).
- 6) **Integration of Modern Technologies:** Various personalized and specialized modern technologies such as AI, ML, IOT and chatbots, etc. can be developed through the geospatial education in India, which will greatly contribute to informed decision making [Bhambri \(2024\)](#) and strengthening cyber security [Kage and Salakki \(2024\)](#).

6. RELEVANCE OF GEOSPATIAL EDUCATION SYSTEM IN NATIONAL EDUCATIONAL POLICY

- 1) **Growing Importance of Geospatial Technologies:** In modern era the importance of geospatial technologies is continuously grow in various sector like environmental management, infrastructure development, urban and smart city planning, disaster management and agriculture management. To show this importance, the NEP aims to integrate geospatial education into the different part of the main stream curriculum [Venugopal \(2024\)](#).
- 2) **Interdisciplinary Approach:** Interdisciplinary approach is very crucial for any kind of educational structure. The NEP promotes the interdisciplinary approach to education, which is encouraging the students in their core specialization. Geospatial education system can be integrated with different discipline such as geography, computer science, environmental studies, engineering, geoinformatics and geology [Adaktylou et al. \(2018\)](#), [Duarte et al. \(2022\)](#), [Botezatu and Vevera \(2024\)](#)
- 3) **Emphasis on Vocational Training and Skill Development:** The NEP focus on vocational training and skill development to expert the students with practical skills, which is very crucial for industrial sector development [Tripathi et al. \(2023\)](#), [Kaur \(2024\)](#). Geospatial education has been perfectly matching with this type of object of the NEP and thus NEP provides students to hands on experiences in using geospatial data, tools and techniques for build up career in this type of flourishing branch of academia.
- 4) **Focus on Research and Innovation:** The NEP emphasis on strongly building up the research and innovation sector of India. Geospatial

education can play an important role in this part by encouraging students to use geospatial techniques for informed decision making [Sharma and Jaglan \(2012\)](#), [Lohani \(2021\)](#).

- 5) **Sustainable Development and Policy Making:** Sustainable development and policy making is one of the major goals of NEP, and geospatial education perfectly aligns with this by providing appropriate technologies and relevant data. These data and technologies are very crucial for the policy making in various sectors, such as, agriculture [Sutradhar et al. \(2019\)](#), [Sen Modak et al. \(2023\)](#), transportation, urban planning [Attah et al. \(2024\)](#), [Costa et al. \(2024\)](#), disaster management [Thapa \(2021\)](#), [Valachamy et al. \(2022\)](#), national security [Sapru and Sapru \(2014\)](#) etc.

7. CHALLENGES OF THE GEOSPATIAL EDUCATION SYSTEM IN INDIA

- 1) **Lack of Infrastructure and resources:** To develop a concrete and strong geospatial educational system, it is mandatory to build up high-quality infrastructure and resources. But still many institutions in India lack these and hindrance in setting up geospatial education system.
- 2) **Lack of awareness:** Many streams consider geospatial education as a part of Geo science, Environmental Science and Engineering only. But geospatial education is actually trans-disciplinary integrated approach. Still many students and educational institutions are not aware about the significance of geospatial technologies and thus limited number of students pursuing geospatial courses and the use of geospatial technology in research is limited to some subjects only.
- 3) **Shortage of skilled Faculty:** Shortages of experienced, skilled and qualified faculty members is a big problem for developing a strong GEE in India, which adversely impact the quality of teaching and research on geospatial education system.
- 4) **High Cost of Software and Technologies:** The cost of software and technologies of geospatial courses are very high and are not affordable for many students and educational institutions, shortage of funding is big issue in these cases.
- 5) **Generation Gap in Geospatial education:** Though government of India and other agencies try to develop a strong GEE in India, but still there is a big generation gap in this field specially the older generation cannot fully adopt it.
- 6) **Lack of Industry Collaboration:** In India, there is a big gap of collaboration between different educational institutions and the geospatial industry, which create a big problem to develop a strong geospatial education ecosystem in India.

8. STRATEGIES FOR STRENGTHENING GEOSPATIAL EDUCATION SYSTEM IN INDIA

- 1) Fostering geospatial thinking from the primary stages through introduction of geospatial concept and tools in school level, encourage the students in map reading, creating simple maps etc.

