Issue Brief
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China's Techno-Military Modernization in Tibet and its Impact on Climate

Amrita Jash

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This issue brief examines China's extensive techno-military modernization in the Tibet Autonomous Region (TAR), with a focus on infrastructure development and its ecological implications. The Chinese government's investment in TAR's infrastructure development, a crucial component of the 14th Five-Year Plan, is focused on large-scale dual-use infrastructure, including road networks, highways, airports, and railroads. Despite being presented as developmental, these infrastructure projects significantly expand China's military mobility and enhance its strategic depth in the region. However, this rapid securitization comes with serious ecological consequences, such as grassland degradation, waterway pollution, and community displacement. Consequentially, Tibet's fragile ecosystems are increasingly strained by anthropogenic pressures, particularly those linked to China's intensified land use and infrastructure expansion. This issue brief argues that China's aggressive infrastructure drive, under the guise of economic development, is a primary driver in accelerating the climate and ecological crisis on the Qinghai-Tibet Plateau (QTP)—underscoring the entanglement of geopolitical strategy and environmental degradation on the 'Roof of the World.'

Introduction

Over the years, China has significantly increased its military presence in the Tibet Autonomous Region (TAR), through troop deployment and dual-use infrastructure development. Early January 2025, the Chinese government announced plans to allocate US$11.3 billion for infrastructure development in Tibet this year, claiming that "this investment, representing more than a third of the region's GDP, is aimed at advancing the area's infrastructure, with a particular focus on transport projects, including railways, roads, and up to 10 new airports."[1] Last year, China announced an 80-billion-yuan (about US$ 11.26 billion) investment to boost key infrastructure, as outlined by the Work Report released by the Autonomous Region on January 11, 2024, stating:

> Accelerate the construction of major projects such as the Tibet section of the Sichuan-Tibet Railway, the G4218 Shiquanhe Town to Kunsha Airport section, the G219 Medog to Zayu section and the G318 quality improvement and transformation, and realize the full opening of the Lhasa-Rihe Expressway. Strive to start the construction of the Bomi-Ranwu section of the railway and the electrification transformation project of the Golmud section of the Qinghai-Tibet Railway. Start the construction of 10 general airports and 47 temporary landing and take-off points.[2]

Furthermore, in March 2024, the TAR Transportation Department during a video conference to mobilize and deploy the resumption of construction of highway transportation projects across the region, announced an extensive plan of 417 roadway construction projects scheduled for completion within 2024. As per reports, the meeting categorically emphasized that:

> The construction of key highway projects be accelerated, the key highway projects under construction such as the G4218 Lhasa to Shigatse Airport section be steadily promoted, and the preliminary work of new projects such as the quality improvement and renovation project of the G109 Golmud to Nagqu section be accelerated. The construction of rural highway projects should be accelerated, and the implementation of 281 administrative village access projects should be promoted, and efforts should be made to add 175 administrative villages with hardened roads. All projects within the "14th Five-Year Plan" should be started within the year, and the mid-term regulation adjustment projects should be ready for construction as soon as possible, and major projects such as the quality improvement and renovation of the G318 line from Genyao to Wada (Lengqu River) section should be implemented as soon as possible within the year.[3]

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Under its 14th Five-Year Plan (2021-2025), China has specially allocated approximately US$30 billion on infrastructure projects in Tibet,[4] including building new expressways, upgrading existing highways and improving the road conditions in rural areas, among other fields. The goal is: "By 2025, Tibet will exceed 1,300 km of expressways and total to over 120,000 km of highways".[5]

What adds to the 'funding' is the emphasis on the scope and scale of the projects—highlighting China's aggressive push towards strategic infrastructure upgrades in TAR. China's rapid securitization and militarization of Tibet through the build-up of dual-use infrastructure have brought significant disruptions to Tibet's fragile ecosystems, threatening wildlife, drying up grasslands, polluting rivers, and displacing local populations through "environmental resettlement" or "ecological migration."[6]

Notably, the environmental impact of climate change on Tibet has been studied from a multifaceted perspective, which includes changes in water resources, geo-environmental changes,

and alterations in temperature and precipitation patterns, causing increased rainfall, accelerated water cycles, and intensified desertification; which has also impacted ecosystems, productivity, carbon sequestration, and livelihoods of herder households and communities. The available literature suggests that anthropogenic pressures, such as population increase, urbanization, overgrazing, and land use and cover change in the Qinghai-Tibet Plateau (QTP), have had a more significant local and regional scale impact than non-anthropogenic influences.[7] In other words, if the intensity of growing anthropogenic activity surpasses the ecosystem's capacity, adverse ecological effects are a given in Tibet. Pivoting on the anthropogenic aspect, this issue brief argues that China's techno-military modernization activities are a key causal factor that is contributing to the climate crisis on the 'Roof of the World.'

Why Tibet is Vulnerable?

Tibet, known as "the third pole of the world" and "the Asian water tower", lies at an average altitude of more than 4,000 meters, covering more than 1,228,400 square kilometers, and accounts for one-eighth of China's total land mass.[8] Identified as one of the most "geologically, geographically and ecologically unique areas on the planet", scholars have interpreted 'Tibet' in varying ways, such as, "a natural laboratory for understanding the interactive evolution of the man-land relationship"; "China's ecological shield and water conservation area"; "an ecologically fragile area, as exemplified by alpine grassland degradation and glacier retreat"; and having "a unique ecological status and significant role in ecological protection", among others.[9] To sum up, as a regulator of environmental change in Asia and the Northern Hemisphere, the Tibetan Plateau plays a key role in maintaining 'the stability of the climate system, water supply, and carbon balance, in addition to protecting biodiversity and preserving ecological security barriers'.[10]

"Studies have found that western China suffers from the most severe ecological pressures, among which the Tibet Autonomous Region and Qinghai province had the highest degree of environmental vulnerability. Notably, 74.79 percent of the Tibetan Plateau consists of moderately to severely vulnerable areas, making it the largest ecologically vulnerable area in China.

In assessing the ecological/environmental vulnerability[1] (EV) of mainland China, studies found that western China suffered from the most severe ecological pressures, among which the Tibet Autonomous Region and Qinghai province had the highest degree of EV.[11] Notably, 74.79 percent of the Tibetan Plateau consists of moderately to severely vulnerable areas, making it the largest ecologically vulnerable area in China, with low ecological resilience and serious ecological vulnerability.[12] For instance, it is pointed that while Lhasa, Shigatse, and Shannan prefectures are important bases for the socio-

1 EV is an estimate of the inability of an ecosystem to withstand stress. Its characterization involves topography, climate change, vegetation degradation, land suitability, desertification, salination, biodiversity degradation, and human activities. See Kang Hou, et al., "A new perspective on ecological vulnerability and its transformation mechanisms," *Ecological Health and Sustainability* 8, no. 1 (2022), https://doi.org/10.1080/20964129.2022.2115403.

economic development of the whole Tibetan Plateau, most areas of these prefectures along the Yarlung Zangbo (Brahmaputra) River have been highly threatened by land desertification and, in the Ngari and Nagqu prefectures, it is difficult to restore the degraded land due to the arid climate and high elevation.[13] Calling it the "most fragile and sensitive ecosystem on earth", to an extent, scholars also assert that: warming of the QTP can lead to glacier retreat, inconsistent snow cover change, and permafrost melting, which influences far beyond the QTP itself by changing the water supply of billions of people downstream and altering the Earth's atmospheric circulation.[14]

Observed data from Chinese investigations on glacier shrinkage, permafrost degradation, and their environmental effects on the QTP indicated that a large part of the QTP had experienced significant warming since the mid-1950s.[15] Of all factors, one such aspect is anthropogenic factors on the Tibetan Plateau, which are responsible for speeding up the environmental degradation and its associated problems. One of the major causes has been the Chinese government's policy to bring about changes in land use, in particular, the conversion of grassland into cropland to maximize agricultural production or for that matter infrastructural development such as roads, railways and new settlements, as various studies suggest:

> Human activities in the Tibetan Plateau have expanded dramatically, owing to accelerated industrialization and rapid regional economic expansion. […] The local ecological environment has begun to deteriorate due to overgrazing, excessive land use, and poorly constructed road networks. Increasing pressure from climate change and human activities makes local ecosystems highly vulnerable and exacerbates soil erosion risk.[16]

"While China sees its infrastructure buildup as development, the rampant infrastructure buildup has caused severe climate and environmental impacts. Apart from deforestation and land degradation, air pollution and carbon emissions, some of the specific impacts are glacial retreat, permafrost degradation and water cycle disruption.

China's Militarization of Tibet: An Anthropogenic Factor

Tibet is part of the People's Liberation Army's (PLA) Western Theatre Command, which oversees combat operations and joint training of Chinese military forces—responsible for security along the border with India as well as maintaining stability in the Tibet and Xinjiang regions. As a result, China has revamped its military activities that exemplify its core concentration on combat missions in terms of new military equipment deployment and infrastructure build-up, among others.[17] According to reports, China is constructing a large heliport in Golmud, a key staging post for troops and heavy equipment against India, alongside other military developments in Tibet, including a major military logistics hub in Shigatse, a surface-to-air missile site on the banks of Mansarovar Lake, and air defense positions in sensitive disputed areas.[18] Additionally, it is also reported that China has deployed advanced weapons systems to border areas in the high-altitude desert in its northwest and the QTP in its southwest, including the Type PHL-03 multiple launch rocket system (MLRS), which has a firing range of 70 to 130km, and PCL-181 vehicle-mounted howitzers.[19]

What has become apparent with time is China's heavy investments in the infrastructure development in Tibet, including roads, railways, airports, urban expansion and others (see Table 1). While these projects, on one hand, aim to improve connectivity, economic growth, and regional integration, and most importantly, are mainly dual use in nature, on the other hand, they have significant environmental consequences, especially for Tibet's fragile climate and ecosystem.

Table 1. China's Select Infrastructure Projects in Tibet

Nature of Infrastructure	Name of Infrastructure	Details
Roadways	National Highway G6/ G109	G109 connects Beijing to Lhasa. The G6 is the portion that connects Lhasa to Xining in Qinghai.
	National Highway G219 / G564	G219 connects Xinjiang to Tibet–originates from Yecheng in Xinjiang and terminates at Lhatse in Tibet. G564 will emerge from G219 and will reach Purang near the China-India-Nepal tri-junction. It will pass between Mansarovar and Rakshas lake.
	National Highway G318	G318 connects Shanghai to Tibet through Chengdu in Sichuan. It then enters Nepal near Zhangmu near the China-Tibet border. The road passes through Nyingchi, close to the China-India border near Arunachal Pradesh, and a feeder road originating from G318 also reaches opposite Tawang near Cono county.
	National Highway G317	G317 originates in Chengdu, Sichuan and runs parallel to G318 through Chamdo and Nagqu before meeting G109- which meets G318 at Lhasa.
	Other Highways	Pei-Metok Highway (Nyingchi to Mehtok), Lhasa-Nagqu highway, Nagqu-Ngari Ali Highway, Borne to Medok Highway, Qiongjie to Cona Highway, Bayi-ManlWing Highway, G214 Kunming-Lhasa Highway and more.
Railways	Sichuan-Tibet Line	Divided into three sections: Chengdu to Ya'an (140 km), which opened in December 2018; Lhasa to Nyingchi (435 km), which opened in June 2021; and Ya'an to Nyingchi (1,011 km), which is likely to be completed by 2030.
	Qinghai-Tibet Line[2]	Construction began in 2001 and was completed by 2006. This line was further extended to Shigatse in 2014. It is the only railway connecting China's mainland to Tibet. The length is 1,956 km.
	Shigatse-Yadong Extension	Lhasa–Shigatse line will be further extended from Shigatse to Yadong County. Yadong County is the last county on the China-India border near Sikkim and adjacent to India's Nathu la pass.

2 It is the first rail line which was completed in 2006 and has been expanded since then.

Nature of Infrastructure	Name of Infrastructure	Details
Railways	Shigatse-Gyirong-Katmandu (Nepal)	Project stands incomplete
	South Xinjiang-Tibet Loop	Hotan-Shigatse line (825 km– under construction) largely follows G 219 route – unknown if it would enter Aksai Chin region like the highway, Hotan – Ruoqiang line (Xinjiang–under construction), Ruoqiang–Korla section of the Golmund–Korla line (in operation since 2014) and Gomund–Lhasa Section of the Qinghai-Tibet line (in operation since 2006). Together, these lines form the Tibet–South Xinjiang loop connecting most major cities in the region.
	Other Lines	Yunnan-Tibet line (still planned); 617 km Dunhuang – Golmud Railway (opened in 2019)
Airbases and Airports	Lhasa Gonggar Airbase	Dual-use airport
	Shigatse Peace Airport	Dual-use airport
	Nyingchi Mainling Airport	Dual-use airport
	Ngari Gunsa Airport	Dual-use airport
	Qamdo Bangda Airport	Dual-use airport
	Shigatse Tingri Airbase	Under construction
	Damxung Airbase	Under construction
Border Villages (Xiaokang Villages)	To develop 628 villages (427 first-line and 201 second-line villages)	Spanning from Ngari Prefecture to Nyingchi.

Source: Compiled by author with reference to Desai (2021)[20] and Singh (2024)[21]

While China sees its infrastructure buildup as development, it is important to note that such rampant infrastructure buildup has caused severe climate and environmental impacts. Apart from deforestation and land degradation, air pollution and carbon emissions, some of the specific impacts caused by infrastructure build-up are as follows.

First, it has caused severe glacial retreat in Tibet, which is the third-largest ice mass in

the world after Antarctica and the Arctic. The melting of glaciers has accelerated due to the rising temperatures on one end and due to disturbances caused by the infrastructure buildup on the other. More specifically, it is found that 'black carbon' (BC) is a key contributor directly related to anthropogenic atmospheric emissions[22] caused by pollution from construction and transport, which contributes to the melting of the glacier. As noted, BC affects approximately 28 percent of total glacier melt in the Hindu Kush Himalayas (HKH)—affecting the cryospheric melt and, therefore, the quantity and timing of seasonal melt feeding major river systems.[23] Studies suggest that ice loss at the third pole has accelerated over this century and is now roughly double the melt rate of 1975 to 2000, when temperatures were on average 1C lower—with the glaciers currently losing about half a vertical meter of ice per year because of anthropogenic global heating.[24] This glacial retreat carries a significant risk of death and injury (far more than in the sparsely populated Arctic and Antarctic), caused by glacial lake outbursts (when a lake forms and suddenly spills over its banks in a devastating flood) and landslides caused by destabilized rock.[25]

Second is permafrost degradation, wherein large-scale infrastructure, such as roads and railways, disturbs permafrost layers, causing ground instability and releasing greenhouse gases. Studies have found that large-scale desertification appears in the permafrost regions of the QTP and has become a remarkable local factor affecting the stability of the underlying permafrost.[26] Roadways have especially caused severe degradation of the permafrost soil, its vegetative mat along the highway and also its adjoining areas. It is noted that the construction of the Qinghai-Tibet Highway has damaged the vegetative mat, leading to the loss of organic matter and carbon in the soil and the melting of the warm permafrost layer[3] under the topsoil.[27] This road construction has led to the onset of warming/thawing of the underlying permafrost, and the destruction of the adjacent and nearby vegetation initiated similar warming/thawing processes in those areas.[28] In other words, the road construction has resulted in faster degradation of the permafrost layer compared to the natural state.

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Third, the infrastructure build-up has caused water cycle disruption by disrupting river flows. For instance, the Shigatse Tingri airbase (under construction since 2017) is perched at an altitude of 4,300 meters and currently features a 4.5-kilometre-long runway and taxiway. This airbase is located below the Bamchu River, and due to this, the river's course was altered to establish the runway.[29]

Conclusion

Certainly, China's infrastructure push in Tibet under the 14th Five-Year Plan is transforming the region. China's quest for rapid militarization

3 This layer of permafrost maintains a water reserve at the topsoil layer for plants and as it gets depleted, it will be difficult to restore vegetation naturally due to lack of soil moisture and its nutrients.

of Tibet through dual-use infrastructure involves serious environmental and geopolitical risks. That is, the infrastructure boom in Tibet is not just China's domestic issue but concerns the region as well as holds global implications. At the local level, the impacts are visible in terms of land degradation, habitat loss and others; at the regional level, as Tibet is the source of major rivers in Asia, thereby, any disturbances caused to the hydrology affect Asia's water security and; finally, being the "Third Pole" of the world, any changes to Tibet's climate caused due to melting of glacier accelerates global climate change.

Author –

Dr. Amrita Jash *is an Assistant Professor at the Department of Geopolitics and International Relations, Manipal Institute of Social Sciences, Humanities and Arts, Manipal Academy of Higher Education (Institution of Eminence), Manipal, India. She holds a PhD in Chinese Studies from Jawaharlal Nehru University. She was a Pavate Fellow at the University of Cambridge and an IAS Visiting Fellow at the Loughborough University. Her research is focused on China's foreign policy, Chinese military, security and strategic issues in China-India and China-Japan relations as well as the Indo-Pacific. Dr. Jash is the author of 'China's Japan Policy: Learning from the Past' (Palgrave Macmillan, 2023), and 'The Concept of Active Defence in China's Military Strategy' (Pentagon Press, 2021).*

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Endnotes

1 Tibet Rights Collective, "China Allocates $11.3 Billion for occupied Tibet Infrastructure amid Dual-Use Concerns," January 9, 2025, https://www.tibetrightscollective.in/news/china-allocates-113-billion-for-occupied-tibet-infrastructure-amid-dual-use-concerns.

2 Department of Civil Affairs of Tibet Autonomous Region, "Government Work Report (Excerpt)," January 11, 2024, https://mzt.xizang.gov.cn/zxzx/mzyw/202401/t20240111_398310.html.

3 "Tibet plans to implement 417 highway transportation projects this year," sina.com.cn, March 28, 2024, https://finance.sina.com.cn/jjxw/2024-03-28/doc-inapvtry5809768.shtml.

4 Jagannath Panda and Ana Carolina De Oliveira, "The Climate Crisis in Tibet: The Dalai Lama's Warning," *The National Interest*, August 22, 2024, https://www.isdp.eu/publication/the-climate-crisis-in-tibet-the-dalai-lamas-warning/#:~:text=The%20intensive%20infrastructure%20buildup%20has,operations%20on%20the%20Tibetan%20plateau.

5 Ibid.

6 Ute Wallenböck, "Balancing Development amid Climate Crisis in Tibet," Institute of Security and Development Policy, January 21, 2025, https://www.isdp.eu/balancing-development-and-heritage-amid-climate-crisis-in-tibet/.

7 Yangqiang Wei, et al., "Dual Influence of Climate Change and Anthropogenic Activities on the Spatiotemporal Vegetation Dynamics Over the Qinghai-Tibetan Plateau From 1981 to 2015," *Earth's Future* 10, no. 5 (May 2022), https://doi.org/10.1029/2021EF002566.

8 Bai Li, et al., "Rapid warming in Tibet, China: public perception, response and coping resources in urban Lhasa," *Environmental Health* 12, (August 2013): 1, https://doi.org/10.1186/1476-069X-12-71.

9 Zhenbo Wang, et al., "Ecological risk in the Tibetan Plateau and influencing urbanization factors," *Environmental Challenges* 6, (January 2022): 1, https://doi.org/10.1016/j.envc.2022.100445.

10 Qilong Tian, et al., "Potential risk of soil erosion on the Tibetan Plateau during 1990–2020: Impact of climate change and human activities," E*cological Indicators* 154, (October 2023): 2, https://doi.org/10.1016/j.ecolind.2023.110669.

11 Mu Xia, et al., "Spatio-temporal changes of ecological vulnerability across the Qinghai-Tibet Plateau," Ecological Indicators 123, (April 2021): 2, https://doi.org/10.1016/j.ecolind.2020.107274.

12 Wang, et al., n. 9, p. 1.

13 X. D. Wang, et al., "Regional assessment of environmental vulnerability in the Tibetan Plateau: Development and application of a new method," *Journal of Arid Environments* 72, no. 10 (October 2008): 1937, https://doi.org/10.1016/j.jaridenv.2008.06.005.

14 Xia, et al., n. 11, 1-2.

15 Wei, et al., n. 7.

16 Tian, et al., n. 10, 1.

17 Amrita Jash, "Tibet Military Command: People's Liberation Army's Combat Role in High Altitude," CLAWS Issue Brief, No. 181, May 18, 2019, https://www.claws.in/publication/tibet-military-command-peoples-liberation-armys-combat-role-in-high-altitude/.

18 Free Tibet, "Report Highlights China's Military Build-up in Tibet," February 15, 2021, https://freetibet.org/latest/report-highlights-chinas-military-build-up-in-tibet/.

19 Minnie Chan, "China deploys long-range rocket launcher 'as deterrent to India'," *South China Morning Post*, April 19, 2021, https://www.scmp.com/news/china/military/article/3130179/china-deploys-long-range-rocket-launcher-deterrent-india.

20 Suyash Desai, "Infrastructure Development in Tibet and its Implications for India," China Brief 21, no. 22 (November 2021), https://jamestown.org/program/infrastructure-development-in-tibet-and-its-implications-for-india/.

21 Vivek Singh, "China's Infrastructure Development along the Line Of Actual Control (LAC) and Implications for India," Centre for Joint Warfare Studies, January 29, 2024, https://cenjows.in/chinas-infrastructure-development-along-the-line-of-actual-control-lac-and-implications-for-india/#_edn1.

22 ICIMOD, "Black carbon and glacier melt," August 14, 2020, https://www.icimod.org/success-stories/chapter-2/black-carbon-and-glacier-melt/.

23 Ibid.

24 Gaia Vince, "The World has a Third Pole - and it's melting quickly," *The Guardian*, September 15, 2019, https://www.theguardian.com/environment/2019/sep/15/tibetan-plateau-glacier-melt-ipcc-report-third-pole.

25 Ibid.

26 Tianli Lan, et al., "The changing permafrost environment under desertification and the heat transfer mechanism in the Qinghai-Tibetan Plateau," *Journal of Environmental Management* 367 (September 2024), https://doi.org/10.1016/j.jenvman.2024.122055.

27 Environment and Development Desk, Department of Information and International Relations (DIIR), Central Tibetan Administration, "The Impacts of Climate Change on the Tibetan Plateau: A Synthesis of Recent Science and Tibetan Research," 2009, 33, https://tibet.net/wp-content/uploads/2011/08/climatechangereport.pdf.

28 Ibid.

29 Y. Nithiyanandam, "#4 Rapid Military Infrastructure Expansion in Tibet: A Satellite Imagery Analysis," *Takshashila Geospatial Bulletin*, September 30, 2023, https://geospatialbulletin.takshashila.org.in/p/4-rapid-military-infrastructure-expansion.