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GS 3: SCIENCE AND TECHNOLOGY -> USE OF DRONE FOR ELECTION MONITORING

THE HINDU PAGE : 3

Drones help thwart bid to distribute cash to voters, 5 arrested

The Hindu Bureau

PUDUCHERRY

Teams involved in the enforcement of the Model Code of Conduct for the April 9 Assembly election in Puducherry used drone surveillance to apprehend five persons and seized ₹66,000 cash from them, which was meant to be distributed to voters.

Flying squad members deployed at the Mannadipet constituency apprehended three persons – Thirumaran, Silambarasan, and Chakravarthy – and seized ₹55,000 from them. Another team deployed at the Mangalam constituency took into custody P. Rajendran and P. Suresh and seized around ₹11,000 from them.

The accused and the seized amount were handed over to the police for further processing, Chief Electoral Officer P. Jawahar said in a release.

Mr. Jawahar said the department was using drone technology for real-time monitoring of campaigns

by political parties and candidates in all 30 Assembly segments.

The footage captured by the drones would be relayed to the Integrated Command Control Centre for alerting flying squads deployed in various areas.

Appeal to public

Citizens are encouraged to report voter inducement activities to the authorities through the cVIGIL App or 1950 to ensure free, fair, and transparent elections, the CEO said.

“The use of drone technology is an effective mechanism to prevent electoral malpractices in real time. The act of inducement of electors through the distribution of money constitutes bribery under Section 123(1) of the Representation of the People Act, 1951, and also attracts provisions under section 170 of the Bharatiya Nyaya Sanhita. Necessary legal action has been initiated in the seizures at Mannadipet and Mangalam constituencies,” Mr. Jawahar said.

GS 3: INTERNAL SECURITY

THE HINDU PAGE : 8

Opportunity corridor

Inclusive development must be the focus in areas freed of Naxalism

India is now Naxal-free, Home Minister Amit Shah declared in the Lok Sabha on March 30, a day ahead of a deadline he had set for himself for ending Left Wing Extremism (LWE). His assertion follows three years of intensive paramilitary operations, during which 4,839 Maoists surrendered, 2,218 were arrested, and 706 were neutralised in encounters. Mr. Shah had made tackling LWE a central piece of his internal security policy, and of his political legacy. Not surprisingly, he made it a point to contrast the measures and milestones under his watch with those of the UPA regime on this front. Former Prime Minister Manmohan Singh had flagged LWE as the biggest internal security challenge before the country and his government launched Operation Green Hunt in 2009-10, an expansive paramilitary offensive that faced stiff criticism from his allies. The belt of Maoist influence, at its peak, touched over 180 districts covering tribal, forest, and mineral-rich areas in Bihar, Jharkhand, Chhattisgarh, Odisha, Andhra Pradesh and Maharashtra. The approach to tackling LWE then was more hesitant and measured, mindful of the human and institutional costs.

Mr. Shah launched an uncompromising militarist strategy which he reiterated in his speech. He said the government had a dual approach – dialogue and rehabilitation for those who surrendered arms, and no mercy for those who refused. His sweeping strategy steamrolled human rights activists and academics who were branded 'urban Naxals'. Police measures went far beyond even the harsh provisions of India's anti-terrorism laws, strangling freedoms and distorting judicial processes. The paramilitary operations have, in all probability, decapitated the military capabilities of the insurgents, opening the possibility of state presence in some of the least governed regions of the country. Mr. Shah said that a campaign to establish a school in every village and provide Aadhaar and ration cards to residents in some of the worst-affected areas has already begun. He is right that Maoists are ideologically opposed to parliamentary democracy, which is a position delinked from development or its absence. Nevertheless, inclusive development is imperative for a stable, peaceful society. The defeat of LWE extremism should not accelerate crony capitalist extraction of natural resources and further alienate tribal rights. Instead, it must lead to the genuine expansion of the rights of tribals, their substantive participation in parliamentary democracy, and accountability in resource extraction. Mr. Shah deserves credit for leading the operational success in curtailing LWE. He must now lead a politics of reconciliation and heal the wounds of the battle.

GS 2: JUDICIARY

THE HINDU PAGE : 8

A textbook, criticism, the Court and contempt

It is prime news ever since the Supreme Court reacted to the treatment of the judiciary in the Class eight textbook brought out by the National Council of Educational Research and Training (NCERT). The Court has shelved the book and the authors, and a new committee of legal eminences is to decide what our children should read.

