UPSC CURRENT AFFAIRS NOTES 08-04-2024

SUPERCONDUCTIVITY

On April 8, 1911, superconductivity was discovered by Dutch physicist Heike Kamerlingh Onnes.

Superconductivity is a state in which a material exhibits zero electrical resistance and the expulsion of magnetic flux when cooled below a critical temperature.

Heike Kamerlingh Onnes discovered superconductivity in 1911 in mercury.

Types of Superconductors

Type I Superconductors:

Examples: Mercury, lead, tin.

Properties: They have a single critical temperature and are typically pure metals with strong electron-phonon coupling.

Behavior: They undergo a sudden transition from normal to superconducting state and exhibit perfect diamagnetism.

Type II Superconductors:

Examples: Niobium, yttrium barium copper oxide (YBCO).

Properties: They have a complex phase diagram with multiple critical temperatures and exhibit both type I and type II behavior.

Behavior: They can support magnetic flux penetration in the form of vortices and exhibit mixed state behavior.

Basic Principles

Cooper Pairs: Superconductivity is explained by the formation of Cooper pairs, where electrons in the material form pairs due to interactions with lattice vibrations (phonons).

Zero Resistance: Superconductors offer zero electrical resistance, allowing for lossless transmission of electrical currents.

Critical temperature (TcTc): The temperature below which a material becomes superconducting.

Critical magnetic field (HcHc): The maximum magnetic field a superconductor can withstand while maintaining its superconducting state.

Critical Current Density (Jc): The maximum current density a superconductor can carry before it transitions to a resistive state.

Meissner Effect and Flux Quantization

Meissner Effect: The expulsion of magnetic field lines from the interior of a superconductor when it transitions to the superconducting state.

Flux Quantization: The quantized magnetic flux that penetrates a superconductor in the form of vortices. This flux is quantized in units of the magnetic flux quantum Φ0=h2eΦ0=2eh, where hh is Planck's constant and ee is the elementary charge.

BCS Theory of Superconductivity

Bardeen-Cooper-Schrieffer (BCS) Theory: Proposed in 1957 by John Bardeen, Leon Cooper, and Robert Schrieffer.

BCS theory explains superconductivity in terms of the formation of Cooper pairs, which are bound pairs of electrons due to electron-phonon interactions.

At low temperatures, electrons near the Fermi surface form pairs with opposite momentum and spin, leading to a macroscopic quantum state with zero resistance.

Applications of Superconductivity

Magnetic Resonance Imaging (MRI): Superconducting magnets are used to generate strong magnetic fields for medical imaging.

Power Transmission: Superconducting cables can carry electricity with minimal loss, leading to more efficient power transmission over long distances.

Quantum Computing: Some quantum computing architectures utilize superconducting qubits due to their long coherence times and ease of manipulation.

Magnetic Levitation (Maglev): Superconductors are used in magnetic levitation trains for frictionless transportation.

Particle Accelerators: Superconducting materials are used in particle accelerators like the Large Hadron Collider (LHC) to generate powerful magnetic fields for accelerating and steering charged particles.

Superconducting Quantum Interference Devices (SQUIDs): Sensitive magnetic field detectors used in various scientific and medical applications, including biomagnetic imaging and materials testing.

High-Temperature Superconductors (HTS)

High-temperature superconductors were discovered in the late 1980s, initially in copper-based compounds like YBCO.

These materials exhibit superconductivity at significantly higher temperatures compared to traditional superconductors.

HTS materials have potential applications in power transmission, magnetic levitation, and medical imaging due to their higher critical temperatures.

High Temperature Superconductors: Efforts are ongoing to discover or engineer materials that exhibit superconductivity at higher temperatures, which would make practical applications more feasible.

Fabrication Techniques: Developing cost-effective fabrication techniques for superconducting materials and devices is crucial for widespread adoption.