- 2) Upgrading curriculum in college and universities offering specialized courses and program on geospatial technologies like GPS, RS, GIS, spatial data analysis and urban planning etc. Geospatial education system must be added into the multidisciplinary subjects like natural science, environmental science, social science, urban planning, disaster management etc.
- 3) Enhance training program and certification courses on geospatial tools, techniques and software for capacity building under this education system should be started.
- 4) Government should collaborate with different national and international private and public geospatial companies to ensure that students can easily access the upgraded tools and technologies of geospatial education for free.
- 5) Establishing upgraded geospatial educational related research centers and innovation hubs focusing on geospatial technology application in different sectors of education, economy and society.
- 6) Indian Government has already taken many initiatives for developing the geospatial education ecosystem in India, which is a very good sign. But government should take initiatives to build up a strong updated geospatial data repository, that can be easily used for educational and research purposes.
- 7) Developing and promoting the free Massive Open Online Courses (MOOCs) on geospatial technologies will definitely be a step forward in bridging the disparities in geospatial education system in all forms.

9. CONCLUSION

The integration of geospatial education within the NEP 2020 framework presents a transformative opportunity for India. By prioritizing holistic development, digital literacy, and skill-based learning, we can cultivate a generation proficient in geospatial technologies. This ecosystem, encompassing robust curriculum development, industry partnerships, and accessible resources, will empower individuals to address critical challenges in urban planning, disaster management, agriculture, and environmental conservation. Furthermore, aligning geospatial education with national priorities like sustainable development and digital India will drive innovation and economic growth. While challenges remain in implementation and accessibility, a concerted effort to foster this ecosystem will position India as a global leader in geospatial technology, contributing significantly to national development and a data-driven future enriching the goal of building 'Atmanirbhar Bharat'. This strategic investment in geospatial education is not just about creating jobs; it's about building a nation empowered by spatial intelligence.

CONFLICT OF INTERESTS

None.

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REFERENCES

- Acharya, P. S., and Pandey, S. (2018). National Spatial Data Infrastructure India (NSDI-India): Present Status and Future Strategies. In *Geospatial infrastructure, Applications and Technologies: India Case Studies* (7–16). Springer. https://doi.org/10.1007/978-981-13-2330-0_2
- Adaktylou, N. E., Landenberger, R. E., Czajkowski, K. P., Liu, P., Hedley, M. L., and Struble, J. (2018). Using Geospatial Technology to Enhance Science Teaching and Learning: A Case Study for “SATELLITES” Geo-Science Program. *International Journal of Environmental and Science Education*, 13(7), 605–621.
- Attah, R. U., Gil-Ozoudeh, I., Garba, B. M. P., and Iwuanyanwu, O. (2024). Leveraging Geographic Information Systems and Data Analytics for Enhanced Public Sector Decision-Making and Urban Planning. *Magna Scientia Advanced Research and Reviews*, 12(2), 152–163. <https://doi.org/10.30574/msarr.2024.12.2.0191>
- Bhambri, P. (2024). Shaping the Future of Geospatial AI. In *Recent Trends in Geospatial AI* (177). <https://doi.org/10.4018/979-8-3693-8054-3.ch007>
- Botezatu, U. E., and Vevera, A. V. (2024). Geospatial Synergies in Education: Cultivating Sustainable Futures Through Global Learning Networks. In *INTED2024 Proceedings* (5409–5413). IATED. <https://doi.org/10.21125/inted.2024.1394>
- Chakraborty, D., and Jha, V. C. (2011). Assessment of Landscape Ecology of Siddheswari–Nunbil Riparian Tract in Birbhum District, West Bengal. *Deccan Geographer*, 49(2), 1–12.
- Chattaraj, M., Goswami, A., Ganguly, A., and Chattaraj, S. (2025). Considerations of Policy and Morality in Waste Management. In *AI Technologies for Enhancing Recycling Processes* (233–266). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3693-7282-1.ch012>
- Chaudhari, S., Bharambe, U., and Bhangale, U. (2023). Geospatial Policy in India: Impact, Opportunities and Challenges in Education. In *IGARSS 2023—2023 IEEE International Geoscience and Remote Sensing Symposium* (2293–2296). IEEE. <https://doi.org/10.1109/IGARSS52108.2023.10281836>
- Costa, D. G., Bittencourt, J. C. N., Oliveira, F., Peixoto, J. P. J., and Jesus, T. C. (2024). Achieving Sustainable Smart Cities Through Geospatial Data-Driven Approaches. *Sustainability*, 16(2), Article 640. <https://doi.org/10.3390/su16020640>
- Das, U., Bajpai, R., and Chakraborty, D. (2020). River Regulation and Associated Geo-Environmental Problems: A Case Study of Lower Reaches of Shilabati River Basin, West Bengal, India. *International Journal Of Ecology and Environmental Sciences*, 2, 233–240.
- Dasgupta, A. (2017). Unlocking the Potential of Geospatial Data. *Space India*, 20, 51. Department of Science and Technology, Government of India. (2021). Draft National Geospatial Policy (20–24).
- Doorga, J. R., Rughooputh, S. D., Chung, S. Y., and McGivern, A. (2022). A Geospatial Approach for Addressing Long-Term Solid Waste Management Issues: Extracting Value from Waste. *Journal of Cleaner Production*, 334, Article 130282. <https://doi.org/10.1016/j.jclepro.2021.130282>
- Duarte, L., Teodoro, A. C., and Gonçalves, H. (2022). Evaluation of Spatial Thinking Ability Based on Exposure to Geographical Information Systems (GIS) Concepts in the Context of Higher Education. *ISPRS International Journal of Geo-Information*, 11(8), Article 417. <https://doi.org/10.3390/ijgi11080417>