Contempt and the handling of criticism
What is this power of contempt? It consists of two types. The first is civil contempt, invoked for disobedience of a court order. That is clear. The second is criminal contempt, and that is for obstructing the administration of justice, or prejudicing judicial proceedings. And, importantly, scandalising or lowering the authority of the court by hostile criticism that shakes public confidence in the judiciary. This is a little more complicated, requiring lines to be drawn.

Criminal contempt is not to be invoked because an individual judge's sense of pride or ego is offended. It is invoked because a false image of the court is spread which can be deleterious and prejudicial. Why should this be actionable? Because the court and public opinion are connected by multiple twists of the democratic thread.

Judges do not have the power of the purse, or the sword. They have their power under the Constitution and the law. But the real substratum of their power, the hard rock, is the faith the public vests in the courts. Every government knows that, and that is the reason they do not mess with the courts. That goodwill and trust are garnered over countless judicial actions upholding the law, delivering justice and being the bulwark for the protection of precious rights. It is that public goodwill and trust which constitute the real power of the court, the unspoken major premise in the balance of power doctrine. That favourable opinion and support are threatened by motivated reports denigrating the judiciary, especially when repeatedly and widely spread.

Over the years, great judges have made one thing clear – that they are not immune from criticism. Chief Justice of India (CJI) Sabyasachi Mukherjee spoke about the inability of the courts to deliver quick and substantial justice and said that this criticism should turn the search light inward.

Here is CJI P.B. Gajendragadkar: "We ought never to forget that the power to punish for contempt, large as it is, must always be exercised cautiously, wisely and with circumspection. Frequent or indiscriminate use of this power in anger or irritation would not help to sustain the dignity and status of the court but may sometimes affect it adversely. Wise Judges never



Sriram Panchu
Senior advocate
and mediator

forget that the best way to sustain the dignity and status of their office is to deserve respect from the public at large by the quality of their judgments, the fearlessness, fairness and objectivity of their approach, and by the restraint, dignity and decorum which they observe in their judicial conduct."

There is also the broad shoulder approach. CJI S.P. Bharucha, while disapproving of the statements of Medha Patkar and Arundhati Roy, explained that he was dropping action against them because "the Court's shoulders are broad enough to shrug off their comments". This seems rather apposite now. Justice Bharucha was one of the earliest to come out loud about corruption in the judiciary; he even offered a percentage estimate. Several other judicial leaders have since voiced concerns. It is nowhere near the malaise that affects the other branches; but even one corrupt judge is an aberration and is not to be tolerated. And, unfortunately, it is the one bad apple that makes news and taints the rest.

And from abroad the ringing voice of the great Lord Denning: "Let me say at once that we will never use this jurisdiction as a means to uphold our own dignity. That must rest on surer foundations. Nor will we use it to suppress those who speak against us. We do not fear criticism, nor do we resent it. For there is something far more important at stake. It is no less than freedom of speech itself. It is the right of every man, in Parliament or out of it, in the press or over the broadcast, to make fair comment, even outspoken comment, on matters of public interest... We must rely on our conduct itself to be its own vindication."

Here is another example, humorous yet telling. After the Spycatcher judgement in 1987, the *Daily Mail* called the judges "Old Fools". Contempt action did not follow. Lord Templeman said he could not deny that he was old, and being a fool was a matter of opinion – obviously, he could not be bothered about the Mail's.

Where the line is drawn

But the Court draws a line. The criticism must be founded on facts set forth correctly. It must not be reckless. It must not be ill-motivated to denigrate the institution. Because, as said above, bringing down its image lessens its capacity to deliver justice to people and institutions at large. And lessens a crucial power it holds in our country, the power of judicial review over acts of legislature and executive. This is the birthing ground for millions of cases seeking relief against administrative wrongdoing and legislative excess. Politicians and bureaucrats rail against the court invoking this power, but it is this which ensures accountability, transparency and good governance. The other branches do not value these, the judiciary does. And it can hold and

exercise this power because people welcome judicial relief, and place the judiciary in high esteem. The cord that binds the court and the common man sustains both in a commonality of purpose and benefit. We must, therefore, not be at ease when that connective tissue comes under threat. When it is a piece of writing that comes under the lens of contempt of court, wise judges tread cautiously. After all, they are the protectors of free speech when policemen and other harassers pick on citizens. And academic freedom, not chilling silence, is what judges would seek to protect.