Understanding Unconventional Superconductivity: Many superconducting materials exhibit unconventional behavior not fully explained by BCS theory, and further research is needed to understand and harness these properties.

High-Temperature Superconductors (HTS)

Discovery: In 1986, IBM researchers discovered high-temperature superconductivity in copper-based compounds, sparking immense interest.

Operate at temperatures above the boiling point of liquid nitrogen, making them more practical for applications.

Examples include Yttrium barium copper oxide (YBCO) and Bismuth strontium calcium copper oxide (BSCCO).

Ongoing Research

Iron-Based Superconductors: A class of superconductors discovered in 2008, offering different properties and potential applications compared to conventional superconductors.

Topological Superconductors: These exotic materials, which may host Majorana fermions, are being investigated for applications in quantum computing and fault-tolerant quantum information processing.

SOUTHERN OCEAN

Scientists found that the Southern Ocean's clean air results from reduced winter sulphate production, along with the cleansing effect of clouds and rain, particularly from open honeycomb clouds, enhancing climate modelling and improving air quality.

Details

The Southern Ocean, a vast and remote stretch of water encircling Antarctica, has long been recognized for having the cleanest air on Earth. However, the specific reasons behind this remarkable phenomenon remained secret. Recent scientific advancements have finally unlocked this mystery, revealing an interplay between clouds, rain, and a unique cloud formation – the honeycomb cloud.

Beyond the Absence of Human Activity

While the limited human presence in this region naturally translates to less industrial pollution from burning fossil fuels or using chemicals, it's not the sole contributor.

Natural sources like sea spray, tiny airborne droplets produced by crashing waves, and wind-whipped dust particles add their own share of fine particles, known as aerosols, to the atmosphere. Regardless of their origin, these aerosols are detrimental to air quality. The goal is to minimise their presence for truly clean air.

Rainfall's Role in Purification

Research has brought to light the crucial role clouds and rain play in purifying the Southern Ocean's atmosphere.

Unlike other parts of the world, the Southern Ocean experiences occasional, short-lived rain showers with exceptional intensity.

Honeycomb Clouds

With the new generation of satellites offering high-resolution images, researchers were able to identify distinct **honeycomb patterns within the cloud formations across the vast expanse of the Southern Ocean**. These honeycomb clouds hold immense significance for regulating Earth's climate.

When a honeycomb cell is filled with clouds, creating a "closed" state, it appears whiter and brighter. This characteristic allows it to **reflect more sunlight back into space, contributing to a cooler Earth.**

Empty, or "open," honeycomb cells might seem less cloudy in satellite imagery, but here's the surprising twist: they are linked to cleaner air. These open cells are packed with more moisture, leading to significantly **heavier rain showers compared to their closed counterparts**. These intense downpours effectively "wash out" the aerosol particles from the air, acting as a natural air scrubber.

Another interesting observation is that **open honeycomb clouds are more prevalent during winter months**. This neatly coincides with the period when the Southern Ocean boasts its cleanest air. Scientists believe large-scale weather systems influence the formation of these open and closed honeycomb patterns.

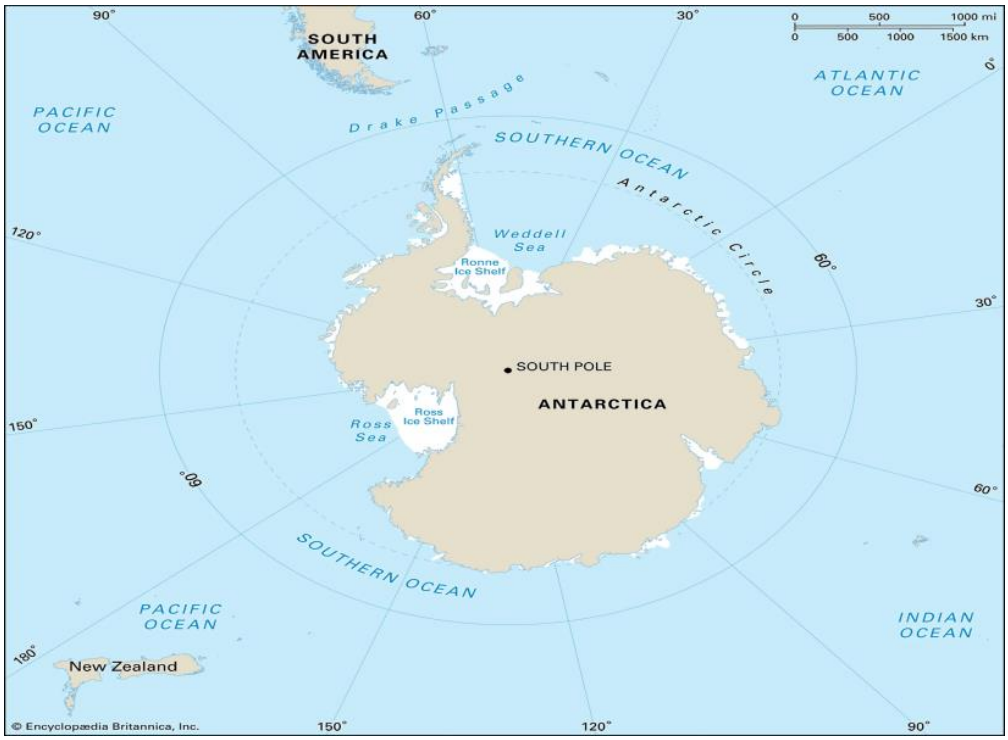
Southern Ocean

The Southern Ocean, also known as the Antarctic Ocean, is a vast body of water encircling Antarctica. It holds the distinction of being the world's second-smallest ocean.

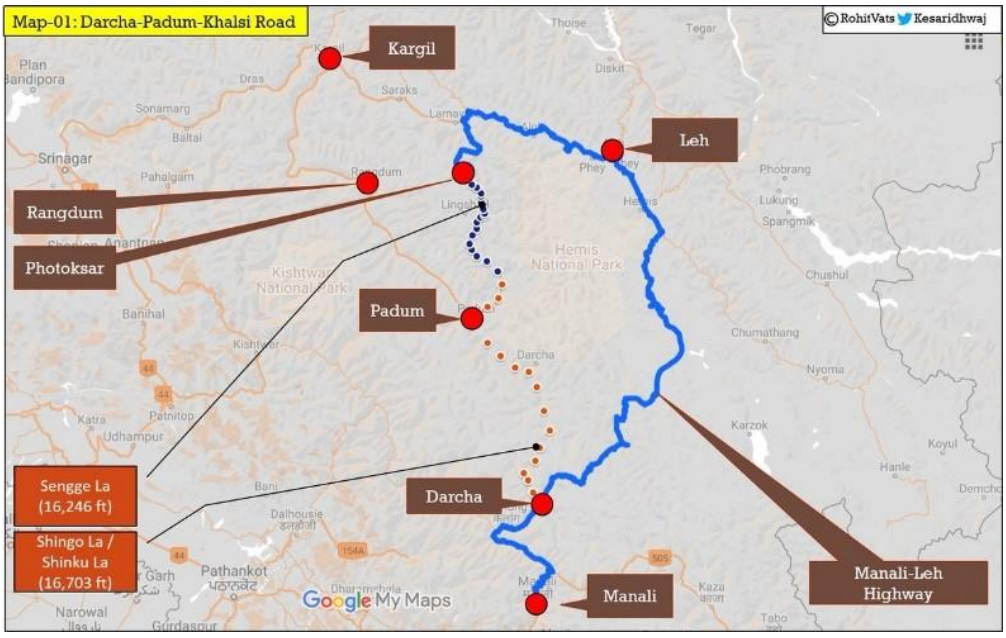
It was formed around 34 million years ago when Antarctica and South America drifted apart, creating the Drake Passage.

Occupying the southernmost waters of the Earth, the Southern Ocean generally stretches south of 60 degrees latitude.

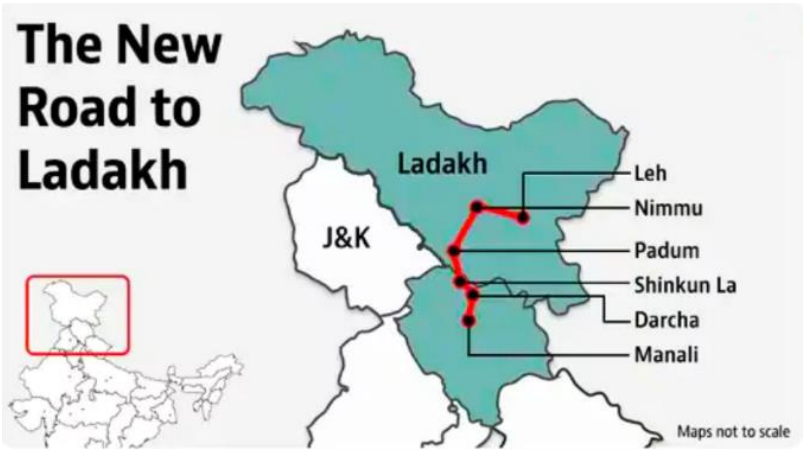
This ocean plays a vital role in regulating Earth's climate through a process called overturning circulation. Similar to the Atlantic Meridional Overturning Circulation (AMOC), this circulation helps move heat around the globe.



NIMMU-PADAM-DARCHA ROAD



By establishing connectivity on the 298-km Nimmu-Padam-Darcha road in Ladakh, the Border Roads Organisation (BRO) has accomplished a significant milestone.



The Road

The road that connects Nimmu, Padam, and Darcha has only one pass, ShinkunLa, which is 16,558 feet high.

As part of the Kargil–Leh highway, the road will pass through Darcha and Nimmu and offer all-weather access to Leh.

The road starts 35 kilometres before Leh, at Nimo on the Leh-Srinagar highway.

The Nimmu-Padam-Darcha road connects Manali to Leh via Darcha and Nimmu on the Kargil-Leh highway.

The Nimmu-Padam-Darcha road derives its strategic importance from the fact that it is not only shorter vis-a-vis the other two axes, but crosses only one pass; Shinkun La (16,558 feet) on which tunnel work is about to commence by the BRO. The road is quicker and more effective.

This 298-km road is now the third axis apart from Manali-Leh and Srinagar-Leh which connects Ladakh to the hinterland.

In addition to the current Manali-Leh and Srinagar-Leh routes, this road will serve as the third axis through the strategically important area.

This will reduce dependence on airways during the colder months, and will facilitate movement of Army personnel.

Bengaluru and Cape Town

With Bengaluru facing severe water shortage, many have compared the city's predicament to Cape Town's in 2015-18.

Causes of the water shortage in banglururu

Low rainfall

The crisis in Bengaluru is caused by scanty rainfall in the Cauvery basin — which accounts for 60% of the city's water supply — and the depletion of its groundwater reserves.

Like in Cape Town, Bengaluru's water reservoirs have fallen to critically low levels due to this.

Urbanization

Beyond low rainfall, rapid, unplanned urbanization has played a significant role in the crisis in both Cape Town and Bengaluru.

As the city expanded, existing water infrastructure (reservoirs, pipelines, and treatment plants) struggled to keep up with demand. This strain then resulted in leaks and other problems and led to inefficient water use.

Concretization of floors

As concrete covered increasing swathes of land, groundwater levels fell drastically, with replenishment not keeping up with consumption.

Inadequate Infrastructure

The city's infrastructure, including water supply systems and sewage networks, has not kept pace with its rapid growth. This inadequacy exacerbates the challenges of distributing water efficiently to meet the demands of the expanding population.

The anticipated completion of Phase-5 of the Cauvery project, designed to provide 110 liters of drinking water daily to 12 lakh people, is expected by May 2024.

Destruction of water bodies

In the 1800s, the city had 1,452 water bodies, with roughly 80% of its area covered in greenery. Now, only 193 water bodies remain, and green cover is below 4%.

With tech parks, gated communities, and high-rise apartments covering the once-green stretch of land, simply not enough water is percolating underground.

Mismanagement and Inequitable Distribution

Inefficient water management practices, including wastage, leakage, and unequal distribution of water resources, contribute to the severity of the water scarcity crisis, with some areas receiving inadequate or irregular water supply.

Government Schemes To Tackle The Groundwater Crisis in India

MGNREGA: Supports water conservation through rural employment.

Jal Kranti Abhiyan: Raises awareness on water conservation.

National Water Mission: Promotes sustainable water management.

Atal Bhujal Yojana (ABHY): Improves groundwater management.

Jal Jeevan Mission (JJM): Aims to provide tap water to rural households.

National Mission for Clean Ganga (NMCG): Addresses Ganga basin groundwater issues.

Case of The Cape Town water crisis

Cape Town faced a serious water shortage between 2015 and 2018, which peaked around 2017. It was characterized by critically low levels of water in the city's reservoirs, threatening to completely exhaust the city's water supply, and forcing authorities to implement strict water-rationing measures.

The scarcity was such that the prospect of "Day Zero" — the day when municipal authorities would effectively cut water supply due to empty reserves, and residents would have to queue up for a daily ration of water — defined life in the city. This would have made Cape Town the first major city in the world to "run out" of water.

The crisis was caused by a prolonged period of below-average rainfall, resulting in a drought across the Western Cape. This resulted in the water levels in Cape Town's reservoirs dropping significantly. A rapidly growing population, unplanned urbanization, and inefficient water-use practices further strained the city's water supply.

Like in Cape Town, Bengaluru's poor are the worst hit in the crisis, with increased health risks arising due to the lack of water for sanitation and hygiene

purposes. Images of residents queuing up to collect water from public taps and tankers have dominated the news in Bengaluru this year, just as they had during the Cape Town crisis.

Efforts taken to resolve the water crisis?

The Bengaluru Water Supply and Sewerage Board (BWSSB) has banned the use of potable water for washing cars, gardening, swimming pools, construction activities, road maintenance, entertainment, etc. The board has announced a penalty of Rs 5,000 for violators.

The Karnataka government has banned the use of drinking water for gardening and other purposes.

It has ordered a supply of water in huge tankers to Bengaluru from adjoining towns.

A substantial budget of Rs 131 crore is allotted by civil bodies for drilling borewells in priority zones.

To control water prices, all private water tankers and borewells are instructed to register with the BWSSB.

In the 2024-2025 budget speech, CM Siddaramaiah announced that the BWSSB would start Phase 5 of the Cauvery project, aiming to provide 110 liters of drinking water daily to 12 lakh people. The project is expected to be completed by May 2024.

Karnataka Water Policy 2022 suggested strategies like recycling, re-use of treated wastewater and rainwater harvesting, industrial water use planning, and other such measures.

Status of the water crisis in India as per NITI Aayog

The NITI Aayog report projected the country's water demand to be twice the available supply by 2030, implying severe scarcity for hundreds of millions of people and an eventual loss in the country's GDP.

The rate of depletion of groundwater in India during 2041-2080 will be thrice the current rate with global warming, according to a new report.

Across climate change scenarios, the researchers found that their estimate of Groundwater Level (GWL) declines from 2041 to 2080 is 3.26 times current

depletion rates on average (from 1.62-4.45 times) depending on the Climate model and Representative Concentration Pathway (RCP) scenario.

Gender Disparity in Labour Force Participation

The recently released India Employment Report, 2024, by the Institute for Human Development and the International Labour Organization highlights improvements in key labour market indicators in recent years.

The Labour Force Participation Rate (LFPR), Workforce Participation Rate (WPR), and Unemployment Rate (UR) demonstrated long-term deterioration between 2000 and 2019 but showed signs of improvement thereafter, despite challenges posed by economic distress, including the COVID-19 pandemic.

Despite overall improvements, the female LFPR remains significantly lower compared to male counterparts. In 2023, the male LFPR stood at 78.5, while the female LFPR was only 37.

This disparity is pronounced when compared to the global average female LFPR rate of 49, as reported by the World Bank.

Historical Trends and Modest Improvements

The female LFPR had been steadily declining since 2000, reaching a low of 24.5 in 2019 before showing slight improvement, particularly in rural areas.

However, the authors note that despite these modest gains, employment conditions for women continue to be challenging.

Analysis by Azim Premji University

Amit Basole, an Economics professor at Azim Premji University and head of the Centre for Sustainable Employment, sheds light on the increase in labour force participation, primarily in rural areas and self-employment, which often entails unpaid work.

He attributes this trend to distress resulting from the economic slowdown preceding COVID-19 and the pandemic itself.

Increase in Self-Employment and Unpaid Family Work

The India Employment Report highlights that women account for a significant portion of the increase in self-employment and unpaid family work.

Following 2019, nearly two-thirds of incremental employment comprised self-employed workers, with unpaid family workers, primarily women, dominating this segment.

Meanwhile, the share of regular employment, which had been steadily increasing since 2000, started declining after 2018.

Youth Employment Challenges in South Asia

Global Trends

Globally, the rate of youth not in employment, education, or training (NEET) has consistently been highest in South Asia, averaging 29.2% between 2010 and 2019 according to the International Labour Organization (ILO) 2022 report.

Indian Scenario

India also grapples with a significant share of youth NEET, with rates higher among young women compared to men.

This trend underscores the challenges young women face in accessing employment, education, or training opportunities.

Addressing these disparities is crucial for fostering inclusive economic growth and empowerment of young women in India.

Overview of Barriers

Economists and women's rights experts identify various barriers hindering women's participation in careers or jobs.

These barriers encompass a range of factors, including a lack of job opportunities, disproportionate caregiving responsibilities at home, low wages, patriarchal mindsets, and safety concerns.

Insights from Jayati Ghosh's Analysis

In her 2022 book, "The Making of a Catastrophe: The Disastrous Economic Fallout of the COVID-19 Pandemic in India," Jayati Ghosh notes a sharp decline in women's labour participation between 2004 and 2018.

Ghosh suggests that while some of this decline could be attributed to increased involvement in education, especially among young women, overall scarcity of paid work appears to be a significant factor contributing to women leaving the labour market.

Supply and Demand Side Factors

Analysis by Prof. Basole

Basole emphasizes both supply and demand side reasons for the decline in women's Labour Force Participation Rate (LFPR).

On the demand side, India's growth pattern has not been job-intensive, combined with social norms restricting women's mobility and confining them to caregiving roles at home.

Concerns over public safety and lack of transportation further limit women's options in seeking employment.

Insights from Claudia Goldin's Research

Claudia Goldin's research, recognized with the 2023 Economics Nobel Prize, highlights various factors influencing the supply and demand for female labour.

These include opportunities for balancing paid work and family responsibilities, educational decisions, technological innovations, laws, norms, and economic structural transformations.

Goldin's insights underscore the persistent limitations imposed on women's choices by marriage and domestic responsibilities.

Recommendations for Change

Intervention on Demand and Supply Side

Economists advocate for interventions addressing both demand and supply sides of the labour market.

Basole suggests policies promoting labour-intensive sectors and public investments in safety, transport, and affordable childcare and eldercare.

These interventions aim to create an enabling environment for women to participate in the workforce and access better-paying opportunities.