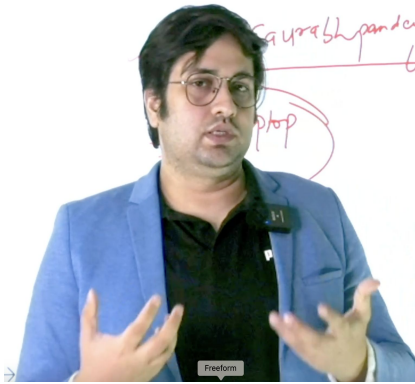
Topics - MINDS MAPS included (Daily current affairs 21st APRIL 2025

- What are Cloudbursts?
- Gandhi Sagar Wildlife Sanctuary
- Perovskite Technology
- Rejosari Senik
- M83
- Heatwaves
- Trump Trade War



By saurabh Pandey

THE HINDU

Five feared dead in J&K in cloudburst havoc

Govt. yet to issue official number of people dead or injured; more than 100 rescued in Ramban after landslips, flash floods leave people stranded; IMD forecasts inclement weather till Tuesday; five places along the Srinagar-Jammu National Highway at Ramban were blocked; CM Omar Abdullah says the focus now is on managing situation

Peerzada Ashiq
SRINAGAR

Jammu and Kashmir grappled with the trail of destruction left behind by cloudbursts and flash floods over the weekend, with at least five people feared dead and hundreds more left stranded and needing rescue. Scores of vehicles were either pushed into deep gorges or buried under unprecedented landslips in Ramban district.

Three people, two children among them, were killed when a house collapsed in Bagna in Ramban, officials said. However, the J&K government has not issued any official death toll or the number of the injured.

Gujjar community leader Talib Hussain said two people were killed after lightning struck Jamedi village in Arnas, Reasi, on Sunday. He added that around 40 cattle were killed in the lightning.

Swept away: Vehicles stuck in debris after heavy rain and flash floods in Ramban, J&K, on Sunday. PTI

Senior Superintendent of Police (SSP), Ramban, Kulbir Singh told pressperson that more than 100 people had been rescued in the district.

Chief Minister Omar Abdullah said he was extremely anguished by the tragic events, "which have caused considerable damage to life and property".

Freaky weather

Parts of the Union Territory witnessed freaky weather over a 48-hour-period, marked by lightning, gusty winds, hailstorms, and snowfall.

Five places along the Srinagar-Jammu National Highway at Ramban were blocked following the sudden change in weather. Debris from the landslip-damaged houses and shops along the highway and parts of the highway itself. Dozens of commuters also remained stranded on the highway that connects the Kashmir Valley with the Jammu division.

Rescue and relief

"We are in touch with the local administration to ensure immediate rescue efforts wherever needed. Later today, I will be reviewing restoration, relief, and repair plans. For now, the focus remains on managing the situation on the ground. Citizens are advised to follow travel advisories and avoid non-essential movement in vulnerable areas," Mr. Abdullah said.

Union Minister and BJP MP for Udhampur Jitendra Singh posted on X: "There was a heavy hailstorm, multiple landslides and fast winds throughout the night in the Ramban region, including the areas surrounding the Ramban town. The National Highway stands blocked and unfortunately there have been three casualties and loss of property for a couple of families."

The MP said he was in "constant touch with Deputy Commissioner Baseer-ul-Haq Chaudhary".

The district administration deserves appreciation for timely and prompt action, which helped save several precious lives, he said, adding that every kind of relief, both financial and otherwise, is being provided. The DC has been told that whatever more is required can be provided from the MP's personal resources as well. "The request is not to panic. We shall all together overcome this natural calamity," Mr. Singh said.

Bad weather forecast

The India Meteorological Department's centre in Srinagar issued a fresh weather advisory regarding an active Western Disturbance expected to affect J&K from April 20, with improvement expected from April 22. It warned of thunderstorms, lightning, hailstorm and gusty winds, especially across the Pir Panjal Range, Jammu Division, and the middle and higher reaches of Kashmir Division.

It urged the public to avoid visiting riverbanks, streams, and other water bodies. "Do not travel to higher reaches unless absolutely necessary. Secure loose items and avoid taking shelter under trees during thunderstorms. Farmers are advised to take necessary precautions to protect crops and livestock," it added.

In view of the inclement weather and heavy rain, causing flash floods, all government and private schools, colleges and technical education institutions in Ramban district will remain closed on April 21, officials said.

What are Cloudbursts?

Cloudbursts are sudden and intense rainfall events that can release a staggering amount of water in a short duration, leading to catastrophic consequences. Defined by the India Meteorological Department, a cloudburst occurs when there is more than 100 mm of rain in one hour over a small geographical area (20 to 30 square kilometers).

Characteristics:

Associated with cumulonimbus clouds, which can grow up to 12-15 km in height.

Not indicative of clouds exploding but defined by the torrential downpour.

Can lead to flash floods and landslides, particularly in hilly terrains.

Formation and Causes

The formation of cloudbursts is predominantly influenced by the rapid uplift of moist air, leading to condensation and cloud formation.

Orographic Lifting:

When moist air encounters mountains, it is forced upward, cooling and condensing to form clouds.

Moisture Convergence:

During monsoon, winds bring in moisture-rich air that converges over land, significantly increasing the potential for cloudbursts.

Tall cumulonimbus clouds can develop rapidly, with moisture updrafts occurring at speeds of 60 to 120 km/h, resulting in a cloudburst within as little as 30 minutes.

Regions Most Affected

Cloudbursts predominantly impact rugged terrains, especially:

- Himalayas: Known for steep inclines and rapid weather changes.
- Western Ghats: Heavy rainfall during the monsoon season leads to frequent cloudbursts.
- Northeastern India: A region prone to intense weather phenomena due to its geography and climate.

Historical data shows that cloudbursts in these regions have caused significant loss of life and property, necessitating urgent disaster management strategies.

Detection and Forecasting Challenges

Detecting cloudbursts remains a formidable challenge due to the limitations of current technology.

- Satellite Limitations:
  - While satellites can monitor large-scale weather systems, their resolution often misses localized cloudburst events.
- Doppler Weather Radars:
  - Essential for tracking moving cloud droplets, yet expensive to deploy widely.
- Long-term Monitoring:
  - Implementing automatic rain gauges in cloudburst-prone areas is crucial for early warning systems.

As climate change intensifies weather patterns, the frequency and magnitude of cloudbursts are expected to rise, emphasizing the need for improved forecasting methods.

FAQs

What is a cloudburst?

A cloudburst is a sudden and intense rainfall event, defined by over 100 mm of rain in an hour over a small area.

How do cloudbursts form?

They are formed through rapid uplift of moist air, leading to condensation and heavy rainfall.

Which regions are most affected by cloudbursts?

Rugged terrains like the Himalayas and Western Ghats in India are particularly vulnerable.

What are the dangers associated with cloudbursts?

They can cause flash floods, landslides, and significant damage to infrastructure and loss of life.

How can we detect cloudbursts?

Detection is challenging; Doppler radars and automatic rain gauges are essential for monitoring.

What is the role of climate change in cloudbursts?

Warmer temperatures can lead to increased moisture in the air, raising the likelihood of cloudbursts.

Two cheetahs move to new home in Madhya Pradesh

Chief Minister Mohan Yadav releases Prabhas and Pawak into Gandhi Sagar Wildlife Sanctuary; the six-year-old males are from the batch of cheetahs brought from South Africa in February 2023

Mehul Malpani
BHOPAL

Two cheetahs, Prabhas and Pawak, moved to their new home as Madhya Pradesh Chief Minister Mohan Yadav released them into the Gandhi Sagar Wildlife Sanctuary on Sunday.

The six-year-old males are from the batch of cheetahs brought to the Kuno National Park from South Africa in February 2023.

They will now sprint in their 64-sq. km enclosure at Gandhi Sagar that is spread between Mandsaur and Neemuch districts, with the Chambal river cutting the sanctuary into almost two equal halves.

Calling the Cheetah Project an ambitious initiative by Madhya Pradesh, Mr. Yadav said the goal was to increase the number of cheetahs in India and preserve the species. Cheetahs were first introduced at Kuno in September 2022.

"Encouragingly, the project is achieving success. Gandhi Sagar Sanctuary has become the second site in the State, after Kuno National Park, where cheetahs are being reintroduced," he said. Mr. Yadav said efforts were on to bring more cheetahs from South Africa, Kenya, and Botswana.

New territory: Chief Minister Mohan Yadav releases a cheetah into the Gandhi Sagar Wildlife Sanctuary in Madhya Pradesh on Sunday. PTI

Four to arrive

Four cheetahs are scheduled to be translocated to Gandhi Sagar from Botswana in May, while four will arrive later in the second phase, the State government had said in a statement on April 18.

Mr. Yadav claimed that following the intercontinental translocation, Kuno had recorded the highest number of cheetah births in the world.

Earlier in the day, a 20-member team, led by Kuno's Chief Conservator of Forest (CCF), Uttam Kumar Sharma, transported the two cheetahs by road to Gandhi Sagar, located over 250 km away from Kuno.

The team will spend seven days at the sanctuary, during which the Gandhi Sagar staff, who have received extensive training at Kuno, will get accustomed to handling the big cats.

With the movement of two of its cats, Kuno now has 24 cheetahs – 14 in the wild and 10 in enclosures.

Over the past year, the State wildlife authorities have increased the prey base of the sanctuary.

Gandhi Sagar Wildlife Sanctuary

- Two cheetahs, Prabhas and Pawak, moved to their new home as Madhya Pradesh Chief Minister Mohan Yadav released them into the Gandhi Sagar Wildlife Sanctuary .
- 📍 Location: Situated in northwestern Madhya Pradesh, along the border with Rajasthan.
- 🌳 Ecoregion: Part of the Khathiar-Gir dry deciduous forests.
- 🦅 Sanctuary Status: Established as a sanctuary in 1974, covering an area of 368 sq. km.
- 🌊 Chambal River: The river traverses the sanctuary, dividing it into two parts.
- 🐦 Biodiversity Significance: Designated as an Important Bird and Biodiversity Area (IBA)
-

Scientists find green way to recycle toxic perovskite solar cells

Scientists have developed a way to process perovskite solar cells — which are more efficient but have shorter lifespans — such that the efficiency is almost the same as using fresh materials, even after being recycled up to five times; they were also able to re-obtain about 99% of the cells' layers after multiple rounds

Rohini Subrahmanyam
BENGALURU

Using solar energy may be better for the environment than burning through fossil fuels, but the process still isn't exactly perfect. Making silicon-based solar panels is energetically expensive and we still don't know what to do with the silicon once the panels are done being used.

There is a cheaper way to make solar panels, also called photovoltaics (PVs), using crystal structures called perovskites. However, perovskite crystals contain toxic elements like lead, which needs to be processed carefully once these solar panels reach the end of their lifespan. And so far, researchers have had to use toxic organic solvents like dimethylformamide to recycle such solar panels.

A yummy sandwich

Now, in a paper published in *Nature*, scientists have described another, potentially greener way of dealing with the problem. Using a water-based recycling solution, they have reported a way to degrade and recycle used perovskite. They were also able to get back high-quality perovskite crystals, which can potentially be used again for making new solar cells.

"It's kind of a complex chemistry to make the water solution usable and very stable for perovskite recycling, to fully remove the [the use of] organic solvents," Xun Xiao, a postdoctoral researcher at Linköping University in Sweden and lead author of the paper, said.

Perovskite solar cells are made up of multiple layers. The perovskite layer is sandwiched between materials that can conduct and transport charges, in this case metal electrodes and glass sheets.

"People have been very excited about [perovskite PVs] for a decade or more now because very quickly they have been able to achieve very high power conversion efficiencies," Rhys Charles, a researcher in the chemical engineering department at Swansea University in the U.K. explained. "So you could deliver an extremely cheap solar energy technology, but there are some things that have been holding the field back."

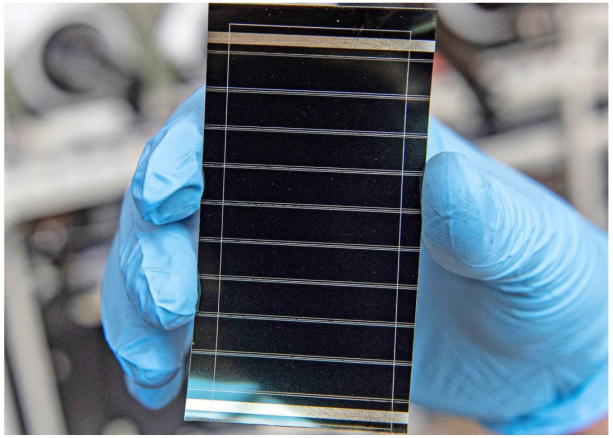
Stability is one of them: perovskite solar cells have a shorter lifespan.

Improving solar energy

"Early attempts to recycle these devices have all focused on capturing lead. Now, people are taking a little bit more of a holistic view of it," Charles continued. "From a circular economy point of view, recycling is also important because they want to capture the major impact materials [that] they use again."

For a circular economy, the aim is to keep the product – in this case the components of a perovskite solar cell – in use for as long as possible, to minimise waste. This way, if the cells are made again with recycled components, they would have a much lower environmental impact, which means lower emissions and lower cost associated with solar energy generation.

Thus far, the only way to recycle these important materials has been to use toxic organic solvents.



A researcher holds up a PET perovskite solar module. DENNIS SCHROEDER / NREL

Acids and salts

Dissolving and recycling the lead-containing perovskite layer in water was a major challenge to overcome. For this, the scientists added three key salts to help in the recycling process.

The first salt they added was sodium acetate. The acetate ions bound with the lead ions in the perovskite, making a highly soluble lead acetate that dissolved well in water.

They then added sodium iodide and hypophosphorous acid to help regenerate pure perovskite crystals in their water solution. Sodium iodide contains iodide ions that help repair and restore the degraded perovskite, such that when the solution is cooled, high-quality, pure perovskite crystals re-emerge from the solution.

The acid acts as a long-term stabiliser, ensuring the water solution can be reused and that the quality of the recycled crystals remains high.

"I'm pleased to see this focus on recycling, remanufacturing, and green chemistry," said Matthew Davies, a professor of chemical engineering at Swansea University. "It lays the foundation for perovskite PVs to deliver on their promise as a low-cost, high-efficiency solar technology within a circular economy, avoiding the large-scale waste challenges faced by earlier PV technologies."

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>
> **RHYS CHARLES**
> Researcher at chemical engineering department, Swansea University

The scientists also developed solutions made of ethanol and ethyl acetate to dissolve other components of the perovskite solar cell, after which they were able to recycle each component to reuse along with the perovskite crystals. Then they reassembled the solar cell layer by layer and found that the efficiency was almost the same as using fresh materials, even after being recycled up to five times. They were also able to re-obtain about 99% of the different layers even after multiple rounds of recycling.

"These guys seem to have solved the problem; they seem to be able to use this aqueous system to recycle the cells and make them again with high efficiency," Charles said. "If it can be scaled [up] and if it works as well as the paper claims, it could potentially overcome some of the most significant barriers to commercialising perovskites and solve some of the key environmental concerns about the technologies as well."

Charles also stressed the need to underpin scientific and industrial progress, especially when it came to environmental technologies, with life cycle assessments. Life cycle assessment, he explained, is an approach to quantify all the impacts of a technology across its entire life cycle, from the start to when one has the final product. "But you can go further," he said. "Then you can look at the use phase of the technology and the end-of-life phase as well."

"I always enjoy it when I see these things underpinned by life cycle assessment, to make sure there aren't unintended consequences and to make sure the research really is targeting the key environmental problems for the technology," Charles added. "I'd like to see more of that as well, as just standard practice."

(Rohini Subrahmanyam is a freelance journalist in Bengaluru. roh.subb@gmail.com)

THE GIST

- Perovskite crystals used in making solar panels contain toxic elements like lead. And so far, researchers have had to use toxic organic solvents like dimethylformamide to recycle such solar panels
- Dissolving and recycling the lead-containing perovskite layer in water was a major challenge to overcome. Now, using a water-based recycling solution, scientists have reported a way to degrade and recycle used perovskite. They were also able to get back high-quality perovskite crystals, which can potentially be used again for making new solar cells.
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The Promise and Challenges of Solar Energy: A Deep Dive into Perovskite Technology

Introduction to Solar Energy

Solar energy is a cleaner, renewable, and more sustainable alternative to fossil fuels.

Despite its benefits, solar energy has its own set of challenges

The Drawbacks of Silicon-Based Solar Panels

Energy-Intensive Production: Manufacturing silicon panels requires significant energy and resources.

Disposal Dilemma: End-of-life silicon panels pose disposal challenges.

Enter Perovskite Solar Cells

What are Perovskites?: A new type of solar cell with a unique crystal structure offering cost-effective and efficient energy solutions.

Advantages: High power conversion efficiency and lower production costs.

The Toxicity Challenge

Lead and Other Toxic Elements: Perovskite cells often contain harmful elements, raising environmental concerns.

Current Recycling Methods: Traditional methods use toxic solvents, necessitating greener solutions.

A Greener Solution: Water-Based Recycling

The Breakthrough Research: A new water-based method for recycling perovskite cells without harmful solvents.

How it Works: Specific salts in water dissolve the lead-containing layer, allowing for material recovery and reuse

The Future of Perovskite Solar Cells

Circular Economy and Sustainability: Emphasizing material reuse to minimize waste and environmental impact.

Life Cycle Assessments: Evaluating the environmental footprint of solar technologies to ensure sustainable practices.

Conclusion

- Solar energy, particularly through perovskite technology, holds great promise but requires careful management of its challenges.
- Innovative recycling and sustainability practices are key to a bright future for solar energy.

FAQs

What are perovskite solar cells?

A type of solar panel with high efficiency and lower production costs.

Why are perovskite solar cells considered toxic?

They contain lead and other toxic elements, posing environmental risks.

What is the new water-based recycling method?

A method using water and salts to recycle perovskite cells without harmful solvents.

How does recycling benefit the environment?

It reduces waste, emissions, and the environmental impact of new panel production.

What is a circular economy?

An economic system aimed at minimizing waste and promoting sustainability through recycling and reuse.

WHAT IS IT?

Rejosari Senik: rising above water

Rejosari Senik is a hamlet in the Demak district of Indonesia's Central Java province. In the 1970s, the distance between the hamlet and the nearest shoreline, on the Java Sea, was about 7 km. Today, the land on which the hamlet lies is permanently underwater.

Even by the mid 2000s, Rejosari Senik had become disconnected from mainland Java by erosion. The few structures in the hamlet still occupied today stand on stilts.

Its people once used to grow rice and vegetables. As global warming caused the local sea level to rise slowly but steadily, they switched to fish ponds, but many of them also moved further inland in search of new homes and better jobs.

But even by 2020, reports emerged that Rejosari Senik wore the look of a ghost town: the only reason it actually wasn't one is that it still counted a few residents.

One of them, Pasijah, is a 55-year-old woman who told *Reuters* in February, "I do have every intention to stay here and my feelings for this house remain." Her family raises its stilts, sometimes up to thrice a year, to keep it above the rising water.

While Indonesia at large plans to build a 700-km-long sea wall to keep sea-level rise at bay, Pasijah and her family have also been planting 15,000 mangrove trees a year for two decades to keep the tides from flooding her home.

A drone view of the house belonging to Pasijah and other buildings, surrounded by mangrove planted by her, in Rejosari Senik. REUTERS

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Rejosari Senik

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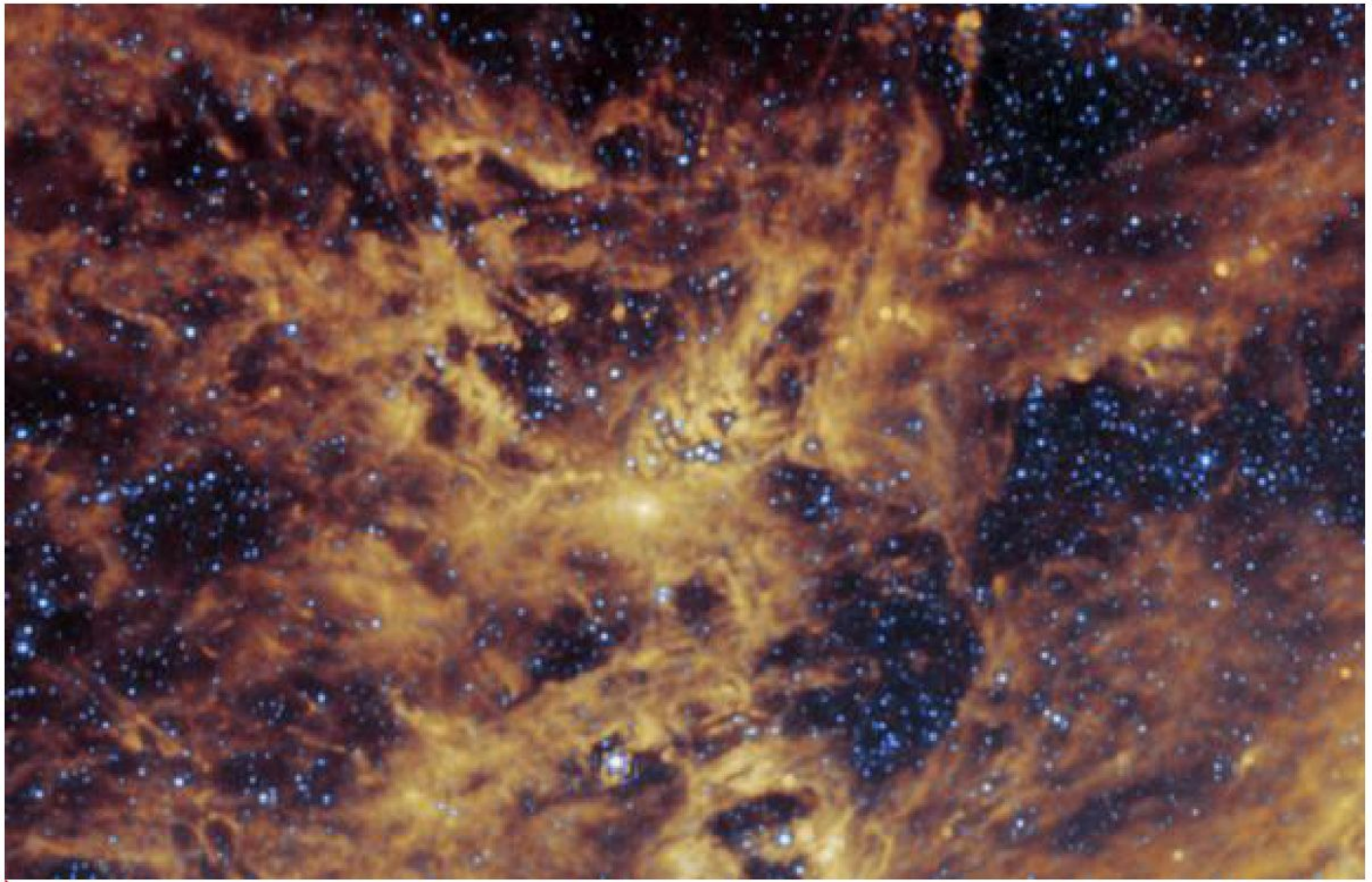
BIG SHOT



The James Webb Space Telescope (JWST) has revealed strong signs of a previously unknown black hole in the M83 galaxy, pictured here. Massive spiral galaxies like this one often host a growing black hole but astronomers have struggled for decades to confirm one in M83. JWST revealed for the first time highly ionised neon gas that could be a telltale signature of its presence. NASA

M83

- Messier 83 or M83, also known as the Southern Pinwheel Galaxy and NGC 5236, is a barred spiral galaxy approximately 15 million light-years away

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THE HINDU

Tackle heatwaves with short- and long-term measures

Dr. Chandrakant Lahariya

is a practising physician and expert in global health, with nearly 17 years of professional work experience with the United Nations system including the World Health Organization and UNICEF

On March 15, some States and cities in India experienced the first of severe heatwaves for the year 2025. This was 20 days earlier than the first severe heatwave in 2024. In the last decade, the number of severe heat days and the severity/intensity of heatwaves have been rising. The year 2024 was the warmest year on record at about 1.55°C above pre-industrial level, according to the World Meteorological Organization. In India, December 2022 was the hottest December since temperature monitoring in the country started in 1901. The frequency of heatwaves in India has increased in the last two decades, in comparison to the previous two decades.

The impact of rising external temperature and heatwaves along with humidity and wind speed, is reflected in the form of heat stress. When the outside temperature reaches close to our body temperature of 37° Celsius, the body fails to release the internal heat which is generated as a part of the basal metabolic rate. Thus, one starts to feel heat-stressed. Heat stress can affect multiple organs including the kidneys, the liver and the brain, and may cause sickness and even death.

Socio-economic impact and equity issue

However, heatwaves have many non-health and socio-economic impacts. Climate change, specifically rising temperature, is one of the causes of farming sector stress in India. With rising temperatures, it becomes difficult for farmers to work in the field and harvest comes down. Livestock can die, further impacting the poor and farmers. Heat stress can reduce livestock production, food production, farm productivity and the ability of outdoor workers/workforce productivity. As India is a labour-intensive country, especially in the agriculture and construction sector, heatwaves result in an individual's reduced working ability. Thus, loss of work hours and loss of job reduce personal and family income. In India, up to 75% of the workforce, or 380 million people are dependent on heat-exposed labour. There are estimates that heat stress results in an economic loss of 3% to 5% of GDP in many countries including India. There are estimates that in 2023, nearly 6% of work hours in India were lost due to heat stress. As temperature rises, electricity demand and power cuts affect industrial production. Heatwaves and heat stress impact personal income and may slow down a nation's economic growth.

Heat-related data indicate that the impact of heat stress is worst on the poor, the marginalised, migrants, subsistence workers, women, and the elderly. Women are additionally impacted due to social norms such as working in the kitchen, the need to wear clothing due to cultural requirements, or space allocated for sleeping. From every angle, it is a matter of inequity.

As early as the middle of the 19th century, researchers and scientists made observations that urban areas have a higher temperature than rural areas, arriving at the inference that much of the rise in temperature is human made. Yet, it took another 150 years for the first heat and health action plans (HHAP) to be prepared in the European countries; ironically, the first such efforts were from the non-tropical regions, between 2003 to 2008.

In 2013, Ahmedabad, Gujarat, became the first municipal corporation in Asia to develop a heat action plan (HAP). Since then, and in the last decade, more than 23 Indian States and around 140 cities across India have State- and city-level HAPs. India's National Programme on Climate Change and Human Health (NPCCHH) also provides heat advisories and other health-related information through the National Disaster Management Authority (NDMA).

Heat action plans need nuances

Most HAPs have four to five components, i.e., early prediction of heatwaves to raise alerts; increasing awareness among the communities/people on actions to be taken; and preparing and getting the health system ready to manage health conditions. The fourth component of such plans focuses on ensuring long-term measures to reduce heat, government initiatives to increase the number of trees and parks and keeping gardens open for public use. There is experience, from various cities, about painting rooftops white to reflect heat. The fifth component of HAP must be collecting, analysing and interpreting heat stress, and also morbidity and mortality data. Though many Indian States and cities have HAPs, their implementation demands more attention. These HAPs have shown partial success and only in some settings where city authorities work with the State government, engage local public health institutions, subject experts, non-governmental organisations and community-based organisations.

As India might be heading into another warm year, there are some learning and action points which should be considered.

First, every State should consider developing and/or updating its HAP, informed and guided by the learnings and best practices from the existing plans. The HAP should factor in humidity and not just temperature. The HAPs should be developed based on a local vulnerability assessment. Plans should ensure the clear accountability and the responsibility of various identified stakeholders. These should be activated from the beginning of March.

Second, a review article published in the medical journal, *Preventive Medicine: Research & Reviews*, noted that most Indian cities have excess mortality due to heat stress, which demands better heat stress-related data collection. Besides, when heat-stress related data is not comprehensive and an under-estimation, it is worthwhile interpreting available data to review who the people who suffer a heat stroke are and which part of the city they live in, which, in turn, would provide useful, actionable and potentially lifesaving information.

Third, a few countries such as the United Kingdom have started Heat Health Alert (HHA) systems which use both daytime and nighttime maximum temperatures. The HAPs in India also need to factor in the day and nighttime temperature monitoring. There is also a need for more sophisticated and specific warning systems which can predict thermal comfort and the timings during the day when temperatures are likely to be low. This can ensure health as well as continuity of work such as school and office functioning.

Fourth, the long-term preventive measures of HAPs need to be strengthened. Better building and urban infrastructure and building material need to be promoted. Heatwaves impact the poor the most, and it is during these periods that governments should also consider financial support for informal sector workers who may suffer wage losses.

Fifth, a 2022 study from three Asian countries (India, Pakistan and Bangladesh) suggested that the universal 'stay indoors' advisory during specific hours may not be helpful for all families. People in a poor neighbourhood and in a confined space that is surrounded by high-rise buildings may experience higher temperatures in their homes and outside, in comparison to the rest of the city. Even within cities, there is a need for geography and social context-specific heat advisories.

Need for a people-centric approach

Sixth, it is time that more Indian cities start 'summer or cold shelters' similar to winter shelters. There are already some States that are developing a 'cool roof policy' to promote the use of material in building roofs which will keep houses cool by reflecting sunlight. Prevention of heatwaves needs more practicable and science-based innovations.

Seventh, during heatwaves, local authorities carry out a lot of short-term measures such as advisories to drink a lot of water. However, to make that happen, municipalities and city authorities need to ensure the easy availability of drinking water points, and the availability of electrolyte solution/ORS powder. Offices and workplaces (both formal and informal) should allow staggered work times and also early morning and late evening work. Work can be closed during the day, especially for those who work in the informal sector and open spaces.

The evidence is that investments in heat-related actions and adaptation are highly cost effective. Therefore, every effort should be made to reduce the economic burden of heat stress in hospitals and emergency rooms and its indirect social and economic costs. With every passing year, in India and globally, the average temperature is rising. Therefore, the actions should be focused not just on short-term measures but also on long-term strategies to address the challenge of rising temperatures and steps such as enhanced coordination between multiple agencies, with *inter alia* initiatives such as provision of insurance coverage for lost work days. If policymakers and planners remember that a heatwave is an equity issue and that the approach has to be people-centric, half of the task will be done.

As India might be heading into another warm year, there is a need for people-centric and multi-sectoral interventions, along with science-based innovations

Rising Temperatures and Heatwaves in India: A Comprehensive Analysis of Impacts, Challenges, and Solutions

Section 1

Understanding Heatwaves

Criteria for Classifying Heatwaves

01

Temperature Thresholds
Classification relies on specific temperature limits, such as 40° C in India, adjusted for local climatic variations and historical data.

02

Duration and Frequency
Heatwaves are defined by prolonged high temperatures over consecutive days, with frequency analysis essential for understanding climate trends.

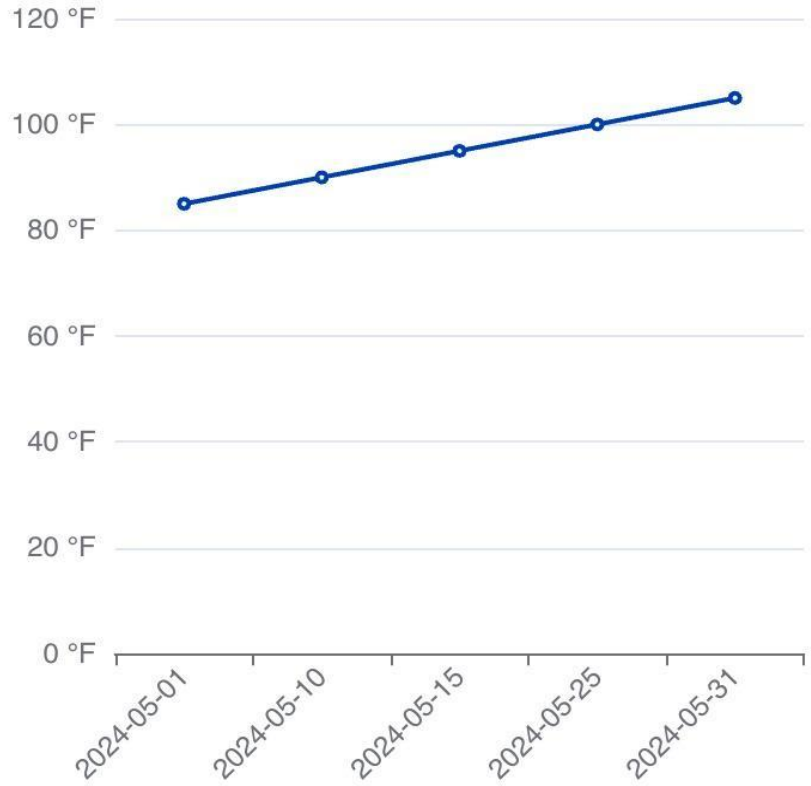
03

Heat Stress Measurement
The heat index integrates temperature and humidity, indicating health risks when exceeding critical levels, such as 54° C.

Historical Context of Heatwave Occurrences in India

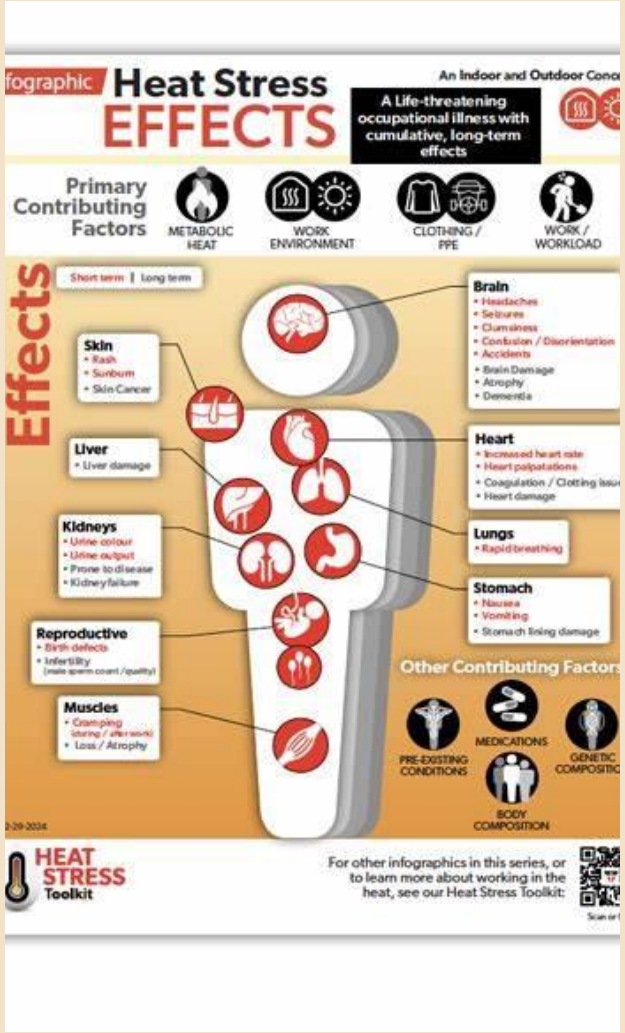
Escalating Heatwave Trends

Historical data indicates a significant rise in heatwave frequency and intensity in India, with the average annual heatwave days increasing from approximately 11 in the 1995-2005 period to around 24 in 2010-2020, highlighting the urgent need for adaptive climate strategies.



Section 2

The Science Behind Heatwaves



Mechanisms of Heat Stress on the Human Body

01

Physiological Responses

The body increases heart rate and blood flow to the skin to enhance heat dissipation.

02

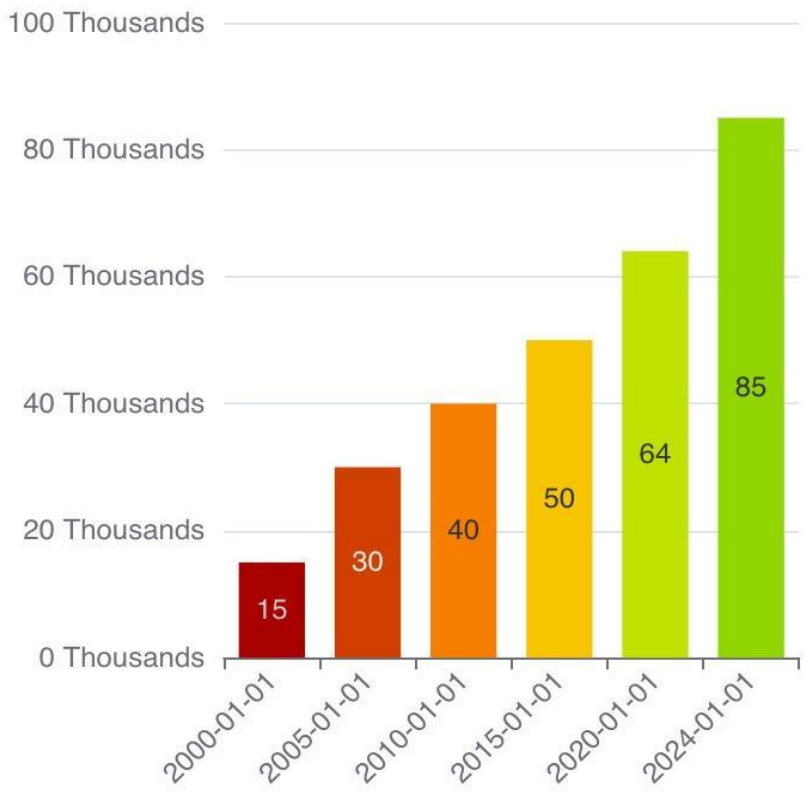
Environmental Interactions

High humidity impairs sweat evaporation, exacerbating heat stress effects on the body.

03

Health Risks

Prolonged heat exposure can lead to severe conditions like heat exhaustion and heat stroke.



Interaction of Temperature, Humidity, and Wind Speed

Microclimate Dynamics

The interplay of temperature, humidity, and wind speed creates distinct microclimates that significantly affect human comfort and health, necessitating targeted public health interventions during extreme heat events.

Historical Trends in Heatwaves

Significant Increase in Incidents

The frequency of heatwaves in India has surged by approximately 25% from 2001 to 2020, with record temperatures exceeding 50° C in 2024, highlighting the urgent need for effective climate adaptation strategies.

Section 3

Global Context

Comparison of India’s Heatwave Trends with Global Patterns

The rise in heatwave events in India, averaging 10 per year from 2010 to 2020, underscores the urgent need for climate adaptation strategies.

Increasing Frequency in India

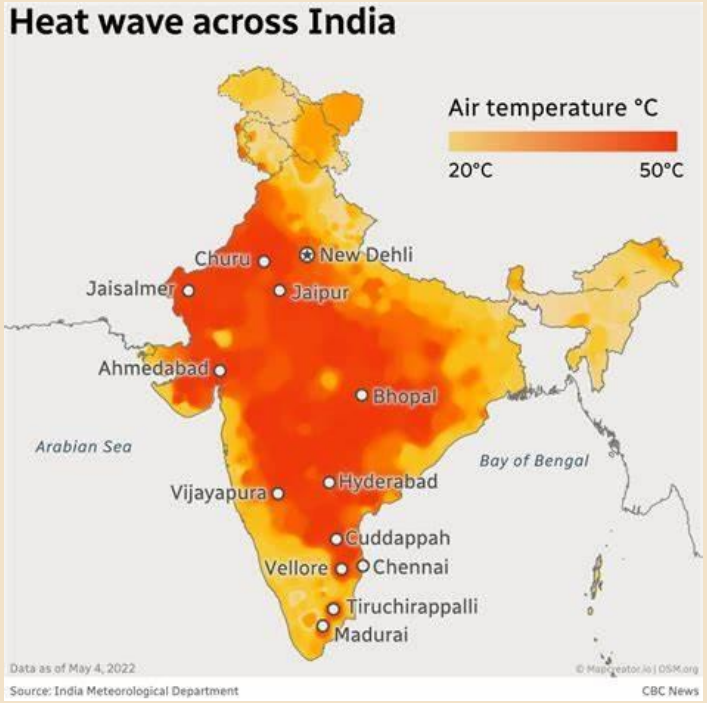
Global Heatwave Patterns

The global increase in heatwave duration, averaging 1.2 days per decade, highlights the interconnectedness of climate change impacts across different regions.

The Role of Climate Change in Exacerbating Heatwaves

Impact of Greenhouse Gases

The rise in greenhouse gas emissions has intensified heatwaves in India, with projections indicating potential temperature increases of up to 2° C by century's end, necessitating urgent climate action and adaptive strategies.



Section 4

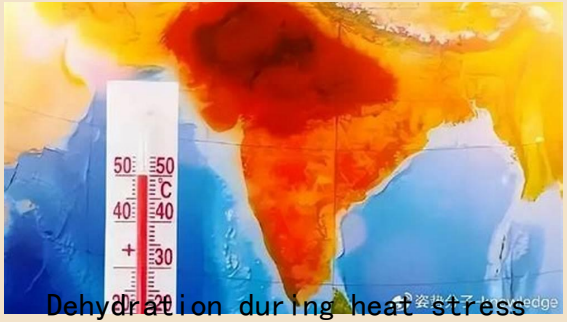
Health Impacts of Heatwaves

Physiological Effects of Heat Stress

Cardiovascular Strain

Heat stress elevates heart rate and blood pressure, increasing the risk of cardiovascular events, particularly in individuals with pre-existing heart conditions or hypertension.

Kidney Function Impairment



Dehydration during heat stress can lead to acute kidney injury, especially in vulnerable populations, necessitating increased hydration and monitoring during heat events.

Cognitive Decline

affect cognitive abilities, leading to confusion and impaired decision-making, particularly in older adults and those with mental health issues.

Vulnerable Populations

Socio-Economic Disparities

Low-income groups face heightened risks due to inadequate housing and limited access to cooling resources during heatwaves.

Health Vulnerabilities

The elderly and individuals with pre-existing conditions are more susceptible to heat-related illnesses, necessitating targeted health interventions.

Gender and Age Factors

Women and children experience unique risks from heat stress, influenced by social roles and developmental stages, requiring gender-sensitive approaches.

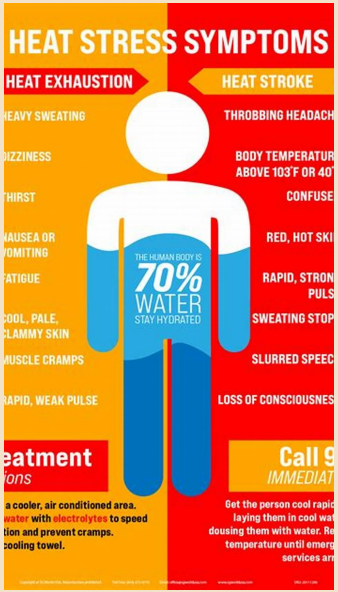
Symptoms and Health Conditions Associated with Heat Stress

Critical Heat Stroke Signs

Symptoms include confusion and hot, dry skin; urgent medical intervention is essential to prevent severe outcomes.

Heat Exhaustion Indicators

Characterized by excessive sweating, weakness, and nausea, requiring immediate hydration and cooling measures.



Dehydration Consequences

Symptoms like dry mouth and fatigue can escalate to serious health issues, including kidney damage if untreated.

Section 5

Socio-Economic Impacts of Heatwaves

Economic Consequences

01

Agricultural Vulnerability

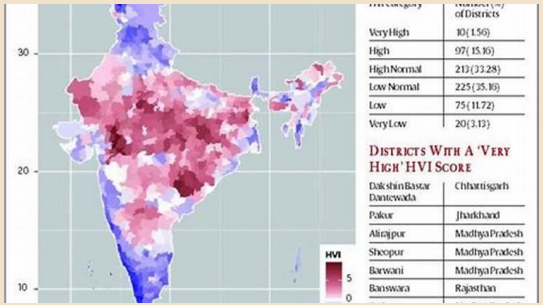
Extreme heat significantly reduces crop yields, particularly for staple crops, threatening food security and increasing reliance on imports to meet demand.

02

Labor Market Disruptions

Heatwaves lead to decreased productivity in outdoor labor sectors, resulting in substantial economic losses and increased strain on workers' health and safety.

Equity Issues

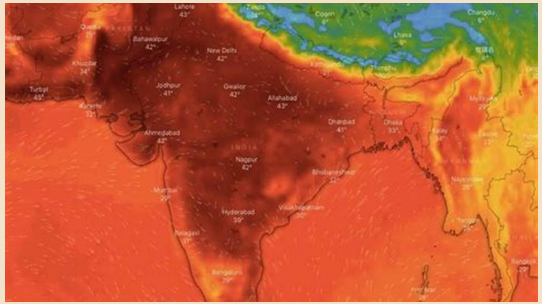


Disproportionate Impact on Vulnerable Groups

Marginalized communities, including low-income households and the elderly, face heightened risks during heatwaves due to inadequate resources and support systems.

Systemic Inequities in Resource Access

Research shows stark disparities in access to cooling facilities and healthcare, with urban slums significantly lacking compared to wealthier neighborhoods.



Need for Targeted Interventions

Effective heat action plans must incorporate gender-sensitive approaches and tailored outreach to address the unique challenges faced by vulnerable populations during extreme heat events.

Section 6

Policy Responses to Heatwaves

Historical Policy Development

2013

The Ahmedabad Heat Action Plan was launched, setting a precedent for future heat management policies.

2015

A severe heatwave prompted a national reevaluation of heatwave preparedness and response strategies.

2017

The number of cities with heat action plans reached 10, marking the beginning of widespread policy adoption.

2018

The count of cities with heat action plans doubled to 20, reflecting growing awareness of heat risks.

2020

The implementation of HAPs expanded to 50 cities, showcasing significant progress in heat stress management.

2023

A total of 75 cities adopted heat action plans, indicating a robust national commitment to combat heatwaves.

Current State of Heat Action Plans

Strength in Local Adaptation

Tailored HAPs address specific regional vulnerabilities effectively.

Opportunities for Collaboration

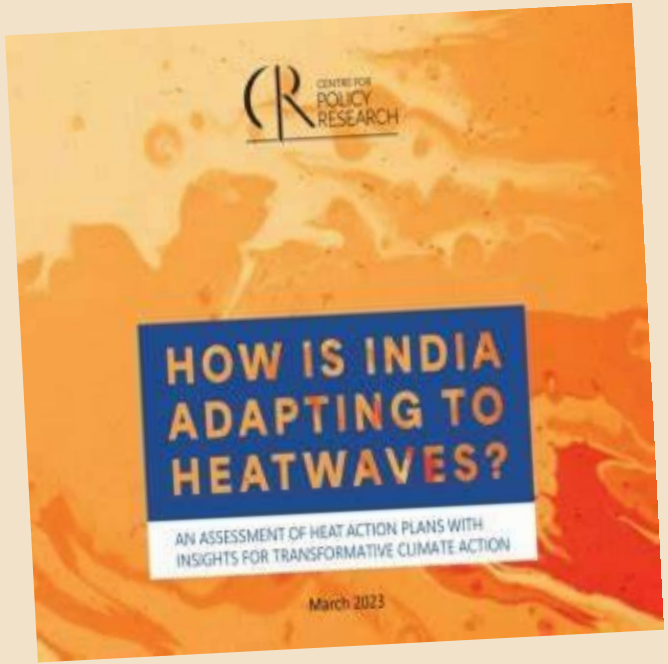
Potential for partnerships between government and NGOs to enhance outreach and education.

Weakness in Data Gaps

Incomplete datasets hinder comprehensive monitoring and evaluation of HAP effectiveness.

Threat of Climate Change

Increasing temperatures may outpace current HAP effectiveness, necessitating urgent updates.



Challenges in Implementation of Heat Action Plans

Data Collection Limitations

Inadequate and inconsistent data collection methods hinder the effective analysis of heat stress impacts, leading to poorly informed strategies that fail to address the specific vulnerabilities of diverse communities across India.

Section 7

Innovations and Best Practices

Successful Strategies from Other Countries

Integrated Heat Management Systems

Countries like Canada and Japan have successfully implemented integrated heat management systems that combine real-time data monitoring, urban greening initiatives, and community outreach, significantly reducing health risks and enhancing public resilience during heatwaves.

Community Engagement and Awareness

01

Importance of Local Involvement

Engaging local communities ensures that heat action plans are tailored to specific needs, enhancing their effectiveness and acceptance.

02

Role of Technology

Utilizing mobile apps and online platforms can facilitate real-time information sharing and community feedback on heatwave preparedness.

03

Sustained Engagement Efforts

Continuous community involvement through regular events and updates fosters long-term awareness and resilience against heatwave impacts.

Section 8

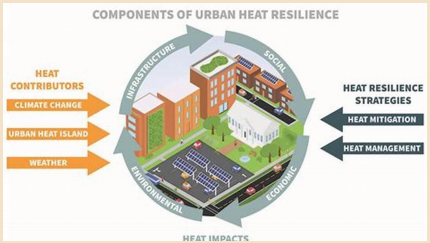
Long-Term Solutions to Combat Heatwaves

Infrastructure Improvements

01

Heat-Resilient Urban Design

Implementing urban design principles that prioritize heat resilience, such as strategic building orientation and ventilation, can significantly enhance thermal comfort in cities.



02

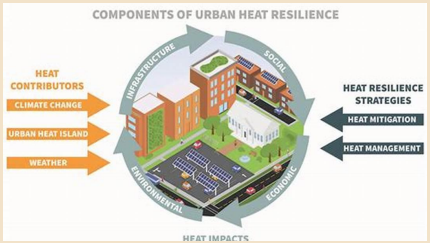
Sustainable Water Management

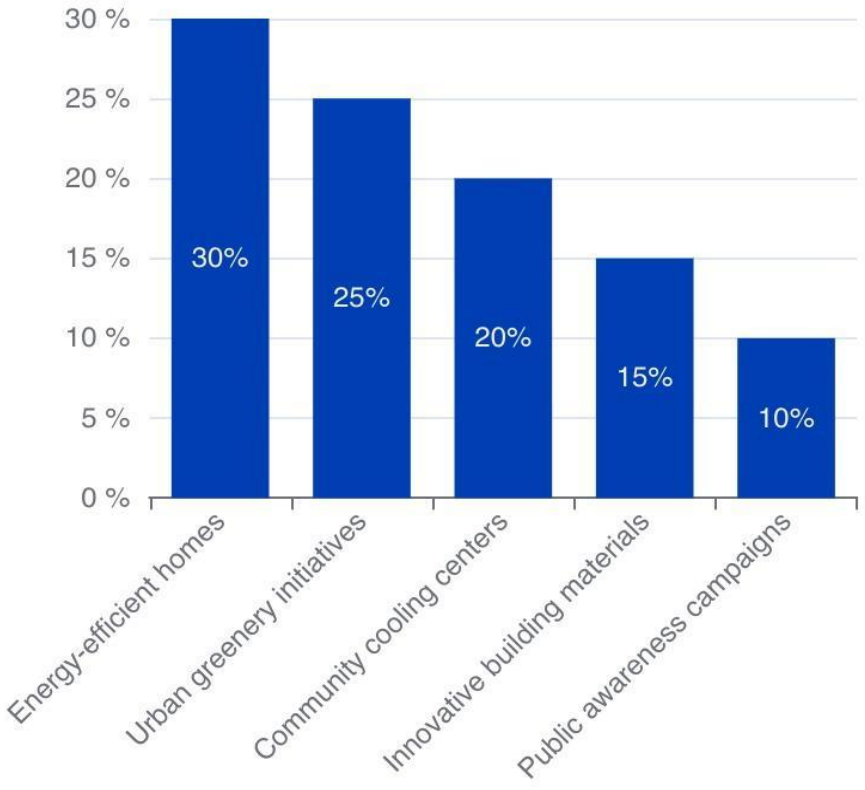
Integrating sustainable water management practices, like rainwater harvesting and efficient irrigation, can help mitigate heat effects while promoting resource conservation in urban areas.

03

Community-Centric Infrastructure

Developing infrastructure that actively involves community input ensures that local needs are met, fostering greater acceptance and effectiveness of heat mitigation strategies.

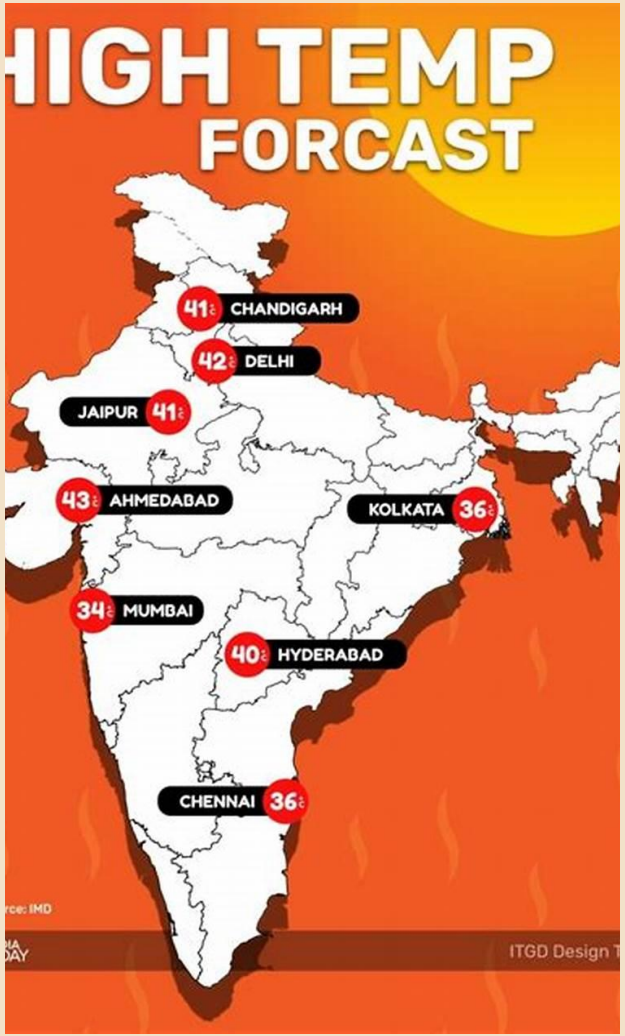




PFinancial Support Mechanisms

Targeted Financial Aid Programs

Establishing targeted financial aid programs for informal sector workers during heatwaves is essential to ensure immediate economic relief, with proposed allocations of ₹10,000 per worker to compensate for income loss and enhance community resilience against extreme heat impacts.



The Role of Technology in Mitigating Heatwaves

01

Real-Time Data Utilization

Advanced sensor networks provide critical temperature and humidity data for effective heatwave management.

02

Community Cooling Innovations

Establishing climate-controlled cooling centers offers refuge for vulnerable populations during extreme heat events.

03

Mobile Application Engagement

Digital platforms disseminate heat health advisories, promoting proactive community responses to heatwave conditions.

Section 9

Conclusion

Summary of Key Findings and Recommendations

01

Rising Heatwave Incidence

The analysis reveals a concerning increase in heatwave days, necessitating urgent public health interventions and enhanced community preparedness strategies to mitigate impacts.

02

Targeted Policy Enhancements

Recommendations emphasize the need for localized heat action plans and educational outreach to effectively address the vulnerabilities of at-risk populations during extreme heat events.

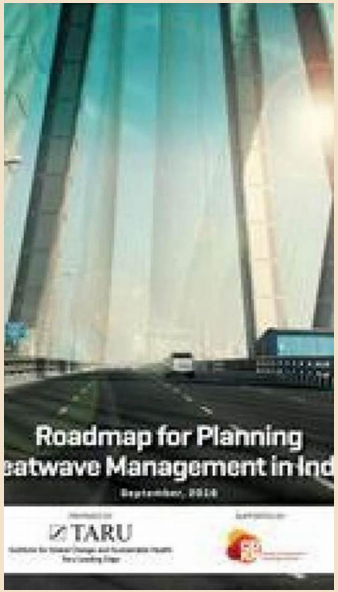
: The Importance of a People-Centric Approach to Heatwave Management

Targeted Education Initiatives

Tailored community education on heat risks improves awareness and compliance with preventive measures.

Community Resilience Building

Engaging local populations enhances adaptive capacity and ensures relevant heatwave response strategies.



Collaborative Governance Models

Partnerships between communities and authorities foster effective heat action plans and resource allocation.

Calling out American trade illegality

The world is shaken by the reckless decision of the United States to impose reciprocal tariffs, which were announced on April 2, 2025, though it has been paused for 90 days, barring the tariff rates on China. The illegality of these tariffs under international trade law, as defined by the World Trade Organization (WTO), makes little difference to U.S. President Donald Trump, who treats international norms with derision. Since the announcement of the tariffs, countries have responded in various ways, with some openly criticising the U.S. while others have chosen to remain silent.

Criticising the U.S.

Several nations have condemned the U.S. for imposing illegal tariffs and undermining the fundamental principles of international trade. Singapore's Prime Minister Lawrence Wong remarked recently that the imposition of reciprocal tariffs "is a complete repudiation of the MFN principle", which is a cornerstone of the multilateral trading system. Similarly, Brazil stated that these tariffs "violate" the U.S.'s commitments under WTO rules. Another BRICS nation, China, has openly criticised the U.S. for breaching its WTO obligations and has initiated a dispute within the WTO. In addition, China has imposed retaliatory tariffs on U.S. imports. Japan has also formally stated that the unilateral imposition of tariff rates contradicts WTO agreements. Canada, too, has not hesitated to challenge the legality of the U.S. actions. It has imposed retaliatory tariffs and filed a legal claim at the WTO regarding U.S. tariffs on Canadian automobiles and automobile parts. The positions adopted by these countries are justified; international trade is complex and cannot operate effectively without fundamental rules. If a powerful country disregards these rules, other nations that uphold the rule-based system must call out that country.

Prabhash Ranjan

is Professor and Vice Dean (Research), Jindal Global Law School

India's weak-kneed response is jarring especially at a time when it should be leading the Global South and advocating a fair and just trading order

While some nations have refrained from explicitly condemning the U.S. for violating international law, they have expressed general dissatisfaction with the unjustifiable increase in tariff rates. For instance, Fiji referred to the tariff hikes as 'unfair', and Italy's Prime Minister described them as a 'mistake'.

However, some countries have chosen to maintain silence regarding the U.S.'s illegal actions, issuing insipid statements that they are carefully examining the U.S.'s decision. These countries neither criticise the U.S.'s blatantly illegal actions nor formally express their discontent. India falls into this category.

Reasons behind India's silence

There are primarily two reasons presented to justify India's silence on the U.S. tariffs. First, India is negotiating a bilateral trade agreement (BTA) with the U.S., and it is deemed not in India's interest to criticise the U.S. for its illegal actions publicly. This reasoning is questionable. The U.S. is also negotiating with India but has not hesitated to express its dissatisfaction with India's high tariff rates publicly, even when they are legal. Mr. Trump has openly criticised India's tariff levels on several occasions. Yet, it did not prevent the U.S. from negotiating with India even prior to the announcement of the reciprocal tariffs. Moreover, India is not the only country negotiating bilaterally with the U.S.; many nations are in similar situations, and yet have publicly called out the U.S. for its unilateral actions. Claiming that the U.S.'s actions violate WTO law should not hinder negotiations, as New Delhi is not confronting Washington by imposing retaliatory tariffs but reminding it to honour international trade rules. Presumably, India will privately communicate this to the U.S., but a public statement would show its commitment to a rule-based trading order.

The second reason is that the WTO's dispute settlement body is currently dysfunctional. Therefore, calling out the U.S. for its illegal actions, such as by filing a legal claim at the WTO, is useless. This transactional perspective is flawed because it limits the role of international law to material outcomes such as compliance and enforcement. We must move beyond this narrow view. A key function of any legal system is its ability to differentiate between sheer public power and legitimate authority. Even though international law may not always and immediately punish decision-makers for non-compliance, it enables other actors to question those in power and to argue that their actions are illegitimate. Both China and Canada are well aware of the dysfunction of the WTO's dispute settlement mechanism. However, this has not deterred them from filing legal claims against the U.S.; they understand that they can use international law to strengthen their case for legitimacy.

Respect for trade rules

Recently, around 40 WTO member countries, including many developing nations, issued a statement supporting trade multilateralism and WTO rules in response to U.S.-imposed tariffs. Notably, India, which often champions a rule-based trading system, did not sign this statement. In accordance with its professed vision, this is a crucial moment for India to lead the Global South by advocating trade multilateralism and building a coalition against unilateral actions. History should remember India as a nation that defended national interests while taking up the cudgels for the developing world to establish a fair and just trading order.

The views expressed are personal

Tariff Turmoil: The Global Response to U.S. Trade Recklessness and the Call for a Rule-Based Order

Section 1

The U.S. Tariff Announcement

Background of the Tariff Decision

2025

The U.S. announced reciprocal tariffs amid escalating U.S.-China trade tensions.

2024

U.S. exports to China reached approximately $120 billion, highlighting trade dynamics.

2024

Imports from China totaled around $500 billion, resulting in a significant trade deficit.

2025

The average tariff rate proposed is 25%, potentially impacting trade volumes significantly.

2025

A 90-day pause was established for negotiations to address trade grievances diplomatically.

2025

The role of the WTO is emphasized in mitigating unilateral trade actions and fostering cooperation.

Key Motivations Behind the Tariff Imposition

Domestic Industry Protection

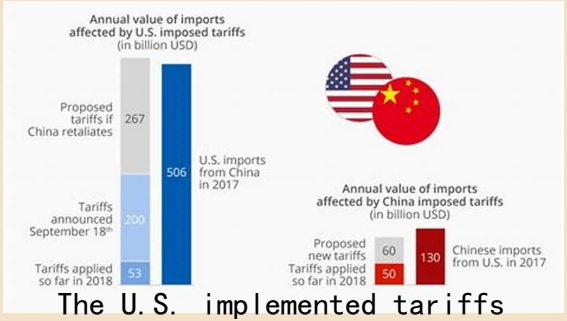
The tariffs aimed to shield U.S. industries from foreign competition, particularly in critical sectors like steel and aluminum, thereby preserving jobs and fostering local manufacturing to enhance economic resilience.

Section 2

Implications of the Tariff Rates on China

Specifics of the Tariffs Imposed on Chinese Goods

Tariff Rate Overview

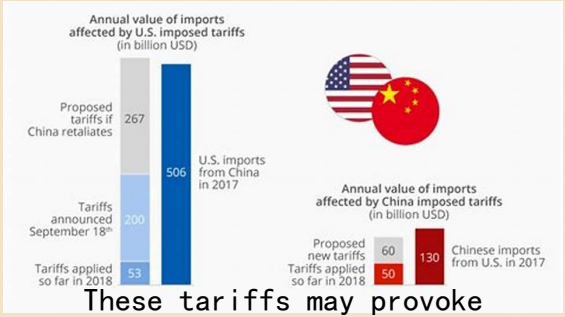


The U.S. implemented tariffs ranging from 10% to 25% on Chinese goods, targeting key sectors like machinery and electronics to protect domestic industries.

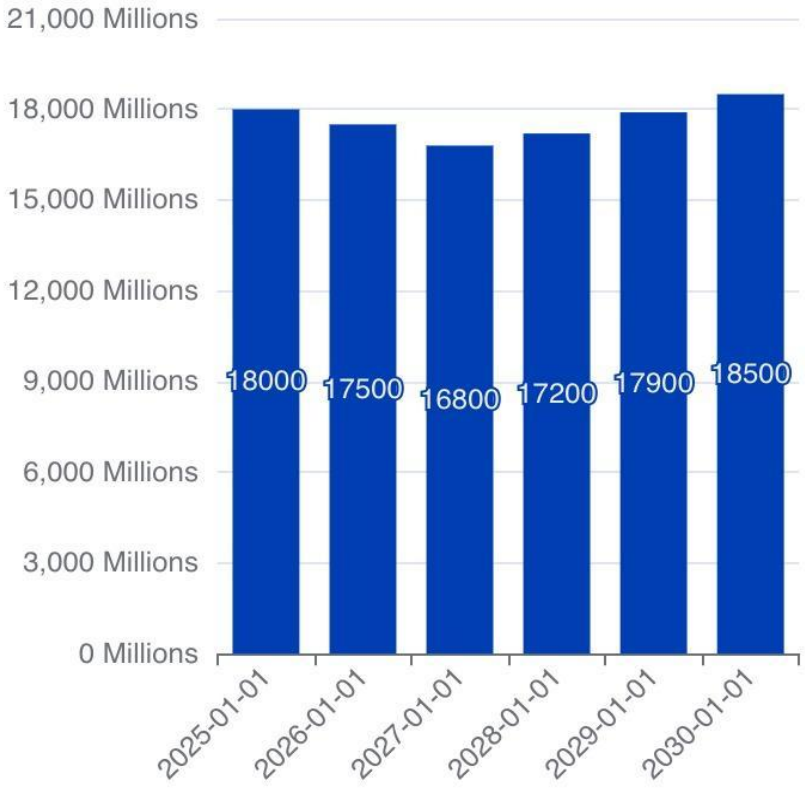
Economic Impact Assessment

Approximately $300 billion in imports are affected, with electronics alone accounting for $80 billion, significantly influencing U.S. trade dynamics and inflation rates.

Global Trade Ramifications



These tariffs may provoke retaliatory actions from China, potentially destabilizing international trade relations and challenging the principles upheld by the World Trade Organization.



Economic Impact on U.S.-China Trade Relations

Projected Trade Volume Decline

The anticipated 14.4% decrease in U.S.-China trade volume post-tariff imposition underscores the fragility of economic interdependence, potentially leading to long-term shifts in global supply chains and market strategies.

Potential Long-Term Consequences for Global Trade Dynamics

01

Trade Partnership Shifts
Countries may prioritize trade with partners less affected by tariffs, fostering new regional alliances and altering global trade networks.

02

Strengthened Multilateralism
A push for robust multilateral trade agreements may emerge, emphasizing collective bargaining and compliance with international trade norms.

03

Supply Chain Resilience
Businesses will likely diversify sourcing strategies, enhancing supply chain resilience while potentially increasing short-term operational costs.

Section 3

International Reactions to U.S. Tariffs

Open Criticism from Various Nations

Global Trade Stability Concerns

Nations express alarm over the potential destabilization of global trade systems, emphasizing the need for adherence to established international trade agreements to ensure economic cooperation.

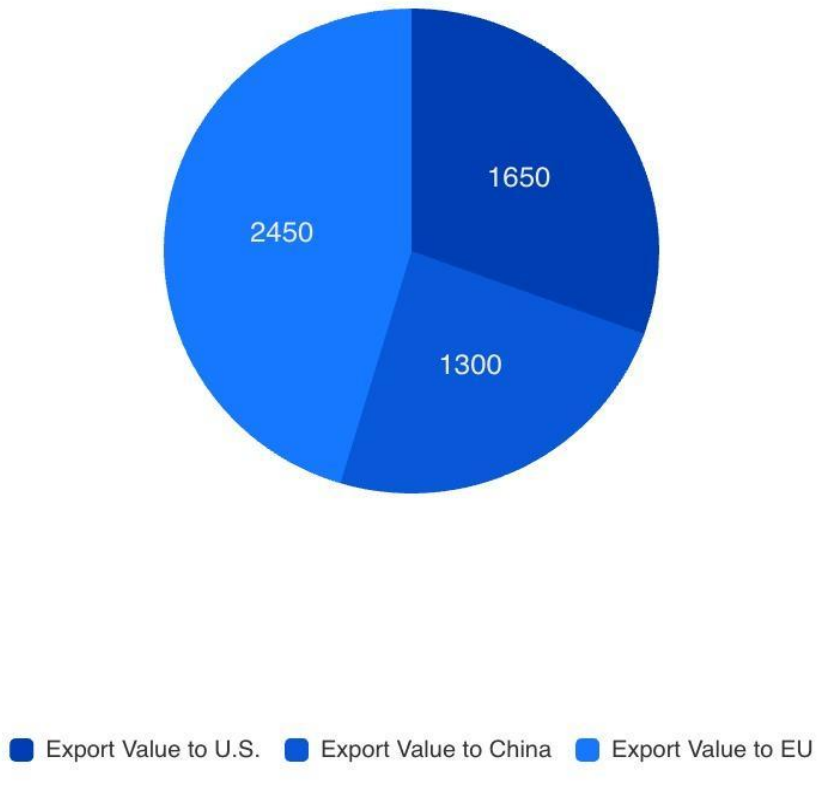
Collective Call for Dialogue

Countries advocate for renewed diplomatic discussions to address trade grievances, aiming to restore trust and promote a collaborative approach to international trade relations.

The Silence of Some Nations

India's Strategic Silence

India's muted response to U.S. tariffs reflects a calculated diplomatic strategy aimed at preserving vital trade negotiations and economic ties, highlighting the complexities of balancing national interests with global trade dynamics.



Analyzing India's Cautious Stance

01

Bilateral Trade Negotiations

India's cautious response aims to protect ongoing trade talks with the U.S. for mutual economic benefits.

02

Economic Dependency Awareness

Retaliation risks jeopardizing India's export-driven sectors, crucial for economic stability and growth.

03

WTO Dispute Mechanism Limitations

India's silence reflects a lack of confidence in the WTO's ability to resolve trade disputes effectively.

Section 4

The Role of International Trade Law

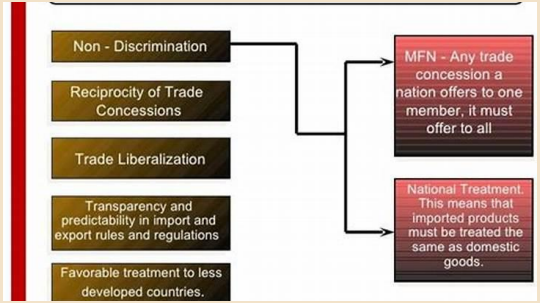
Understanding WTO Regulations

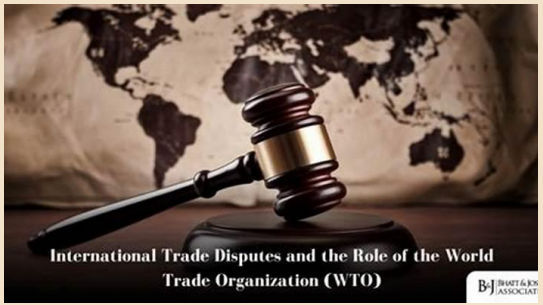
WTO's Role in Trade

The World Trade Organization facilitates negotiations and agreements among member countries, ensuring that trade flows as smoothly and predictably as possible.

Principles of Non-Discrimination

The Most-Favored-Nation and national treatment principles prevent discrimination, promoting equal trading opportunities and fostering a level playing field in international commerce.





Dispute Resolution Mechanism

The WTO provides a structured process for resolving trade disputes, which is essential for maintaining compliance and stability in global trade relations.

The Importance of Upholding Trade Rules

Framework for Fair Trade

Compliance with established norms reduces the likelihood of trade disputes, promoting peaceful resolutions and maintaining international economic relations.

Collective Commitment to Multilateralism

A unified approach among nations to uphold trade rules strengthens the integrity of global trade systems and encourages cooperative economic practices.

Mitigating Trade Conflicts

Adhering to trade rules ensures equitable competition, fostering economic growth and stability among nations in the global

Section 5

The Global Call for Trade Multilateralism

Building a Coalition Against Unilateral Actions

Strengthening Global Alliances

Countries should prioritize forming strategic partnerships to collectively address unilateral trade actions, enhancing their bargaining power in international negotiations and forums.

Advocating for Fair Trade Practices

A unified front among nations can effectively challenge unilateral tariffs, promoting adherence to international trade laws and fostering a more equitable global trading environment.

Section 6

Conclusion

Summary of the Implications of U.S. Tariffs on Global Trade

Retaliatory Trade Measures

Affected countries have implemented counter-tariffs, escalating trade tensions and complicating international relations.

Disruption of Supply Chains

U.S. tariffs have led to significant alterations in global supply chain dynamics, affecting production and distribution.

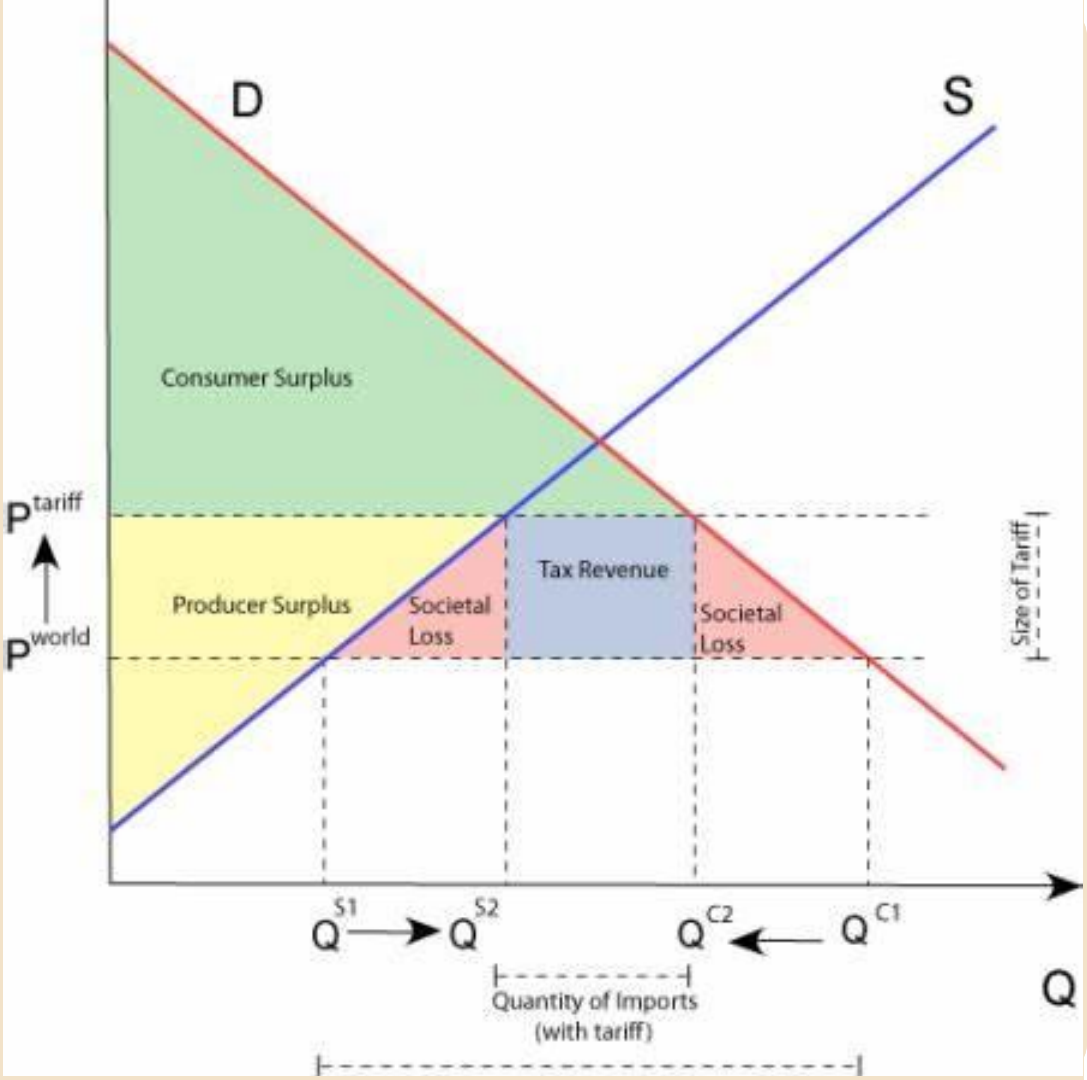
Erosion of Trade Norms

The tariffs challenge established WTO principles, potentially destabilizing the global trading system and encouraging protectionism.

The Importance of a Unified Response to Uphold International Norms

Collective Action Necessity

A unified international response is essential to counter unilateral tariff actions, ensuring adherence to global trade norms and preventing the escalation of trade conflicts that could destabilize economic relations among nations.



agreement (CEPA)

Diplomatic standoff puts India-Canada trade pact on hold

Proposed trade treaty aims to boost trade by

$6.5 bn

Talks to finalise trade pact discontinued in September

Trade pact could boost Canada's GDP to

$5.9 bn by 2035

Long-term investors not spooked, yet

Canada is among India's top foreign investors

FPIs have an exposure of ₹ 1.77 lakh crore to Indian markets

Equity exposure of ₹ 1.51 lakh crore and debt exposure of ₹ 21,443 crore

Leading investors include CPPIB, CDPQ, Ontario Teachers' Pension Plan, Brookfield

The Potential for India to Emerge as a Leader in Advocating for a Rule-Based Trading System

Economic Positioning

India's status as the fourth largest economy enhances its influence in advocating for trade reforms.

Strategic Alliances

Strengthening ties with ASEAN and EU can bolster India's leadership in promoting multilateral trade agreements.

Commitment to Transparency

Upholding WTO principles reinforces India's role as a moral authority in international trade discussions.

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