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Natural Objects and Environmental Processes as Defense

A Literature Review on the Historical Use of Nature for National Security and Relevant Ecological Initiatives of the People's Republic of China

By: NSPC/NSDPI Summer Researchers

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Introduction

The Department of War (DOW) manages roughly 5,000 military installations with a global real estate portfolio valued at over $1 trillion.[1] These installations provide key positioning for critical national security infrastructure. However, many of these military installations stand in settings highly exposed to climate-related hazards. As of 2023, one-third of the DOW's military installations worldwide are located in coastal areas and have experienced, or are at risk of, sea-level rise and extreme weather events.[2] Installations within the United States are also vulnerable. A DOW report published in 2019 found that of 79 mission-critical installations examined, approximately 92% were experiencing negative climate change effects such as recurrent flooding, drought, desertification, wildfires, or thawing permafrost.[3] It is estimated that climate change and extreme weather have cost the DOW $15 billion over the past decade.[4]

The threat from environmental degradation to security and defense infrastructure is not solely a Western concern. The People's Republic of China (PRC) is facing similar issues surrounding environmental degradation and its implications for national defense. Due to China's topography, roughly 44% of the nation's population and 61% of its GDP come from coastal regions, many of which are projected to experience a sea-level rise of 55 to 170 mm over the next 30 years.[5] [6] Even with major advances towards green technology and carbon neutrality to combat rising temperatures, it is estimated that the PRC's GDP would decline by more than 241.7 billion USD for every 1°C increase.[7] Beyond these substantial economic losses, China's military infrastructure has become increasingly vulnerable to environmental change, leaving many to question the structural resilience and longevity of these vital security installations. While naval establishments and military outposts have been prioritized due to the nation's perceived vulnerability on its eastern front, many facilities and necessary infrastructure across mainland China simultaneously face pressure from desertification, permafrost thawing, and pollution. Despite being one of the United States' most pressing economic and military adversaries, the US can learn from China and take note of how the nation's military and government institutions have looked to prepare for extreme weather and protect infrastructure from further environmental degradation.

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[1] U. S. Government Accountability Office. 2022. "Climate Resilience: DOD Needs to Assess Risk and Provide Guidance on Use of Climate Projections in Installation Master Plans and Facilities Designs | U.S. GAO." February 1. https://www.gao.gov/products/gao-19-453.

[2] Kelley M. Sayler, 2023. *Climate Change and Adaptation: Department of Defense*. CRS In Focus IF12161, version 3. Washington, DC: Congressional Research Service. April 6. https://crsreports.congress.gov.

[3] U.S. Department of Defense, Office of the Under Secretary of Defense for Acquisition and Sustainment. 2019. *Report on Effects of a Changing Climate to the Department of Defense*. Washington, DC: Department of Defense. January. RefID: 9-D30BE5A.

[4] "GAO-26-107786, MILITARY INSTALLATIONS: DOD Should Improve Natural Disaster Cost Tracking and Planning for Resilience Improvements." n.d. Accessed June 12, 2026. https://files.gao.gov/reports/GAO-26-107786/index.html.

[5] Ryan Campbell, "The Coast of China," ArcGIS StoryMaps, March 12, 2021, https://storymaps.arcgis.com/stories/7924782f48264fd0bcc6c4b3a728e186.

[6] Adája Stoetman et al., "Military Capabilities Affected by Climate Change: An Analysis of China, Russia and the United States" (Clingendael Netherlands Institute of International Relations, January 2023), https://www.clingendael.org/sites/default/files/2023-01/Military_capabilities_affected_by_climate_change.pdf.

[7] Hongbo Duan et al., "Valuing the Impact of Climate Change on China's Economic Growth," *Economic Analysis and Policy* 74, no. 74 (June 2022): 155–74, https://doi.org/10.1016/j.eap.2022.01.019.

Instances of states using nature for military purposes have been observed as far back as the fall of Babylon in 539 BC. However, the use of natural objects in defense infrastructure varies across regions and has evolved in response to technological advances. Understanding how natural objects have been used as defense infrastructure throughout history will strengthen efforts to enhance the resilience of US defense infrastructure and guide policymakers in protecting these critical military assets. This literature review will explore the question: **How have societies used natural objects and environmental processes as infrastructure, particularly for defense and resilience purposes?**

This literature review begins by examining how natural landscapes and environmental processes have been employed as forms of defensive infrastructure throughout history. Through a series of historical and contemporary case studies, this review examines how states and non-state actors have leveraged waterways, terrain, forests, and coastal environments to advance military and security objectives. The second half of the literature review examines how these patterns are reflected in Chinese policy, considering both historical and contemporary approaches to environmental management, infrastructure development, and national security in the People's Republic of China. Finally, the review synthesizes its findings into six primary takeaways for policymakers.

Part I: Natural Objects and Environmental Processes as Defense Infrastructure in History

The case studies can be categorized into four major themes: Coastal Infrastructure, Strategic Inundations, Terrain-based Infrastructure, and Water Weaponization.

Coastal Infrastructure

Historically, coastal infrastructure has served as a key element of national defense, helping protect against attacks launched from the sea. The literature commonly conceptualizes seawalls, breakwaters, canals, and even natural or hybrid features, such as reefs, as forms of coastal infrastructure for managing coastal security and resilience.[8] The manipulation of maritime environments for defense purposes is not a modern concept; the literature shows that this tactic has been used for centuries. Scholars have done limited evaluations on this specific intersection of coastal infrastructure and national defense; however, this section will provide case studies from the literature that highlight this connection. This section will examine Taiwan's Artificial Reefs for Deterrence, Syracuse Defenders in the Peloponnesian War, and the Battle of Tarawa.

Case 1: Taiwan's Artificial Reefs for Deterrence

Taiwan has implemented artificial reefs in its waters to address the issue of overfishing and to protect its environment.[9] Since 1974, 89 artificial reefs and 62 reef protection zones have been constructed in Taiwan.[10] However, as discussed by Savitz (2023), Taiwan could expand its environmental project for national defense purposes, specifically to deter a Chinese invasion.[11]

In the event of a Chinese invasion of Taiwan, forces would have to move through a 100-mile strait and onto Taiwan quickly; Savitz argues that an increased number of artificial reefs would not only slow Chinese naval forces but deter them altogether.[12] Artificial reefs could force ships aground or damage them, severely limiting their mobility and combat effectiveness. Additionally, Savitz notes that China would likely not attempt a naval invasion, given its knowledge of how the artificial reefs would affect its fleet and military equipment.[13] Savitz points out that the reefs offer Taiwan alternative military benefits beyond invasion.[14] Artificial reefs could obstruct uncrewed undersea vehicles (UUVs) or low-profile uncrewed surface vessels (USVs).[15] The reefs would hinder Chinese intelligence-gathering efforts by reducing the effectiveness of reconnaissance drones, therefore, increasing uncertainty and potentially deterring an attack.

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[8] Kristina Hill, "Coastal Infrastructure: A Typology for the Next Century of Adaptation to Sea-Level Rise," *Frontiers in Ecology and the Environment* 13, no. 9 (2015): 468–76, https://doi.org/10.1890/150088.
[9] Ministry of Foreign Affairs, Republic of China (Taiwan), "Artificial Reef Zones," accessed June 22, 2026, https://en.fa.gov.tw/view.php?theme=web_structure&id=108.
[10] Ministry of Foreign Affairs, "Artificial Reef Zones."
[11] Scott Savitz, *Defending Taiwan with Artificial Reefs* (2023), https://www.rand.org/pubs/commentary/2023/05/waiting-to-impale-defending-taiwan-with-artificial.html.
[12] Ibid.
[13] Ibid.
[14] Ibid.
[15] Ibid.

Savitz has done extensive work on coastal infrastructure, specifically in Taiwan, and, as of now, appears to be the leading scholar on Taiwan's potential use of artificial reefs for defense.

Case 2: Syracuse Defenders' Manipulation of the Syracuse Harbor in the Peloponnesian War

According to Thucydides in Book 7 of *History of the Peloponnesian War*, during the Siege of Syracuse, the defenders drove wooden stakes into the harbor to create obstacles for enemy ships.[16]

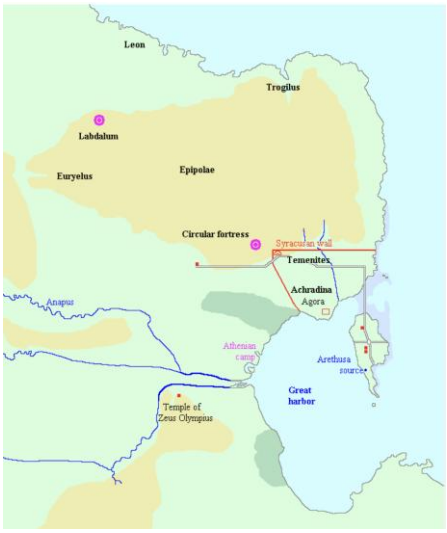

Figure 1: Map of Syracuse Harbor

Thucydides describes how the Syracusans reinforced the harbor with stakes, using the coastal environment as part of their defensive strategy to impede the Athenian attack.[17] The stakes disrupted naval operations by forcing Athenian sailors to dive to remove them, rerouting enemy movements, and giving Syracuse defenders more time to prepare for the attack (See Figure 1).[18] Using the stakes as obstacles was part of a broader defensive system that leveraged Syracuse's geography to hinder the Athenian military. This case illustrates how natural waterways could be intentionally altered to enhance military resilience and deny adversaries' access.

Case 3: The Use of Coral Reefs in The Battle of Tarawa

In "Island-Hopping at Tarawa", Walker (2009) highlights the significance of the Japanese-engineered defensive environment in prolonging resistance during the Battle of Tarawa in World War II.[19] The United States constructed an 'island hopping' plan for the Gilbert Islands chain, with high confidence in their amphibious attack on Betio.[20] Betio is a small island surrounded by coral reefs, helping to make up the Tarawa Atoll. The US crafted its attack with new naval techniques and plans for naval bombardment. Walker points out that the Japanese were anticipating this attack and leveraged the environmental conditions of Betio Island; the coral reef surrounding Betio created significant difficulty for the US, as the natural landscape could destroy landing craft and forced the US to approach on foot through choppy water, exposing them to concentrated Japanese fire and creating obstacles in their mission.[21]

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[16] Thucydides, *History of the Peloponnesian War* 7.25.
[17] Ibid.
[18] Jona Lendering, *Map of the Siege of Syracuse, Stage 1*, 2014, map, Livius.org, https://www.livius.org/pictures/a/maps/map-of-the-siege-of-syracuse-stage-1/.
[19] John Walker, "Island-Hopping at Tarawa," *Warfare History Network*, December 2009, https://warfarehistorynetwork.com/article/island-hopping-at-tarawa/.
[20] Walker, "Island-Hopping at Tarawa."
[21] Ibid.

After seventy-five hours of brutal fighting between the US and Japan, the US secured Betio. Despite losing the battle, the Japanese natural-landscape engineering revealed the vulnerabilities of the US Marine Corps' amphibious attack doctrine. Walker's piece demonstrates how Japan could dramatically increase the cost of an amphibious assault through careful use of fortifications and environmental features.

Strategic Inundations

This literature review defines inundation as the intentional covering or submerging of previously dry land by water released from a large body of water or a waterway. Inundations can be either offensive or defensive, but primarily serve counterforce rather than countervalue purposes. The literature shows that inundations enable militaries to manipulate waterways and create a natural frontline for offensive or defensive operations. However, attempts to forecast their consequences are often imprecise, and nations that rely on inundations for defense tend to adopt adaptive management practices. This section outlines two prominent cases of inundation: the Dutch Inundations of the Eighty Years' War and the Battle of the Irpin River.

Case 1: The Dutch Inundations in the Eighty Years' War (1572-1648)

Dutch forces have utilized strategic inundations from the onset of the Eighty Years' War (1572-1648) to the final years of the Second World War in 1944. Thus, the Netherlands presents a unique case of a government that has institutionalized the use of natural objects and processes in its defense infrastructure.

