

WEEKLY UPDATES – (23rd-29th Oct)

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ENVIRONMENT

India & Green Hydrogen

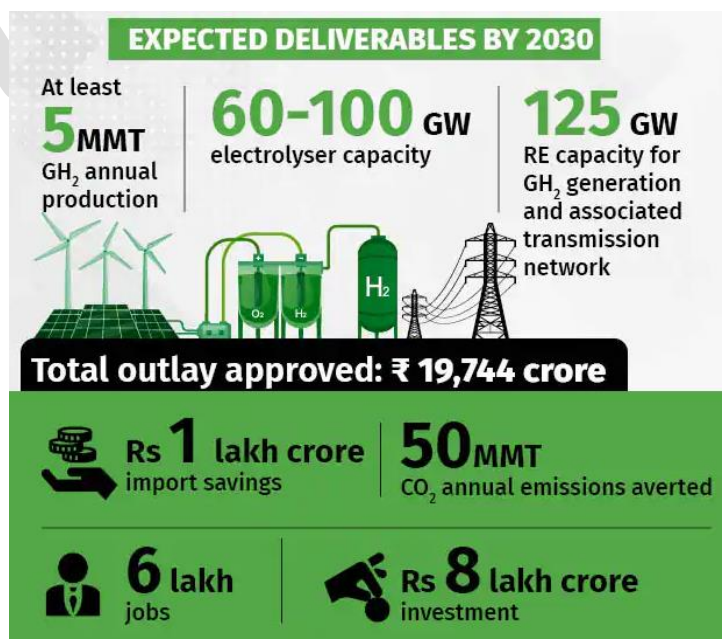
Context: India's plans to produce so-called 'green hydrogen' — where the gas is produced without resulting in fossil fuel emissions — may end up worsening pollution if proper checks and balances are not in place, according to a study by environmental and energy think-tank, Climate Risk Horizons (CRH).

Key Highlights

- The National Green Hydrogen Mission, piloted by the Ministry of New and Renewable Energy (MNRE), expects to manufacture five million tonnes by 2030.
- This would require the installation of renewable energy capacity worth 125 GW and the use of 250,000 gigawatt-hour units of power, equivalent to about 13% of India's present electricity generation.
- As of August 2023, India's total renewable energy (RE) capacity stood at 131 GW.
- The 2030 green hydrogen plan thus envisages adding an equivalent RE capacity by 2030. This is over and above the 500 GW of RE capacity that India has committed to install by 2030 as part of the Paris Agreement.
 - To put that in perspective, India installed only 15 GW of new solar and wind capacity in 2023, against the 45 GW per year needed to reach the 2030 target.

National Green Hydrogen Mission

- **Aim:** To make India a 'global hub' for using, producing and exporting green hydrogen.
- It is a program to **incentivise** the commercial production of green hydrogen and make India a **net exporter** of the fuel.
- The **Mission will facilitate** demand creation, production, utilization and export of Green Hydrogen.
- **Objective:**
 - Developing green hydrogen production capacity of at least 5 MMT (Million Metric Tonne) per annum, alongside adding renewable energy capacity of about 125 GW (gigawatt) in India by 2030.
 - It aims to entail over Rs 8 lakh crore of total investments and is expected to generate six lakh jobs.
 - It will also lead to a cumulative reduction in fossil fuel imports by over Rs 1 lakh crore and an abatement of nearly 50 MT of annual greenhouse gas emissions.



How Is Hydrogen Energy Better?

It has zero carbon content

Non-polluting source of energy whereas hydrocarbons have a net carbon content in the range of 75–85 percent

Expected to reduce carbon emissions which are set to jump by 1.5 billion tons in 2021

Highest energy content by weight and the lowest energy content by volume

It is the most abundantly available element on earth, but commercially viable Hydrogen can be produced from hydrocarbons including

Natural Gas

Oil and Coal Through Processes Like Steam Methane Reforming, Partial Oxidation, And Coal Gasification

From Renewables Like Water, Sunlight, And Wind Through Electrolysis And Photolysis And Other Thermo-chemical Processes

Using Coal-Based Power

The MNRE has defined green hydrogen as hydrogen produced in a way that emits no more than two kg of carbon dioxide per kg of such hydrogen.

- Currently, producing one kg of ‘grey hydrogen’, as it is known, ends up emitting nine kg of carbon dioxide.
- “While a detailed methodology is awaited, the definition as it stands leaves a lot to interpretation,” said CRH’s chief executive Ashish Fernandes, in the report released.
- The main concern is that if electrolyzers were run 24x7, they would be expected to operate even at night when no solar power is available.

Where Will The Electricity Come From?