- Ganguly, A., Mahapatra, S., Ray, S., Chattopadhyay, S., Islam, M. J., Garai, S., et al. (2025). The Rising Threat of Nipah Virus: A Highly Contagious and Deadly Zoonotic Pathogen. *Virology Journal*, 22(1), Article 139. <https://doi.org/10.1186/s12985-025-02728-4>
- Ghosh, S., Sachan, A., and Srinivas, G. (2018). Collaboration and Outreach Towards use of Geospatial Technologies in India with an Emphasis on ISRO's Effort. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 42, 51–57. <https://doi.org/10.5194/isprs-archives-XLII-5-51-2018>
- Gupta, S., Karnatak, H., and Raju, P. L. N. (2016). Geo-Informatics in India: Major Milestones and Present Scenario. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 41, 111–121. <https://doi.org/10.5194/isprsarchives-XLI-B6-111-2016>
- Kage, V. R., and Salakki, S. S. (2024, July 26). Cyber Security and Security Impacts in Digital Transaction for Rural India. In Seminar proceedings.
- Kaur, H. (2024). National Education Policy (NEP) 2020: Skill Enhancement Through Vocational Education. *Edumania—An International Multidisciplinary Journal*, 2(1), 23–32. <https://doi.org/10.59231/edumania/9015>
- Koul, M. A., Tandon, B., and Dua, B. (2024). NEP 2020's Vision for Environmental Sustainability in Education. In *Integrating environmental sustainability into Education: Insights from NEP 2020* (1).
- Kumar, A. S. (2022). Capacity Development in Geospatial Technology—An Overview. *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 5, 9–16. <https://doi.org/10.5194/isprs-annals-V-5-2022-9-2022>
- Lee, J. (2023). Beyond Geospatial Inquiry—How can we Integrate the Latest Technological Advances into Geography Education? *Education Sciences*, 13(11), Article 1128. <https://doi.org/10.3390/educsci13111128>
- Lohani, B. (2021). New Geospatial Data Guidelines: Impact on Research and Education. *Current Science*, 120(7), 1138–1139.
- Modak, S. S., Chattaraj, M., and Chakraborty, D. (2023). Patterns of Crop and Agricultural Regionalisation: A Case Study from Bankura District, West Bengal. *International Journal of Creative Research Thoughts*, 11(7), g128–g140.
- Mohtich, F. E., Bensiali, S., Idri, A., and El-Ayachi, M. (2023). Geospatial Data Integration for Intelligent Transportation Systems: A Review of the State of the Art of Spatio-Temporal Traffic Forecasting. *African Journal of Land Policy and Geospatial Sciences*, 6(4), 683–692.
- Moore, S., Haviland, D., Moore, W., and Tran, M. (2016). Preparing Teachers to Use GIS: The Impact of a Hybrid Professional Development Program on Teachers' use of GIS. *Journal of Science Education and Technology*, 25, 930–946. <https://doi.org/10.1007/s10956-016-9641-5>
- Mukul, E., and Büyüközkan, G. (2023). Digital Transformation in Education: A Systematic Review of Education 4.0. *Technological Forecasting and Social Change*, 194, Article 122664. <https://doi.org/10.1016/j.techfore.2023.122664>
- Nagavi, J. C., Shukla, B. K., Bhati, A., Rai, A., and Verma, S. (2024). Harnessing Geospatial Technology for Sustainable Development: A Multifaceted Analysis of Current Practices and Future Prospects. In *Sustainable Development and Geospatial Technology: Volume 1: Foundations and Innovations* (147–170). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-65683-5_8