The Netherlands first used waterways for strategic inundations to defend against the Spanish siege on Leiden during the Eighty Years' War. In 1574, the Spanish Army of Flanders laid siege to the city of Leiden with a force size of approximately 67,000, the largest army in the western world at the time.[22] The Dutch recognized that the fall of Leiden would likely lead to the quelling of the rebellion as a whole. Ultimately, the States of Holland decided that the best course of action was to inundate the water board regions of Rijnland, Delfland, and Schieland. Inundating the land served two purposes for the Dutch rebels. Firstly, the flooded land created a natural frontier between the Spanish and Dutch, as it was inhospitable to life, and there was little motivation to repair the dams.[23] Secondly, flooding the land allowed the Dutch to counter overwhelming Spanish forces by using their superior Navy.

Teigs (2014) maintains that the Dutch approached these initial inundations with intentional management and strategic foresight. The Dutch government created an army of diggers and breachers, all with decades of water-management experience, to carry out the inundations.[24] The peacetime warden of the respective dam often supervised these armies. As a result, initial inundations were orderly and systematic. However, as the war progressed, the Dutch realized that flooding levels in some areas were too low and ordered that inland secondary dams be

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[22] Geoffrey Parker, *The Army of Flanders and the Spanish Road, 1567–1659: The Logistics of Spanish Victory and Defeat in the Low Countries' Wars* (Cambridge: Cambridge University Press, 1972), 00.
[23] A. M. J. de Kraker, "Flooding in River Mouths: Human Caused or Natural Events? Five Centuries of Flooding Events in the SW Netherlands, 1500–2000," *Hydrology and Earth System Sciences* 19 (2015): 2673, https://doi.org/10.5194/hess-19-2673-2015.
[24] Robert Tiegs, "Hidden beneath the Waves: Commemorating and Forgetting the Military Inundations during the Siege of Leiden," *Canadian Journal of Netherlandic Studies*3 5, no. 2 (2014).

flooded as well. This resulted in less consistent management practices, and by 1576, roughly half of the Netherlands' farmland was inundated.[25] Due to the war's duration, such extensive flooding led to the formation of deep, expansive new tidal channels, clearing previously existing settlements and structures.

Following the Eighty Years' War, Dutch waterways used for inundations were regarded as vital military infrastructure. In the 17th and 18th centuries, existing infrastructure was expanded to create a network of sluices and channels capable of flooding within a few days. Existing scholarship recognizes that, as the Dutch government expanded its inundation capabilities, its water management practices also evolved. For example, until the 18th century, strategic flooding largely relied on salt water, which had devastating effects on agricultural lands. Despite being less militarily effective, the Dutch government began building infrastructure in the 18th century to provide access to fresh water, thereby better protecting agricultural lands.[26]

Case 2: The Ukrainian Inundations of the Irpin River

In February 2022, Russian forces launched an offensive campaign against Ukraine's capital, Kyiv, expecting a swift collapse. Ukraine managed to defend itself and eventually force a Russian retreat largely due to their decision to inundate the Irpin River.

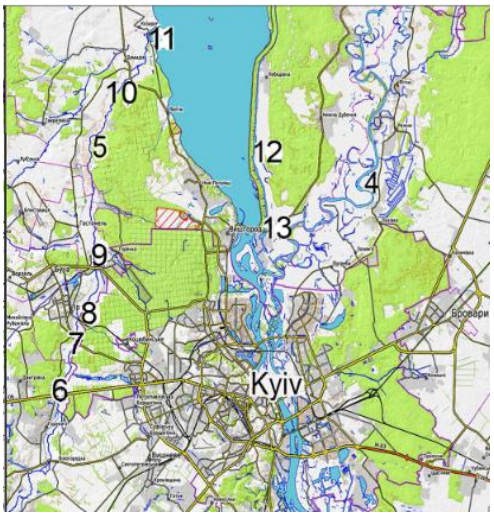

Figure 2: Map of Kyivske Reservoir and Tributaries

The Russian strategy to invade Kyiv and quickly topple the Ukrainian government consisted of two main elements: flying special forces operators into the city center and moving conventional forces from southern Belarus through the northwest of Kyiv. This strategy required moving Russian troops and military equipment across the Irpin River, a tributary of the Dnipro that feeds from the Kyivske Reservoir (See item 11 on Figure 2).[27] Due to the proximity of the Irpin River to Kyiv's western city limits, Ukrainian forces decided to intentionally flood the river to slow advancing Russian forces.[28] This was done by detonating explosives to create a small hole in the Kozarovychi Dam. According to a study conducted by the Urban Warfare Project at West Point, Ukrainian military engineers used computer programs to visualize the impact of flooding, ensuring that the inundation achieved the desired effects while minimizing flood risk to civilian communities in the river valley.[29] Higher river levels prevented Russian heavy vehicles from bypassing destroyed bridges and turned the ground around critical access points outside

[25] Tiegs, "Hidden beneath the Waves."
[26] de Kraker, "Flooding in River Mouths," 2673.
[27] Peter Gleick, Viktor Vyshnevskyi, and Serhii Shevchuk, "Rivers and Water Systems as Weapons and Casualties of the Russia-Ukraine War," *Earth's Future* 11 (2023): e2023EF003910, https://doi.org/10.1029/2023EF003910.
[28] Richard James Sladden, Liam Switzer Collins, and Alfred Benjamin Connable, "The Battle of Irpin River: February/March 2022," *The British Army Review*, no. 187 (Spring 2024): 6–53.
[29] Liam Collins and John Spencer, "Urban Warfare Project Case Study #12: Battle of Kyiv," Modern War Institute at West Point, February 21, 2025, https://mwi.westpoint.edu/urban-warfare-project-case-study-12-battle-of-kyiv/.

Kyiv into thick marshes. This transformed the Irpin River into a largely impenetrable natural front line, forcing Russian assault forces into tight urban settings south of the city.[30]

The initial breach of the Kozarobychi dam was successful, but a small dam just south of Chervone (See item 5 on Figure 2) was still closed. Since the area wasn't experiencing inundation, the Russian forces could cross the river using pontoon bridges, and the offensive continued. In response, Ukrainian forces used explosives to expand the existing hole in the Kozarovychi dam.[3132] This overwhelmed the dam, causing flooding to spread farther down the Irpin and ultimately leading to a final Russian retreat. This points to a trend in the literature: the level of inundation required to achieve an objective, and the associated environmental and humanitarian consequences, are imprecise, especially when used as a reactive strategy. Despite using computer imagery to forecast the results of the first inundation, the circumstances of the battle required more. Furthermore, the environmental and humanitarian consequences were significant. By the end of the battle, flooding in the Irpin River reached 1 km in width, and analysis of waterlines on trees suggests that water levels rose by 3 meters.

Terrain-Based

Figure 3: Map of the Ho Chi Minh Trail

Terrain-based infrastructure for defense can be characterized as the strategic use of topography or climate regions by a state for military purposes, including the manipulation of forests and the strategic placement of military operations. The literature on this topic highlights the use of natural landscapes for camouflage or the adaptation to extreme climates to gain an advantage over an adversary. A central theme in the literature is that militaries accustomed to the natural landscape have an additional line of defense.

Case 1: The Ho Chi Minh Trail as Natural Camouflage

The Ho Chi Minh Trail was used by the Democratic Republic of Vietnam (DRV), or North Vietnam, to move both troops and supplies through Laos and into the South for military operation. Often viewed as the lifeline of the DRV, the Ho Chi Minh Trail was approximately 12,000 miles long and extremely difficult to navigate; the route was intricate and confusing by design, so the US could not see it from above (See Figure 3).[33] [34] Rosenau (2001) provides a description of the American attempts to dismantle the Ho Chi Minh Trail by C-123 planes, since officials ruled out

[30] Liam Collins and John Spencer, "Waterworld: How Ukraine Flooded Three Rivers to Help Save Kyiv," Modern War Institute at West Point, July 1, 2022, https://mwi.westpoint.edu/waterworld-how-ukraine-flooded-three-rivers-to-help-save-kyiv/.
[31] Ibid.
[32] See Appendix, Figure B & C for Satellite imagery of before and after flooding.
[33] William Rosenau, "U.S. Air-Ground Operations against the Ho Chi Minh Trail, 1966–1972," in *Special Operations Forces and Elusive Enemy Ground Targets: Lessons from Vietnam and the Persian Gulf War* (Santa Monica, CA: RAND Corporation, 2001), http://www.jstor.org/stable/10.7249/mr1408af.8.
[34] Kenneth R. Olson and Larry Cihacek, "Long-Term Fate of Agent Orange and Dioxin TCDD Contaminated Soils and Sediments in Vietnam Hotspots," *Open Journal of Soil Science* 8, no. 1 (2018): fig. 1.

putting troops in Laos.[35] The US attempted to carry out clandestine CIA operations, air strikes, and even used Agent Orange—a highly toxic chemical herbicide and defoliant—on the trail in an attempt to destroy the Ho Chi Minh trail's full coverage for the DRV.[36] The DRV used the natural, intense jungle to their advantage to move past the US and the South Vietnamese unnoticed. A significant tactic for North Vietnam, with the Ho Chi Minh Trail, was guerrilla warfare, which consisted of unconventional surprise ambushes enabled by the trail, giving the North a way to move into the South undetected.[37] McElwee (2020) emphasizes the significance of the Ho Chi Minh Trail to the North, stressing the importance of the trail's covert nature in a situation where aerial visibility was crucial to US success.[38] The DRV knew that the Ho Chi Minh trail blocked that visibility and leveraged the natural camouflage. Concealing troop movements and operations from the US view illustrates how North Vietnam successfully used natural terrain as a strategic defense.

Case 2: Finland Leveraging Natural Climate in the Winter War

The Finland-Russia border is in a subarctic climate characterized by extremely cold conditions, deep snow, dense forests, frozen terrain, and limited daylight.[39] In a case study of Arctic warfare, Tuunainen (2014) demonstrates how Arctic climate changes military operations.[40] Tuunainen argues that "In cold regions (including mountainous areas receiving snowfall) the armies have two adversaries: the cold and the opposing force." [41] When armies exploit weather conditions, this compensates for inferior military ability or strength, as Tuunainen illustrates with the Winter War of 1939-1940.

Catherine Moriarty (2022) also examines the military dynamics of the Winter War, arguing that although Finland faced a far stronger Soviet opponent, its forces leveraged their mastery of Arctic warfare to overcome the disparity in military capacity.[42] The article presents Finland as an example of an early total defense system, in which military preparedness extends beyond the armed forces. Civil society, infrastructure, education, welfare systems, and community cooperation all contributed to national resilience. Moriarty makes a direct connection between natural landscapes and national success, as she uses the term 'expanded functionalism' throughout the article, highlighting that architects and planners built the environment to strengthen the nation itself. Additionally, Moriarty argues that the Finns viewed architecture along with defense, rather than being separate entities; the Finns believed that a healthier, better educated, and more cohesive society would increase resilience in wartime.[43] Specifically, the Soviets, unlike Finland, struggled with the deep snow and sub-zero temperatures, which

[35] Pamela McElwee, "The Origins of Ecocide: Revisiting the Ho Chi Minh Trail in the Vietnam War," *Environment & Society Portal*, May 21, 2020, https://www.environmentandsociety.org/arcadia/origins-ecocide-revisiting-ho-chi-minh-trail-vietnam-war.
[36] Ibid.
[37] Ibid.
[38] Ibid.
[39] Pasi Tuunainen, "New Approaches to the Study of Arctic Warfare," *Nordia Geographical Publications* 43, no. 1 (2014): 87–99, https://nordia.journal.fi/article/view/65102.
[40] Ibid.
[41] Ibid.
[42] Moriarty, Catherine. "Environments of Defence: Finland and the Winter War." *Fabrications* 32, no. 1 (2022): 6–30. https://doi.org/10.1080/10331867.2022.2038828.
[43] Ibid.

eventually slowed the efficiency of their military operations. A unique point Tuunainen makes is the Finns' use of skiing in military operations, which allowed them to outmaneuver Soviet units and conduct surprise attacks.[44] Tuunainen focuses primarily on Finland's landscape, while Moriarty's article draws attention to Finland's intentional use of natural landscapes for defense.

Case 3: The Green Walls of Russia as a Natural Blockade

The term 'zaseka' refers to the forest blockade established as a Russian defensive measure in the 16th century.[45] Belyaeva (2004) provides an in-depth case study of the Green Walls of Russia on a broad scale, examining the intersection of natural landscapes and national defense. Belyaeva explains the history of the Green Walls of Russia, beginning with how the zaseka served as a natural defense line against nomadic tribes and, eventually, in the 16th century, as an engineered terrain-based defense project.[46]

Towards the end of the 16th century, the Russians decided to extend the forests further south for defense purposes. Belyaeva uses the term 'abatis', which is a military obstacle made from fallen trees whose branches are left attached and pointed toward an approaching enemy. The abatis was created by partially cutting or tree felling in defensive forests, creating controlled obstacles for an adversary.[47] The literature describes the evolution from a circumstantial defense into a deliberate project; the Russian government introduced a tax for this project, called the 'zasetsky money', brought in foreign specialists to help with construction, and passed laws related to conservation of the abatis forests.[48] The literature suggests that the abatis forest project was important to Russia and was critical for its national security.[49] The Russians used the abatis of the Green Walls to slow advancing forces and complicate an invasion, as Belyaeva points out, taking advantage of the natural terrain for national defense.

The case illustrates how natural terrain alone was not responsible for the effectiveness of the defense system; rather, the forests were intentionally modified, maintained, and integrated into a broader network of forts and surveillance systems. As a result, Belyaeva's work suggests that natural landscapes can become significantly more valuable for defense when states actively shape and manage them for strategic purposes.

Water Weaponization

Water weaponization is the intentional use of water systems by state or non-state actors for military or political aims, targeting countervalue targets, primarily human populations. This literature review follows Daoudy's (2020) framework, which characterizes water weaponization strategies as those that exploit the dual offensive-defensive capabilities of natural water infrastructure.[50] Building on this framework, the literature shows that, due to the relatively low

[44] Tuunainen, "New Approaches to the Study of Arctic Warfare."
[45] Elena Belyaeva, "Green Walls of Russia," *Science and Life (Наука и жизнь)*, no. 11 (2004), https://www.nkj.ru/archive/articles/3522/.
[46] Belyaeva, "Green Walls of Russia."
[47] Ibid.
[48] Ibid.
[49] Ibid.
[50] Marwa Daoudy, "Water Weaponization in the Syrian Conflict: Strategies of Domination and Cooperation," *International Affairs* 96, no. 5 (September 2020): 1347–66, https://doi.org/10.1093/ia/iiaa131.

cost and high effectiveness of water weaponization, non-state actors can cause damage beyond their traditional military capabilities. Once a group's ability to use waterways to inflict significant harm on humans has been established, the threat of water weaponization is often used as a political as well as military weapon.

Case 1: Draining of the Mesopotamian Marshlands

In 1991, the Ba'athist government, under the authority of Saddam Hussein, executed a large-scale drainage of the Mesopotamian Marshlands. This drainage was performed with the primary goals of facilitating the use of military equipment within the region and ridding the region of Shi'a rebels. Illustrating the weaponization of water by a sovereign government for military purposes.

The Mesopotamian Marshlands are located between south-eastern Iraq and Iran and are the historical home of the Marsh Arabs (Ma'san). This region comprises three principal marshes: the Hammar, Amara, and Hawizeh. Before its destruction, it was the largest wetland in southwest Asia, covering up to 20,000 square kilometers and home to approximately 400,000 people.[51] In addition to playing a critical role in the flood regulation of southern Iraq, the marshlands served as a natural defense against military and state control for those living within them. As Ibn Battuta observed in the 14th century, the Marsh Arabs "fortified themselves with this jungle and are able to defend themselves in it against all attacks."[52]

During the Iran-Iraq War, the marshes became a key strategic defense front. The marshlands offered Iranian forces natural concealment, and Iraq's more modern arsenal proved less effective in that terrain. In response, the Iraqi government tried to expand the marsh's defensive capacity by controlling the flow of canals feeding into the marshlands. By the end of the conflict, both Iraqi and Iranian hydrological manipulation of the marshes had significantly reduced their size. After the Gulf War, Saddam Hussein and the Ba'athist party faced rebellion in the Kurdish north and the Shi'a south, particularly in the Marshland region. By 1991, the region had been partially infiltrated by Iranian-backed Iraqi Shi'a militias in active rebellion against the Ba'athist government. Alongside the violent removal of Marsh Arabs viewed as rebellious, in March of 1991, Hussein issued a national directive which called for plans to drain the Marshlands as a means to rid the region of rebels.[53] This was achieved through the construction of the drainage channel known as the "Third River" project in 1992. While the project was theorized and developed in the 1950s as a means to rejuvenate Iraqi agriculture, Hussein used the channel to divert water from the Euphrates and Tigris away from the Marshlands. The channel was 172 kilometers long and had a discharge capacity of 220-250 m3/s.[54] In addition to the "Third River," at least four other drainage canals were constructed from 1993 to 1994 for the same purposes. The literature indicates that the drainage canals were highly effective in achieving Hussein's two

[51] *The Iraqi Government Assault on the Marsh Arabs*. 2003. Briefing Paper. Human Rights Watch. https://web.archive.org/web/20240913084805/https://www.hrw.org/legacy/backgrounder/mena/marsharabs1.pdf.
[52] Ibn Battuta, *The Travels of Ibn Battuta, A.D. 1325–1354*, vol. 2, trans. C. Defrémery and B. R. Sanguinetti, ed. H. A. R. Gibb, Hakluyt Society, 2nd ser., no. 117 (Cambridge: Cambridge University Press for the Hakluyt Society, 1962), [272].
[53] Ariel I. Ahram, "Development, Counterinsurgency, and the Destruction of the Iraqi Marshes," *International Journal of Middle East Studies* 47, no. 3 (August 2015): 447–66, https://doi.org/10.1017/S0020743815000495.
[54] Mishkat Al Moumin, "Mesopotamian Marshlands: An Ecocide Case," *Georgetown International Environmental Law Review* 20, no. 3 (2008): 499–520.

primary goals: removing the rebels and destroying the Marshlands to allow easier access to military equipment. The drainage systems and complementary tactics of violence used by the Ba'athist government led to the displacement of 200,000 people from the marshes.[55] Rebel forces no longer had civilians to hide among and were thus forced to leave. Furthermore, of the approximately 9,000 square kilometers of marsh in 1973, 85% had been lost by 2000, although some of the loss was due to the Iran-Iraq war. NASA-produced geospatial imagery shows how much the marshes shrank over this timeframe (Figures 10 and 11).[56] Draining the landscape dramatically expanded military capacity in the region, enabling tanks and helicopters to move with far fewer restrictions.[57]

Case 2: The Weaponization of Dams by the Islamic State of Iraq & Syria (ISIS)

The manipulation of water infrastructure within Syria and Iraq by ISIS provides a unique case of water weaponization. By late 2012, ISIS controlled all major dams within Syria, and starting in 2014, it had expanded its control to dams along the Euphrates and Tigris in the Iraqi northwest (Figure 4).[58] Unlike national governments, non-state actors such as ISIS have fewer obligations to frame natural infrastructure as serving the public good. The literature illustrates that non-state actors possess a unique ability to use natural infrastructure to protect themselves and to cause damage in ways that would otherwise be beyond their military capabilities. ISIS's use of natural infrastructure illustrates three primary forms of water weaponization as outlined in the literature: increasing the amount of water available, decreasing the amount of water available, or lowering water quality. For the purposes of this literature review, we will focus on cases in which ISIS intentionally increased or decreased water supply for military purposes.

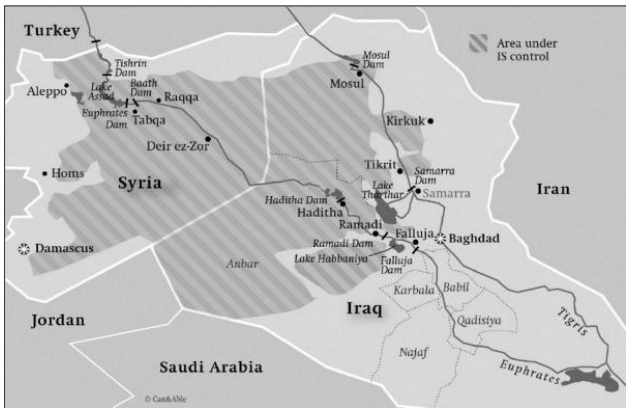

Figure 4 – Dams on the Euphrates and Tigris under Islamic State Control

ISIS used its control of dams in both Syria and Iraq to greatly increase water levels in certain areas through controlled inundations. For example, in 2014, ISIS blocked water flow from the Fallujah dam, which led to the flooding of the city of Abu Ghraib.[59] The floods displaced 40,000 people and destroyed 200 square kilometers of agricultural land.[60] Daoudy (2020) shows that once ISIS controlled waterways, it could use harmful increases in the water supply as a weapon.

[55] Ahram, "Destruction of the Iraqi Marshes."
[56] See figures 10 and 11 in Appendix A.
[57] Ahram, "Destruction of the Iraqi Marshes."
[58] Tobias von Lossow, *Water as Weapon: IS on the Euphrates and Tigris*, SWP Comments 3 (Berlin: Stiftung Wissenschaft und Politik / German Institute for International and Security Affairs, January 2016).
[59] Ben Smith, *Worsening Humanitarian Crisis in Syria and Iraq*, Standard Note SNIA 6926 (London: House of Commons Library, July 8, 2014).
[60] Smith, "Worsening Humanitarian Crisis."

After capturing the Tabqa dam, ISIS gained the ability to release 11 million cubic meters of water in Syria and cut electricity to major cities.

ISIS also depleted vital water resources as a means to reap military and political benefits in both Syria and Iraq. After taking control of the Ramadi Dam in Iraq in 2015, ISIS intentionally reduced the outflow of the Euphrates by 50%.[61] The literature suggests that ISIS often used the reduction of water available to legitimize its rule over Iraqi and Syrian populations. Daoudy (2020) highlights how ISIS would purposefully withhold water access from the Euphrates Valley until occupied populations acquiesced to their authority. At the height of its control, ISIS was able to deprive approximately 5 million people in the cities of Aleppo and Raqqa of access to safe drinking water.[62]

Limitations of the Literature

There are two primary limitations to the body of literature on natural objects and processes as defense infrastructure:

1. The literature on older case studies tends to be thinner than that of case studies within the last century. This is especially evident in the quality of mapping and imagery provided. For example, imagery from the past fifty years often took the form of satellite imagery or highly detailed cartography. Earlier examples tend to take the form of rough sketches and newspaper illustrations.
2. The literature uses specific cases as opposed to a broad concept of the intersection of natural landscape and national security. While scholars have made connections between specific events of states leveraging their natural environment for defense purposes, there has yet to be a recognized pattern. Furthermore, the cases of natural processes and objects as defense infrastructure are often split between the literature. For example, Water Weaponization has its own literature with only some cases being relevant to this literature review. The same applies to other academic literatures, such as Militarized Landscapes, Historical Coastal Ports and Harbors, and Irregular Warfare.[63] [64] [65]

[61] Ahram, "Destruction of the Iraqi Marshes."
[62] Marwa Daoudy, "Water Weaponization."
[63] Chris Pearson, "Researching Militarized Landscapes: A Literature Review on War and the Militarization of the Environment," *Landscape Research* 37, no. 1 (February 2012), https://doi.org/10.1080/01426397.2011.570974.
[64] Arthur de Graauw, Palaeoportology: Ancient Coastal Settlements, Ports and Harbours, vol. 1, The Catalogue, 9th ed. (Grenoble: Arthur de Graauw, 2024), http://www.AncientPortsAntiques.com.
[65] Nathan Hall and Andrew Brock, "Refilling the Suwar Canal: An Irregular Warfare Case Study in Infrastructure Effects," *Military Review* (November–December 2024).

Part II: Natural Objects and Environmental Processes as Defense Infrastructure within the PRC

In recent decades, China has combined its status as a global superpower and leader in climate adaptation to create resilient natural infrastructure. With a rich history of natural-process management and unique vulnerability to climate threats, the Chinese approach to climate challenges provides valuable insights for global leaders.

Historical Use of Natural Objects and the Environment for Defense within China

For thousands of years, Chinese leaders have combined natural processes and innovative engineering to manage water. Major rivers shifted courses and regularly flooded many of the settlements along them: from 602 BC to 1949, the Yellow River breached its levees 1,600 times.[66] One of the most famous Chinese emperors is Yu the Great, who earned his name and throne by successfully utilizing canals to prevent mass flooding.[67] Culturally, politically, and mythologically, water management carries immense importance for Chinese society.[68]

The Grand Canal is the most prominent example of this work, with construction beginning in the 5th Century.[69] By the 13th Century, the canal stretched more than 1,600km and linked five major river basins.[70] Much of the literature on this period agrees that the Grand Canal's construction was critical for the development of the first centralized Chinese state. It enabled nationwide communication, the collection and transfer of taxes, and the inland transportation of troops.[71] Chinese hydraulic engineers were pioneers in their field; for example, the Huayiang and Jiangnan canals, built during the Song period, used gate, diversion/withdrawal drain, and storage pond designs that would not become common in Europe for approximately another 400-600 years.[72]

Canals also enabled troop movement across difficult terrain. As discussed in "*The Technical History of China's Grand Canal: Introduction*," a prime example of the military utilization of canals is the Lingqu, which was constructed across a previously impenetrable hilly region.[73] The mountainous topography had prevented warfare on horseback or foot, but the emperor's new canal allowed a floating army to conquer the region easily.[74] The Lingqu canal is uniquely impressive in its construction, connecting the Xiangjiang and Guijiang rivers across a 6 m elevation difference.[75] The Lingqu is the world's first contour canal, using a series of curves along the slope and two sub-canals (northern and southern) to make the elevation difference

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[66] James Carter, "When the Yellow River Changes Course." The China Project. June 29, 2022. https://thechinaproject.com/2022/06/29/when-the-yellow-river-changes-course/.
[67] Alex Colville, "Yu the Great, Tamer of China's Greatest Floods." The China Project. August 24, 2020.
[68] Ibid.
[69] UNESCO World Heritage Centre. 2013. "The Grand Canal." Unesco.org. 2013. https://whc.unesco.org/en/list/1443/.
[70] Ibid.
[71] Ibid.
[72] Xuming Tan. 2019. "Introduction." In *The Technical History of China's Grand Canal*, 1–46. https://doi.org/10.1142/9781945552045_0001.
[73] Tan, "Introduction." In *The Technical History of China's Grand Canal*
[74] Tan, *The Technical History of China's Grand Canal*
[75] Tan, *The Technical History of China's Grand Canal*

more gradual.[76] These innovations, in combination with a spade snout dividing the Shi'an, provide the velocity to move boats forward without human or animal input.[77] The Lingqu is still in use today to irrigate approximately 4,333 acres of farmland.[78] Many ancient canals have been retrofitted for modern farming, and some are used in water transfer projects from south to north.[79]

Ecological Civilization

One of the keys to understanding the Chinese approach to climate threats is "ecological civilization." The term was first used publicly by Chinese officials approximately 30 years ago and has increased in importance under the leadership of Xi Jinping.[80] In "*Reflections on Dr. Wang Zhihe's Speech at Xi'an University of Technology,"* the author, Wang Lidi, states that "ecological civilization" incorporates traditional Chinese values of harmony with nature and the interconnectedness of life.[81] This concept is distinct from Western style "ecological modernization" wherein innovation is intended to make things more efficient and thus use less resources.[82]

According to Yeh (2022), "Ecological civilization has been variously interpreted as an ideological framework, a form of symbolic legitimation for the party-state and a socio-technical imaginary."[83] In "*The Making of Natural Infrastructure in China's Era of Ecological Civilization*," Emily Yeh asserts that ecological civilization's ties to the Chinese cultural framework provide the state with justification for sweeping controversial measures, such as the forced relocation of 55,000 traditional nomadic herders to "restore grasslands," and to seize private assets.[84]

According to Rodenbiker (2023), the usage of the term "ecological civilization" also serves nationalist purposes.[85] By pioneering a uniquely Chinese approach to "environmentalism," Chinese scientists and leaders present themselves as global leaders, with the belief that ecological civilization is superior to current industrial "primitive" societies.[86] Rodenbiker also characterizes "ecological civilization" efforts as an opportunity to exercise soft power via green

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[76] Tan, *The Technical History of China's Grand Canal*
[77] Tan, *The Technical History of China's Grand Canal*
[78] "Lingqu Canal | International Commission on Irrigation & Drainage (ICID)." 2022. Icid-Ciid.org. 2022. https://icid-ciid.org/award/his_details/101.
[79] Tushaar Shah, Khalid Mohatadulla, and Asad Qureshi. 2012. "Irrigation Modernization: Chinese Style." IWMI-TATA Water Policy Program.
[80] Yang Lidi, "Ecological Civilization in China as an Aspirational Ideal." Open Horizons. 2025. https://www.openhorizons.org/ecological-civilization-in-china-as-an-aspirational-ideal-yang-lidi8203.html.
[81] Ibid.
[82] Ibid.
[83] Emily T. Yeh "The Making of Natural Infrastructure in China's Era of Ecological Civilization." *The China Quarterly* 255 (2023): 611–27. https://doi.org/10.1017/S0305741022001588.
[84] Ibid.
[85] Jesse Rodenbiker, "Ecological Civilization Goes Global: China's Green Soft Power and South-South Environmental Initiatives." ResearchGate. Wilson China Fellowship. November 1, 2023. .
[86] Zhihe Wang, Meijun Fan, and Jungfeng Wang, "Ecological Civilization, Organic-Process Thinking and the Future of China in the Global Context." Ecopoiesis.ru. 2019. https://en.ecopoiesis.ru/aktualnoe/news_post/wang-zhihe-fan-meijun-wang-junfeng-ecological-civilization-orhanic-process-thinking-and-the-future-of-china-in-the-gobal-contex.

development, spreading Chinese technology and values across the Global South.[87] Chinese scientists and bureaucrats are regularly dispatched to countries such as Thailand and Indonesia to provide training, conduct research, and oversee green development.[88] However, Rodenbiker finds that the strength of "green soft power" remains mixed, due to the fragmentation of the Chinese government and strong economic reliance on the Global North.[89]

Ecological civilization is a still-developing framework, and the quality of its implementation varies. Nonetheless, the potential of a new approach to climate security issues remains of interest to many around the world.

Attitudes within the Chinese Government and its Military Institutions

In a 2022 report on Chinese climate security vulnerabilities, author Erin Sikorsky found that China has largely avoided framing climate change threats as a defense issue, instead preferring to use the language of "beautification" or "ecology." In 2021, China stated a desire to avoid "pan-securitization" of climate change globally, and Chinese Defense White Papers have not referenced climate threats since 2010.[90] However, a 2020 article in the PLA Daily referenced concerns around the security of underwater weapons systems and coastal installations with rising sea levels and shifting oceanic patterns.[91] Additionally, several military leaders have expressed concern about the strain that responding to climate disasters has placed on their commands.[92] From 2012 to 2019, the People's Liberation Army (PLA) deployed 950,000 soldiers and 190,000 vehicles, and assembled 26,000 vessels for disaster response.[93]

Current environmental threats impacting China include pollution, water scarcity, desertification, permafrost thaw, coastal degradation, and sea-level rise. Particularly concerning are rising sea levels; the Chinese coast is experiencing rates far higher than the global average, with more than 40 percent of the nation's GDP produced in regions facing potential inundation.[94] For more information and specific literature on each threat, please see Appendix C.

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[87] Rodenbiker, "Ecological Civilization Goes Global."
[88] Ibid.
[89] Ibid.
[90] Erin Sikorsky. 2022. "Center for Climate and Security | Council on Strategic Risks I China's Climate Security Vulnerabilities." https://councilonstrategicrisks.org/wp-content/uploads/2022/11/China-Climate-Security-Vulnerabilities-2022.pdf.
[91] Sikorsky, "China's Climate Security Vulnerabilities."
[92] Ibid.
[93] Ibid.
[94] Wang, Huiping, and Qi Ge. 2024. "Ecological Resilience of Three Major Urban Agglomerations in China from the 'Environment–Society' Coupling Perspective."

Initiatives

The "Great Green Wall"

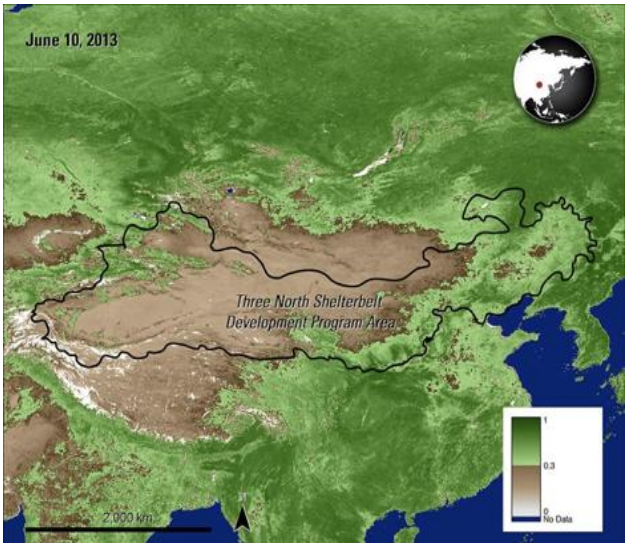

Figure 5: Outline of China's Shelterbelt Program

Since the inception of China's Three North Shelterbelt Program in 1978, the PRC has successfully planted more than 66 billion trees in the northern, northeastern, and northwestern regions of the nation to combat desertification.[95] The "Great Green Wall" is estimated to span roughly 4,500 km, running along shared borders with Mongolia, Kazakhstan, and Kyrgyzstan' while protecting vital ecosystems necessary for sustaining agricultural land and institutional preservation (see Figure 5).[96] [97] Through the Taklamakan Afforestation Project, a regional sub-component of the aforementioned shelterbelt, China has targeted and fully encircled the Taklamakan Desert in Xinjiang, forming a carbon sink that helps tackle both pollution and desertification.[98] One study shows that long-term trends surrounding the Taklamakan Desert reveal increasing CO2 absorption (NEE trend: −5.2 × 10−12 kg/m2/s/y) and vegetation (6.8 × 10^{-4}/y).[99] Other related afforestation efforts and desertification-control initiatives include the Grain for Green Project and the Beijing-Tianjin Sandstorm Source Control Project. Despite studies showing positive environmental impacts in the Desertification Control Zones (DCZ) since 2000, it is important to note that the introduction of a substantial number of trees in an arid environment has altered China's water cycle, posing major concerns regarding the scarce resource.[100]

Although the Three North Shelterbelt Program is for environmental restoration and preservation, academic literature that showcases historical examples such as the Battle of the Hedgerows in Normandy (see Appendix B, Figure 14) and the Cactus Curtain in Cuba highlights the potential of this vegetative belt for national defense. German soldiers utilized dense hedgerows during the

[95] Sascha Pare, "China's Great Green Wall: The Giant Artificial Forest Designed to Slow the Expansion of 2 Deserts," Live Science, December 12, 2025, https://www.livescience.com/planet-earth/plants/chinas-great-green-wall-the-giant-artificial-forest-designed-to-slow-the-expansion-of-2-deserts.
[96] Ibid.
[97] Danae Verba, "Hydrothermal Alteration Zones, Greenness Trends, and Forest," NASA EarthData, May 27, 2025, https://www.earthdata.nasa.gov/learn/data-in-action/hydrothermal-alteration-zones-greenness-trends-forest-disturbance.
[98] Salma Noor et al., "Human-Induced Biospheric Carbon Sink: Impact from the Taklamakan Afforestation Project," *Proceedings of the National Academy of Sciences* 123, no. 4 (January 20, 2026), https://doi.org/10.1073/pnas.2523388123.
[99] Ibid.
[100] Darren Orf, "China Planted 78 Billion New Trees—and Seriously Messed up Its Water Cycle," Popular Mechanics, April 25, 2026, https://www.popularmechanics.com/science/environment/a71126116/china-reforesting-changes-hydrology/.

Battle of Normandy to fend off incoming attacks, making it difficult for adversarial forces to make offensive gains.[101] Similarly, Fidel Castro planted an 8-mile barrier of cacti surrounding Guantanamo Bay to prevent Cubans from seeking refuge or defecting.[102] The expansive Green Wall in China may serve as dual-use infrastructure and prove beneficial if the PRC's relations with its northern and western neighbors sour, providing protection against potential invasion.

Underground Infrastructure

Reports first revealed in 2008 that China is home to a complex underground tunnel network, dubbed the "Great Wall Project."[103] [104] Since then, satellite imagery has helped identify and locate hidden entrances. Carved into mountains and rocky outcrops, these covered passageways span about 3,000 miles and provide the PLA with naturally hardened infrastructure that protects military infrastructure and supports naval submarines and nuclear capabilities.[105] Much of the available literature suggests that the primary purpose of the vast network of hardened underground infrastructure is to provide the nation with credible second-strike nuclear capabilities.[106] [107] In addition to infrastructure that supports naval ambitions, there are many airbases that are housed underground for similar strategic purposes (see Figure 6).[108]

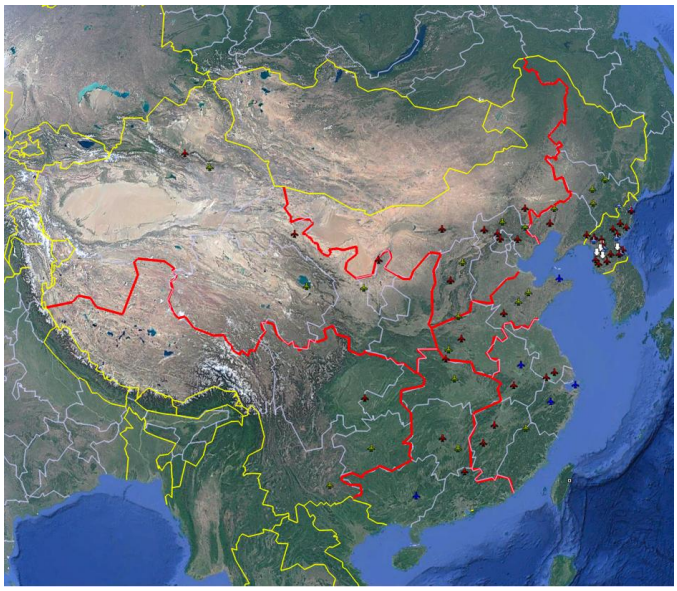

Figure 6: Location of PLA's Underground Airbases

[101] Paul Cornish, "War in the Normandy Bocage," in *Conflict Landscapes*, ed. Nicholas J. Saunders and Paul Cornish (London: Routledge, 2021), 241–59, https://doi.org/10.4324/9781003149552-16.
[102] Bill Gabbert, "Wildfire Causes Mines to Explode at Guantanamo Bay, Cuba – Wildfire Today," Wildfiretoday.com, February 28, 2018, https://wildfiretoday.com/wildfire-causes-mines-explode-guantanamo-bay-cuba/.
[103] Hui Zhang, "The Defensive Nature of China's 'Underground Great Wall,'" Bulletin of the Atomic Scientists, January 16, 2012, https://thebulletin.org/2012/01/the-defensive-nature-of-chinas-underground-great-wall/.
[104] Global Times, "It Is Said That the Second Artillery Corps Is Building Underground Missile Depots to Ensure a Second-Strike Nuclear Capability in Wartime." (Sina Corporation, December 11, 2009), https://mil.news.sina.com.cn/2009-12-11/0909576995.html.
[105] Hui Zhang, "China's Underground Great Wall: Subterranean Ballistic Missiles," The Belfer Center for Science and International Affairs (Harvard Kennedy School, January 31, 2012), https://www.belfercenter.org/publication/chinas-underground-great-wall-subterranean-ballistic-missiles.
[106] Guancha.cn, "Military Newspaper Reports Suggest That the Upgrade of the 'Great Power's Sword Sheath' May Be in Preparation for the Deployment of the Dongfeng-41 Missile.," Ifeng.com, June 10, 2016, https://finance.ifeng.com/a/20160610/14475840_0.shtml.
[107] Zhang, "The Defensive Nature of China."
[108] Sean O'Connor and Carlo Kopp, "Assessing PLA Underground Air Basing Capability," *Air Power Australia Analyses* VIII, no. 1 (February 16, 2011), https://www.ausairpower.net/APA-2011-01.html.

Figure 7: Chinese Submarine Entering Underground Base at Hainan Island

Some of the best-known tunnels that equip the PLA's Navy (PLAN) with strategic access to the sea lie near islands south of Shipuzhen, the Jianggezhuang Naval Base near Qingdao, and the Yulin Naval Base on Hainan Island (see Figure 7), providing easy access and deployment into highly contested waters.[109] [110] [111] While exact locations of China's hidden nuclear storage and military facilities are largely unknown, some have been discovered through satellite imagery and open-source analysis, including PLA's Rocket Force (PLARF) Base 67 near Taibai in the Qinling Mountains and "Beijing Military City" in the Qinglonghu area (see Appendix B, Figure 15).[112] [113]

[109] H I Sutton, "Chinese Navy Submarines Are Protected by Underground Tunnels," *Forbes*, May 5, 2020, https://www.forbes.com/sites/hisutton/2020/05/05/chinese-navy-submarines-are-protected-by-underground-tunnels/.
[110] Felix K. Chang, "Strategies behind China and the Asia-Pacific's Military Base Construction," *Foreign Policy Research Institute*, April 14, 2022, https://www.fpri.org/article/2022/04/strategies-behind-china-and-the-asia-pacifics-military-base-construction/.
[111] Brad Lendon, "Satellite Photos Appear to Show Chinese Submarine Using Underground Base," CNN, August 21, 2020, https://edition.cnn.com/2020/08/21/asia/china-submarine-underground-base-satellite-photo-intl-hnk-scli.
[112] Matthew Bruzzese and BluePath Labs, "Dancers at the Knife's Edge: PLA Rocket Force Nuclear Warhead Management" (China Aerospace Studies Institute, March 2026), https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/Infrastructure/2026-03-09%20PLARF%20Nuclear%20Warhead%20Management.pdf?ver=QKld6QVtdUfPeiYhGFch4w%3D%3D.
[113] Yong Jian, "China Building World's Biggest Military Base in Prep for US War - Asia Times," Asia Times, February 3, 2025, https://asiatimes.com/2025/02/china-building-worlds-biggest-military-base-in-prep-for-us-war/.

Artificial Islands in the South China Sea

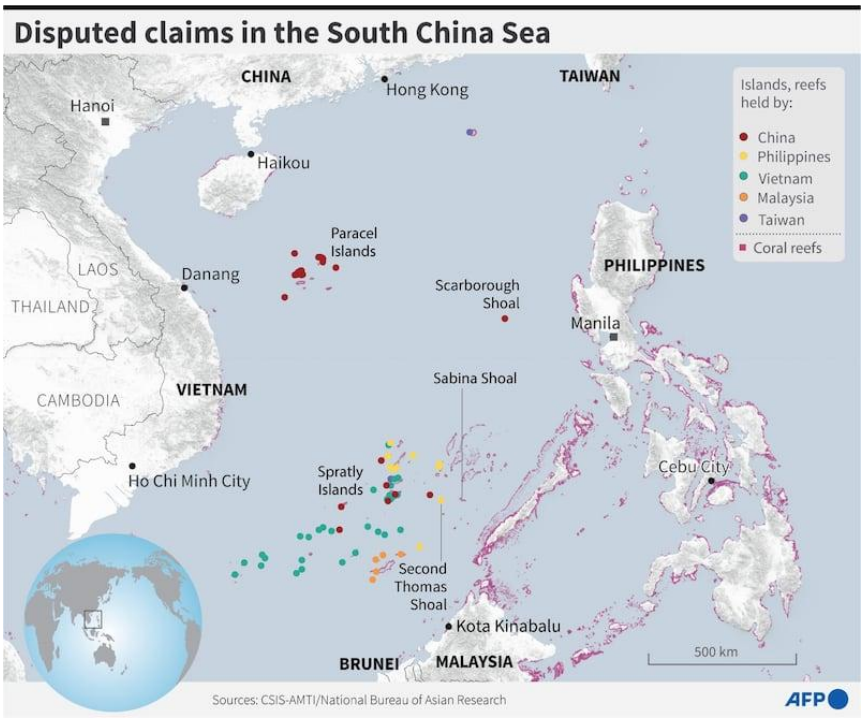

Figure 8: Map of Islands and Reefs Held within the South China Sea

China is pursuing ecological militarization within the South China Sea, which is the process of transforming nature to support military pursuits.[114] The PRC began building up its artificial islands during the 2010s and currently has 27 outposts located across the Spratly and Paracel Islands many equipped with hardened infrastructure and military equipment designed to support the People's Liberation Army (see Figure 8).[115] [116] [117] Despite a pledge by Xi Jinping in 2015 that stated the nation did not intend to pursue militarization within the Spratly Islands, three major islands known as Subi Reef, Fiery Cross, and Mischief Reef, are home to fully operational military bases (see Appendix B, Figures 16, 17, and 18). [118] [119] [120]

Utilizing dredging techniques and calcareous sand, the PRC has created more than 3,200 acres of land within the South China Sea, competing with nations like Vietnam, Malaysia, Taiwan, and the Philippines for territorial expansion and acquisition.[121] Much of the surrounding marine life has been destroyed due to these destructive techniques, including the overall loss of more than

[114] Jesse Rodenbiker, "Ecological Militarization: Engineering Territory in the South China Sea," *Political Geography* 106 (October 2023), https://doi.org/10.1016/j.polgeo.2023.102932.
[115] Henry Zwartz, "Intelligence Reveals Scale of China's Base-Building in the South China Sea," Abc.net.au (ABC News, July 29, 2025), https://www.abc.net.au/news/2025-07-30/tracking-militarisation-in-the-south-china-sea/105473948.
[116] Gregory B. Poling, "China's Military Power Projection and U.S. National Interests" (Center for Strategic & International Studies, February 20, 2020), https://www.uscc.gov/sites/default/files/Poling_Written%20Testimony.pdf.
[117] Jason Gutierrez, "Philippines Says It Did Not Surrender Sabina Shoal to China," Radio Free Asia, September 16, 2024, https://www.rfa.org/english/news/southchinasea/south-china-sea-sabina-shoal-09162024141029.html.
[118] Jeremy Page, Carol E. Lee, and Gordon Lubold, "China's President Pledges No Militarization in Disputed Islands," *The Wall Street Journal*, September 25, 2015, sec. World, https://www.wsj.com/articles/china-completes-runway-on-artificial-island-in-south-china-sea-1443184818.
[119] Poling, "China's Military Power Projection."
[120] Caitlin Campbell, "Naming and Shaming: U.S. Surveillance over China's Land Reclamation Projects and Regional Reactions" (United States - China Economic and Security Review Commission, June 10, 2015), https://www.uscc.gov/sites/default/files/Research/Naming%20and%20Shaming_Issue%20Brief_6.10.15_0.pdf.
[121] Rodenbiker, "Ecological Militarization."

7,000 acres of coral reef, where China alone is responsible for burying roughly 4,600 acres since 2013.[122] Furthermore, overfishing, along with illegal, unreported, and unregulated (IUU) fishing, has led to a significant 70-95% decline in total fish stocks since the 1950s, while visible damage from clam harvesting was reported to cover 16,350 acres across the South China Sea in 2023.[123] [124]

Despite many actions that have harmed the marine environment, the PRC has taken steps toward preservation while directing projects aimed at infrastructure protection and resilience. Although China primarily relies on physical hardening to protect its artificial islands, it often accompanies these projects with natural resources such as sand and rocks to shelter underground facilities.[125] The nation is also capitalizing on the remaining natural reefs located roughly 100-200 meters offshore from these outposts to reduce wave action and mitigate infrastructural erosion caused by harsh marine conditions.[126]

Another environmental initiative in the South China Sea centers on Scarborough Shoal, a highly contested atoll located roughly 230 km off the Philippine coast.[127] In 2025, China announced plans to designate the atoll as a marine nature reserve, giving it the name Huangyan Dao.[128] Interviews conducted by Chinese Media Group's (CMG) Voice of the South China Sea (VSCS), report that this reserve is designed to strengthen protection and management of the surrounding ecosystem while promoting sustainability and environmental diversity.[129] Through increased monitoring and scientific research, China strives to promptly respond to ecological threats in accordance with the United Nations Convention Law of the Sea (UNCLOS) and marine environmental protection laws and regulations set by the PRC.[130] However, this decision sparked debates about territorial sovereignty and environmental lawfare, as the atoll lies within the Philippines' exclusive economic zone (EEZ) and infringes on various maritime rights.

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[122] Harrison Prétat, Monica Sato, and Gregory B. Poling, "China and Vietnam Are Driving Reef Destruction in the South China Sea," Center for Strategic & International Studies, January 30, 2025, https://www.csis.org/analysis/china-and-vietnam-are-driving-reef-destruction-south-china-sea.
[123] South China Sea Expert Working Group, "A Blueprint for Fisheries Management and Environmental Cooperation in the South China Sea," Asia Maritime Transparency Initiative (Center for Strategic & International Studies, September 13, 2017), https://amti.csis.org/coc-blueprint-fisheries-environment/.
[124] "China's Nature Reserve at Scarborough—More than a Decade Too Late | Asia Maritime Transparency Initiative," Asia Maritime Transparency Initiative (Center for Strategic & International Studies, September 18, 2025), https://amti.csis.org/chinas-nature-reserve-at-scarborough-more-than-a-decade-too-late/.
[125] J. Michael Dahm, "Hardened Infrastructure, Counter-Reconnaissance, and Battlespace Environment Management" (John Hopkins University Applied Physics Laboratory, November 2021), https://www.jhuapl.edu/sites/default/files/2022-12/HardenedInfrastructure.pdf.
[126] Ibid.
[127] Laura Zhou, "Is That a Chinese Antenna at Scarborough Shoal? The Philippines Thinks So," South China Morning Post , June 9, 2026, https://www.scmp.com/news/china/diplomacy/article/3356508/chinese-antenna-scarborough-shoal-philippines-thinks-so.
[128] Yu Hai Dang and Tran Thi Huyen Trang, "Scarborough Peace Park: The Road to Peace and Sustainability in the South China Sea | Asia Maritime Transparency Initiative," Asia Maritime Transparency Initiative (Center for Strategic & International Studies, November 21, 2025), https://amti.csis.org/scarborough-peace-park-the-road-to-peace-and-sustainability-in-the-south-china-sea/.
[129] VSCS, "In Depth: Why Does China Establish the Huangyan Dao National-Level Nature Reserve?," Vscs.cri.cn, September 11, 2025, https://vscs.cri.cn/m/20250911/51bcba32-482f-78ab-a732-6a2d3df747de.html.
[130] Ibid.

Dams

Many major rivers originate in the Tibetan Region in southwestern China, granting the state with an unmatched geographic position. Currently, the PRC is home to more than 98,000 dams, some of which are heavily fortified with missile defense systems and weaponry due to their strategic value and overall importance to the state's national security.[131] [132] The Chinese government deems these projects essential to ensuring water security and supporting the nation's broader shift towards renewable resources, especially hydropower.[133] Simultaneously, these installations serve as protection against catastrophic floods that have historically devastated many regions within China. According to the PRC State Council, the Three Gorges Dam, constructed along the Yangtze River, has effectively intercepted over 70 floods since its completion in 1994.[134] The hydropower project has generated over 1.7 trillion kWh, effectively reducing carbon dioxide emissions by 1.49 billion tons while producing an average economic benefit of 4.78 billion USD.[135]

Figure 9: Dams Along Rivers Stemming from Tibet

Despite China's support for climate goals and advances in clean energy, international news publications and opinion pieces highlight concerns that Beijing is constructing massive dams as an offensive tool to gain leverage over neighbors that rely on the water to sustain their economies and livelihoods.[136] Major concerns have arisen due to the construction of numerous projects along the Mekong and Brahmaputra Rivers, respectively known as the Lancang and Yarlung Tsangpo rivers within China (see Figure 9).[137] [138] [139] These dams provide the PRC with an opportunity to capitalize on their upstream location, causing international

[131] Chunqiao Song et al., "A Comprehensive Geospatial Database of Nearly 100 000 Reservoirs in China," *Earth System Science Data* 14, no. 9 (September 6, 2022): 4017–34, https://doi.org/10.5194/essd-14-4017-2022.
[132] Asia Times Staff, "Two Missiles Could Blow up Three Gorges: Strategist," Asia Times, January 15, 2018, https://asiatimes.com/2018/01/two-missiles-can-blow-up-chinas-three-gorges-dam-taiwan-strategist-claims/.
[133] Shi Weijun, "The Yarlung Tsangpo Dam: China's Energy Megaproject in Tibet," CKGSB Knowledge, October 28, 2025, https://english.ckgsb.edu.cn/knowledge/article/china-energy-ambition-inside-the-yarlung-tsangpo-dam-project/.
[134] CGTN, "How China's Three Gorges Project Transforms Flood Management," English.gov.cn, December 15, 2024, https://english.www.gov.cn/news/202412/15/content_WS675e265cc6d0868f4e8edf74.html.
[135] Xinhua, "Three Gorges Project Generates 1.7 Trln KWh of Power," English.gov.cn, December 14, 2024, https://english.www.gov.cn/archive/statistics/202412/14/content_WS675d69d3c6d0868f4e8edf67.html.
[136] Kunal Sharma, "How China Uses Geoengineering to Pursue a Hybrid Warfare Strategy," The Diplomat, January 31, 2023, https://thediplomat.com/2023/01/how-china-uses-geoengineering-to-pursue-a-hybrid-warfare-strategy/.
[137] NOVAsia Contributor, "The Mekong River - Environment and Economic Impacts of Dam Building in Southeast Asia," NOVAsia Magazine, January 12, 2022, https://novasiagsis.com/the-mekong-river-environment-and-economic-impacts-of-dam-building-in-southeast-asia/.
[138] Jack Silvers, "Water Is China's Greatest Weapon and Its Achilles Heel - Harvard Political Review," Harvard Political Review, October 16, 2020, https://harvardpolitics.com/china-water-policy/.
[139] International Campaign for Tibet, "Chinese Hydropower: Damning Tibet's Culture, Community, and Environment," International Campaign for Tibet, December 5, 2024, https://savetibet.org/chinese-hydropower/.

members to worry about the destruction and coercion of downstream nations through artificially manufactured droughts or floods.[140] [141]

Coastal & Marine Restoration

China's coastal vulnerabilities are widely understood by the central government, despite a lack of public discussion by officials. The majority of the literature on coastal resilience in China concludes that the last two decades have seen a marked pivot from hard structures, such as seawalls, to integrative methods, including mangroves and artificial reefs.[142] According to You (2020), the construction and maintenance costs of hard infrastructure have made them politically unpopular, with Shanghai seawalls totaling $7 million per additional kilometer built.[143] "*Mangrove forests can be an effective coastal defense in the Pearl River Delta,"* finds that mangroves and other wetlands are especially suited to protecting cities in deltas from major storms, with a 600m patch of mangroves absorbing up to 1.4 meters of storm surge.[144]

Approaches to improving coastal resilience vary significantly depending on site-specific conditions, such as frequent tidal storm surges in the Taiwan Strait or the Yangtze's low salinity.[145]

"*Characteristics and Evaluation of Living Shorelines: A Case Study from Fujian, China*" finds that across 54 Chinese cities, coastal resilience improved on average by 33 percent from 2012 to 2022.[146] Fujian province, which has one of the highest rates of porosity and soil movement along China's coasts, was designated one of the first demonstration zones in China for integrated coastal management.[147] Emerson Tsui's 2026 study of maritime power in the Taiwanese strait found that Fujian's maritime militia is one of the PLA's key force multipliers in the effort to control access to Taiwan.[148] Fujian also contains several key PLA deep-water ports and training facilities, including in Xiamen (classified as "highly vulnerable" to climate-related storms and sea rise).[149] The province is heavily affected by typhoons, with approximately a third of the

[140] Tessa Wong, "China Starts Building World's Largest Dam, Fuelling Fears in India," *BBC News, Singapore*, July 21, 2025, https://www.bbc.com/news/articles/c4gk1251w14o.
[141] Tsewang Dorji Jeshong and Kalsang Dolma, "China's Strategy to Escalate Water War over Tibet's River," The Borderlens, August 2, 2025, https://www.borderlens.com/2025/08/02/chinas-strategy-to-escalate-water-war-over-tibets-river/.
[142] Xingfan Li, Shihui Lin, Libing Qian, Zhe Wang, Chao Cao, Qi Gao, and Jiwen Cai. 2025. "Characteristics and Evaluation of Living Shorelines: A Case Study from Fujian, China." *Journal of Marine Science and Engineering* 13 (7): 1307–7. https://doi.org/10.3390/jmse13071307.
[143] Li You, "Rising Seas Threaten China's Long, Low, and Crowded Coast." SixthTone. 2020. https://www.sixthtone.com/news/1006652.
[144] Michela De Dominicis, Judith Wolf, Rosanna van Hespen, Peng Zheng, and Zhan Hu. 2023. "Mangrove Forests Can Be an Effective Coastal Defence in the Pearl River Delta, China." *Communications Earth & Environment* 4 (1): 1–13. https://doi.org/10.1038/s43247-022-00672-7.
[145] Li et al., "Characteristics and Evaluation of Living Shorelines."
[146] Ibid.
[147] Ibid.
[148] Emerson Tsui, "Fujian's Maritime Militia and Cross-Strait Signaling: Institutional Foundations and Governance Dynamics | Global Taiwan Institute." Global Taiwan Institute. April 23, 2026. https://globaltaiwan.org/2026/04/fujians-maritime-militia-and-cross-strait-signaling/.
[149] Ibid.

coastline considered "heavily developed" and especially at risk.[150] Fujian has taken a combined approach to coastal restoration, implementing the "Regulations on the Protection and Utilization of Coastal Zones in Fujian Province," as well as extensive mangrove restoration.[151] Mangroves are used throughout the south due to their effectiveness at erosion prevention and storm wave absorption; this year, a plan to plant and restore 18,000 hectares of mangroves along the southern coast was announced.[152]

According to Xingfan et al., with this combination of hard bank protection and mangrove forests, all measures of coastal vitality in Fujian increased over the last ten years, but significant variation across the region remains.[153] During the study, the percentage of coastal waters classified as Category II (high-quality) increased from 45 to 85 percent, bringing economic and ecological benefits to the region.[154]

Gaps in the literature remain, as the study found that despite the successes of "living shoreline" initiatives across Fujian, the effectiveness of implementation and methodology varies by local conditions, requiring further observation.[155]

Limitations of the Literature

1. Given the nature of China's geopolitical relations and suspected strategic motives, there are potential concerns around the validity of data sourced from government documents and reports. Furthermore, Chinese academic sources are frequently under-cited within the broader global community. Although exact reasoning varies, potentially stemming from language barriers or international tensions, this has the potential to further undermine the legitimacy of relevant scholarly literature.
2. Many of the previously highlighted initiatives were developed under the notion of environmental protection. While the PRC's environmental initiatives could serve defensive purposes or support military endeavors, it was difficult to find any mention from the Chinese government surrounding dual-use relevancy for specific research thrusts or investments. Much of the geopolitical concerns appear to be based off speculation, rather than specific acts or statements from the Chinese government outlining their desire to manipulate the environment for political gain.

[150]Li et al., "Characteristics and Evaluation of Living Shorelines."
[150] Ibid.
[151] Xidi Chen, Weiming Yang, and Yu Liu. 2024. "Recent Developments in China's Coastal Zone Management Legislation: An Appraisal." *Coastal Management* 52 (6): 315–39. https://doi.org/10.1080/08920753.2024.2425473.
[152] You, "Rising Seas Threaten China's Long, Low, and Crowded Coast."
[153] Li et al., "Characteristics and Evaluation of Living Shorelines."
[154] Ibid.
[155] Ibid.

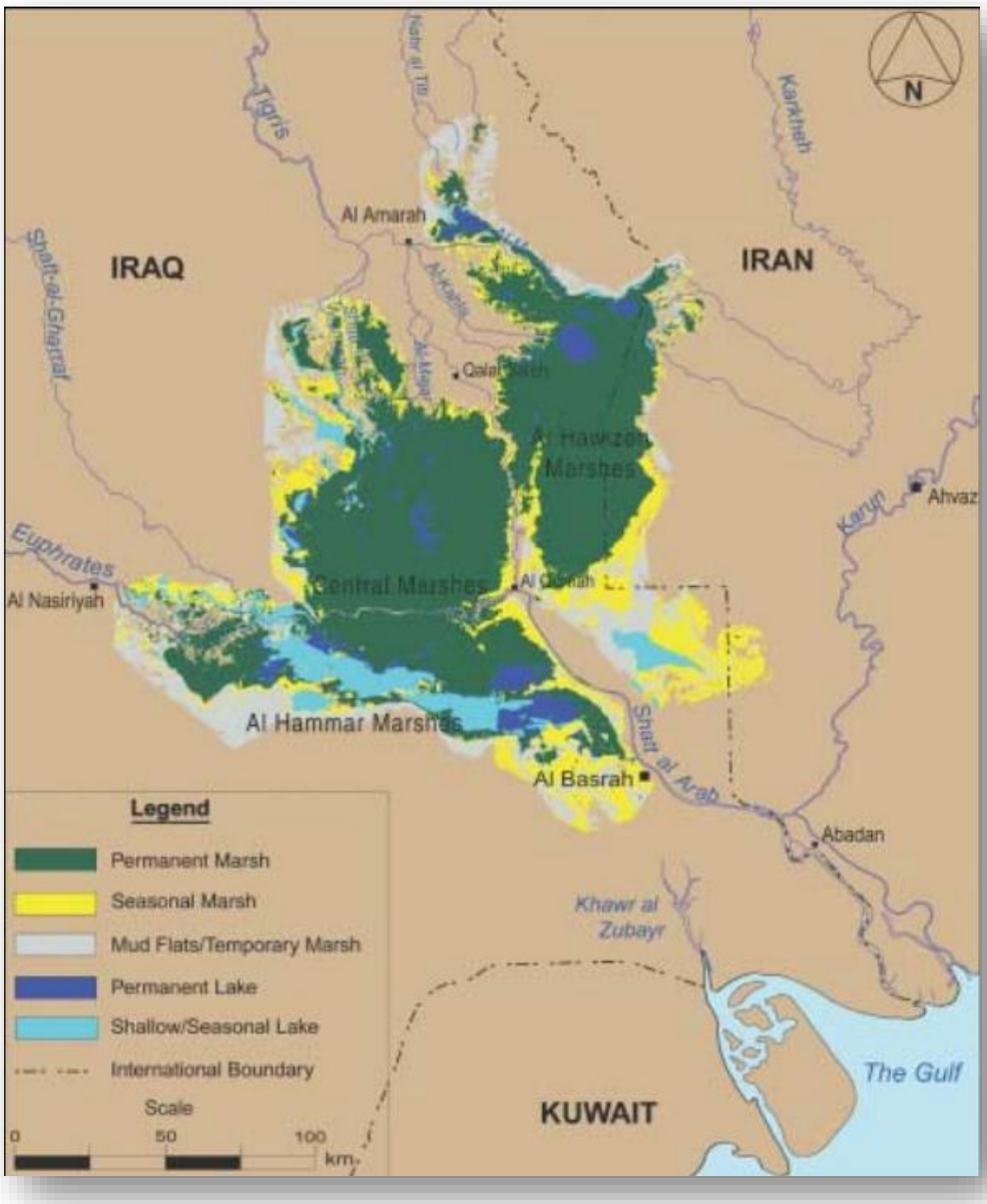
Part III: Takeaways for US Policymakers

The DOW has spent at least $15 billion on climate-change and extreme-weather-related infrastructure repairs over the past decade. The United States is currently taking steps to properly protect its land from ecological threats through projects such as the Sentinel Landscape Partnership, the US Army's *Engineering With Nature* (EWN) project, and DOW's *Readiness and Environmental Protection Integration* (REPI). These projects reflect the DOW's fledgling efforts to pair natural landscapes with engineering for both ecological and military benefit. There are several key takeaways from a review of the literature on the use of natural processes and objects as defense infrastructure, which may benefit policymakers in these efforts:

1. **Climate impacts on military installations do not just pertain to the Western world.** It is an evolving problem for militaries worldwide and should be considered a viable solution for fortifying defense infrastructure. Since the 2000s, Chinese doctrine has stressed the importance of Military Operations Other than War (MOOTW) and has swiftly begun to prioritize the fortification of vital infrastructure and the advancement of environmental initiatives.
2. **Natural infrastructure often serves as a natural front-line that channels and slows enemy forces**. Syracuse's harbor stakes, Russia's abatis "green walls," and the inundation of the Irpin River all used natural infrastructure to redirect enemy movement and protect defending forces. The evidence for this pattern is the strongest and most thorough in the review.
3. **Defensive and natural infrastructure regularly merge into one another**. Projects created with environmental and ecological purposes often have latent defense values, and vice versa. Iraq's Third River project, Taiwan's artificial reefs, and China's "Great Green Wall" all started as environmental projects that were, or could be, repurposed for defensive means. Resilience programs in the US will likely also offer dual-use potential.
4. **Military use of natural landscapes often disregards long-term ecological and environmental consequences.** Dutch saltwater flooding ruined farmland, Iraq's marshland drainage displaced roughly 200,000 people, and China's island-building in the South China Sea buried thousands of acres of coral reefs. These cases illustrate that operational planning will be key to sustained program implementation.
5. **Long-term infrastructure effectiveness consistently relies on adaptive management.** Russian abatis lines were maintained through taxes and strict property laws, while the Dutch sluices were managed by experienced dam wardens. Policymakers cannot achieve effective long-term infrastructure resilience without management practices that are intentional and iterative.
6. **China's model for natural defense infrastructure is worth studying with caution.** The PRC conceptualizes natural infrastructure through its "ecological civilization lens" rather than defense, despite facing many of the same environmental threats as the United States. China's natural defense infrastructure initiatives have faced mixed success, but because many of the sources this review cites are likely state-controlled, reported "success" warrants scrutiny. Nonetheless, US policymakers may benefit from continued observation of Chinese natural defense infrastructure efforts.

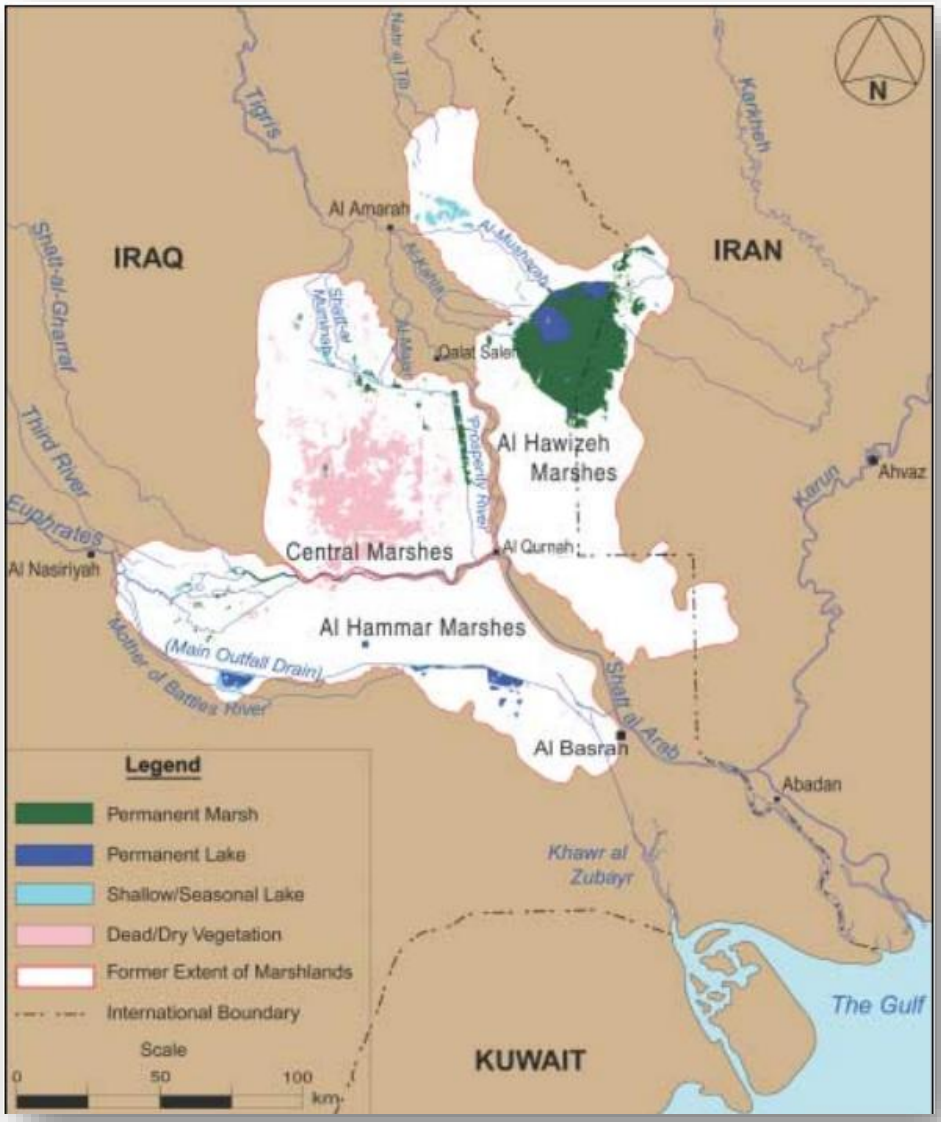
Appendices

Appendix A: Additional Figures for Part I



10: Mesopotamian Marshlands: Land Cover 1973-76[156]

[156] Hassan Partow, *The Mesopotamian Marshlands: Demise of an Ecosystem*, UNEP/DEWA/TR.01-3 (Nairobi: Division of Early Warning and Assessment, United Nations Environment Programme, 2001), 00.



11: Mesopotamian Marshlands: Land Cover 2000[157]

[157] Partow, "The Mesopotamian Marshlands"

12: Images obtained by the Sentinel 2 satellite on 11.03.2022, which shows the flooding of the Irpin River floodplain.[158]

[158] S. Shevchuk and V. Vyshnevskyi, "Use of Water Bodies for the Defense of Kyiv in the Course of the Russian-Ukrainian War" (paper presented at Monitoring 2022: XVI International Scientific Conference "Monitoring of Geological Processes and Ecological Condition of the Environment," Kyiv, Ukraine, November 15–18, 2022).

13: Image obtained by the Sentinel 2 satellite on 18.03.2022 which shows the flooding of the Irpin River floodplain.[159]

[159] Shevchuk and Vyshnevskyi, "Use of Water Bodies."

Appendix B: Additional Figures for Part II

Figure 14: Aerial View of Hedgerows in Normandy [160]

[160] Brian Haren, "We Missed the Hedgerows," Northing & Easting, May 26, 2014, https://oldtopographer.net/2014/05/26/we-missed-the-hedgerows/.

Figure 15: Beijing Military City [161]

[161] Jian, "China Building World's Biggest Military Base."

Figure 16: Fiery Cross [162]

[162] Asia Maritime Transparency Initiative, "China Island Tracker," Asia Maritime Transparency Initiative (Center for Strategic & International Studies, 2025), https://amti.csis.org/island-tracker/china/.

Figure 17: Subi Reef[163]

[163] Asia Maritime Transparency Initiative, "China Island Tracker."

Figure 18: Mischief Reef[164]

[164] Ibid.

Appendix C: Expansion on Specific Environmental Threats to China and Relevant Attitudes

Pollution

China is the world's largest source of carbon emissions due to the nation's heavy reliance on coal to produce sufficient energy required to support its economic and industrial ambitions. In 2024, the PRC emitted more than 12.29 billion tons of carbon dioxide while simultaneously consuming 30% more coal than the rest of the world.[165] [166] Studies have shown that air pollution causes more than 1.2 million premature deaths on an annual basis within China, many scientists citing the harmful environmental conditions that have led to the creation of byproducts like smog and acid rain.[167] The introduction of toxic chemicals into the natural environment through rapid urbanization and industrialization has raised concerns for the general wellbeing of the nation's citizens, especially regarding vital resources like food and water.

The PRC holds very limited freshwater resources, relying on 6% of the world's total freshwater to properly nourish more than 1.4 billion people.[168] Concerns about resource scarcity have only been intensified with pollution and the construction of many factories alongside critical water resources. In 2015, more than 716 kilotons of plastic were dumped into China's rivers.[169] Studies have shown that roughly 70% of the nation's rivers are polluted, forcing farmers to use the contaminated water to grow their crops while more than 280 million people still lack access to safe drinking water due to limited water treatment plants and an initial lack of strict regulations.[170] [171]

Desertification

More than a quarter of China's land has undergone desertification, impacting roughly 400 million people due to the reduction in viable soil for agricultural processes and loss of necessary water resources that are drying up.[172] Many individuals within the Chinese population and government have raised concerns about insecurities surrounding food and water as crops fail and livestock continue to die. Food and water scarcity are exacerbated by desertification, and officials are worried about the potential for resource-driven conflict and heightened geopolitical tensions in the near future.

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[165] Hannah Ritchie and Pablo Rosado, "CO_2 and Greenhouse Gas Emissions," Our World in Data, 2025, https://ourworldindata.org/profile/co2/china.
[166] Institute for Energy Research, "Global Coal Use Hits Another Historic Record in 2024," IER, January 21, 2025, https://www.instituteforenergyresearch.org/fossil-fuels/coal/global-coal-use-hits-another-historic-record-in-2024/.
[167] Eleanor Albert and Beina Xu, "China's Environmental Crisis," Council on Foreign Relations, February 12, 2025, https://www.cfr.org/backgrounders/chinas-environmental-crisis.
[168] Silvers, "Water Is China's Greatest Weapon."
[169] Yanan Li et al., "The Plastic Age: River Pollution in China from Crop Production and Urbanization," *Environmental Science & Technology* 57, no. 32 (August 1, 2023): 12019–32, https://doi.org/10.1021/acs.est.3c03374.
[170] Silvers, "Water Is China's Greatest Weapon."
[171] Ting Wang et al., "China's Drinking Water Sanitation from 2007 to 2018: A Systematic Review," *Science of the Total Environment* 757 (February 23, 2021): 143923, https://doi.org/10.1016/j.scitotenv.2020.143923.
[172] Amelia Browne, "Desertification in China: Causes, Impacts, and Solutions," Earth.Org, December 20, 2022, https://earth.org/desertification-in-china/.

Marine Degradation and Sea Level Rise

The People's Republic of China is especially vulnerable to rising sea levels due to its expansive shoreline (over 18,000 km) and the clustering of cities and economic activity in low-lying regions.[173] [174] In "*Ecological resilience of three major urban agglomerations in China from the "environment–society" coupling perspective,"* authors Huiping Wang and Qi Ge assert that the three regions that make up 40 percent of China's GDP (Beijing, Pearl River Delta, and Yangtze River Delta) are all at risk of flooding as sea levels rise. Between the three, approximately 126 million people live in flood prone areas, and Beijing in particular ranks poorly on several ecological resilience indicators.[175] According to You (2020), much of central Shanghai is concave and lies below sea level.[176] Land subsidence is a national problem, with 32 cities losing sediment; many protective levees are becoming increasingly ineffective as they lose up to 20 cm each year.[177]

A 2023 report on the impact of climate threats on Chinese military readiness found that China's SLR is significantly higher than the global average, with China's coastal sea level predicted to rise by 55 to 170 mm over the next 30 years.[178] Rising tides threaten China's economy, food security, and military assets.[179] Two large shipyards that supply military vessels in the Yangtze region and two naval bases in Hainan and Jiangsu are at risk of inundation.[180] According to Sikorsky (2022), Chinese artificial islands in the South China Sea are at risk of sea level rise due to the destruction of protective coral reefs during their construction[181]. Sikorsky asserts that the submersion of several islands during recent major storms demonstrates the fragility of Chinese control of the region.[182]

The Chinese government is aware of the threat that rising sea levels and coastal degradation poses to its economic wellbeing and national security, taking steps to mitigate further destruction while outlining the role that the environment and military play when it comes to infrastructural protection. In 1964, Mao Zedong launched a program called the "Third Front," an initiative designed to move vulnerable defense and research facilities away from the coast and towards inland China that was shielded by mountainous terrain.[183] However, the nation found that many

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[173] Don Hinrichsen, "The Coastal Population Explosion," in *Trends and Future Challenges for U.S. National Ocean and Coastal Policy*, ed. Biliana Cicin-Sain, Robert W. Knecht, and Nancy Foster (National Oceanic and Atmospheric Administration (NOAA), National Ocean Service, 1999), 27–29, https://repository.library.noaa.gov/view/noaa/14875.
[174] Ke Zhang, "Regime Shifts and Resilience in China's Coastal Ecosystems," *Ambio* 45, no. 1 (August 19, 2015): 89–98, https://doi.org/10.1007/s13280-015-0692-2.
[175] Wang & Ge, "Ecological Resilience of Three Urban Agglomerations"
[176] Yu, Li. 2020. "Rising Seas Threaten China's Long, Low, and Crowded Coast." SixthTone. 2020. https://www.sixthtone.com/news/1006652.
[177] Yu, "Rising Seas Threaten China's Coast."
[178] Stoetman et al., "Military Capabilities Affected by Climate Change.
[179] Erin Sikorsky, "China's Climate Security Vulnerabilities," ed. Francesco Femia, The Center for Climate & Security, November 28, 2022, https://climateandsecurity.org/reports/chinas-climate-security-vulnerabilities/.
[180] Sikorsky, "China's Climate Security Vulnerabilities."
[181] Ibid.
[182] Ibid.
[183] Abhijeet Kumar, "Why China Is Reviving Mao-Era Inland Bases as Nuclear Buildup Gains Pace," Business Standard, March 31, 2026, https://www.business-standard.com/world-news/china-mao-third-front-inland-bases-nuclear-buildup-explained-126033100582_1.html.

of these regions were not suitable and the project quickly faded during the 1980s after Mao's death. Shortly after, the China Marine Surveillance (CMS) agency was officially established in 1998 but eventually merged into the China Coast Guard (CCG) in 2013, along with three other maritime law enforcement agencies.[184] [185] The primary role of the CMS was to act as a maritime law enforcement agency and enforce environmental protections and conservation laws; the organization continues to advance similar objectives under the CCG. A 2013 Defense White Paper released by the Information Office of the State Council highlighted that the PLA's Navy actively coordinates with China's Maritime Law Enforcement (MLE) to carry out surveillance and fishery administration, providing security support for MLE while striving to prevent the exploitation of vital resources like oil and gas.[186] In 2021, the Thirteenth National People's Congress adopted its "Coast Guard Law," outlining the role that law enforcement and the People's Liberation Army have in protecting and advancing the PRC's maritime rights.[187] The CCG's main goals were specifically stated as the following: protection of PRC's maritime security; marine ecological and environmental protection; combating maritime smuggling and illegal immigration; preventing and punishing of illegal maritime activities.[188] This literature highlights how the Chinese government and military is actively thinking about protecting its coastline and maritime environment from regional adversaries and ecological decay.

Permafrost Thawing

Following the Seventeen-Point Agreement in the 1950s, the PRC and the PLA began to modernize the Tibet Autonomous Region (TAR), focusing on the introduction of dual-use infrastructure that advances both economic and civilian aims purposes while supporting strategic military endeavors.[189] However, much of the current infrastructure that lies within the region sits on permafrost layers that are melting due to changes in climate and expansive human activities. One study has shown that permafrost area in the Tibetan Region has decreased at an accelerated rate of -3.62×10^4 km^2 decade^{-1} since the 1970s due to rising temperatures and regional modernization, highlighting that many facilities sitting on these layers are at risk of environmental degradation. [190]

Airports have been introduced near military bases as part of China's techno-military modernization efforts in the Tibetan Region, many of which are designed to serve both strategic

[184] Abhijit Singh, "China's Enhanced Ocean Surveillance," SP's Naval Forces, March 2011, https://www.spsnavalforces.com/story/?id=142.
[185] Ryan D. Martinson, "Early Warning Brief: Introducing the 'New, New' China Coast Guard - Jamestown," Jamestown, January 25, 2021, https://jamestown.org/early-warning-brief-introducing-the-new-new-china-coast-guard/.
[186] Information Office of the State Council, "The Diversified Employment of China's Armed Forces," ed. Fu Peng (Xinhua, April 16, 2013), https://media.nti.org/pdfs/China_Defense_White_Paper_2013.pdf.
[187] Standing Committee of the 13th National People's Congress, "Coast Guard Law of the People's Republic of China," January 22, 2021, https://www.airuniversity.af.edu/Portals/10/CASI/documents/Translations/2021-02-11%20China_Coast_Guard_Law_FINAL_English_Changes%20from%20draft.pdf.
[188] Standing Committee of the 13th National People's Congress, "Coast Guard Law."
[189] Information Office of the State Council of the People's Republic of China, "Tibet's March toward Modernization," The Office of the Chargé d'Affaires of the People's Republic of China in the Republic of Lithuania, May 30, 2004, https://lt.china-office.gov.cn/eng/zt/zfbps/200405/t20040530_2910867.htm.
[190] Tongqing Shen et al., "Permafrost on the Tibetan Plateau Is Degrading: Historical and Projected Trends," *Journal of Hydrology* 628 (January 2024), https://doi.org/10.1016/j.jhydrol.2023.130501.

operations and commercial flights. Satellite imagery highlights that these airports are home to long runways and hardened shelters designed to support military aircraft (see Figure XX), granting China with an advantageous geopolitical location in the Himalayas.[191] While authorities maintain that these airports are mainly designed to connect citizens living in remote areas, merely five percent of Chinese pilots have received proper certification to fly in the region due to its difficult terrain and high altitude, creating speculations about the actual intention behind these installations.[192] However, as the construction of bases and airports continues and disrupts the surrounding environment, thawing permafrost raises the risk of runways cracking and creating unsafe operational spaces, regardless of the infrastructure's primary purpose.

Additionally, there are many pipelines and railways providing necessary transportation of crucial resources that are currently impacted by permafrost degradation, leaving many to wonder about the implications surrounding China's economic and military wellbeing. More than one-fourth of the Qinghai-Tibet Railway sits on permafrost, raising concerns about infrastructure resilience and its ties with commerce and tourism.[193] In 2006, a publication by the Congressional Executive Commission on China highlighted the urgency of the permafrost degradation in the region, arguing that the railroad's operations would become unsafe ten years.[194] While the railway remains fully operational as of 2026, continuous maintenance is necessary to combat structural challenges caused by the changing land beneath the infrastructure. Estimates under SSP245, a specific research scenario used to model future energy and environmental trends, project that by 2090, an additional $6.31 billion USD will be required to maintain the function of current infrastructure within the Qinghai-Tibet Plateau.[195] Further issues have been raised surrounding the Power of Siberia 1 natural gas pipeline and the Skovorodino-Mohe-Daqing (SMD) oil pipeline, both of which are essential for meeting the nation's energy requirements and maintaining the economy. These pipelines, respectively carrying more than 100 million cubic meters of gas and 600,000 barrels of oil per day, are being threatened by the instability that permafrost degradation in northeastern and western China presents as the ground shifts and sinks, potentially interrupting the necessary flow of natural gas and oil into the PRC.[196] [197]

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[191] China Power Team, "How Is China Expanding Its Infrastructure to Project Power along Its Western Borders?," China Power Project (Center for Strategic & International Studies, November 9, 2023), https://chinapower.csis.org/china-tibet-xinjiang-border-india-military-airport-heliport/.

[192] Niharika Mandhana, Josh Chin, and Camille Bressange, "Chinese Forces Battle Dizzying Altitudes to Expand Military Footprint," Wall Street Journal, December 5, 2025, https://www.wsj.com/world/china/chinese-forces-battle-dizzying-altitudes-to-expand-military-footprint-c9350bbd.

[193] Sikorsky, "China's Climate Security Vulnerabilities."

[194] Congressional Executive Commission on China, "Thawing Permafrost May Threaten Qinghai-Tibet Railroad in 10 Years," CECC, March 2, 2006, https://www.cecc.gov/publications/commission-analysis/thawing-permafrost-may-threaten-qinghai-tibet-railroad-in-10-years.

[195] Youhua Ran et al., "Permafrost Degradation Increases Risk and Large Future Costs of Infrastructure on the Third Pole," *Communications Earth & Environment* 3, no. 1 (October 13, 2022): 1–10, https://doi.org/10.1038/s43247-022-00568-6.

[196] Demian Shevko, ed., "Gazprom Reports First Daily Gas Supply Record to China in 2026," The New Voice of Ukraine, January 12, 2026, https://english.nv.ua/business/gazprom-sets-first-2026-daily-gas-supply-record-to-china-via-power-of-siberia-50574989.html.

[197] Oceana Zhou et al., "Russia-Ukraine Conflict Puts China's Incremental Crude Appetite in Spotlight," S&P Global, February 25, 2022, https://www.spglobal.com/energy/en/news-research/latest-news/crude-oil/022522-russia-ukraine-conflict-puts-chinas-incremental-crude-appetite-in-spotlight.