- If it comes from India’s coal-powered grid in general, it will in fact increase carbon emissions, since about 70% of the electricity on the grid is coal-generated — more in non-daylight hours when solar generation is nil,” the report notes.
- The vast majority of projects have not disclosed their source of electricity.
- It is also not clear if those few projects that have committed...to meet 100% of their requirement from these sources.

ECONOMY

AI To Help Construction Industry Face Challenges

Context: The emergence of new technologies such as Artificial Intelligence (AI), 3D printing, and robotics, would transform the construction industry, one of the oldest and largest industries in the world and help it address multiple challenges effectively, according to a white paper by an advisory firm.

Key Highlights

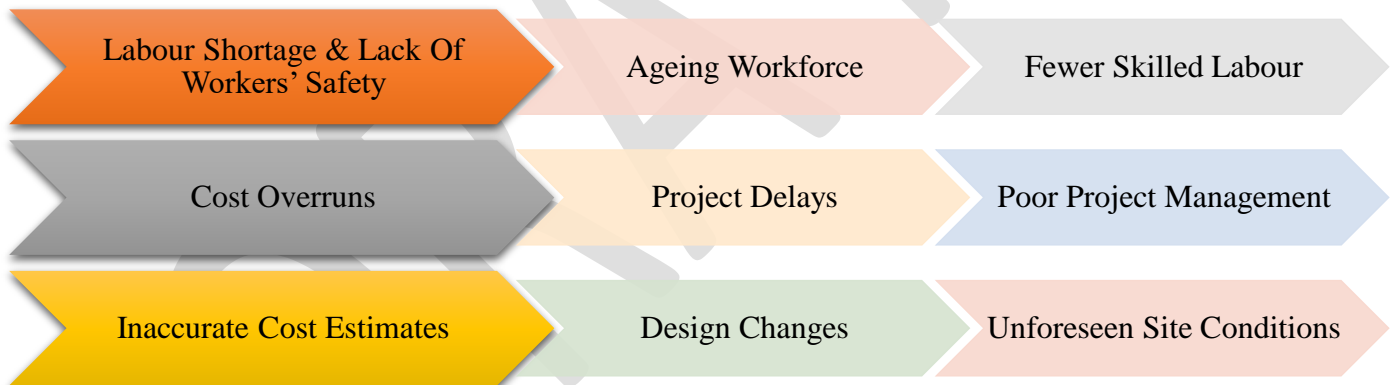
The construction industry which contributes to 13% of global GDP, is expected to grow significantly in the coming years — at an estimated CAGR of 11% — from \$8.2 trillion to \$17 trillion by 2029.

- This growth is driven by certain factors such as



- White paper said, “AI is poised to play a pivotal role in reshaping the sector by addressing a range of challenges and delivering significant advantages.”
 - To meet industry needs, AI has the potential to accelerate growth and add value at all project stages, from design and financing to construction, operations, and business model changes.”
 - AI is estimated to boost industry productivity by increasing it by 1% to 1.5% annually.

Challenges Faced By Construction Industry



GOVERNANCE

DNA, Face Matching Systems at Police Stations

Context: Centre to introduce DNA, Face Matching Systems at Police Stations across country.

- In April 2022, the Criminal Procedure (Identification) Act (CrPI) was passed by Parliament. The Act enables police and central investigating agencies to collect, store and analyse physical and biological samples including retina and iris scans of arrested persons.
- The rules that would govern the Act were notified in September 2022. However, the Act is yet to be implemented fully as the National Crime Records Bureau (NCRB), the nodal agency, is still preparing the guidelines and Standard Operating Procedure (SOP) to implement the legislation.

- The NCRB operates under the Union Ministry of Home Affairs (MHA). Though the Act and rules do not distinctly mention collection of DNA samples and face-matching procedures, in subsequent meetings with State police officials, the NCRB has said that these measures will be rolled out in around 1,300 locations across the country.

Why Was The Legislation Brought In?

- The CrPI Act repealed the British-era Identification of Prisoners Act, 1920 whose scope was limited to collecting and recording finger impressions, footprint impressions and photographs of certain category of convicted persons and impressions of non-convicted persons on the orders of a Magistrate.
- The government said the new Act made provisions for the use of modern techniques to capture and record appropriate body measurements.

Key Highlights

It will be implemented under the **Criminal Procedure Identification Act** which was passed last year; the law enables police and Central investigating agencies to collect, store, and analyse physical and biological samples, including retina and iris scan of arrested persons; NCRB to prepare the SOPs.