- Naik, G., Basavaraj, K. P., Hegde, V. R., Paidi, V., and Subramanian, A. (2013). Using Geospatial Technology to Strengthen Data Systems in Developing Countries: The Case of Agricultural Statistics in India. *Applied Geography*, 43, 99–112. <https://doi.org/10.1016/j.apgeog.2013.06.002>
- Nayak, S. (2020). Remote Sensing for National Development: The Legacy of Dr. Vikram Sarabhai. *Journal of the Indian Society of Remote Sensing*, 48(8), 1101–1120. <https://doi.org/10.1007/s12524-020-01156-x>
- Raju, P. L. N., and Gupta, P. K. (2012). Satellite-Based Education and Training in Remote Sensing and Geo-Information: An E-Learning Approach to Meet the Growing Demands in India. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 39, 25–29. <https://doi.org/10.5194/isprsarchives-XXXIX-B6-25-2012>
- Rao, M. K., Murthi, K. S., and Raj, B. (2016). Indian Space: Toward a “National Ecosystem” for Future Space Activities. *New Space*, 4(4), 228–236. <https://doi.org/10.1089/space.2016.0008>
- Remilla, M., and Kishore, J. K. (2018). Capacity Building for RS and GIS Technology Applications: Student Remote Sensing and Geospatial Programme in Academic Institutions. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 42, 907–911. <https://doi.org/10.5194/isprs-archives-XLII-5-907-2018>
- Sapru, R. K., and Sapru, Y. (2014). Good Governance Through E-Governance with Special Reference to India. *Indian Journal of Public Administration*, 60(2), 313–331. <https://doi.org/10.1177/0019556120140208>
- Sharma, M., and Jaglan, M. S. (2012). Significance of Geospatial Technology and Status of its Education and Training in India. *International Journal of Geomatics and Geosciences*, 2(3), 730–737.
- Singh, S., Sharma, S. K., and Shukla, A. K. (2024). The Role of Geospatial Technology in Sustainable Development. In *Sustainable development and Geospatial Technology: Volume 1: Foundations and Innovations* (17–31). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-65683-5_2
- Survey of India. (2024, April 8). Survey of India.
- Sutradhar, A., Chakraborty, D., and Chattaraj, M. (2019). Identification of Agricultural Productivity Regions and its Major Determinants: A Case Study from Bankura District, West Bengal. *International Journal of Research in Social Sciences*, 9(5), 661–678.
- Tao, W. (2013). Interdisciplinary Urban GIS for Smart Cities: Advancements and Opportunities. *Geo-Spatial Information Science*, 16(1), 25–34. <https://doi.org/10.1080/10095020.2013.774108>
- Thakur, P. K., Aggarwal, S. P., Nikam, B. R., Garg, V., Chouksey, A., and Dhote, P. R. (2018). Training, Education, Research and Capacity Building Needs and Future Requirements in Applications of Geospatial Technology for Water Resources Management. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 42, 29–36. <https://doi.org/10.5194/isprs-archives-XLII-5-29-2018>
- Thapa, P. (2021). Using Geospatial Technologies for Disaster Management in Developing Countries. *Journal of Remote Sensing and GIS*, 9(4), 1–5.
- Tripathi, S. N., Bhatia, A. K., and Sethi, R. (2023). Assessing the Sustainability of “Vocational Education” in Higher Education Institutions Under the NEP 2020 in India. *Research in Science Education*, 7(2).
- Turkar, V., Chaudhari, S., and Naik, A. (2019). Geographic Information System and Remote Sensing Education in India—Issues and Solutions. In *IGARSS 2019—2019 IEEE International Geoscience and Remote Sensing*

Symposium (4304–4307).
<https://doi.org/10.1109/IGARSS.2019.8898348>

IEEE.

Valachamy, M., Sahibuddin, S., Ahmad, N. A., and Bakar, N. A. A. (2022). Critical Success Factors for Geospatial Data Sharing in Disaster Management. In IOP Conference Series: Earth and Environmental Science (Vol. 1064, No. 1, Article 012038). IOP Publishing. <https://doi.org/10.1088/1755-1315/1064/1/012038>

Venugopal, K. R. (2024). National Education Policy (NEP-2020): Issues, Challenges and Implementation. Techsar Pvt. Ltd.