

Vision for Harnessing India's Capability for Space Research in Central Asia

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Post-Soviet disintegration in 1991, a combination of five Commonwealth of Independent States (CIS) countries i.e. Kazakhstan, Uzbekistan, Turkmenistan, Kyrgyzstan and Tajikistan constituted the Central Asian Region (CAR). Since the beginning, relations between India and the CAR countries were focussed mainly upon soft power drivers like culture, education, films, medical, academics, etc. along with reasonably good conventional diplomatic ties, especially till the announcement of an all-encompassing Connect Central Asia Policy 2012. This policy was mainly based on 4Cs i.e. Commerce, Connectivity, Consular and Community, and provided a comprehensive workable roadmap for enhancing multilateral cooperation between India and Central Asia.¹ However, albeit having a multi-domain focus, the Connect Central Asia Policy seems to have inadvertently overlooked

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1. Martand Jha, "India's Connect Central Asia Policy: A Look Back at India-Central Asia Relations in the Post-Soviet Era", *The Diplomat*, December 2, 2016, <https://thediplomat.com/2016/12/indias-connect-central-asia-policy-2/>. Accessed on April 3, 2024.

the enormously relevant aspect pertaining to space research for peaceful purposes in the CAR.

PROLOGUE FOR INDIA'S PRESENCE IN SPACE RESEARCH IN CENTRAL ASIA

As is the common understanding, India's interests in the Central Asian Region (CAR) have been focussed primarily around the energy potential offered by the region. However, though India has been paying attention to the CAR by establishing friendly ties with these nations, its efforts towards this strategic need have not been so fruitful in establishing the Indian footprint here for various reasons. Perhaps one of the main reasons for this has been that India has been trying to explore its presence in the CAR mainly through the aforesaid soft power drivers. A shift in the strategic approach of India by contributing to the CAR states in a way positively different from the routine, therefore, was the need of the hour.

Considering the above, and by virtue of the expertise accumulated over the decades in space research, India enjoys brighter prospects of collaborating with the Central Asian nations to help augment the facilities of space research that though, are available in some of these CAR countries, have not been exploited in the desired measure. The other established space powers like China and Russia also are actively involved in the CAR, but are perhaps more focussed on realising their regional aspirations amidst the unending power game. Considering the ongoing power play between these two big powers, a far-sighted, well calculated and calibrated strategic shift in the Indian approach, by offering to collaborate in space research for peaceful and developmental purposes in the CAR, may yield better results, thereby solidifying the Indian strategic footprint here, indirectly paving the way for safeguarding and promoting smooth energy logistics through the CAR nations.

In view of the above, the sharing of the Indian expertise in space exploration and research in the CAR appears to be a preferred option, as this is likely to benefit not only India but also the countries constituting the CAR. Central Asia stands out as a potential participant in space activity because of its growing technological prominence and strategic potential. With continued efforts, enhanced collaborations and innovations in the sphere of space, India as well as the Central Asian countries stand a better chance to collaborate in the field of exploration and utilisation of outer space and, in turn, get mutually benefitted.

EXISTING SPACE CAPABILITY LANDSCAPE IN CENTRAL ASIA

The space capabilities of Central Asia are significantly manifested through its Baikonur cosmodrome, which happens to be the world's oldest and largest space launch facility. This cosmodrome, a cornerstone in the sphere of space exploration in Central Asia since the erstwhile Soviet era, came into the limelight with the first artificial satellite, the Sputnik-1, and Yuri Gagarin, the first human to go into space, having been launched from this site.² After the space shuttle programme was accomplished in 2011, the US National Aeronautics and Space Agency (NASA) preferred having all its astronauts fly from Baikonur until the new Commercial Crew Programme was ready to launch the astronauts.³

Among the countries of Central Asia, it is mainly Kazakhstan which has closely collaborated with Russia, the United States and the European Space Agency (ESA) in the sphere of space research. This was evident with their leaders having pledged to enhance

2. "Baikonur Cosmodrome", The European Space Agency, https://www.esa.int/Science_Exploration/Space_Science/Baikonur_Cosmodrome. Accessed on April 3, 2024.