- More than a year after the Criminal Procedure Identification Act was passed by Parliament, the Centre is all set to roll out “DNA and face-matching” systems at 1,300 police stations across the country.
- The Act and rules do not explicitly mention the collection of DNA samples and face-matching procedure, the NCRB, in meetings with State police officials, informed them that the said measures would be rolled out in around 1,300 locations spread across police districts, commissionerates, and special investigation units at State headquarters.
- The Union Home Ministry has constituted a Domain Committee for the successful implementation of the Act with representatives from the State Police, Central law enforcement agencies, and other key stakeholders.
- A technical sub-committee for preparing the SOPs for capturing DNA as a measurement has also been constituted.
- The States have been asked to identify the locations and prepare the sites where the measurement collection unit (MCU) may be established as suggested by the NCRB. The Central body under the Home Ministry will be the repository of the database at the national level.
- A Delhi Police official said they were recording measurements such as thumb and finger impressions and photographs of accused persons according to the old format and were also using the National Automated Fingerprint Identification System (NAFIS).
 - Under the NAFIS, another project maintained and managed by NCRB, workstations and scanners have been put up at around 1,300 police stations.
 - It has fingerprint details, a unique 10-digit number of more than one crore people, accused and convicts, across the country.
 - This database is also being integrated with the Criminal Procedure Identification Act.
- An official said the NCRB has cautioned against the misuse of databases by ensuring identification and deployment of appropriate safeguards, adding that only designated officials must have access in real time.

- The NCRB has said the tools and systems used by the police should be technologically, legally, and forensically sound and accredited.

Food Labels To Have QR Code To Help The Visually Disabled

Context: The Food Safety and Standards Authority of India (FSSAI) has recommended the use of quick response (QR) codes on food products for accessibility by persons with visual disabilities, stating that this would ensure access to safe food for all, including those with special needs.

Key Highlights

The FSSAI said that ensuring inclusive access to information was a fundamental right of citizens. “It is imperative that food products are labelled in a manner that ensures accessibility to all consumers, including those with visual impairments.

- The FSSAI under its Food Safety and Standards (Labelling and Display) Regulations, 2020 has **comprehensively outlined the information** to be included on the labels of food products.
 - This includes product name, shelf life, nutrition facts, vegetarian/non-vegetarian logos, ingredient lists, allergen warnings, and other product-specific labelling requirements.
- The information is **aimed** at empowering consumers to make informed choices when selecting food products.
 - The Rights of Persons with Disabilities Act, 2016 recognises the rights and needs of individuals with disabilities, which emphasise accessibility and the promotion of health for persons with disabilities.
- The FSSAI said that to **enhance accessibility**, food business operators were encouraged to incorporate provisions that facilitate easy access to nutritional information for visually impaired individuals.

The latest advisory caters to two important regulations

- The FSSAI’s Food Safety and Standards (Labelling and Display) Regulations, 2020 which outlines the information to be included on labels of food products.
- The Rights of Persons with Disabilities Act, 2016 which recognises the rights of individuals with disabilities and emphasises accessibility of health for persons with disabilities.

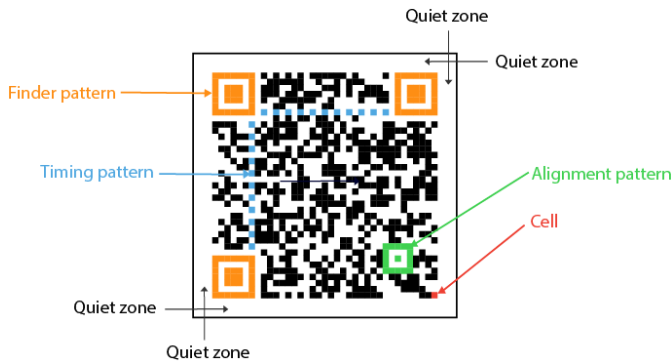
Information Provided By QR Codes

- These QR codes should encompass comprehensive details about the product, including, but not limited to, ingredients, nutritional information, allergens, manufacturing date, best before/expiry/use by date, allergen warning, and contact information for customer inquiries, the FSSAI said.
- It added that the inclusion of QR code for the accessibility of information did not replace or negate the requirement to provide mandatory information on the product label, as prescribed by relevant regulations.

About QR Code

A QR code is a type of two-dimensional matrix barcode, invented in 1994, by the Japanese company Denso Wave for labelling automobile parts.

- According to market experts, for the food manufacturers, using QR codes on food products can help improve their brand image, customer loyalty, and operational efficiency.



Line Barcode

- Traditional one-dimensional barcodes
- Can only be read horizontally (1D)
- Only hold a limited amount of data - UPC = 12 digits (#s)



QR Code

- Two-dimensional Barcode or Matrix Barcode
- Can be read horizontally and vertically
- 4,000+ characters of information

HEALTH

Indian Osteoporosis Care Crisis

Context: The unpleasant reality is that only a small percentage of people in India receive care for their osteoporosis - a condition characterised by weakening of bones.

- People begin to stoop as they grow older. That is because of osteoporosis.
- The weakening of the bone not only causes long-term pain but also changes in posture and increases chances of fractures and nerve injury if the bone affected is the spine.
- All of these problems negatively impact the quality of life and increase disability and financial burden on the family, and yet osteoporosis is not receiving the attention it deserves in medical practice.

Key Highlights

- Projected data shows that at least 46 million women in India currently live with post-menopausal osteoporosis, which is only one type of osteoporosis.
- If you include women who had surgeries to remove their uterus, people who used steroid medication for a long time and, men who developed osteoporosis because of old age, the number may be over double.
- A 2019 study also revealed that India was the highest contributor to osteoporosis fracture-related deaths/disabilities worldwide.
- There are enormous gaps in knowledge about osteoporosis, even among doctors.
 - Nobody with long-term pain is going to make an appointment with an endocrinologist (which is where all the knowledge about bone conditions is concentrated, as of date).

- ✓ **Osteoporosis**, which literally means porous bone, is a disease in which the density and quality of bone are reduced.
- ✓ **Occurrence:** Bone is living tissue that is constantly being broken down and replaced. Osteoporosis occurs when the creation of new bone doesn't keep up with the loss of old bone.

- They will either come to a general practitioner or, if it worsens, to an orthopaedic.
- And **in India, doctors in this capacity are ill-equipped to handle osteoporosis.**
- Considering that Indian women have many micronutrient deficiencies and do not set aside time for exercise, there needs to be a high index of suspicion for osteoporosis in every patient.
- Also of interest is that most of the Indian population does not have access to DEXA or the bone mineral density scan - the gold standard test for osteoporosis. A study found that in India, there are only 0.26 DEXA machines per million of the population.
- “If you look at guidelines for treatment, they say, perform a DEXA for diagnosis and start medication. The guidelines also ask us to repeat the DEXA yearly to see if treatment is working.
- This focus on a scan which is available to barely 10% of the population is unreasonable.
- In the realm of osteoporosis care, India’s infrastructure limitations can be overcome by acquiring proper knowledge and engaging in meaningful discussions within our context.

Osteoporosis Day

This osteoporosis day’s (20th October) the theme was ‘**Build better bones**’.

- To do so, we must realise that our nation is grappling with this silent epidemic.
- Millions suffer in silence as their pain goes unnoticed and their quality of life is compromised.
- To bridge the osteoporosis care gap in India we must promote awareness and aim for early intervention.
- It’s time to empower healthcare providers everywhere with context-specific knowledge to diagnose, treat, and prevent this debilitating condition, ensuring a healthier and pain-free future for all.

DEFENCE

Phasing Out Cheetah, Chetak Helicopters From 2027

Context: The Army will start phasing out the first lot of vintage Cheetah and Chetak helicopters from 2027 on completion of their total technical life, as it looks to induct the indigenous light utility helicopters (LUHs) to replace them, according to defence sources. The armed forces have been attempting to replace the Cheetah and Chetak helicopters for well over a decade.

Key Highlights

- In November 2021, the Defence Acquisition Council approved the procurement of 12 limited series production (LSP) variants of the LUH at a cost of around ₹1,500 crore, six each for the Army and the Air Force.
 - The choppers have been designed and developed by Hindustan Aeronautics Ltd. (HAL), but the project was delayed due to issues with the autopilot.
 - The issue with the autopilot of the LUHs has been addressed and the trials by the HAL have commenced.
- The six LSP LUHs are expected to be delivered to the Army between December 2024 and June 2025.
- The bigger contract for LUHs is expected to be concluded by January 2024 and deliveries expected by 2026 onwards.
- In the interim, the Army is also looking to lease 20 utility helicopters to address the shortage.

About LUH

- LCH is the **first indigenous Multi-Role Combat Helicopter**.
- **Designed and developed by:** Hindustan Aeronautics Limited (HAL).
- **Specifications:**
 - Maximum take-off weight: 3,100 kg.
 - Can carry a useful load of 1,500 kg.
 - Maximum speed: 220 km/h, cruise speed: 200 km/h.
 - Service ceiling (maximum altitude it can reach): 6,500 meters.
- **Range:** Approximately 500 km.
- **Features:** It has potent ground attack and aerial combat capability.
 - Equipped with a 3-axis autopilot for stable and controlled flight in various conditions.
 - Features a modern glass cockpit with digital avionics and instrumentation.
 - Includes a weather radar system for real-time weather information.
 - Cockpit lighting works with night-vision goggles for low-visibility conditions.

INTERNATIONAL RELATIONS

Sri Lanka Announces Free Visas For Indians To Boost Tourism

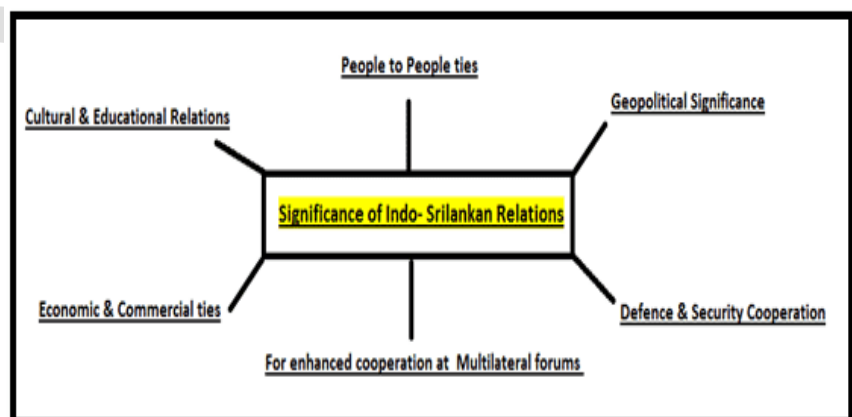
Context: Sri Lanka waived visa fee for Indians and tourists from six other countries, as part of its efforts to boost tourist arrivals and help rebuild the island nation’s battered economy following last year’s financial crash.

Key Highlights

- India has remained Sri Lanka’s top source market for many years. This year, over 2 lakh Indian tourists — constituting 20 % of the total tourist arrivals — have visited the island nation until September.
- As part of its decisions this week, the Cabinet announced implementation of a pilot project to issue free tourist visas to tourists from China, India, Russia, Thailand, Indonesia, Malaysia, and Japan until March 31, 2024.

Several measures

- According to a statement on the weekly Cabinet decisions, published by the Department of Government Information, the move is part of “**several new programmes**” planned for the promotion of the Sri Lankan tourism industry, one of the chief foreign exchange earning sectors for the country, apart from exports and worker remittances.



- Sri Lanka’s tourism sector is struggling to bounce back after three major setbacks in the last few years — the Easter Sunday terror attacks in 2019, the coronavirus pandemic in 2020 and 2021, and the unprecedented economic crisis in 2022.
- Until now, Indian tourists were charged \$20 with their visa application online. The decision to issue free tourist visas is likely to boost tourist arrivals including from India, officials said.

India & China-Bhutan Boundary Talks

Context: China and Bhutan held their 25th round of boundary talks in Beijing and signed a Cooperation Agreement on the “Responsibilities and Functions of the Joint Technical Team (JTT) on the Delimitation and Demarcation of the Bhutan-China Boundary.” This advances their 3-Step Roadmap initiated in 2021 for border resolution, building on the positive momentum since their last talks in 2016.

THE GIST

- China and Bhutan held their 25th round of boundary talks and signed a Cooperation Agreement related to the demarcation of the Bhutan-China border.
- Bhutan-China border dispute primarily concerns the Doklam plateau and the India-China-Bhutan trijunction, as well as the Jakarlung and Pasamlung valleys.
- The 3-Step Roadmap initiated in 2021 aims to clearly delineate the Bhutanese and Chinese territories, involving discussions at the table, on-site visits, and formal demarcation.

Dividing line

A brief overview of the boundary dispute between China and Bhutan

- Bhutan and China have no formal diplomatic relations but have held 24 rounds of boundary talks between 1984 and 2016
- Talks concentrated on north and west Bhutan regions
- Eastern Bhutan not part of the talks
- Sakteng sanctuary is situated close to the border with Arunachal Pradesh
- In June 2020, China attempted to stop UNDP-GEF funding for Sakteng by claiming it was disputed, but was overruled
- so far, say officials



Significance of Talk

- The Boundary talks between Bhutan and China were held after a gap of seven years and indicate significant progress has been made.
- Bhutan and the Tibetan Autonomous Region share a contiguous border to Bhutan’s north and west. Since 1984, Bhutan and China had held 24 rounds of talks to resolve the disputes until 2016, but the 25th round appeared to have been held up after the Doklam Standoff between Indian and Chinese armies in 2017, and then the COVID-19 pandemic in 2019-2021.
- However, the two sides used the pause to hold talks at other levels in rapid succession, especially after China threatened to open a new front for a border dispute to Bhutan’s east.
- Since then, the Expert Group of diplomats on both sides met in 2021 to agree on a 3-step roadmap, and the first boundary delimitation technical talks were held in August 2023.

3-Step Roadmap

- The 3-Step roadmap MoU signed by the Bhutanese Foreign Minister and Chinese Assistant Foreign Minister in 2021, and the JTT established to implement the roadmap by the Expert Group in August are hoping to draw a line clearly delineating Bhutanese and Chinese territory for the first time.

- Bhutan and China don't have diplomatic ties, as Bhutan has traditionally avoided diplomatic relations with all the United Nations Security Council permanent members.
- The 3-Step Roadmap involves first, agreeing to the border “on the table”; then visiting the sites on the ground; and then formally demarcating the boundary.

Why Is India Watching Closely?

- For India, given the breakdown in its ties with China over the standoff at the Line of Actual Control from 2020, any hint of closer ties between China and one of its closest neighbours is a cause for worry.
- More specifically, New Delhi is watching the demarcation discussions over Doklam, as amongst the proposals China has placed on the table is an agreement to “swap” areas in Doklam under Bhutanese control with areas in Jakarlung and Pasamlung which China claims.
- The Doklam trijunction cuts very close to India's Siliguri corridor a narrow area that connects the North Eastern States to the rest of India and India would not like to see China gain access to any area closer to it.
- Since the Doklam standoff in 2017, China has doubled down on its control of the Doklam plateau, and according to a recent Pentagon report, has continued to build “underground storage facilities, new roads, and new villages in disputed areas in neighbouring Bhutan,” erasing many of the strategic gains that New Delhi had hoped for after China agreed to step back from the standoff point in 2017.
- Finally, India's worry is over China's demand for full diplomatic relations with Bhutan, and opening an Embassy in Thimphu.
- Given India's challenges with Chinese projects and funding in other neighbouring countries including Bangladesh, Nepal, Sri Lanka and the Maldives, any Chinese presence in a small country like Bhutan would be problematic.
- However, Bhutan's leadership has thus far said that all decisions would consider India's interests and that it has always consulted India on issues of concern.

Bangladesh Is Building Memorial To Honour Indian Heroes Of 1971 War

Context: A memorial to honour the Indian soldiers who sacrificed their lives in the **Liberation War of Bangladesh in 1971** at Ashuganj in Bangladesh is in the advanced stages of completion. It will have the names of around 1,600 Indian soldiers inscribed on it.

Key Highlights

- It is expected to be ready by December. This will be the first memorial in Bangladesh to exclusively honour Indian soldiers from the 1971 war.
- The foundation stone for the memorial at Ashuganj, Brahmanbaria was laid by Prime Minister Narendra Modi and Bangladesh Prime Minister Sheikh Hasina in March 2021.



- All the names of the Indian soldiers martyred will be engraved so that everybody can know who are these people who sacrificed for our emancipation, for our liberation,” Mr. Haque had said.

SCIENCE & TECHNOLOGY

Ball Lightning

Context: One of the most rare and mysterious forms of lightning is ball lightning.

- It is a ball of luminosity that usually occurs near the impact point of a flash and moves horizontally at a speed of a few centimetres per second.
- It can penetrate closed windows, is usually accompanied by a hissing sound, and has a lifetime of several seconds.
- The colour is quite variable and the ball often ends with an explosion. However, it is not usually destructive.



Important Facts

- Also called globe lightning, it occurs at times of intense electrical activity in the atmosphere.
- These balls are said to be plasmas.
 - Plasma is a completely ionised state of matter, at high temperature, in which positive and negative ions freely move about.
- However, no theory has so far satisfactorily explained the behaviour of a ball as scientists have not been able to reproduce it in the laboratory.

Possible Causes of Ball Lightning

Ground Strike Theory

- Some scientists propose that ball lightning may result from ground strikes, initiating chemical reactions between oxygen and vaporized soil elements.
- This process creates ionized air or plasma, resembling phenomena like St. Elmo's Fire.

Glass-Related Hypothesis

- Another theory suggests that ball lightning might form due to the buildup of atmospheric ions on glass surfaces, creating an electrical field capable of generating discharges.

Microwave Radiation

- An alternative theory posits that ball lightning could be linked to microwave radiation produced when lightning strikes the Earth's surface, potentially encapsulating it in a plasma bubble.

Association with Earthquakes

- In rare instances, ball lightning has been observed in connection with earthquakes, displaying as bluish flames, sudden bright flashes from the ground, or floating orbs.



- A 2014 study exploring earthquake lights proposed that specific rock types release electrical charges during seismic waves, leading to luminous displays.

Study About Internal structure of Mars

Context: Mars’s liquid iron core is likely to be surrounded by a fully molten silicate layer, according to a pair of studies published in Nature.

- These results offer a new interpretation of the interior of Mars, suggesting its core is smaller and denser than previously proposed.
- Seismological study of Mars to understand the interior of the red planet was carried out in 2019.
- The InSight Mars Lander used an instrument called the Seismic Experiment for Interior Structure (SEIS) to record seismic waves passing through Mars’s interior.
- Data from three years of quakes in Mars, including two seismic events caused by meteorite impacts, were used for the study.

Measurement analysis

The analysis of measurements from the NASA InSight lander’s Seismic Experiment for Interior Structure (SEIS) project in 2021 suggested the presence of a large but low-density core, composed of liquid iron and lighter elements such as sulphur, carbon, oxygen and hydrogen.

Lighter elements

- However, the result of the two studies published in Nature results suggest that the core has a higher proportion of lighter elements than is feasible according to estimates of the abundances of these elements early in Mars’s formation history.
- The two studies found that the liquid iron-nickel core of Mars is surrounded by an approximately 150 km-thick layer of near-molten silicate rock, the top of which was previously misinterpreted as the surface of the core.
- This decrease in core radius implies a higher density than estimated in the earlier InSight study. These estimates can more easily be reconciled with our existing knowledge of chemical abundance on Mars.
- The molten state of this layer suggests that its temperature must be at least 2,000 Kelvin.
- This could be a sign that Mars had a turbulent interior following its formation, rather than a calmer one that more gently transported and shed heat to interplanetary space.

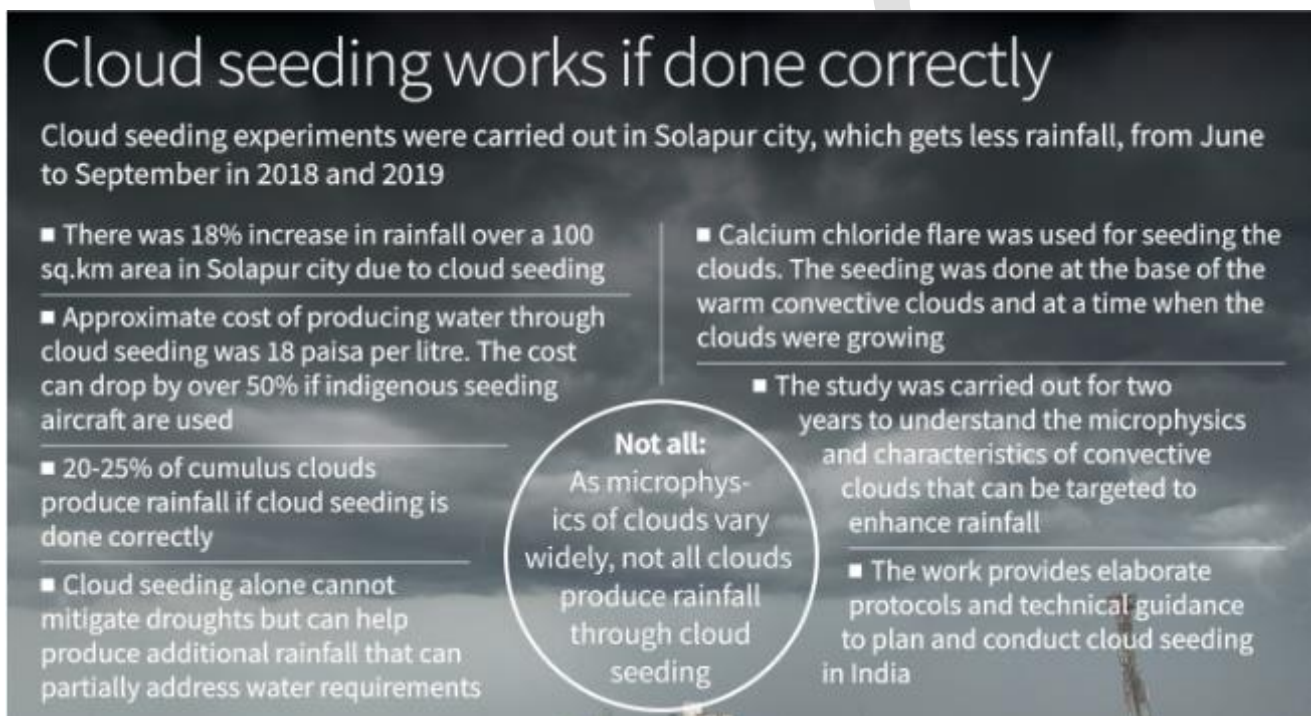
About Mars	
Size and Distance	<ul style="list-style-type: none"> • It is the fourth planet from the Sun and the second-smallest planet in the Solar System. • Mars is about half the size of Earth.
Similarity to the Earth (Orbit and Rotation)	<ul style="list-style-type: none"> • As Mars orbits the Sun, it completes one rotation every 24.6 hours, which is very similar to one day on Earth (23.9 hours). • Mars' axis of rotation is tilted 25 degrees with respect to the plane of its orbit around the Sun. This is similar to Earth, which has an axial tilt of 23.4 degrees. • Mars has distinct seasons like Earth, but they last longer than seasons on Earth. • Martian days are called sols—short for ‘solar day’.