Perhaps we could have avoided this scenario if the writers, who were senior academicians, had been put on notice and given an opportunity to explain their comments or conclusions. Who knows? A suitable rectification or clarification could have been undertaken. A cautionary admonition may have sufficed. The judges may have come around to amend their initial assessment of the impact on the institution and simply dropped the proceedings. It may have passed off as a storm in a teacup, or the broad shoulders would have simply shrugged. Due process works in wondrous ways. One hopes that the matter will end soon, and satisfactorily, with respect for the Court being dimmed not a whit, and free speech and fair comment not seen as adversarial to the Court. As wisely observed, when the Court onboard criticism, it affirms the system that we are all under the rule of law.

Once we cross this bridge, there is much to do. Students must be duly apprised of the role of the judiciary, not just in resolving disputes between individuals and entities, but also in its stellar role as the protector and enforcer of the Constitution. The importance of fundamental rights including the right to equality, free speech, practice of religion, and the judiciary's role in their preservation and enhancement must be set forth. As also the challenges which it faces, of infrastructure, manpower and corruption.

The end note

One parts with a concern. The judiciary is struggling to develop adequate instruments to tackle this menace within. Impeachment is lengthy; politics plays its part there. Transfer is resorted to, but may just be a location change. In-house inquiry procedures show that action is taken, but may be futile if there is resistance from the offender. Our original constitutional scheme did not envisage encountering judicial corruption beyond the odd instance, and we now have to fashion deterrents and remedies for wider application. This will be of great benefit to hardworking and honest judges, who constitute the vast majority, as well as to the system of administration of justice. Textbook improvement will follow.

The NCERT textbook controversy should be resolved without diminishing judicial respect or free speech

GS 2: INTERNATIONAL RELATIONS

THE HINDU PAGE : 8

A West Asia security rethink amid America's role

As the United States and Israel-led war against Iran enters its second month – with conflicting viewpoints from Washington DC. and Tel Aviv on what the aims of this conflict are and under what conditions they intend to seize their respective military operations – regional countries in West Asia are re-thinking their security future. The closure of the Strait of Hormuz along with Iran's 'scorched earth' policy of striking any targets across the Persian Gulf even remotely attached to American interests is leading to demands for a strategic reset.

U.S. President Donald Trump's view that he and his team were surprised that Gulf states were targeted by Tehran as a response to the U.S.-Israel military strikes has surprised many. For a long time, Iran has said that if it was targeted and the regime's collapse made a state aim, the conflict would become regional. However, regional security has always been a minefield as far as interests are concerned; some tough questions and issues will have to be navigated, the trailers of which are visible today.

Pakistan's attempts to claw its way back in Pakistan's attempt to insert itself as a mediator between Iran and the U.S. has, as expected, ruffled feathers in India. For Islamabad – or more accurately Rawalpindi, given self-anointed Field Marshal Asim Munir's central role in the country's political direction – the access it has built with Mr. Trump over the past year provides it an opportunity to further strengthen this relationship. However, more importantly, this is also an opportunity for Pakistan to reorient itself toward West Asia's Islamic identity, as it was often on the peripheries of this identity due to its long-standing economic troubles.

The Iran conflict has provided Pakistan's



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Middle East

The urgency for a new regional security architecture grows amid the West Asian crisis

leaders the rare opportunity to break through some of these shackles; its position as the only Muslim-majority country with a nuclear weapon, is one in demand as of today. The fact that Pakistan hosted the Foreign Ministers of Türkiye, Saudi Arabia and Egypt, last week, as a consortium, and attempted to leverage its access to Tehran as a neighbouring state highlights its exploration of new security arrangements that are more rooted in regional and Islamic cooperation.

Stirrings within the Gulf

Countries such as Kuwait, which has also been on the receiving end of Iranian aggression, have gone ahead and even criticised constructs such as the Arab League. Kuwait's Foreign Minister Sheikh Jarrah Jaber Al-Ahmad Al-Sabah in an address to other Arab Foreign Ministers, has said that the League has struggled to address the fast-moving challenges being faced.