3. Elizabeth Howell, "Baikonur Cosmodrome: Russian Launch Complex", Space.com, June 16, 2018, <https://www.space.com/33947-baikonur-cosmodrome.html>. Accessed on April 3, 2024.

cooperation in the space sector, especially after Russian President Putin's visit to Kazakhstan in November 2023. The Kazakhstan-Russia-USA combine seems to be actively collaborating in space research, which was exhibited through a NASA astronaut and two Russian cosmonauts landing in the snow-covered Kazakh steppe in January 2018 after a 167-day mission aboard the International Space Station (ISS).⁴ In addition, Russia, intending to augment its space presence further, has pledged to invest Rubles 609 billion, equal to \$6.7 billion, by 2030, to create its orbital station, enhancing Transfers of Technology (ToT), joint research initiatives and physical launch of satellites, thereby contributing to the development of space expertise and infrastructure of the CAR.⁵

The Central Asian countries have established and strengthened their respective national space agencies to coordinate and promote space activities to some extent. Kazakhstan's Kazcosmos⁶ and Uzbekistan's UzbekCosmos, as the space research and technology agency under the Ministry of Digital Technologies of the Republic of Uzbekistan,⁷ and Kyrgyzstan's Kyrgyz Space Programme Agency⁸ are examples of such initiatives. These agencies facilitate international space cooperation in developing the space policies

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4. "US-Russian Space Trio Land Safely in Kazakhstan", Business line, *The Hindu*, January 24, 2018, <https://www.thehindubusinessline.com/news/science/us-russian-space-trio-land-safely-in-kazakhstan/article62315732.ece>. Accessed on April 3, 2024.
 5. "World's Top Spaceport Faces Hard Times as Russia, Kazakhstan Squabble", *Business Standard*, April 1, 2024, https://www.business-standard.com/world-news/world-s-top-spaceport-faces-hard-times-as-russia-kazakhstan-squabble-123121400145_1.html. Accessed on April 3, 2024.
 6. Asia-Pacific Regional Space Agency Forum, <https://www.aprsaf.org/participants/countries/kazakhstan.php>. Accessed on April 4, 2024.
 7. "Overview", The Space Research and Technology Agency under the Ministry of Digital Technologies of the Republic of Uzbekistan, <https://uzspace.uz/en/page/overview>. Accessed on April 4, 2024.
 8. "Kyrgyz Space Program Blasting Gender Stereotypes Out of Orbit", Report by UNDP Eurasia, February 10, 2023, <https://undpeurasia.exposure.co/kyrgyz-space-program-blasting-gender-stereotypes-out-of-orbit>. Accessed on April 4, 2024.

and regulations besides supporting the domestic space industry, thereby driving the region's space ambitions. With advancements in the field of commercial space travel, Central Asia has the potential to explore the opportunities in space tourism through the capabilities of spaceport construction, astronaut training facilities and partnerships with companies dealing in space tourism. This progress signifies the region's aspirations to capitalise on this emerging space potential. Another effective manifestation of space power in the CAR is exhibited in the form of the Sharjah Centre for Astronomy and Space Sciences (SCASS)⁹ which is involved in collaboration with the Kazakhstan Gharysh Sapary Company for space technology and systems.¹⁰ The company is mandated to provide space images and remote sensing data from its KazEOSat-1 and KazEOSat-2 satellites in exchange for data processing services in the United Arab Emirates (UAE). The enterprise is also intended to promote training and information exchange.¹¹

Apart from this, the Central Asian countries are enhancing regional cooperation in space exploration through initiatives such as the Central Asian Regional Space Agency (CARSA) which aims to facilitate collaboration among member states in satellite development, space research and data sharing. In addition, Kazakhstan's Garysh Sapary (Kazakhstan Space Travel) established in 2007, signed a Memorandum of Understanding (MoU) in the sphere of space cooperation with various countries,

9. "Your Shuttle to Space", Sharjah Centre for Astronomy and Space Sciences, <https://www.sasst.ae/>. Accessed on April 4, 2024.