Other Features

- The reason Mars looks reddish is due to oxidation or rusting of iron in the rocks, and dust of Mars. Hence it is also called the Red Planet.
- It has the largest volcano in the solar system i.e., Olympus Mons.
- It has two small moons, Phobos and Deimos.

Cloud Seeding Can Produce Rainfall

Context: IITM Pune demonstrates cloud seeding can produce rainfall. The approximate cost of producing water through cloud seeding was 18 paise per litre; the cost will drop by more than 50% if we use indigenous seeding aircraft.



Cloud seeding works if done correctly

Cloud seeding experiments were carried out in Solapur city, which gets less rainfall, from June to September in 2018 and 2019

- There was 18% increase in rainfall over a 100 sq.km area in Solapur city due to cloud seeding
- Approximate cost of producing water through cloud seeding was 18 paise per litre. The cost can drop by over 50% if indigenous seeding aircraft are used
- 20-25% of cumulus clouds produce rainfall if cloud seeding is done correctly
- Cloud seeding alone cannot mitigate droughts but can help produce additional rainfall that can partially address water requirements
- Calcium chloride flare was used for seeding the clouds. The seeding was done at the base of the warm convective clouds and at a time when the clouds were growing
- The study was carried out for two years to understand the microphysics and characteristics of convective clouds that can be targeted to enhance rainfall
- The work provides elaborate protocols and technical guidance to plan and conduct cloud seeding in India

Not all:
As microphysics of clouds vary widely, not all clouds produce rainfall through cloud seeding

Key Highlights

- A cloud seeding experiment carried out in Solapur city, which falls on the leeward side of the Western Ghats and hence gets low rainfall — 384 mm and 422 mm of total rainfall during the period June to September 2018 and 2019, respectively — was able to achieve 18% relative enhancement in rainfall, which is approximately 8.67mm more rainfall.
- The relative enhancement of accumulated rainfall was seen over two hours after seeding the clouds.
- In all, the total enhancement of water availability through cloud seeding experiments was 867 million litres.
- The experiment — Cloud Aerosol Interaction and Precipitation Enhancement Experiment (CAIPEEX phase-4) — was a scientific investigation conducted in Solapur city during the summer monsoon period of 2018 and 2019.
 - The primary objective was to investigate the efficacy of hygroscopic seeding in deep convective clouds and to develop a cloud seeding protocol.
 - The experiment used two aircraft for studying various cloud parameters and for seeding the clouds.

- The study found that cloud seeding is an effective strategy for enhancing rainfall in a region under suitable conditions.
- A randomised seeding experiment was undertaken to study the effectiveness of cloud seeding in producing rainfall.
- In total 276 convective clouds were chosen, and 150 were seeded while the remaining 122 clouds were not seeded.

In our previous work we have found certain characteristics in a cloud such as the liquid water content in the cloud, the vertical motion in the cloud, which is an indicator of the growth of the cloud, will help inform us if the cloud will rain or not. Based on several criteria we know if a convective cloud has a potential to rain as all clouds cannot rain.

- Convective clouds with a depth of over one kilometre and likely to evolve into deep cumulus clouds were targeted.
- The seeded clouds produced more rainfall than the unseeded clouds,” Dr. Thara Prabhakaran from the Indian Institute of Tropical Meteorology, Pune and the corresponding author of the paper.
- **Calcium chloride flare** was used for seeding the clouds.
 - A cloud seeding flare releases these particles when triggered.
 - The seeding was done at the base of the warm convective clouds and at a time when the clouds were in their growing stage so that the seed particles could enter the clouds with minimum dispersion.
- The convective cloud bases are found at 500-1,500 metres altitude during the summer monsoon period and around 2,000 metres or more altitude during the monsoon break periods, which depends on the moisture content in the lower atmosphere.
- Since the clouds are found at lower heights, the base of the convective clouds is warm, around 15 degrees C.
- But cloud seeding alone cannot mitigate droughts but can help produce 18% more rainfall and partially address water requirements. Undertaking cloud seeding as catchment-scale projects can possibly help in managing drought conditions.

The study was carried for two years to first study and understand the microphysics and characteristics of convective clouds that can be targeted to enhance rainfall.

- The two-year study has helped develop a high-resolution numerical model that can help stakeholders to identify target locations, clouds that can be seeded, and a suitable seeding strategy to enhance rainfall in an area.
- One of the most important findings of the study was that not all cumulus clouds produce rainfall when cloud seeding is done.
- We found 20-25% of cumulus clouds produce rainfall if cloud seeding is done correctly.
- The micro physics of clouds vary widely and so not all clouds produce rainfall through cloud seeding. Though the relative enhancement of rainfall was 46% as measured by automatic rain gauges, the actual increase in rainfall over a 100 sq.km area was only 18%.