The leaders of Saudi Arabia, Jordan and Qatar have also met to commit to deepened security cooperation. Until a few years ago, Saudi Arabia and Qatar were fundamentally at odds, with Riyadh imposing an economic blockade on Qatar over regional geopolitical differences. Today, everyone in the Arab construct, from the United Arab Emirates and Saudi Arabia to Kuwait and Bahrain, is looking to side-step their own intra-Gulf differences, of which there are many, to manage these immediate challenges. Many of these Gulf states had built insurance ecosystems with Iran, either through economic cooperation, or in Saudi Arabia's case, a very public détente brokered by China in 2023, bringing the Shia and Sunni seats of power to a level of normalisation for the first time since 2016.

But these "new" regional security ideations will continue to have fundamental problems. For

example, while Iran's actions are shaping responses today, Israel's display of unfettered dominance of air power from the Red Sea to the Persian Gulf will also create anxieties. Israel's strike against Hamas in Doha, Qatar, in 2025, was a testament to this thinking. In addition, the Arab state's relationship with the U.S. will also come under the spotlight. While security cooperation is expected to increase, the Gulf states may have to be operationally more agile and unilaterally active instead of exclusively banking on the U.S.

The U.S. has fallen short

From the 2019 drone attack on Saudi oil facilities by the Houthis to the current conflict, direct American involvement in protecting the Gulf states has clearly not been sufficient. Recent comments by the White House that the Trump administration could ask its Gulf partners to commit finances to help cover the cost of the conflict with Iran raise further questions about what the U.S. role in regional security will be. A high level of American energy self-sufficiency means that Mr. Trump has actionable leverage. However, more than the supply of oil and gas, it is the management of international pricing that remains hugely volatile.

After this war, the West Asian security architecture will face hard questions. Beyond the role of the U.S., can a fool-proof system be created without Iran's buy-in? Will hedging security demands to Asian countries, including India – the main buyers of oil and gas – in the coming decades, be a successful tactic in matters of security? Can the Gulf act unanimously to pursue a common security aim despite internal fractures?

Hard questions await in the aftermath of a war reshaping West Asia as we have known it since the Second World War.

GS 3: ENERGY THE HINDU PAGE : 10

Why is India pushing piped gas now?

Can PNG replace LPG for cooking? Why has LPG been preferred so far? How is LNG transported and used? What is holding back PNG expansion? Can domestic production meet demand? Will PNG reduce LPG import dependence?

EXPLAINER

M. Kalyanaraman

The story so far:

India has a total of 33 crore LPG connections. Recently, Anjan Kumar Mishra, Secretary at the Petroleum and Natural Gas Regulatory Board, said that domestic natural gas production alone could cater to 30 crore connections if all were to switch to piped natural gas (PNG).

What is the difference between LPG, LNG, PNG, and CNG?

LPG is a co-product of oil refining and natural gas processing. That is, its production depends on the processing of both crude oil and natural gas.

Liquefied Natural Gas (LNG), as the name suggests, is natural gas that has been cooled to below -160 degrees Celsius to turn it into a liquid for shipping. Liquefaction reduces its volume by 1,000 times.

Compressed Natural Gas (CNG) is primarily used as a vehicular fuel. It involves compressing natural gas to a pressure of 200-250 kg/cm² (g) to reduce its volume and enable efficient distribution.

How are LPG and natural gas transported to the user?

Propane and butane gases are mixed, pressurised, and cooled to below 40 degrees Celsius, and then transported from the source to consuming countries via ships. LPG is bottled in cylinders and physically delivered to customers.

Piped natural gas is transported through pipelines. Before this, imported natural gas is liquefied and transported through LNG carriers. "LNG carries use special cargo tanks and insulation systems designed for ultra-low temperatures," stated Mitsui O.S.K. Lines in The Hindu. "But simply, the basic task is to move a very cold liquid onto the ship while preventing it from warming up too much."

At the destination, LNG is regasified and transported to the final consumer through pipes.

Last-mile delivery of LPG is easier through trucks and tricycles than building an extensive pipeline network covering every household for natural gas. This has been a key reason why India adopted LPG for domestic cooking.

Why the push for piped gas against LPG now?

India's dependence on LPG imports is currently higher. For instance, in natural gas, India's one-year import was about 27 million tonnes of LNG last year, and production was roughly the same, according to government data. On the other hand, India – until recently – imported three-fifths of its LPG requirements, of which 90% was routed through the Strait of Hormuz, which has now been blocked due to the war in West Asia. Typical annual LPG consumption is 34 million tonnes, out of which 12 million tonnes are produced in India.

If gas is to be imported, LNG has many more sources across the world. In LPG, India was largely reliant on Saudi Arabia and Qatar and the supplies had to pass through the Strait to reach India. "Globally large capacities of liquefaction plants for natural gas are coming online over the next few years, so availability should be healthy," said Prashant Vasishth, Senior Vice President of ICRA.



A domestic LPG cylinder supplier carries cylinders for delivery in Bengaluru on March 30. J. ALLEN EGENUS

Can natural gas replace LPG straight?

Natural gas is much lighter than LPG. But one kilogram of natural gas can deliver more energy than one kilogram of LPG. For cooking purposes, these differences are not significant, making PNG a drop-in replacement for LPG.

However, in industrial uses, the equipment may need to be tuned to a different setting or even altered. For instance, LPG is widely used by MSMEs for welding and cutting. Reports from the ground indicate that while the government is encouraging industrial users to switch, a lack of awareness and technical know-how may hamper adoption.

How is the government pushing for natural gas?

On March 26, The Hindu learnt from senior government officials that over the next two weeks, India could add another 15 lakh new PNG connections.

The official said that instituting last-mile connectivity amidst unfavourable city infrastructure in certain areas was among the major hurdles in expanding the piped gas network.

To speed it up, in a gazette notification, the Centre instituted provisions to help accelerate the uptake, which, among other things, included specific timelines for approving pipeline expansion in housing and non-housing areas.

The Ministry of Petroleum and Natural Gas (MoPNG) told the Parliamentary Standing Committee, which is assessing its demand for grants for FY 2026-27, that it is targeting to have in place a pipeline network that would cover 12 crore PNG connections by 2034.

The committee, in an earlier report, had asked the Ministry to help City Gas Distribution (CGD) entities to overcome difficulties in pursuing expansion, such as in obtaining permissions, land, bidding criteria, and NOC requirements from local authorities.

Across towns and cities, such as in Maharashtra or Coimbatore in Tamil Nadu, where the GAIL pipeline runs

close, the government is now pushing for piping infrastructure for local distribution.

As of December, the government announced that India's gas pipeline network spans about 25,000 kilometres, with an additional 10,500 kilometres under construction. The government is also ensuring that PNG pricing remains competitive with LPG.

"PNG connections have now crossed 1.5 crore. A recent government gazette notification reinforces this direction, mandating that households cannot hold both LPG and PNG connections. As a result, roughly 6 million households will be required to surrender their LPG connection and transition fully to PNG within a three-month timeframe. This will bring total household PNG connections to 2 crore soon," said Manish Sehgal, Senior Vice President at Rystad Energy. "Since the 2020-21, the compounded annual growth rate in connections has been some 18%. A CAGR of 24% would be needed to reach 12 crore connections by 2034-35," he added.

What are the challenges?

The GAIL pipeline network is currently concentrated in western and northern India, with some coverage in Kerala and Bengaluru. The 10,000-kilometre-plus pipelines under construction cover tier-2 and tier-3 cities in parts of central and eastern India, as well as some parts of Tamil Nadu connecting to the Bengaluru leg, and one section going to the northeast. However, large regions in central, southern, and northeastern India remain uncovered. Further, the alignment of the gas pipeline network is more intended to serve industrial needs than households.

The government has aggressively given CGD licences that would cover more than 300 geographical areas covering households, small industries, hotels and restaurants. As of now, some 90 of them are still not connected to the main trunk pipeline. Last-mile connectivity remains an immediate challenge.

Even if projections of 12 crore PNG connections are met in another 10 years, LPG connections will still be more than 20 crore, leaving India requiring to import significant amounts of LPG.

A little less than 30% of natural gas use goes into making fertilizers, while power plants account for 13% and city gas distribution around 20%, said ICRA's Mr. Vasishth. Some 35% goes to sectors like refineries and industries.

A major diversion from these sectors such as power may be needed to cater to cooling gas demand. Mr. Vasishth said industrial consumers can switch to naphtha and furnace oil. PNGRB secretary Mr. Mishra had said that as of now some 1.2 crore PNG connections consume three million metric standard cubic metres of gas every day.

To supply 13 crore connections, India will have to increase domestic production by at least one-third.

Industry observers say that an increase in domestic production from Oil and Natural Gas Corporation (ONGC) fields is possible. Rystad Energy projects a 25% increase.

For instance, ONGC commenced production in the KG-DWN 98/2 Block in the KG basin in 2024. Peak production of the field is expected to be over 10 million metric standard cubic metres per day of gas, which would mean increasing today's overall gas production in India by 10%. Site officials expect the 98/2 block to increase ONGC gas output by 15% through more wells. Increasing imports through LNG may well be required if natural gas consumption is ramped up. India has some nine import terminals covering both coasts.

It will have to truly ramp up the pipeline network to leverage the imports. Further, India's LNG system is even more of a just-in-time system than LPG, with little long-term storage, unlike in Europe. Any disruption in imports will have an immediate impact on availability. (With inputs from Saptarshi Ghosh and Appala Naidu)

THE GIST

India has 33 crore LPG connections, but domestic natural gas production could cater to 30 crore connections if households switch to piped natural gas (PNG).

LPG is delivered in cylinders, while natural gas is transported through pipelines or as LNG and regasified, with PNG emerging as a drop-in replacement for cooking.

The government is pushing PNG to reduce high LPG import dependence, but pipeline expansion, last-mile connectivity, and supply constraints remain key challenges.

GS 2: SOCIAL JUSTICE

THE HINDU PAGE : 11

Qdenga: a step forward against dengue, but not a silver bullet

India's first dengue vaccine offers hope at reducing severe disease even as evolving viral patterns warrant cautious optimism: the vaccine is best understood as one that modifies the disease rather than blocks transmission, meaning outbreaks will not disappear

Vipin M. Vashishtha

India's long wait for a dengue vaccine may finally be coming to an end. Takeda's tetravalent dengue vaccine, TAK-003 (called 'Qdenga'), recently received clearance from the Subject Expert Committee (SEC) under the Drugs Controller General of India (DCGI) for use among individuals aged 4 to 60 years. This marks a significant milestone in the country's fight against a disease that causes millions of infections and thousands of hospitalisations every year, especially among children.

While India has not experienced a large nationwide dengue surge in the past year, the disease remains endemic, with substantial transmission and a long-term rising trend. For decades, dengue control in India relied almost entirely on vector control measures such as eliminating mosquito breeding sites, insecticide use, and public awareness campaigns. While essential, these strategies have had limited success in preventing recurring outbreaks. The arrival of a vaccine, therefore, represents a shift from a reactive to a more preventive approach.

TAK-003 comes with several advantages. It has been evaluated in large global trials involving more than 28,000 participants and has already been approved in more than 40 countries. Importantly, unlike an earlier dengue vaccine, it does not require pre-vaccination screening to determine prior dengue infection, making it simpler to use in real-world settings. The vaccine has also demonstrated good safety and, crucially, strong protection against severe dengue and hospitalisation – both outcomes that matter the most in clinical practice.

In a country like India, where healthcare systems are often stretched during dengue seasons, even a modest reduction in the number of severe cases could have a substantial impact. Fewer hospital admissions, reduced intensive

care burden, and lower mortality in children and adolescents would all represent meaningful gains.

Challenges and limitations

However, it is equally important to recognise what this vaccine can and cannot achieve. Dengue is caused by four closely related but distinct viruses, known as serotypes (DENV-1 to DENV-4). Immunity to one serotype does not guarantee protection against the others, and in some cases, can even predispose an individual to more severe disease upon subsequent infection. This makes developing a vaccine for dengue uniquely challenging: an effective vaccine must provide balanced protection against all four serotypes.

Herein lies a key limitation of TAK-003. While it performs very well against the DENV-2 serotype, since it was developed on the DENV-2 backbone, and reasonably well against DENV-1, its effectiveness against DENV-3 and DENV-4 appears to be lower – particularly in individuals who have not previously been infected with dengue.

This is not merely a theoretical concern. India's dengue epidemiology is evolving, with increasing reports of DENV-3 becoming more prominent in several regions.

Recent data from India also show that all four dengue serotypes continue to co-circulate, with DENV-2 still predominant in many regions but DENV-3 contributing a substantial and increasing proportion of cases.

For instance, surveillance from North and Western India has reported DENV-2 accounting for around 48-66% of cases, followed by DENV-3 at around 20-30%, with DENV-1 and DENV-4 contributing smaller shares.

If this trend continues, the overall effectiveness of the vaccine at a population level may be lower than expected. In simple terms, while vaccinated individuals are still likely to be

protected from severe disease, they may continue to experience dengue infections, especially during outbreaks dominated by DENV-3.

This distinction is crucial. TAK-003 is best understood as a vaccine that modifies the disease rather than as one that blocks transmission. In other words, it is likely to reduce the severity of illness rather than prevent infection altogether. As a result, dengue outbreaks will not disappear and public health measures such as vector control will remain indispensable.

Another important consideration is cost and access. Dengue vaccines are expected to be relatively expensive, and TAK-003 requires two doses administered three months apart. The expected price of TAK-003 in India is likely ₹3,000-6,000 per dose and ₹6,000-12,000 for the full course. While public programmes may offer the shots at lower prices, questions about affordability and compliance – particularly among lower-income and rural populations – remain unanswered. At least in the initial years, uptake is likely to be limited to the private sector or targeted programmes in areas with a high burden of dengue.

The SEC has appropriately mandated post-marketing safety and effectiveness studies in the Indian population. These will be critical to understand how the vaccine performs in real-world conditions, across different regions and serotype patterns.

Looking ahead, TAK-003 may be only the first step in India's dengue vaccine journey. A second generation of vaccines, based on a different scientific approach developed by the U.S. National Institutes of Health (NIH), is currently under evaluation.

Indian pipeline

India's dengue vaccine pipeline is advancing, with an indigenous candidate called 'DengiAll', developed by Panacea Biotech in collaboration with the Indian

Council of Medical Research, currently undergoing large phase III clinical trials.

A similar vaccine has already been approved in Brazil and it has shown strong protection against severe dengue. If the Indian candidate is also successful, it could be available around 2027. These vaccines aim to provide more balanced protection across all four serotypes and may offer the additional advantage of a single-dose regimen.

Early data from similar vaccines tested elsewhere are also promising, particularly in terms of protecting against severe dengue and broader serotype coverage. If these findings are confirmed in Indian trials, such vaccines could be better suited for large-scale public health deployment.

For policymakers, the challenge will be to balance urgency with prudence. There is a clear and immediate need to reduce the burden of severe dengue and TAK-003 is a valuable tool with which to achieve this. At the same time, the long-term strategy must remain flexible, allowing for the country to adopt better vaccines as the evidence evolves.

For clinicians, clear communication will be essential. Their own and their patients' expectations need to be realistic: the vaccine is not a cure-all but it is a meaningful step forward. Even if it does not eliminate dengue, it can save lives and reduce complications.

Ultimately, the introduction of a dengue vaccine in India should be seen not as the culmination of efforts but as the beginning of a new phase. Success will depend not only on the vaccine itself but also on how well it is integrated with surveillance, vector control, and future innovations.

In public health, progress often comes incrementally. TAK-003 may not be the final answer to dengue in India but it is undoubtedly an important start. (Vipin M. Vashishtha is director and paediatrician, Mangla Hospital and Research Centre, Bijnor)

GS 3: SPACE

THE HINDU PAGE : 14

NASA begins fuelling rocket for first lunar trip in 50 years

Associated Press

CAPE CANAVERAL

NASA began fuelling its moon rocket on Wednesday for humanity's first lunar trip in more than half a century, aiming for an evening lift-off with four astronauts.

Tensions were high as hydrogen fuel started flowing into the rocket hours ahead of the planned launch. Dangerous hydrogen leaks erupted during a countdown test earlier this year, forcing a lengthy flight delay.

The launch team needs to load more than 2.6 million litres into the 32-story Space Launch System rocket on the pad before the *Artemis II* crew can board.

"It is time to fly," com-



People set cameras to photograph NASA's *Artemis II* lunar flyby mission ahead of its launch at the Kennedy Space Center. REUTERS

mander Reid Wiseman said on the eve of launch via X. Favourable weather was forecast.

Three Americans and one Canadian will fly around the moon without stopping or even orbiting – then head straight back for a Pacific splashdown. They

will set a new distance record for the farthest humans have travelled from Earth as they zoom some 6,400 km beyond the moon and then hang a U-turn.

Astronauts last flew to the moon during *Apollo 17* in 1972.