10. "Sharjah University Partners with Kazakh Firm for Space Research", Satellite Pro Middle East, January 14, 2019, <https://satelliteprome.com/news/sharjah-university-partners-with-kazakh-firm-for-space-research/>. Accessed on April 4, 2024.

11. Report on Emerging Spacefaring Nations, European Space Policy Institute, ISSN: 2218-0931 (print) 2076-6688 (online), p21, <https://www.espi.or.at/wp-content/uploads/2022/06/ESPI-Report-79-Emerging-Spacefaring-Nations-Full-Report.pdf>. Accessed on April 4, 2024.

including India in 2009, France in 2009, Israel in 2009, Germany in 2010 and Japan in 2010, followed by the United Kingdom in 2013.¹²

The major milestones achieved by the various Central Asian countries in the sphere of space research and operations can be summarised as under:

- **Kazakhstan:** As stated above, Kazakhstan's space activity is lauded by its cosmodrome located in Baikonur which has served as a crucial hub for launching spacecraft and satellites since the Soviet era and continues to be leased by Russia for its space missions. Squadron Leader Rakesh Sharma (now retired), the first Indian cosmonaut, travelled to the Salyut 7 Orbital Station in a Soviet manufactured rocket, the Soyuz T-11, launched on April 3, 1984, from the Baikonur cosmodrome located in the Kazakh Soviet Socialist Republic.¹³ In addition to this, the National Space Agency of the Republic of Kazakhstan (KazCosmos) is involved in various space-related activities such as satellite launches, space research and international collaborations to handle various space missions, including those of the International Space Station.¹⁴ In short, KazCosmos is instrumental in positioning Kazakhstan as a key player in the field of space exploration and technology,

12. Nelly Becus and Zhomart Medeuov, "Emerging Space Power in Central Asia: Kazakhstan at The Crossroad", Near East Policy Forum, July 18, 2022, <https://nepf.org.au/index.php/emerging-space-power-in-central-asia-kazakhstan-at-the-crossroad/>. Accessed on April 5, 2024.

13. FE Lifestyle, "Meet Rakesh Sharma: The First Indian to Venture into Space; Know about his Journey and How he Leads a Simple Life in a Village Now", *Financial Express*, August 29, 2023, <https://www.financialexpress.com/lifestyle/meet-rakesh-sharma-the-first-indian-to-venture-into-space-know-about-his-journey-and-how-he-leads-a-simple-life-in-a-village-nmeet-rakesh-sharma-the-first-indian-to-venture-into-space-know-about-his-j/3224935/>. Accessed on April 5, 2024.

14. Project Report "Creation Of Ground-Based Infrastructure of Differential Global Navigation Satellite System in the Republic of Kazakhstan", <https://www.unoosa.org/documents/pdf/psa/activities/2009/azerbaijan/presentations/15-1.pdf>. Accessed on April 10, 2024.

contributing to the nation's scientific advancement, economic growth, and international prestige.¹⁵

- **Uzbekistan:** Uzbekistan has displayed keen interest in making advancements in its space sector by establishing the Uzbekistan National Space Agency (UzbekCosmos) in 2017, to oversee its space activities and promote cooperation with other space-faring nations.¹⁶ The premier Uzbek Space Research and Technology Agency (SRTA) operating under the Ministry of Digital Technologies of the Republic of Uzbekistan, plays a crucial role in fostering innovation-driven scientific development in the country's space sector and is tasked with coordinating and implementing the national space programmes, initiatives and projects that aim at leveraging the space technologies for socio-economic development and national security.¹⁷ This was established with a primary objective to develop and launch satellites for various space applications, covering the entire spectrum of telecommunications, Earth observation and navigation.¹⁸ By investing in space infrastructure and capabilities, Uzbekistan aims to enhance its telecommunications networks, monitor natural resources, and bolster national security.
- **Turkmenistan:** While not so actively engaged in space exploration, Turkmenistan has shown interest in satellite communications and remote sensing technologies. The country

15. JSC, "National Company Kazakhstan Gharysh Sapary", LinkedIn page, <https://www.linkedin.com/company/jsc-national-company-kazakhstan-gharysh-sapary-/about/>. Accessed on April 10, 2024.

16. "Uzbekistan Set to Establish Space Research and Technology Agency", *Strategeast*, November 1, 2018, <https://www.strategeast.org/uzbekistan-set-to-establish-space-research-and-technology-agency/>. Accessed on April 5, 2024.

17. The Space Research and Technology Agency (SRTA) operates under the Ministry of Digital Technologies of the Republic of Uzbekistan, ZBEKOSMOS, <https://uzspace.uz/en/page/overview>. Accessed on April 10, 2024.

18. *Ibid.*

has launched a few small satellites mainly for telecommunications purposes and has sought partnerships with other countries to develop its space sector further.¹⁹ The Turkmenistan National Space Agency (TNSA) being the premier governmental organisation, has a mandate to oversee and promote the space exploration and satellite development ambitions of Turkmenistan. It aims to leverage space technology to handle a wide array of operations like communication, remote sensing and scientific research.²⁰ While the agency is not so advanced compared to space agencies operating in other countries, it is found to be making modest strides in promoting the country's space capabilities with achievements like the launch of the TurkmenAlem52E/MonacoSAT, i.e. Turkmenistan's first national communications satellite, accomplished in 2015.²¹

INDIA'S PARTICIPATION IN SPACE RESEARCH IN CENTRAL ASIA

India has made tremendous progress in the sphere of space research in the past decades and, therefore, seems equipped with capabilities to collaborate constructively in the space domain with the CAR countries. Apart from Government of India agencies like the Indian Space Research Organisation (ISRO), now the support of the Indian private sector too has started coming to the fore. The significance of India's global participation in the sphere of space technology and the role of the private sector in the activity has been recently underscored by the prime minister of India stating in February 2024, that "*India needs to increase its share in the global*

19. "Turkmenistan is Expanding its Satellite Capabilities", Space Technology Conference, April 24-26, 2024), STC 2024 Eurasia, November 22, 2022, <https://www.spacetechnologyconference.com/post/turkmenistan-is-expanding-it-s-satellite-capabilities>. Accessed on April 5, 2024.

20. MonacoSat, "Sky Brokers", <https://sky-brokers.com/supplier/monacosat/>. Accessed on April 10, 2024.

21. Ibid.

space industry and the private sector will play a big role in that".²² India is already having some collaborations with the CAR nations in the following space sub-domains:

- **Satellite Launch Services:** India has provided satellite launch services to Central Asia, facilitating the deployment of satellites for communication, remote sensing and scientific research purposes. One of the major examples of this collaboration is India's Polar Satellite Launch Vehicle (PSLV) which has been utilised to launch satellites for countries like Kazakhstan and Uzbekistan, thereby enhancing their space capabilities and connectivity.²³
- **Remote Sensing and Earth Observation:** India's premier space agency, the Indian Space Research Organisation (ISRO), has collaborated with the Central Asian countries through initiatives like the Indian Technical and Economic Cooperation (ITEC) programme, whereby ISRO has provided training and technical assistance to Central Asian scientists and researchers in utilising remote sensing data for applications such as agriculture, land management, and disaster monitoring.²⁴
- **Communication and Navigation:** India has contributed to enhancing communication and navigation infrastructure in Central Asia through satellite-based technologies. The deployment of Indian communication satellites like the GSAT (Geosynchronous Satellite) series has facilitated telecommunication services in remote and under-served areas of the Central Asian countries. India also launched the GSAT-15 satellite using the platform of the European Ariane

22. Industry Scenario, Invest India, February 8, 2024, <https://www.investindia.gov.in/sector/space>. Accessed on April 4, 2024.

23. "PSLV C-37 Successfully Launches 104 Satellites in a Single Flight", Press Release, Embassy of India, Tashkent, Uzbekistan, February 15, 2017, <https://eoi.gov.in/tashkent/?5812?003>. Accessed on April 15, 2024.

24. ITEC Program, Embassy of India, Tashkent Uzbekistan, Ministry of External Affairs, <https://eoi.gov.in/tashkent/?2240?004>. Accessed on April 15, 2024.

rocket from Kourou in French Guiana on November 11, 2015. By November 10, 2015, Arianespace had achieved the distinction of having conducted 227 Ariane launches, and 38 Soyuz launches out of which 12 were from the Guiana Space Centre and 26 from the Baikonur cosmodrome, via Starsem besides five Vega launches.²⁵ Enhanced participation of India with Central Asia and Saudi Arabia may accrue to India the benefits of Saudi Arabia's Arabsat-6B (BADR 7) satellite which is the first of the sixth generation of satellites in the Arabsat fleet and has been positioned to provide telecommunications and Direct-To-Home (DTH) TV broadcast services to the Middle East, Africa and Central Asia.²⁶

- **Scientific Collaboration:** India has also engaged in some scientific collaboration with the Central Asian countries in space research and exploration. Joint research projects, workshops, and academic exchanges have been organised to foster collaboration in areas such as planetary science, and astronomy, besides a host of other fields.²⁷
- **Capacity Building and Training:** This apart, India has been involved in capacity building and training initiatives aimed at building human resources and technical expertise in the Central Asian countries' space agencies and research institutions. The Indian experts provide training and knowledge transfer

25. "Arianespace Orbits Arabsat-6B and GSAT-15 Satellites for Arabsat and ISRO", Arianespace, November 10, 2015, <https://www.arianespace.com/press-release/arianespace-orbits-arabsat-6b-and-gsat-15-satellites-for-arabsat-and-isro/>. Accessed on April 15, 2024.

26. "India's Communications Satellite GSAT-15 Launched Successfully", *Economic Times*, November 11, 2015, <https://economictimes.indiatimes.com/news/science/indias-communications-satellite-gsat-15-launched-successfully/articleshow/49743900.cms?from=mdr>. Accessed on April 15, 2024.

27. "Joint Statement of the 3rd Meeting of the India-Central Asia Dialogue", MEA India Report, December 19, 2021, https://www.mea.gov.in/bilateral-documents.htm?dtl/34705/Joint_Statement_of_the_3rd_meeting_of_the_IndiaCentral_Asia_Dialogue. Accessed on April 15, 2024.

in satellite technology, remote sensing applications, and space science through programmes like the Indian Technical and Economic Cooperation (ITEC) and Space Technology Cooperation Programme (STCP).²⁸

- **Regional Cooperation and Partnerships:** India, being a member of the United Nations Office for Outer Space Affairs (UNOOSA), is a participant in regional forums and initiatives promoting space cooperation in Central Asia.²⁹ This apart, India is also a regular participant in regional workshops, conferences and various forums aimed at fostering collaboration in space-related activities among the Central Asian countries and other stakeholders.³⁰

FUTURE OPTIONS FOR ENHANCING INDIA'S PARTICIPATION IN THE SPACE DOMAIN IN CENTRAL ASIA

India, having made far-reaching progress in the field of space technology, has bright prospects for engaging more effectively in the future with Central Asia in some of the following segments of the space domain:

- **Mining:** Considering the mineral-rich potential of the CAR in respect of sulphur, gypsum and phosphates, to name a few, India, through active participation by undertaking systematic surveying, prospecting and exploring the availability of minerals, can cooperate with the CAR nations through its agencies like the Geological Survey of India (GSI), Oil and Natural Gas Commission (ONGC), Mineral Exploration

28. "Delhi Declaration of the 1st India-Central Asia Summit", Ministry of External Affairs (MEA) India Report, January 27, 2022, https://www.mea.gov.in/bilateral-documents.htm?dtl/34773/Delhi_Declaration_of_the_1st_IndiaCentral_Asia_Summit. Accessed on April 15, 2024.

29. Space Debris Compendium, COPUOS, June 17, 2021, <https://www.unoosa.org/documents/pdf/spacelaw/sd/India.pdf>. Accessed on April 15, 2024.

30. UNCOPUOS, MEA India, <https://eoi.gov.in/eoishow/MyPrint.php?8872?001/0029>. Accessed on April 15, 2024.

Corporation Ltd. (MECL), National Mineral Development Corporation (NMDC), Indian Bureau of Mines (IBM) and Bharat Gold Mines Ltd. The feasibility of mining exploration can be explored with satellite imagery by providing detailed information on geological features, mineral deposits and terrain physiognomies in Central Asia. Through its capabilities to conduct systematic surveys using satellite data to identify the potential mining sites and assess their viability through its expertise in remote sensing and geospatial analysis, India has the capabilities of collaborating with the Central Asian countries in optimising their mineral exploration activities, leading to sustainable resource development and economic growth.

The utilisation of space-based technologies in enhancing mining exploration, resource management and environmental monitoring in the Central Asian region can be explored in the following ways:

- **Using Remote Sensing for Mining Exploration:** Space-borne remote sensing satellites equipped with advanced sensors for multispectral, hyperspectral and thermal imaging merit a positive consideration towards being deployed to identify the potential mineral deposits and geological anomalies across the vast and remote areas in Central Asia. The Indian Bureau of Mines (IBM) and the National Remote Sensing Centre (NRSC) have signed a Memorandum of Understanding (MoU) to facilitate the use of space-based technologies to explore mining capabilities and monitor mining activities, and through mobile apps for field data collection in order to check the ground realities of the mining activities.³¹ This low cost option might

31. "India to Monitor Mining Activity with Satellites", *Mining Technology*, News India monitoring, January 21, 2016, <https://www.mining-technology.com/news/newsindia-monitor-mining-activity-through-satellite-technology-4791593/?cf-view>. Accessed on May 11, 2024.

also be applied by India in the CAR nations in carrying out the activity within affordable economies of scale.

- **Geological Mapping and Survey:** India can also use space-based platforms like LandSat, Aster, QuickBird, Spot and HypariOn, etc,³² to facilitate generating detailed geological maps and providing accurate and up-to-date information on terrain characteristics, geological signatures and resource distribution. Geological mapping from space can enable the Indian mining companies to assess the geological potential, identify favourable exploration targets and plan the mining operations more objectively in the CAR.
- **Monitoring the Environmental Impact:** Satellite-based monitoring systems can track the environmental changes and assess the impact of the mining activities related to the utilisation of land, vegetation cover, water resources and air quality in the Central Asian countries. Remote sensing satellites can be beneficial owing to their inherent capability of detecting the degradation of land, deforestation, soil erosion and water pollution caused by mining operations, enabling regulatory authorities and environmental agencies to enforce the environmental regulations, mitigate risks and prevent ecological damage. By monitoring environmental indicators from space, the Indian policy-makers can promote responsible mining practices, ensure compliance with environmental standards, and safeguard the natural environment and biodiversity in the CAR.³³
- **Infrastructure Planning and Management:** The space-based technologies have the inherent capability to support the planning, construction and management of the mining

32. Vinod Kumar and Arindam Guha, *Geosciences, Remote Sensing Applications*, ch 7, National Remote Sensing Centre, p.168, https://www.nrsc.gov.in/sites/default/files/pdf/ebooks/Chap_7_Geosciences.pdf. Accessed on May 11, 2024.

33. Ibid.

infrastructure in terms of roads, railways, power lines and processing facilities in the Central Asian nations.³⁴ Satellite imagery and geospatial data can objectively assess site suitability, optimised route alignments besides monitoring the construction progress and enabling the infrastructure developers to streamline project delivery, alongside minimising the costs and improving the operational efficiency.³⁵ By utilising satellite-based navigation and communication systems, the Indian mining companies can augment the logistics coordination, real-time logistical tracking and workforce management, facilitating smoother and more productive mining operations in remote and challenging environments.

- **Risk Assessment and Disaster Management:** The space-borne sensors can provide early warning of natural disasters, such as landslides, earthquakes and floods, which pose risks to mining operations and local communities in Central Asia. The satellite-based monitoring systems can detect changes in terrain stability, seismic activity and hydrological conditions, thereby allowing the stakeholders to assess the potential hazards and implement preventive measures, besides responding swiftly to emergency situations. By integrating the satellite data with geospatial analytics and risk assessment models, the mining companies and emergency responders can improve their disaster handling preparedness and minimise loss of life and property besides enhancing the resilience to natural hazards in mining regions.
- **Road and Highway Construction:** The premier Indian highway construction agency the National Highways Authority of India (NHAI) has inked an MoU with the

34. "Evaluation of Space-borne LIDAR for Terrain Feature Extraction and Mapping", *Recent Studies*, Indian Institute of Remote Sensing, Government of India, <https://www.iirs.gov.in/recentstudies>. Accessed on May 11, 2024.

35. Kumar and Guha, n.32.

National Remote Sensing Centre (NRSC), whereby, the NRSC will undertake a comprehensive pan-India estimation of green cover, referred to as the "Green Cover Index" for national highways, using high-resolution satellite imagery.³⁶ NHAI and NRSC can extend the scope of implementing the capability also in Central Asia. For this, India can utilise high-resolution satellite imagery to assess terrain conditions, identify suitable routes and optimise infrastructure development plans.³⁷

- **Agriculture:** Satellite imagery plays a crucial role in assessing the agricultural potential and enhancing food security in Central Asia. India also possesses the prospects of collaborating with regional stakeholders to leverage satellite data for crop monitoring, land use mapping and yield estimation, to mention a few important aspects of agricultural activity. Remote sensing technologies provide valuable information on vegetation health, soil moisture levels and crop performance, enabling farmers to make deliberate and informed decisions besides optimising the agricultural practices. India's experience in satellite-based agriculture monitoring, demonstrated through initiatives like the National Crop Forecast Centre (NCFC),³⁸ if adopted, would prove useful to support the Central Asian countries in improving the farm productivity and creating reasonable resilience to climate change. Needless to state that

36. "NHAI Signs MoU with NRSC for Development and Reporting of 'Green Cover Index' for National Highways of India", Announcements, Ministry of Road Transport and Highways, https://www.nrsc.gov.in/sites/default/files/pdf/Announcements/NHAI_NRSC_MoU.pdf. Accessed on May 11, 2024.

37. Rajat Arora, "NHAI to Use Space Technology, UAVs for Highway Projects", *Economic Times*, January 13, 2016, <https://economictimes.indiatimes.com/news/economy/infrastructure/nhai-to-use-space-technology-uavs-for-highway-projects/articleshow/50562856.cms?from=mdr>. Accessed on April 15, 2024.

38. Mahalanobis National Crops Forecast Centre (MNCFC), Ministry of Agriculture and Farmers Affairs, <https://www.ncfc.gov.in/index.html>. Accessed on April 15, 2024.

by harnessing satellite imagery for precision agriculture, India can contribute to sustainable rural development and poverty alleviation in the CAR.

- **Intelligence Gathering to Guard Against Security Threats:** This is a critical area considering the need to safeguard the Indian national security interests amidst rising rivalries with China in the CAR. Satellite imagery serves as a critical tool for intelligence gathering, surveillance and information sharing between India and the nations of Central Asia, to monitor geopolitical developments, track military activities and assess the border security ecosystem in the region. The high-resolution satellite imagery can provide better situational awareness, enabling policy-makers to anticipate the threats, detect illicit activities and formulate effective response mechanisms. By leveraging satellite-based intelligence, India would be better equipped to contribute to stability, peace-keeping efforts and counter-terrorism initiatives in Central Asia, thereby fostering mutual trust and collaboration among the regional stakeholders.

The operation of a few mechanisms in the sphere of intelligence gathering using the space medium can prove to be a force enhancer for India while dealing with terrorism and misdemeanors caused by the organised terror groups and the rising radicalisation in Central Asia:

- **Remote Sensing Satellite:** Remote sensing satellites equipped with high-resolution cameras, Synthetic Aperture Radar (SAR) and other sensors are deployed to gather intelligence using the space domain. These satellites can be utilised to capture the detailed imagery of the vital areas and vantage points in the CAR and potential threats to these installations.³⁹

39. "India Planning to Launch 50 Satellites for Intelligence Gathering in Five Years: ISRO Chief", *Economic Times*, December 29, 2023, <https://economictimes.com>.

- **Signals Intelligence:** The US and Russia, for the last more than 40 years, have had space-based Signals Intelligence (SIGINT) platforms which have the capacity to intercept, analyse and exploit the electro-magnetic signatures emitted by the communication systems, radars and electronic devices. Even after its disintegration, Russia still operates at least two Electronic Intelligence (ELINT) platforms though at a scaled down level.⁴⁰ Considering the need for enhanced surveillance, India launched an ISRO-developed indigenous ELINT platform called the Electromagnetic Intelligence Gathering Satellite (EMISAT) on April 1, 2019.⁴¹ These SIGINT satellites, with extended ranges, can help in monitoring the moves of, and detecting threats from, radical Islamic groups operating in the CAR by timely the gathering information and initiating suitable rebuttals to the extremists' intelligence network, and safeguarding the military and national security interests of both India and the CAR nations.
- **Geopolitical-Spatial Intelligence:** Geospatial Intelligence (GEOINT) derived from space-based assets provides geospatial information, analysis and wherewithal to support intelligence gathering and decision-making. The GEOINT, with a combination of satellite imagery, terrain data and other geospatial information to create maps, charts and intelligence reports for military and intelligence purposes, can aid India

indiatimes.com/news/science/india-planning-to-launch-50-satellites-for-intelligence-gathering-in-five-years-isro-chief/articleshow/106356380.cms?from=mdr. Accessed on May 11, 2024.

40. Group Captain GD Sharma, "Exploiting Indian Military Capability in Outer Space", Centre for Joint Warfare Studies (CENJOWS), ISBN : 978-93-84492-19-9, Xtreme Office Aids Pvt. Ltd, https://cenjows.in/wp-content/uploads/2022/03/Layout_Exploiting-Indian-Military.pdf. Accessed on May 11, 2024.
41. Satellite Missions Catalogue, eoPortal, April 3, 2019, <https://www.eoportal.org/satellite-missions/emisat#emisat-electromagnetic-intelligence-gathering-satellite>. Accessed on May 11, 2024.

in gathering meaningful information to also collaborate with the CAR nations in fighting against organised terror designs and other actions inimical to India's national security. The data available from multiple sources in real-time, its analysis with minimal human intervention to draw perceptions, and making these insights available to the last man in the chain, i.e. the combatant on the battlefield, facilitate a field commander in making effective tactical decisions. GEOINT also helps in identifying the terrain features, assessing infrastructure, mapping enemy positions and objectively planning military operations.⁴²

- **Communication and Data Relay:** The space-based communication and data relay satellites facilitate secure and reliable communication among the armed forces, intelligence agencies and select government entities. These satellites are expected to provide high-bandwidth communication links, enabling real-time data transmission besides offering an effective platform for command and control, leading to an enhanced sense of situational awareness to the Indian Air Force (IAF) in Central Asia. This can be further extended to cover the CAR nations also to facilitate the IAF's strategic positioning in the CAR.

WAY FORWARD

In view of the foregoing, we can be reasonably confident that as an emerging global power, India's advanced satellite technology and expertise may be harnessed through the active participation of the premier Indian space research agency i.e. ISRO, to explore the utilisation of the space domain in the spheres of mining, road

42. Anurag Garg, "Geospatial Intelligence: The Next Frontier in Space", *The Times of India*, September 13, 2022, <https://timesofindia.indiatimes.com/blogs/voices/geospatial-intelligence-the-next-frontier-in-space/>. Accessed on May 11, 2024.

and highways construction and agriculture potential, besides intelligence gathering for safeguarding the security interests of India as well as the countries constituting the CAR. Needless to say, by utilising space research through collaborative initiatives and information-sharing mechanisms, India can establish its footprint firmly in the region and also play a pivotal role in reshaping the geo-political and security landscape of Central Asia, by contributing to tranquillity, stability, prosperity and peace in the CAR as well as the region around its own periphery.