

SUMMARY OF DOWN TO EARTH

[1-15 DECEMBER, 2024]



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SUBJECTIVE QUESTIONS

MCQS

ANTHROPOCENE EPOCH

Context

- 2024 is the year that marks the beginning of the time of climate change, when:
 - each day some part of the world is hit by extreme weather events;
 - a new record of heat or cold stress is made and then broken;
 - communities already living on the margins of survival are devastated to the point of being unable to recover from the frequent disasters.
- Scientists describe this as the Anthropocene Epoch, which in geological time is defined as the period when human activities have significant impacts on the planet's climate and ecosystems.

| Eons | Era | Period | Epoch | Age/ Years Before Present | Life/ Major Events |
|------------------------|--|------------------------------------|--|--|-------------------------------------|
| | | Quaternary | Holocene Pleistocene | 0 - 10,000 10,000 - 2 million | Modern Man Homo Sapiens |
| | Cenozoic (From 65 million years to the present times) | Tertiary | Pliocene | 2 - 5 million | Early Human Ancestor |
| Miocene | | | 5 - 24 million | Ape: Flowering Plants and Trees | |
| Oligocene | | 24 - 37 million | Anthropoid Ape | | |
| Eocene Palaeocene | | 37 - 58 Million 57 - 65 Million | Rabbits and Hare Small Mammals : Rats - Mice | | |
| | Mesozoic 65 - 245 Million Mammals | Cretaceous | | 65 - 144 Million | Extinction of Dinosaurs |
| Jurassic | | | 144 - 208 Million | Age of Dinosaurs | |
| Triassic | | | 208 - 245 Million | Frogs and turtles | |
| | Palaeozoic 245 - 570 Million | Permian | | 245 - 286 Million | Reptile dominate-replace amphibians |
| Carboniferous | | | 286 - 360 Million | First Reptiles: | |
| | | Devonian | | 360 - 408 Million | Vertebrates: Coal beds |
| Silurian | | | 408 - 438 Million | Amphibians | |
| Ordovician Cambrian | | | 438 - 505 Million 505 - 570 Million | First trace of life on land: Plants First Fish No terrestrial Life : Marine Invertebrate | |

About the Anthropocene Epoch

- It is defined by markers of **human activity** — including fossil - fuel emissions — that have altered Earth.
 - The term ‘**Anthropocene**’ refers to the current geological time interval, in which human activity is driving Earth’s conditions and processes.
- **Anthropocene Working Group (AWG)**, a committee of scientists formed by the **International Commission on Stratigraphy (ICS)**, has been working to formally define the Anthropocene epoch.

Origins and Definition

- The term “Anthropocene” was **popularized by Nobel Prize-winning atmospheric chemist Paul Crutzen in 2000**.
- He suggested that the Anthropocene began in the late 18th century with the onset of the **Industrial Revolution**, which marked a significant increase in human activities affecting the Earth’s systems.
- This period saw the rise of fossil fuel consumption, deforestation, and significant changes in land use, all contributing to global environmental changes.

Human Impact on the Planet

- **Climate Change:** The burning of fossil fuels has led to a significant increase in greenhouse gases, causing global temperatures to rise and altering weather patterns.

Earth’s Geologic Time Scale

- The geologic time scale provides the official framework for our understanding of **Earth’s 4.5 billion-year history**.
- Geoscientists use the **Geologic Time Scale (GTS)** to measure the history of the planet. The GTS (since the formation of Earth, roughly 4.54 billion years ago) is divided, in descending order of duration, into **Eons, Eras, Periods, Epochs and Ages**.
 - For example, we currently live in the **Meghalayan Age**. It’s part of the **Holocene Epoch**, which began at the end of the last ice age 11,700 years ago, when ice caps and glaciers began retreating.
- The **Holocene is part of the Quaternary Period**, the most recent division of the **Cenozoic Era**, which in turn is part of **Phanerozoic Eon** — which spans from 539 million years ago to the present.

- **Biodiversity Loss:** Human activities such as deforestation, habitat destruction, and pollution have led to a rapid decline in biodiversity, with many species facing extinction.
- **Pollution:** The proliferation of plastics, chemicals, and other pollutants has contaminated air, water, and soil, affecting ecosystems and human health.
- **Urbanization:** The expansion of urban areas has transformed landscapes, affecting natural habitats and contributing to environmental degradation.

Debate on Formal Recognition

- Despite the clear evidence of human impact, the proposal to formally recognize the Anthropocene as a new epoch was rejected.
- The **main reasons** for this decision include the difficulty in defining a precise start date and the challenge of identifying a global marker that signifies the beginning of this epoch.
- The proposed start date of 1952, marked by radioactive fallout from hydrogen bomb tests, was seen as too narrow and not representative of the broader and longer-term human impacts on the planet.

EXTREME WEATHER EVENTS

Context

- 2024 witnessed a record number of attributions studies that show climate change as the key factor behind extreme weather events.

About

- Extreme weather events have become a significant global concern, posing severe risks to human life, infrastructure, and ecosystems.
- These events, driven by climate change, include *heatwaves, floods, droughts, hurricanes, and wildfires*.
- The frequency and intensity of these events have increased dramatically, highlighting the urgent need for comprehensive climate action.

Rising Frequency of Extreme Weather Events

- Recent reports indicate a sharp rise in the occurrence of extreme weather events worldwide.
- According to the **World Economic Forum's Global Risks Report 2024**, extreme weather events are among the most severe global risks over the next decade.
- This trend is evident in countries like India, which experienced extreme weather on 235 out of 273 days in 2023.
- The increasing frequency of these events underscores the escalating impact of climate change.

Impact on Human Life and Infrastructure

- The human and economic toll of extreme weather events is staggering. In India alone, deaths due to extreme weather rose by 18% over three years, with significant damage to crops and property.
- In 2024, extreme weather events affected 3.2 million hectares of cropped land and destroyed over 235,000 houses.
- These events not only disrupt daily life but also strain emergency services and infrastructure, leading to long-term socio-economic challenges.

Climate Change as a Driving Force

- Climate change is the primary driver behind the increasing severity and frequency of extreme weather events.
- The warming of the planet, driven by greenhouse gas emissions, has altered weather patterns, making extreme events more common and intense.
- For instance, the El Niño phenomenon, which is expected to persist until mid-2024, has been linked to record-breaking heatwaves, droughts, and floods.

Regional Disparities and Vulnerabilities

- The impact of extreme weather events is not uniform across the globe. Developing countries and vulnerable communities are disproportionately affected due to their limited capacity to adapt and respond.

- In India, states like Madhya Pradesh and Kerala have seen a significant rise in extreme weather days, leading to higher mortality rates and greater economic losses.
- These disparities highlight the need for targeted climate adaptation and resilience-building measures.

Path Forward

- Addressing the challenge of extreme weather events requires a multi-faceted approach. Mitigation efforts, such as reducing greenhouse gas emissions, are crucial to slowing down climate change.
- Simultaneously, adaptation strategies, including building resilient infrastructure, improving early warning systems, and enhancing community preparedness, are essential to minimize the impact of these events.

HEATWAVES & CLIMATE CHANGE

Context

- Almost all studies on heatwaves say such events will be more severe and more likely to occur with climate change.

About

- Heatwaves are becoming increasingly frequent and severe across the globe, posing significant risks to human health, ecosystems, and economies.
- It is closely linked to climate change, which exacerbates the intensity and duration of heatwaves.

Science Behind Heatwaves

- Heatwaves are prolonged periods of excessively hot weather, which may be accompanied by high humidity.
- They are typically defined relative to the usual weather in the area and the time of year.
- Climate change, driven by human activities such as burning fossil fuels and deforestation, has led to an increase in global temperatures.
- This warming trend enhances the likelihood of extreme heat events.

Impact on Human Health

- Heatwaves pose severe health risks, particularly to vulnerable populations such as the elderly, children, and those with pre-existing health conditions.
- High temperatures can lead to heat exhaustion, heatstroke, and even death. For instance, India has experienced over 24,000 heatwave-related deaths since 1992.
- The 2022 heatwave in India, which was one of the hottest years on record, put 90% of the population at increased risk of hunger, income loss, or premature death.

Economic and Social Consequences

- Heatwaves can reduce labor productivity, increase energy demand, and strain water resources.
- In India, failure to implement effective heat action plans could cost the country up to 8.7% of its GDP by 2100.
- Additionally, heatwaves can exacerbate social inequalities, as those with fewer resources are less able to cope with extreme temperatures.

Environmental Effects

- Heatwaves can lead to droughts, wildfires, and loss of biodiversity.
- Marine heatwaves, for example, are becoming more frequent and intense, particularly in climate change hotspots like the Indian Ocean.
- These events can devastate marine ecosystems and the communities that depend on them.

Mitigation and Adaptation Strategies

- To mitigate the effects of heatwaves, it is crucial to address the root cause: climate change.
- It involves reducing greenhouse gas emissions through the adoption of renewable energy sources, enhancing energy efficiency, and protecting forests.
- Additionally, cities can implement heat action plans, which include measures such as creating cooling centers, improving urban green spaces, and raising public awareness about heat risks.

COLD SPELLS AND CLIMATE CHANGE

Context

- Cold spells will still occur but will be less frequent with climate change, risking preparedness.

About

- Climate change is often associated with rising temperatures and heatwaves, but it also plays a significant role in the occurrence and intensity of cold spells.
- This paradoxical relationship between global warming and extreme cold events is a topic of growing interest and concern among scientists and policymakers.

Understanding Cold Spells

- Cold spells, or periods of unusually low temperatures, can have severe impacts on human health, agriculture, infrastructure, and ecosystems.
- These events are typically driven by disruptions in atmospheric patterns, such as the polar vortex, which can bring frigid Arctic air to lower latitudes.

Climate Change and Cold Spells

- While it may seem counterintuitive, climate change can increase the frequency and severity of cold spells.
- This phenomenon is linked to the destabilization of the polar vortex, a large area of low pressure and cold air surrounding the Earth's poles.
- As the Arctic warms at a faster rate than the rest of the planet, the temperature gradient between the poles and the equator weakens, leading to a more unstable polar vortex.
- This instability can cause cold Arctic air to spill southward, resulting in extreme cold events in regions that are not typically accustomed to such temperatures.

Recent Examples

- In January 2024, northern Europe experienced one of its coldest spells in decades, with temperatures in

Sweden and Finland plummeting to levels not seen in 25 years.

- Similarly, the United States has faced several severe cold snaps in recent years, disrupting daily life and causing significant economic damage.

Scientific Evidence

- Attribution studies have become a crucial tool in understanding the link between climate change and extreme weather events.
- These studies use climate models to assess the likelihood of an event occurring in a world without human-induced climate change.
- Recent rapid attribution studies have shown that climate change has increased the frequency and intensity of extreme weather events, including cold spells.

MOISTURE: SILENT FORCE AMPLIFYING GLOBAL WARMING

Context

- Moisture is a silent force that amplifies global warming. Yet scientists understand little about this greenhouse gas and how it influences weather systems.

About

- **Moisture**, in the form of **water vapor**, is a **potent yet often overlooked greenhouse gas**.
- Air can hold **7 percent more moisture for every 1°C rise in temperature**. With global temperatures 1.1°C higher than pre-industrial levels, this increased moisture traps more heat and intensifies precipitation.
- Despite its significant role in amplifying global warming, scientists still grapple with understanding its complex interactions within the Earth's climate system.

Additional Information

- **High Altitude Clouds:** These clouds transmit solar radiation while trapping outgoing infrared radiation, warming the Earth's surface.

- In a warming world, there are more high-altitude clouds that provide extra moisture to cyclonic storms.
- **Low Altitude Clouds:** These are thick with moisture and primarily reflect solar radiation and cool the surface of the Earth. High atmospheric moisture means more precipitation.
- As greenhouse gases (GHGs) increase, Earth's temperature rises, boosting evaporation from land and water.
 - Warmer air holds more moisture, which does not condense easily, trapping heat and further warming the atmosphere.
 - This creates a '**positive feedback loop**' where increased water vapour intensifies warming, doubling the effect of GHGs alone.

Role of Water Vapor in Global Warming

- Water vapor is the most abundant greenhouse gas in the atmosphere.
- Unlike carbon dioxide (CO₂) and methane (CH₄), which are directly emitted through human activities, water vapor enters the atmosphere primarily through evaporation from oceans, lakes, and rivers.
- As the atmosphere warms, it can hold more moisture, creating a feedback loop that exacerbates global warming.

Humidity Paradox

- One of the intriguing aspects of water vapor is the "humidity paradox."
- Specific humidity, which measures the actual amount of water vapor in the air, has increased globally due to rising temperatures.
- However, relative humidity, which measures how saturated the air is with moisture, has declined in many regions.
- This paradox highlights the complexity of moisture's role in the climate system.

Impact on Weather Systems

- Water vapor significantly influences weather patterns.
- It is a key driver of precipitation and storm formation. For instance, the unusual behavior of **Cyclone Asna in India**, which maintained its strength and moisture supply over land, perplexed scientists.
- This phenomenon underscores the need for a deeper understanding of moisture transport and recycling in the atmosphere.

Challenges in Understanding Moisture Dynamics

- Despite its importance, water vapor remains one of the least understood components of the climate system.
- The variability in moisture levels and their interactions with other atmospheric elements pose significant challenges for climate models.
- Accurate predictions of future climate scenarios depend on improving our understanding of these dynamics.

ATMOSPHERIC RIVERS: SKY'S WATERWAYS

Context

- On average, about 30-50% of annual precipitation on the west coast of the US occurs in just a few atmospheric river events and contributes to the water supply-and flooding risk.

About the Atmospheric Rivers

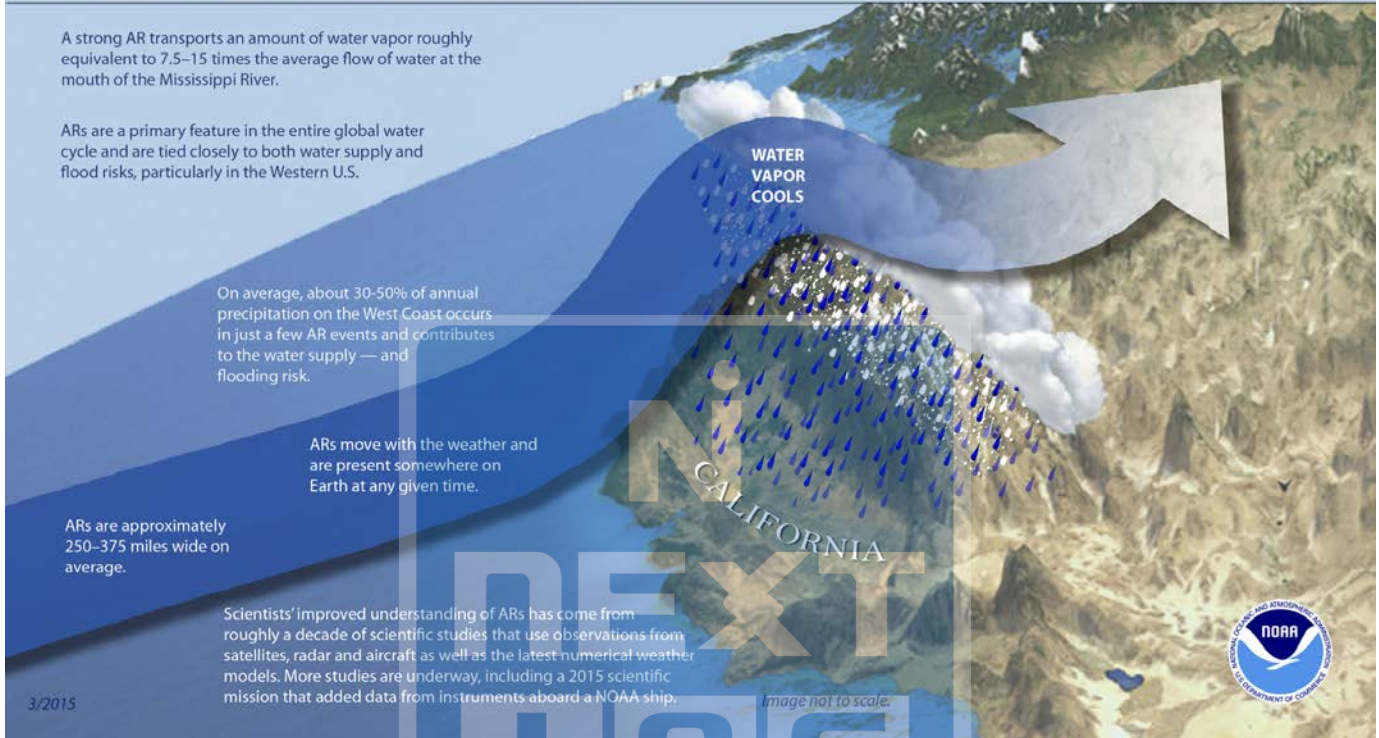
- These are long, narrow bands of concentrated moisture in the atmosphere that transport water vapor from the tropics to higher latitudes.
- These are approximately 400-600 km wide on average.
- These 'rivers in the sky' play a crucial role in the global water cycle and significantly impact weather patterns, particularly in regions like the US West Coast, Southeast Asia, and parts of Europe.

- **Pineapple Express:** A strong atmospheric river that is capable of bringing moisture from

the tropics near Hawaii over to the U.S. West Coast.

The science behind atmospheric rivers

An atmospheric river (AR) is a flowing column of condensed water vapor in the atmosphere responsible for producing significant levels of rain and snow, especially in the Western United States. When ARs move inland and sweep over the mountains, the water vapor rises and cools to create heavy precipitation. Though many ARs are weak systems that simply provide beneficial rain or snow, some of the larger, more powerful ARs can create extreme rainfall and floods capable of disrupting travel, inducing mudslides and causing catastrophic damage to life and property. Visit www.research.noaa.gov to learn more.



Formation and Characteristics

- Atmospheric rivers form when warm, moist air from the tropics is lifted into the atmosphere by weather systems such as cyclones. This air cools and condenses, forming clouds and precipitation.
- These rivers can be thousands of kilometers long and several hundred kilometers wide, carrying as much water as the Amazon River.

Impact on Weather and Climate

- Atmospheric rivers are responsible for significant rainfall and snowfall events. For example, they contribute to up to 50% of California's annual precipitation.
- While they are essential for replenishing water supplies, they can also cause severe flooding and landslides when they make landfall.

Poleward Shift and Climate Change

- Recent studies have shown that atmospheric rivers are shifting poleward due to climate change.
- This shift is altering weather patterns globally, leading to more intense droughts in some regions and increased flooding in others.
- The movement of these rivers towards the poles is also affecting sea ice melt in the Arctic, further influencing global climate systems.

EXTREME RAINFALL

Context

- Studies that link extreme rain events with climate change have risen in 2015-24.

About

- Extreme rainfall events are becoming increasingly frequent and intense across the globe, posing significant challenges to communities, economies, and ecosystems.

Causes of Extreme Rainfall

- Extreme rainfall is primarily driven by climate change, which alters weather patterns and increases the atmosphere's capacity to hold moisture. Key factors include:
 - **Global Warming:** Rising temperatures lead to more evaporation and, consequently, more moisture in the atmosphere. This can result in heavier and more prolonged rainfall events.
 - **Atmospheric Circulation Changes:** Shifts in atmospheric circulation patterns, such as the jet stream, can lead to more frequent and intense storms.
 - **Urbanization:** Increased urbanization contributes to the urban heat island effect, which can enhance local rainfall intensity.

Impacts of Extreme Rainfall

- **Flooding:** Heavy rainfall can overwhelm drainage systems, leading to urban and rural flooding. This can cause significant damage to infrastructure, homes, and agricultural lands.
- **Landslides:** In hilly and mountainous regions, intense rainfall can trigger landslides, posing risks to human life and property.
- **Agricultural Damage:** Crops can be destroyed by excessive water, leading to food shortages and economic losses for farmers.
- **Health Risks:** Floodwaters can spread waterborne diseases, posing serious health risks to affected populations.

Case Study: India

- According to a report by Down To Earth and the Centre for Science and Environment, India saw a disaster nearly every day in the first nine months of 2023, with heavy rains, floods, and landslides being significant contributors.

- The report highlights that these events have caused substantial loss of life, damage to crops, and destruction of property.
- In 2024, the frequency and intensity of extreme weather events, including heavy rainfall, continued to rise.
 - The analysis showed that India experienced extreme weather on 255 out of 274 days in the first nine months of the year.
 - It underscores the urgent need for effective climate action and disaster preparedness.

Responses to Extreme Rainfall

- **Improved Forecasting:** Enhancing weather forecasting capabilities can provide early warnings and help communities prepare for extreme rainfall events.
- **Infrastructure Resilience:** Investing in resilient infrastructure, such as improved drainage systems and flood barriers, can mitigate the impacts of heavy rainfall.
- **Sustainable Urban Planning:** Implementing sustainable urban planning practices can reduce the urban heat island effect and improve water management.
- **Community Awareness and Preparedness:** Educating communities about the risks of extreme rainfall and promoting preparedness measures can save lives and reduce damage.

Additional Information

- **West African Monsoon:** It controls hydroclimatic conditions, vegetation and mineral-dust emissions of northern tropical and subtropical Africa, up to the dry Sahel region at the southern edge of the Sahara Desert.
 - **Warming impact:** Climate models predict increased total precipitation by 2070, with more heavy rainfall events, particularly in the eastern Sahel, driven by enhanced moisture convergence.

- It is also likely to be impacted by the northward shift of ITCZ.
- **South American Monsoon:** It accounts for the majority of rainfall across the continent. It begins in October over the Brazilian highlands. It gradually spreads northward, reaching its peak intensity between December and February, before dissipating by April.
 - **Warming impact:** Since the 1970s, there has been a delayed onset of precipitation, a trend increasingly linked to climate change. This delay is likely to worsen as global temperatures continue to rise, disrupting the delicate balance of atmospheric and oceanic conditions that drive the monsoon.
- **Western Disturbances:** These are weather systems that originate in the Mediterranean region and bring rain and snow to the Indian subcontinent and surrounding areas in the winter.
 - **Warming impact:** The warming of the Arctic and the Mediterranean Sea is weakening Western Disturbances in winter, reducing rainfall in northeast India, while increasing their frequency in summer, often interacting with the monsoon and causing floods.
- **Indian Summer Monsoon:** During the summer season over South Asia (June-September), winds from the southwest carry large amounts of water vapour from the Indian Ocean to the Indian subcontinent and cause heavy precipitation in the region.
 - **Warming impact:** Precipitation declined in the second half of the 20th century along with disruptions. Projections suggest increases in precipitation in future warming scenarios (by 5.3% per 1°C of global warming) and a longer monsoon duration.
- **La Nina:** Considered the counterpart to El Niño, it cools surface waters along South America's tropical west coast, bringing rain to Southeast Asia, Australia and Brazil, and dryness to South America's west coast and the US Gulf Coast.
 - **Warming impact:** It is likely to become more intense in a warming world.
- **El Nino:** It is a climate pattern marked by unusual warming of surface waters in the eastern tropical Pacific, weakening westward trade winds. It brings rains to South America, dry and warm weather to the northern US and Canada and droughts to Indonesia and Australia.
 - **Warming impact:** A warmer atmosphere holds more moisture, so when El Niño events lead to conditions that favour enhanced precipitation in a particular region, it can rain even harder.
 - Likewise, warming trends can lead to soil moisture deficits that help to intensify El Niño-related drought development.
- **Inter-Tropical Convergence Zone (ITCZ):** A low-pressure zone near the equator where hemispheric winds meet, it drives monsoons.
 - **Warming impact:** Increased atmospheric moisture drives vertical air movement by steepening the moist static energy gradient, narrowing the ITCZ. It is also seeing a northward shift, driven by sea surface temperature gradients.
 - This is causing droughts over the maritime continent and devastating floods in southern India.
- **Atmospheric Rivers:** Long, narrow corridors of moisture in subtropical areas that transport water from the tropics to higher latitudes. Responsible for the bulk of the rains in western US.
 - **Warming impact:** They have grown longer, wider and more intense, shifting 6-10 degrees poleward over the past 40 years. As a result, subtropical regions may face droughts, while higher latitudes, including the Arctic, are likely to experience heavier rainfall, flooding, and accelerated sea ice melting.

WILDFIRES: A GROWING THREAT TO ENVIRONMENT

Context

- Wildfires have become more likely in frequency and severity with climate change.

About

- Wildfires, also known as forest fires, have become an increasingly severe issue worldwide, including in India.
- These uncontrolled blazes can devastate vast areas of forest, endanger wildlife, and pose significant risks to human health and property.
- The frequency and intensity of wildfires are rising, driven by a combination of climate change, human activities, and natural factors.

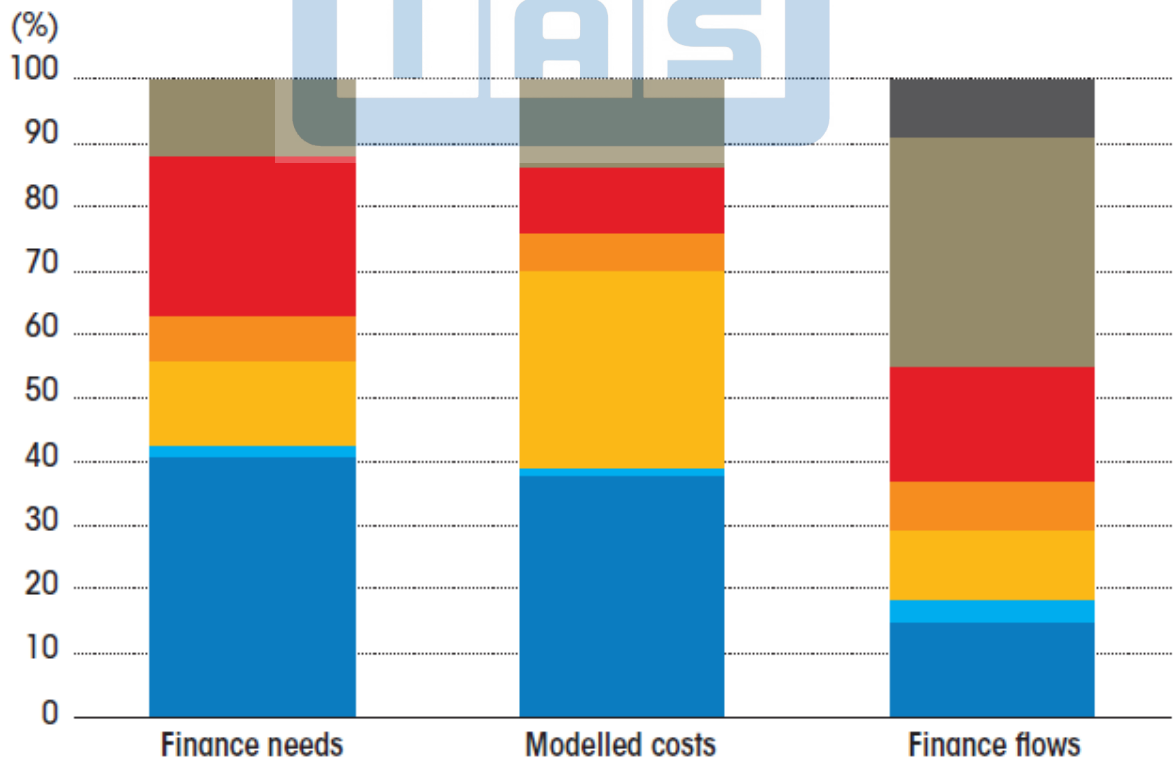
Escalating Threat

- Recent reports indicate that the probability of extreme wildfire events, similar to Australia’s 2019-2020 Black Summer, is expected to increase by 31-57% by the end of the century.
- In India, the forest fire season has already shown alarming trends. For instance, in March 2022 alone, there were around 340 incidents of fires on a single day, with 1,141 large forest fires continuing for several days.
- Wildfires are estimated to have destroyed over 1.3 million hectares (ha) of Brazil’s Pantanal—the world’s largest tropical wetland and a biodiversity hotspot—by August 2024.

AT THE 11TH HOUR

The 2024 Adaptation Gap Report shows a humongous gap between developing countries’ adaptation needs and finance flows

Legend: ■ Unallocated ■ Sub-Saharan Africa ■ South Asia ■ Middle East (West Asia) and North Africa ■ Latin America and the Caribbean ■ Europe and Central Asia ■ East Asia and Pacific



DROUGHT

Causes and Consequences

- Wildfires are influenced by various factors, including prolonged dry spells, high temperatures, and human activities such as deforestation and land-use changes.
- The **Intergovernmental Panel on Climate Change (IPCC)** has noted that weather conditions conducive to wildfires—hot, dry, and windy—are becoming more frequent due to global warming.
- The consequences of wildfires are far-reaching. They lead to the loss of biodiversity, destruction of habitats, and release of significant amounts of carbon dioxide, contributing to climate change.
 - Additionally, wildfires can create their own weather patterns, including tornado-like fire whirls, further complicating firefighting efforts.

Regional Impact

- In India, certain regions are particularly vulnerable to wildfires. According to the Forest Survey of India, approximately 22% of the country's forest cover falls under the highly and extremely fire-prone categories.
- States like Odisha, Andhra Pradesh, Karnataka, and Madhya Pradesh have recorded numerous large forest fires, highlighting the urgent need for effective management and prevention strategies.

Mitigation and Adaptation

- Addressing the wildfire crisis requires a multifaceted approach. This includes enhancing early warning systems, improving forest management practices, and promoting community awareness and preparedness.
- Reducing greenhouse gas emissions is also crucial to mitigate the impact of climate change on wildfire frequency and intensity.

Context

- Studies that link climate change to drought have risen in the past decade.

About

- Drought is a severe and prolonged dry period that significantly impacts ecosystems, agriculture, and human societies.
- It is a complex phenomenon influenced by various factors, including meteorological, hydrological, and ecological conditions.
- As climate change intensifies, droughts are becoming more frequent and severe, posing a significant threat to global sustainability.

Causes of Drought

- **Meteorological Drought:** Caused by prolonged periods of below-average precipitation.
- **Hydrological Drought:** Occurs when water reserves in aquifers, lakes, and reservoirs fall below average levels.
- **Agricultural Drought:** Results from inadequate soil moisture, affecting crop production.
- **Ecological Drought:** Impacts ecosystems, leading to loss of biodiversity and habitat degradation.

Impact on India

- India is particularly vulnerable to droughts, with over 70% of the country experiencing drought-like conditions.
- The skewed distribution of rainfall, prolonged monsoonal breaks, and climate variability are major contributing factors.
- Droughts have severe implications for India's agriculture, water resources, and overall economy. For instance, droughts have reduced India's GDP by up to 5% over the past two decades.

Economic and Social Consequences

- The economic costs of drought extend beyond immediate agricultural losses. They disrupt entire

supply chains, reduce GDP, and lead to hunger, unemployment, and migration.

- A recent report highlighted that the economic damages from droughts are underestimated by 2.4 times, amounting to \$307 billion per year.
- Effective management and investment in nature-based solutions (NBS) are crucial to mitigate these effects.

Nature-Based Solutions

- Adopting NBS for drought mitigation can be economically beneficial. These solutions include restoring wetlands, reforesting degraded lands, and implementing sustainable agricultural practices.
- The **United Nations University Institute for Water, Environment and Health (UNU-INWEH)** estimates that NBS can generate up to \$10.1 trillion annually and create millions of jobs.
- Additionally, restoring over 2.5 billion hectares of land globally can enhance agricultural resilience and protect water resources.

DEVELOPED COUNTRIES & RESPONSIBILITIES AT COP-29

Context

- The **29th Conference of Parties (COP29)** to the UNFCCC, held in Baku, Azerbaijan, aimed to address critical issues of climate finance and emissions reduction, saw developed countries diluting their responsibilities, leaving the Global South in a precarious position.

Key Points

- The G-77 and China reject the NCQG draft, demanding \$1.3 trillion annually from developed nations.
- A revised draft is shared and accepted by the G-77 and China for further discussions. Co-chairs present a synthesised draft text to the COP Presidency G77, China, and the African Group of Negotiators call reports of a \$200–300 billion target ‘a joke’.

- A coalition of 80 countries proposes a roadmap to mobilise additional financing towards the \$1.3 trillion target.
- G77 lowers its public finance demand to \$500 billion annually. