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Study flags overlooked danger posed by hanging glaciers on mountain slopes in Central Himalaya

Rahul Karmakar
GUWAHATI

Unstable hanging glaciers on steep mountain slopes could trigger devastating avalanches and downstream disasters, a new study focused on a sensitive section of the Central Himalaya has warned.

Four researchers from the Indian Institute of Science (IISc), Bengaluru, the Indian Institute of Technology (IIT), Bhubaneswar, and the Defence Research and Development Organisation (DRDO), Chandigarh, assessed such glaciers in the Alaknanda basin of Uttarakhand, a key headstream region of the Ganga.

Their findings revealed the scale of the growing but largely overlooked danger, and a sharp rise in human exposure, driven by rapid development in high-altitude areas.

The authors are Nandu Krishnan and Anil V. Kulkarni from IISc's Divecha Centre for Climate Change, Ashim Sattar of IIT Bhubaneswar's School of Earth, Ocean, and Climate Sciences, and Harendra Singh Negi of DRDO-Chandigarh's Defence Geoinformatics Research Establishment.



Researchers assessed such glaciers in the Alaknanda basin of Uttarakhand, a key headstream region of the Ganga. FILE PHOTO

Their study was published in the latest issue of *npj Natural Hazards*, a peer-reviewed journal.

The researchers identified 219 hanging glaciers – these cling to steep valley walls and often terminate abruptly – across the basin, covering approximately 72 square km with an estimated ice volume of 2.39 cubic km, including less than one square km of hanging ice mass.

These glaciers predominantly face southeast-west and north-northeast, with the Upper Alaknanda basin containing 30% of the total hanging mass volume.

Nearly one-third of these glaciers, assessed using a grid-based numerical model, are in a highly 'un-

stable' state, making them prone to break-offs.

Warmer climes

"Glaciers in high-elevation alpine environments are highly sensitive to climate variability and warming. This sensitivity is particularly pronounced in the Himalaya, where warming over the past two decades has exceeded the global average, resulting in accelerated glacier retreat," the study stated.

"Such retreat has led to the detachment of tributary glaciers from trunk glaciers and has destabilised mountain glaciers (glaciers located on mountain sides) that were previously stable. These instabilities are often

compensated by mass shedding in the form of snow and/or ice avalanches, a process characteristic of hanging glaciers," it read.

The natural process, however, becomes hazardous when it occurs near settlements or infrastructures in the basin, which is also characterised by high seismicity, it stated.

The Alaknanda basin, with elevations ranging from about 400 metres to 7,800 metres, is both geologically fragile and increasingly populated.

The basin hosts pilgrim centres, including Badrinath and Kedarnath, as well as towns, roads, trekking routes, and hydropower projects – most of them near glacier-fed valleys.

'Possible devastation'

Using satellite imagery, elevation models, and avalanche simulations, the researchers assessed the farthest potential ice avalanches could travel and their likely impact.

They deduced that in a worst-case scenario, modelled flows could reach major settlements, including Mana, Badrinath, and Hanuman Chatti.

The simulations suggest-

ed that avalanche debris could be over 50 metres high in some areas, with even greater intensities upstream. Apart from burying land and infrastructure, such events could temporarily block rivers, forming unstable lakes that may burst and cause floods downstream.

According to the researchers, the rapid increase in exposure makes the current situation more alarming. The study estimated that built-up areas within vulnerable zones have expanded dramatically, from about 8,000 square metres in 2000 to over 150,000 square metres projected by 2030.

The Badrinath-Mana stretch showed the most striking growth, with both population and infrastructure expanding towards steep glacier slopes.

The researchers argued that adopting targeted monitoring in high-risk Himalayan locations could significantly reduce future risks. While full-scale systems may be difficult to implement across such vast terrain, they said that identifying the most perilous glaciers and focusing resources would be a practical first step.

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GS Paper II – Polity

Delimitation – a case of to be or not to be

A special session of Parliament to consider the Constitution (131st Amendment) Bill, 2026 – and also the Union Territories Laws (Amendment) Bill, 2026, and the Delimitation Bill, 2026 – for readjustment of Lok Sabha and Legislative Assembly seats across the country and implementation of reservation of seats for women in Lok Sabha and Legislative Assemblies (linking it to proposed fresh delimitation for which there was a separate Delimitation Bill) ended in a spectacular way. The proposed delimitation was to reallocate the number of Lok Sabha and State Legislative Assembly seats among States (and Union Territories with legislatures), and determine the territorial boundaries of each constituency, based on data from the 2011 Census. The total number of Lok Sabha seats was proposed to be increased to 850. The special session was convened at a time when electioneering for the ongoing Legislative Assembly elections is at its peak in West Bengal and Tamil Nadu, which did not go down well at all with several Opposition parties.

Law and practice

Articles 82 and 170 (3) of the Constitution require a readjustment of the number of Lok Sabha and Assembly seats in each State and the extent/boundary of every constituency, after each Census. The first delimitation exercise in independent India was carried out in 1950-51 by the Election Commission of India, in consultation with Parliamentary Advisory Committees established for various States. As the delimitation exercise could not await the completion of the 1951 Census, given the urgency of conducting elections at the earliest, the first delimitation was based on estimated population figures, as of March 1, 1950, as provided by the Census Commissioner.

After the completion of the first general election, a fresh delimitation did take place based on the 1951 Census as per the mandate of Articles 82 and 170. Subsequently, readjustment of constituencies, both in terms of number and boundary, was carried out after the Census in 1961 and 1971. The delimitation based on the 1971 Census was completed in 1976. Subsequently, the Forty-Second Amendment of the Constitution of India froze further delimitation until the Census



K.F. Wilfred

Former Senior Principal Secretary of the Election Commission of India

The delimitation debate raises questions on representation and equity

of 2001. The temporary freeze on delimitation was introduced in the context of population control measures actively promoted by the Indira Gandhi government. It was intended to ensure that States successfully curbing population growth were not disadvantaged in terms of representation in Parliament and State Legislative Assemblies due to lower population figures, while States with higher population growth did not gain a corresponding increase in seats.

The issue of population growth

The temporary freeze on delimitation ended in 2001. However, the government led by Atal Bihari Vajpayee at the time decided that it was necessary to continue the freeze on the number of seats in the Lok Sabha and State Legislative Assemblies. The government decided to redraw the territories of constituencies to ensure *inter se* parity in terms of population across them, as this balance had been disrupted/disturbed due to large-scale internal migration of people in search of employment and livelihood since 1971. To this end, the Constitutional provisions were amended in order to provide that territories of the constituencies would be readjusted on the basis of the 2001 Census figures without altering the number of Lok Sabha or Assembly seats.

The Statement of Objects and Reasons in the Bill for the Constitution (Eighty-fourth Amendment) Act, 2001, *inter alia*, stated that, in view of the progress of family planning programmes across different parts of the country, the government – under the National Population Policy strategy – decided to extend the freeze on undertaking fresh delimitation up to the year 2026. This was intended as a motivational measure to enable State governments to continue pursuing the goal of population stabilisation.

Therefore, the apparent thinking at that point of time was that population growth would stabilise across all States within the next 25 years. As per the provisions of Articles 82 and 170(3), as amended in 2001 by the Eighty-Fourth Amendment Act, the freeze on further delimitation is to be in place until the population figures of the first Census to be taken after 2026 are published. In fact, a new national Census (against the delayed 2021 Census) is under way.

The Statement of Objects and Reasons of the current Delimitation Bill, 2026, *inter alia*, noted

that the growth of population across different constituencies along with migration from one place to another – especially rural to urban migration – “have resulted in varying density of population in electoral constituencies”; the Bill sought to address this issue. Ironically, for bringing about parity in population among constituencies, both intra-State and inter-States, the population figures of the 2011 Census were to be adopted – this means that the base data to be used for course correction or updating would have been 15-year-old population figures.

Looking ahead

There is nothing to suggest that migration has either stopped or slowed since 2011, or that population growth has stabilised uniformly across all regions. Against this backdrop, there is no assurance/guarantee that constituencies based on the 2011 Census would stand the test of parity or uniformity in terms of population – and, by extension, in the electorate – at the point when the delimitation exercise would have been completed.

It was quite likely that when constituencies are finally carved out a couple of years down the line, many of them would exhibit clear and evident real-time disparities when compared with the principles set out in the Statement of Objects and Reasons of the present Bill.

Article 81(2) of the Constitution provides that each State shall be allotted Lok Sabha seats in such a manner that the ratio of seats to population, as far as practicable, remains the same across all States.

There is no dispute that the letter of this Article only refers to population as a criterion. However, if we take a broader view, there would be inherent provisions in the Constitution to support the States to retain their scale of parliamentary representation. There may also be scope to incorporate additional parameters/markers alongside population, especially since the number of seats is expected to increase significantly this time, unlike the relatively modest/nominal increases in earlier exercises. After all, States are the component units forming the Union. Strong components will only strengthen the Union.

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GS Paper II – Polity

Costs and wages

Governments must not view labour unrest as a law-and-order problem

The ongoing factory workers' protests in Noida's industrial belt are one of the largest industrial labour mobilisations in recent times. Violence has been documented as well: stone-pelting and attempts to breach police barricades, as well as a brutal police lathicharge. After Haryana hiked wages for workers by 35% following protests in Faridabad, Gurugram, and Manesar, workers in Noida realised that their own wages were lower, a situation exacerbated by the pinch in LPG supplies. Trade unions have demanded ₹18,000 to ₹25,000 a month – which the Uttar Pradesh government's interim hike of around 21% did not meet – and fixed working hours and holidays and overtime pay. The new Labour Codes that the Union government enforced from late 2025 allow a 12-hour single workday and specify wage floors but not actual wages, leaving them to the States. As a result, the Codes have allowed employers in certain States to extract more work from the longer workday at or near the statutory minimum pay. The share of contract labour in the formal manufacturing sector in India is the highest since 1997-98. Ironically, the provisions of the Labour Codes encourage the sector to persist with contract labour rather than appreciate job security, while also imposing limits on worker strikes. These, together with the energy crisis and increasing food prices, precipitated the protests.

In 2024, the Samsung workers' strike in Sriperumbudur, Tamil Nadu, was similarly over low wages, unpaid overtime, and the company's refusal to recognise unions. More recently, workers at the IOCL Panipat refinery went on strike demanding an eight-hour workday, better wages, and safer working conditions, as did workers at the NTPC plant in Patratu, and Adani's Raikheda plant in Raipur. This is practically a wave in the Labour Codes regime, showing that labour rights are paper tigers – exacerbated by Yogi Adityanath's claim that the protests were a conspiracy, followed by the interim hike. A worker who spends one-sixth of his monthly income on cooking costs alone does not need to be radicalised to understand that his wage is insufficient. Further, neither the State nor the Centre responded substantively to residential societies barring domestic workers who had joined the protests by displaying their photographs at the gates – a serious civil rights infraction. The Indian Labour Conference has not convened since 2015, and the Codes were passed without the tripartite consultation that it would have facilitated. The solution to the agitation, in sum, is simple: institute humane working hours and wages, and institute genuine labour reform that is well enforced. The problem only looks complicated because the government is dragging its feet.

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On delimitation and Parliament seats

What is delimitation, and how does it work in India? What changes were proposed in the 131st Constitutional Amendment Bill? Why was an increase in Lok Sabha seats proposed? What concerns did the Opposition raise against the Bills? What is the way forward?

EXPLAINER

Rangarajan R.

The story so far:

The Union government had introduced the Constitution (131st Amendment) Bill to increase the maximum number of Lok Sabha seats from the existing 550 to 850. It had also introduced a Bill to set up the Delimitation Commission in 2026. However, the Constitution Amendment Bill was defeated in the Lok Sabha, and thereafter, the Delimitation Bill was withdrawn by the government.

What are the existing provisions?

Delimitation refers to the process of fixing the number of seats and the boundaries of territorial constituencies in each State for the Lok Sabha and Legislative Assemblies. This exercise is carried out by a Delimitation Commission set up through an Act of Parliament. Such exercises have previously been conducted based on the 1951, 1961, and 1971 Censuses. The number of Lok Sabha seats, based on the 1971 Census, was fixed at 543 when the population was 54.8 crore. The number has been frozen, based on the 1971 Census, to encourage population control measures. As per the current constitutional provisions, this number is to be readjusted based on the 2027 Census.

In 2023, through the 106th Constitutional Amendment, Parliament provided for one-third reservation of seats for women in the Lok Sabha and State Legislative Assemblies. This would be through delimitation based on the next Census.

What are the Bills?

The 131st Constitution Amendment Bill proposed three key changes. First, to



The Bill proposed to increase the maximum number of Lok Sabha seats from 550 to 850. PTI

increase the maximum number of Lok Sabha seats from 550 to 850. Second, to empower Parliament to determine the Census based on which delimitation would be carried out. Third, to delink one-third reservation for women from the next Census in 2027 and to enable the same based on delimitation as per the last published Census of 2011.

The Delimitation Bill, 2026, provided for the setting up of a Delimitation Commission from time to time by the Union government. This Commission would allocate Lok Sabha seats among the States and Union Territories based on the latest Census figures. Had the Bill been passed and a Commission immediately constituted, the allocation would have been based on the 2011 Census.

What are the issues?

The government argued that increasing the number of Lok Sabha seats by around 50% (from 543 to 816) would enable the seamless implementation of one-third

reservation for women in an expanded House. This would have resulted in approximately 272 seats being reserved for women.

Union Home Minister Amit Shah gave an oral assurance that the number of seats in each State and Union Territory would be increased by 50% on a pro-rata basis, thereby not altering the current proportion of their representation in the total strength of the Lok Sabha.

However, the Opposition raised several objections. Firstly, there was no need to bundle women's reservations with delimitation. The 106th amendment in 2023 enables one-third reservation for women within the existing 543 seats. Second, the draft Bills did not contain an explicit provision for a pro-rata 50% increase in seats for each State or Union Territory. In fact, the Delimitation Bill provided that the allocation of seats would be as per the latest Census population. Third, the Opposition contended that such an important and

sensitive subject requires detailed discussions and should not be rushed through in a brief session.

What can be the way forward?

Democracy implies government by the people. It follows that the government is elected by the majority with the broad principle of 'one citizen-one vote-one value'. This principle has been diluted in the interest of population control since 1976, when the delimitation exercise was frozen based on the 1971 Census. Given the federal nature of India's polity, the next delimitation process has to take into consideration the variation in population growth across States.

Mr. Shah offered to include an explicit provision to guarantee a 50% pro-rata increase in seats for each State and Union Territory. It was unclear whether this would have been provided in the Constitution Amendment or the Delimitation Bill. If it had been provided in the Constitutional Amendment, any future changes for the same could have been effected only by a two-thirds majority. However, if it had been provided in the Delimitation Bill, amendments could be made by a simple majority.

Article 81(2) of the Constitution provides that the ratio between the number of seats and the population of each State should, as far as practicable, be the same across States. While a 50% pro-rata increase may offer a middle ground between democratic and federal principles, it would still be appropriate to discuss the same in more detail through parliamentary committees. The other urgent reform needed in our democracy is to empower the local bodies of Panchayats and Municipalities, which engage with the citizens on a daily basis. (Rangarajan R. is a former IAS officer and author of 'Polity Simplified'. He currently trains civil-service aspirants at Officers IAS Academy. Views expressed are personal)

THE GIST

▼ The proposed increase in Lok Sabha seats and changes to delimitation faced political opposition and were defeated in Parliament.

▼ The core issue remains balancing "one citizen-one vote-one value" with federal concerns, requiring wider consensus and detailed parliamentary scrutiny.



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GS Paper II – Polity

What does U.P.'s minimum wage revision change?

How does the new wage structure balance worker welfare and industrial stability?

Vikram Karuna

The story so far:

The Uttar Pradesh government issued a crucial notification on April 17, in regard to the revision of minimum wages in the State as an interim step, with retrospective effect from April 1, 2026. This move comes in the backdrop of labour unrest in industrial areas such as Noida and Ghaziabad.

These incidents were not isolated, highlighting concerns of wage stagnation, rising cost of living, and disparities in wages when compared with other industrialised States. In response, the State government established a High-Level Committee comprising senior officers, worker representatives and employers from industrial zones. The committee's consultations and suggestions provided the basis of the notification.

What are the key features of the notification?

The notification revises existing minimum wage rates under the Minimum Wages Act, 1948, using powers under the United

Provinces Industrial Disputes Act, 1947. An important provision is the division of the State into three categories, depending upon geographical and economic factors.

Gautam Buddha Nagar and Ghaziabad are categorised as Category I due to their being areas where industrial activity is concentrated and the cost of living. Category II encompasses districts with municipal corporations, while Category III contains the rest. In each case, wages are set based on skill levels – unskilled, semi-skilled, and skilled. The wage structure comprises a basic amount and a Variable Dearness Allowance (VDA). For example, in Category I, monthly wages are fixed at ₹13,690 for unskilled labour, ₹15,059 for semi-skilled labour, and ₹16,868 for skilled labour. The same rates apply for Categories II and III, but with some reduction in the amount of wages paid in the latter cases.

The introduction of the Variable Dearness Allowance ensures the flexibility of wages against any inflationary pressure, while the revision of the basic wage rate corrects structural deficiencies in wages.

Notably, the rates specified in the notice are interim in nature.

What is the legal and economic basis for wage determination?

The determination of minimum wages in the State of Uttar Pradesh involves statutory considerations that blend legal requirements with economic factors. Under the Minimum Wages Act, minimum wages are reviewed periodically, taking into account the All-India Consumer Price Index (CPI). The Variable Dearness Allowance is directly tied to fluctuations in CPI, ensuring that real wages do not lose value due to inflation.

The 2026 notification underscores a key challenge: delays in wage revisions that ought to be conducted at regular intervals. The minimum wages were supposed to be revised based on the averages of CPI in 2017 and 2023 during 2019 and 2024, respectively; however, this did not happen, leading to a widening gap between actual wages and inflation-adjusted wage levels.

The CPI, for instance, increased to an average of 425 by 2025 when compared to the previous index of 216. In other words, the present revision is aimed at responding to current economic realities while simultaneously rectifying a

long-standing problem that occurred in previous years. The framework also finds its place in the larger scheme of the Code on Wages, 2019. While it is true that the Code on Wages aims to update and modernise wage regulations in India, it provides legal support to the existing tri-level categorisation of minimum wages. It gives State governments the authority to fix differential minimum wages, taking into consideration regional variations, cost of living, and type of employment. Furthermore, a national floor wage system is planned to be introduced in the future, which would enable wage harmonisation across States.

What are the implications?

The implications of such a revision are numerous and diverse. Firstly, for workers in the industrial cluster, it offers partial relief by improving incomes and easing cost-of-living pressures, though questions remain on whether it meets the standard of a living wage. Secondly, the revision involves increasing labour costs for employers, potentially resulting in loss of profits. Thirdly, for the State, the key challenge lies in effective implementation, which might prove rather problematic considering the existence of informal sectors with weak regulation.

Since the notification is interim, further reforms are expected, including the establishment of the Wage Board and State rules under the Code on Wages. However, further actions are needed, including the creation of an effective wage system based on solid data.

(Vikram Karuna is an Assistant Professor at the School of Law, Justice & Governance, Gautam Buddha University, Greater Noida)

THE GIST

The Uttar Pradesh government issued an interim notification revising minimum wages in response to worker disturbances, wage stagnation, and rising cost of living, based on recommendations of a High-Level Committee.

The new wage structure, linked to the Consumer Price Index through Variable Dearness Allowance, seeks to correct delays in wage revision while balancing worker relief, employer costs, and implementation challenges.

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GS Paper III – Science & Technology

Keeping honeybees warm in J&K so they stay back in winter

Peerzada Ashiq
SRINAGAR

A new set of protocols and scientific intervention in honeybee farming in Jammu and Kashmir will finally allow beekeepers to rear colonies in sub-zero temperatures, instead of physically migrating hives to the plains for six months with reported 30% mortality. As its spin-off, Kashmir has also recorded its first mono-floral apple honey.

On January 29, when the Kashmir Valley was under a layer of snow, the Council of Scientific and Industrial Research-Indian Institute of Integrative Medicine (CSIR-IIIM), Pulwama, invited around 200 orchardists to the Bonera farm to demonstrate the first surviving bee colony of *Apis mellifera*, a migratory bee species at the core of the production of around 2,000 tonnes of honey annually worth ₹12.5 lakh.

"It was the first demonstration that *Apis mellifera* could survive sub-zero temperatures. It was possible by working on climate resilient honeybees. The CSIR has worked on a new set of protocols, which focused on nutrients for bees to brave cold temperatures and modulated the hives using new material that regulates the thermodynamics and humidity," said Dr. Shahid Rasool, Principal Scientist at CSIR-IIIM's field station in Bonera.

The Bonera centre has already started propagating the new protocols among beekeepers, who otherwise would have to



A new protocol is being shared with Kashmir's beekeepers, who earlier had to move hives to the plains during winters. IMRAN NISSAR

take hundreds of colonies from the hills to the plains of Haryana, Uttar Pradesh, Punjab and Rajasthan in winters, usually from November up to late April.

The mono-floral apple honey being produced as part of the new protocols marks another breakthrough for the Valley's honey industry. "*Apis mellifera* bees, which foraged in nearby apple orchards this winter and early spring, have likely delivered the first mono floral apple honey, which means it should have 40% nectar per one gram from apple flowers only," Dr. Rasool said.

Natural pollinators

Meanwhile, the CSIR centre in Pulwama has trained farmers on using *Apis mellifera* for natural pollination. "Apple orchardists in Kashmir use the gibberellic acid worth ₹50,000 per hectare as a plant growth regulator during pollination. We are short of natural pollinators, mainly honeybees. However, the new intervention could fill this gap too," Dr. Rasool said.



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GS Paper III – Economic Development

Differentiating welfare and development

In contemporary democratic politics, development has emerged as a central electoral promise, often framed as a politically resonant goal that transcends ideological divides. Political actors deploy the language of development to signal commitments to economic growth, infrastructure expansion, employment generation, and improved public services, thereby appealing to a broad spectrum of voters. In India, development-oriented campaigns have increasingly emphasised visible and tangible outcomes such as infrastructure, roads, housing etc. However, the political assurance of development can obscure distributional concerns, mask inequalities, or reduce complex socio-economic challenges to simplified slogans. Political parties' claims of delivering development are ridden with confusion between welfare and development and the pace with which development manifests.

Complementary but different

The confusion between welfare and development arises from their frequent overlap in political and policy discourse. Welfare typically refers to immediate, redistributive interventions aimed at alleviating poverty, reducing vulnerability, and ensuring basic needs such as food security, income support, and access to essential services. Development, in contrast, denotes a broader, long-term process of structural transformation involving sustained economic growth, productivity enhancement, and expansion of human capabilities. However, in practice, the boundaries between the two often blur. This conflation is evident in the Indian context, where large-scale social protection programmes coexist with ambitions of rapid economic growth. The persistence of confusion lies in the differing time horizons and objectives: welfare is often short-term and consumption-oriented, while development is long-term and



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Conflating populist welfare promises and long-term development goals poses significant risks as it prioritises short-term political gains over long-term economic capacity

production-oriented. A more coherent approach requires recognising welfare and development as complementary rather than interchangeable.

Tensions persist between welfare provisioning and development objectives, particularly in the context of fiscal constraints and concerns about efficiency. Excessive redistribution may distort incentives and crowd out productive investment. The design and quality of welfare programmes are critical determinants of their developmental impact, as poorly designed interventions may lead to leakages, exclusion errors, and limited effectiveness.

Political claims of delivering development often refer to short-term visible outcomes. Development is best understood as an incremental and long-term process rather than a series of discrete, short-term achievements. It involves the gradual transformation of economic structures, institutional capacities, and social outcomes over extended periods, often spanning decades. Unlike episodic policy successes or visible infrastructure projects, development unfolds through cumulative improvements in productivity, human capital, technological adoption, and governance systems. Scholars have emphasised the role of institutions in shaping this evolutionary trajectory, highlighting that sustainable development depends on the slow consolidation of rules, norms, and state capacity. Similarly, the capability approach associated with Amartya Sen underscores that expanding human freedoms – through education, health, and social inclusion – is a gradual process requiring sustained public investment and policy continuity. This perspective cautions against viewing development through the lens of immediate outcomes or electoral cycles, and instead frames it as a continuous, path-dependent process where incremental gains, if consistently

reinforced, lead to substantive and durable transformations. The notion of “quick development” as promised by political parties reflects a persistent fallacy in policy and political discourse, rooted in the expectation that complex transformations can be achieved within short time frames.

Dangers of welfare populism

Public goods such as quality schooling, public health systems, infrastructure, and rule of law are generally more conducive to long-term development than welfare populism. They raise productivity and generate broad, economy-wide benefits over time. Because they are non-excludable and produce strong positive externalities, their impact tends to be durable, cumulative, and inclusive. In contrast, populist ‘development welfarism’ such as politically motivated transfers which include free electricity, loan waivers, or cash handouts prioritise immediate consumption gains and electoral appeal. While these measures can provide short-term relief, they often do not expand productive capacity. Importantly when overused, they can strain public finances and crowd out investment in public goods. However, well-designed welfare schemes such as nutrition support, employment guarantees, or basic income floors can enhance human capabilities, reduce vulnerability, and even improve productivity. The problem is not welfare per se, but populist and fiscally unsustainable welfare that substitutes for, rather than complements, development.

Conflating populist welfare promises and long-term development goals poses significant risks as it prioritises short-term political gains over long-term economic capacity. The challenge for policymakers lies in designing welfare systems that are fiscally sustainable, institutionally robust, and aligned with long-term objectives. It is time that election manifestos acknowledge this and embark on refinements.

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CACHE

How AI companies are quietly becoming the world's cybersecurity gatekeepers

Anthropic's Project Glasswing looks noble on the surface, but it is essentially a cartel of the most powerful technology companies that get to decide who can access the most capable cybersecurity tools ever built

John Xavier

When Anthropic launched Project Glasswing earlier this month, it did so with the kind of announcement that sounded like public service and read like a market consolidation.

The initiative brought together Amazon Web Services (AWS), Apple, Broadcom, Cisco, CrowdStrike, Google, JP Morgan Chase, the Linux Foundation, Microsoft, Nvidia, and Palo Alto Networks — essentially the who's who of the global technology industry — under a single coordinated effort to secure the world's most critical software using an unannounced AI model called Claude Myths Preview.

On the surface, it is a noble coalition. But looked at from another angle, it is a cartel of the most powerful technology companies on earth jointly deciding who gets access to the most capable cyber tools ever built.

Myths Preview, Anthropic's new frontier model, has demonstrated an ability to find and exploit vulnerabilities hidden for decades in software that powers everything from operating systems to web browsers to the open-source code underpinning much of the internet.

Exploiting hidden weakness

To understand why this matters, a brief explanation of the terminology is useful. A "zero-day vulnerability" is a flaw in software that nobody knew existed until someone spots it, and so developers have zero days to fix it. An "exploit" is the actual weapon built from that flaw, a piece of code that lets an attacker break into a system, steal data, or crash critical services.

Previously, finding zero-days and turning them into working exploits required expert human researchers working for days or weeks. Myths Preview, according to Anthropic's own technical documentation, can do both autonomously, overnight, and at a fraction of the cost.

Anthropic claims the model identified a 27-year-old flaw in OpenBSD, an operating system specifically built with security as its primary design principle. It found a 36-year-old bug in FFmpeg, a video processing library so widely used and so thoroughly tested that research papers have been dedicated to how best to audit it. In one case, automated testing tools analysed a vulnerable line of code five million times over the years and missed it entirely. But Myths Preview spotted it.

Anthropic says its model has already surfaced thousands of critical vulnerabilities and is still working through an extensive list of open-source codebases.

Building a cyber defence network

The stated mission of Project Glasswing is defensive: find bugs before bad actors do, notify developers, and fund open-source maintainers, who are usually independent programmers who need time and resources to fix flaws in the software.

Anthropic has committed \$2.5 million to the Open Source Security Foundation and Alpha-Omega, and \$1.5 million to the Apache Software Foundation. Free access



Myths Preview, Anthropic's new frontier model, has demonstrated an ability to find and exploit vulnerabilities hidden for decades in software. MITRIM

to Claude subscriptions is being offered to verified open-source developers.

While these are meaningful gestures, the structure of the initiative raises a pertinent question about why Anthropic has decided, unilaterally, that Myths Preview will not be made generally available. The most powerful bug-finding tool in existence is being distributed exclusively through a coalition that Anthropic convened and controls. And the companies gathered under Project Glasswing are also the ones best positioned to profit from a software breakdown.

Google's cybersecurity game

This initiative comes less than a month after Google completed its acquisition of Wiz, an Israeli cybersecurity firm, in a \$3.2 billion deal, marking the largest acquisition in the company's history. Wiz built its reputation by offering a platform that scans cloud environments for vulnerabilities and misconfigurations.

Together, Google Cloud and Wiz will now offer what they describe as an AI-powered cybersecurity platform combining Google's Threat Intelligence and Security Operations with Wiz's Cloud Security Platform, designed to detect, prevent, and respond to threats across all environments. The deal positions Google not merely as a cloud provider that happens to offer security tools, but as a vertically integrated security company with the AI backbone to run it.

For Google, the move is widely seen as a way to differentiate its offering through a security-first cloud strategy. In other words, cybersecurity is no longer a feature Google offers alongside its cloud services; it is the competitive differentiator. Microsoft made a similar bet years ago, quietly building its security division into a business that now

generates over \$20 billion in annual revenue. Vertically integrating cybersecurity into cloud services provides hyperscalers with a new category of enterprise power.

A conspicuous absence

While Google, which offers its own rival model Gemini, is a part of Project Glasswing, OpenAI is conspicuously absent from the partner list. The company whose name is most synonymous with the public face of the AI revolution was not invited to Anthropic's table. But the ChatGPT-maker has moved quickly. Just a week after Glasswing was announced, the company expanded its own Trusted Access for Cyber (TAC) programme and released GPT-5.4-Cyber, a version of its latest model purpose-built for defensive security work with fewer restrictions for verified users.

The launch directly responds to Anthropic's Project Glasswing, with OpenAI's benchmark data showing just how fast these capabilities are advancing: its models went from scoring 27% on capture-the-flag security challenges in August 2025 to 76% just three months later.

But the more structurally interesting question about OpenAI is not its cybersecurity product roadmap. It is the nature of the company's infrastructure bets and what they mean for its ability to compete in a field increasingly defined by the integration of AI, cloud, and security.

Its Stargate infrastructure project gives it unparalleled scale for model development, and its partnership with Microsoft provides some enterprise security reach. But it lacks a platform like Wiz that sits inside enterprise cloud environments, watching for threats in real time. In cybersecurity, that kind of embedded presence is enormously

difficult to replicate through model releases alone.

Anthropic has made the first move and formed a solid alliance with the most important names in the world of tech. That leaves OpenAI with fewer options. It could possibly attempt an acquisition of its own in the security space or deepen its relationship with Microsoft to the point where its models become the intelligence layer beneath Microsoft's security stack.

But OpenAI has said it does not think it is "practical or appropriate to centrally decide who gets to defend themselves," positioning its approach as broader and more democratised than Glasswing's curated coalition.

The new-age cybersecurity firms

So, with Anthropic's Project Glasswing a system is emerging where the same firms that develop the AI models capable of finding vulnerabilities at unprecedented scale will also be the firms selling the platforms that protect against those vulnerabilities.

They convene the coalitions that decide who gets access to the most advanced tools. They fund the foundations that maintain the open-source software those tools scan. And they do all of this while their models grow more capable by the month.

While their goal is rational and, in isolation, defensible, the aggregate effect will lead to a concentration of cybersecurity power in a handful of firms that is difficult to overstate.

This could possibly lead to a cartel-like behaviour sans price fixing as these firms will become companies whose structural position means that the rest of the world's ability to secure its digital infrastructure increasingly runs through their products, their platforms, and their decisions about who gets access to what.



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GS Paper III – Science & Technology

'Nuclear plants require lifetime commitment'

Jacob Koshy
NEW DELHI

As India opens its nuclear power sector to private participation under the newly enacted SHANTI Act, former regulators of the nuclear energy establishment and policy veterans said that nuclear power required "lifetime commitment," and maintaining "financial security" to account for "waste management, settlement of claims (caused by radiation), and decommissioning (nuclear power plants).

The Sustainable Harnessing and Advancement of Nuclear Energy for Transforming India (SHANTI) Act, 2025, as the government has articulated repeatedly, is to help India raise its installed nuclear power capacity from the existing 8.7 gigawatt (GW) to 100 GW by 2047. Unlike the previous half-century, it hopes to achieve this by allowing, in theory, private companies to run nuclear power plants and harness foreign



The SHANTI Act reflects the effort to modernise the laws governing the nuclear sector.

funds for the purpose. Ravi Grover, member, Atomic Energy Commission and veteran nuclear engineer, at a talk in New Delhi on Saturday, said the SHANTI Act clearly prescribed duties and liabilities that power plant operators must adhere to, whether in the private or public sector.

"The prime responsibility for safety, security and safeguards lies with the licensee...Section 10 of the Act clearly and transparently spells out what a

newcomer to the sector should know...there is no place for indulging in regulatory tricks. No one can fudge the half life of a radioisotope. If it is 30 years, it remains 30 years," he said.

Rajan Raghavan, vice-president, Tata Consulting Engineers Ltd., who represented Indian private sector companies interested in expanding their presence in India's nuclear power sector, said four priorities shaped investment decisions: site selection, affordable technology, government hand-holding, and tariff viability.

The 700 MW indigenous pressurised heavy-water reactor, Mr. Raghavan said, which the Nuclear Power Corporation of India Ltd. (NPCIL) – a public sector company which is the sole operator of nuclear plants – plans to deploy in fleet mode over the next 10 to 12 years, was the "natural choice".

The 220 MW design, though indigenous, was fi-

nalised 15 years ago and would need substantial rework to meet current regulatory and safety benchmarks.

Foreign reactors, he cautioned, came with prohibitive costs and lengthy design-validation timelines for Indian conditions – "two to three years" before construction could even begin.

Legal framework

Former Atomic Energy Regulatory Board Chairman. D.K. Shukla offered the regulator's view, arguing that the SHANTI Act finally provided a "unified legal framework" that separated control regulation from safety regulation – a clarity that was implicit earlier only because every player sat within the Department of Atomic Energy.

With private entities entering, he warned that issues previously considered minor would now become major. A central concern Mr. Shukla flagged was the lifetime commitment of

nuclear operation demands. The Act, he noted, now required licensees to "maintain design support throughout the lifetime of the facility" – a requirement far weightier for nuclear than for other power plants, given the longer operating life. Every 10 years, operators must undertake a periodic safety review to demonstrate compliance with current safety standards.

"How do you modify or incorporate the new safety upgrade if you do not have the full-fledged design information and capability?" he said, pointing out that changes to one system can cascade adversely through others.

Design integrity must be preserved throughout the plant's life, he stressed, "whether technology is developed within the country or it is imported" – a pointed caution for private players contemplating foreign reactor imports without securing long-term design support arrangements.



GS Paper III – Science & Technology

How altered mosquitoes could reshape malaria control

New research has confirmed that genetically modified mosquitoes can suppress malaria parasites from real-world infections, not just laboratory cultures; it also reported that advanced mosquito genetic engineering can be carried out in malaria-endemic regions, helping build local scientific expertise and regulatory capacity

Manjoseera Govararaman

For decades, malaria control has worked by reducing the number of mosquitoes and treating infected people. As a result, bed nets, indoor insecticide spraying, and effective medicines have saved millions of lives. Yet malaria remains one of the world's deadliest infectious diseases, killing more than half a million people each year, most of them children in sub-Saharan Africa.

Anti-malaria efforts have also slowed in many regions as mosquitoes become more resistant to insecticides and the malaria parasite evolves resistance to drugs.

These setbacks have led scientists to reconsider a long-held assumption: that the only way to fight malaria is to kill mosquitoes.

For more than 20 years, researchers have explored an alternative: modifying mosquitoes so they no longer carry malaria parasites.

'Transmission Zero'

This idea is now moving closer to reality through a genetic technology called a gene drive. A series of studies over the past few years has shown that gene drives can spread through mosquito populations under increasingly realistic conditions.

One recent study published in *Nature*, led by Tibebu Habteiroad and Dickson Levotseja at the Ifakara Health Institute in Tanzania, working with collaborators at Imperial College London, demonstrated for the first time that genetically modified mosquitoes can block malaria parasites circulating in endemic African settings.

The work forms part of 'Transmission Zero', a Tanzania-led and internationally supported project developing genetic mosquito control.

How gene drives work

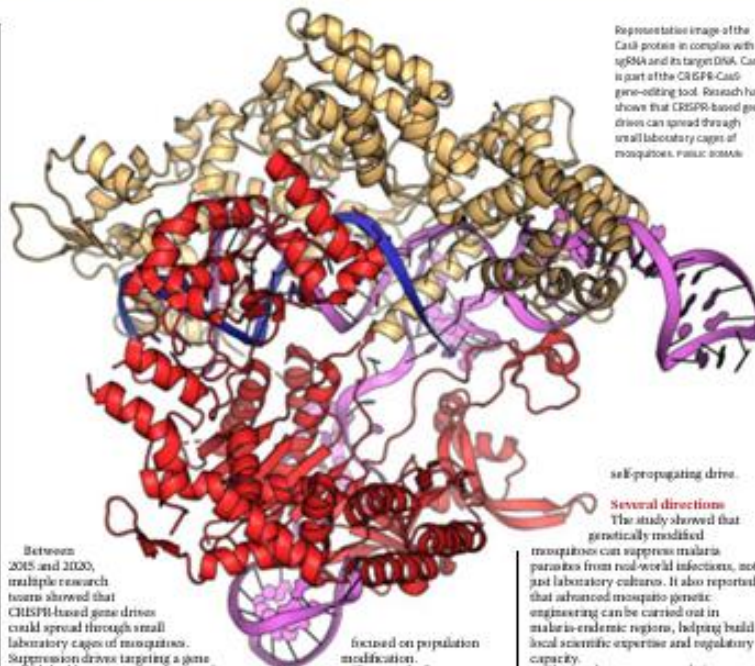
An organism normally has a 50% chance of passing a specific gene to its offspring. A gene drive alters this rule.

Using the gene-editing tool CRISPR-Cas9, scientists design a genetic system that copies itself onto the partner chromosome during reproduction. As a result, far more than half of the offspring inherit the modified gene, often over 90%. Over multiple generations, this biased inheritance allows a gene to spread rapidly through a population.

Researchers are developing two main types of mosquito gene drives.

The first is population suppression. These drives disrupt the genes essential for female mosquitoes to develop or become fertile. As the drive spreads, more females become sterile, causing mosquito populations to shrink or collapse.

The second approach is population modification, also called replacement. Here, mosquitoes remain alive but carry genes that prevent the malaria parasites from developing inside their bodies. This strategy thus reduces the mosquitoes' ability to transmit malaria.



Representative image of the Cas9 protein in complex with sgRNA and its target DNA. Cas9 is part of the CRISPR-Cas9 gene-editing tool. Research has shown that CRISPR-based gene drives can spread through small laboratory cages of mosquitoes. PUBLIC DOMAIN

THE GIST

Scientists are reconsidering a long-held assumption — that the only way to fight malaria is to kill mosquitoes.

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The results of the study support population modification as a realistic alternative to population suppression, with potentially fewer ecological risks as it doesn't aim to eliminate an entire species.

self-propagating drive.

Several directions

The study showed that genetically modified mosquitoes can suppress malaria parasites from real-world infections, not just laboratory cultures. It also reported that advanced mosquito genetic engineering can be carried out in malaria-endemic regions, helping build local scientific expertise and regulatory capacity.

focused on population modification.

The team built a high-containment insectary in Bagamoyo in Tanzania that allowed advanced genetic work to be carried out in a malaria-endemic country rather than having to develop the technology elsewhere, then importing it to Tanzania.

The researchers engineered local *Anopheles gambiae* mosquitoes to produce two antimicrobial peptides in their midgut after taking a blood meal.

Instead of using laboratory parasite strains, the team collected blood samples from children with malaria in three nearby villages. Both modified and unmodified mosquitoes were fed on this blood, and the team tracked the development of parasites.

In ordinary mosquitoes, parasites develop normally and reach the midgut, linked to the salivary glands, starting transmission. In the modified mosquitoes, the parasites were severely impaired and often failed to reach the infectious stage. In some experiments, none of the modified mosquitoes carried potentially transmissible parasites.

The researchers also demonstrated a split gene drive. One mosquito line carried the anti-malaria genes while another provided the Cas9 enzyme. When combined, about 94% of offspring inherited the protective trait, allowing the researchers to test the protective genes without immediately deploying a fully

Between 2015 and 2020, multiple research teams showed that CRISPR-based gene drives could spread through small laboratory cages of mosquitoes. Suppression drives targeting a gene called doublesex caused entire caged populations to collapse within a few generations. Other studies engineered mosquitoes to produce molecules such as antimicrobial peptides or antibodies to harm the malaria parasite.

As small cages provide an overly simple environment, researchers built large indoor cages that allowed mosquitoes to swim, mate, feed, and reproduce in more natural ways.

In 2021, researchers at Imperial College London and partner institutions described experiments designed to mimic real mosquito populations. A small number of mosquitoes carrying a doublesex suppression gene drive were released into stable populations of *Anopheles gambiae*.

Over eight to ten months, the drive steadily increased in frequency, egg production collapsed, and every experimental population eventually died out. Importantly, the researchers didn't detect any genetic changes that would both block CRISPR-Cas9 and allow mosquitoes to evade the gene drive while remaining viable.

The experiments indicated that gene drives could work safely in messy real-world settings as well.

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The Tanzania study
While suppression drives aim to cut mosquito numbers, the Tanzania study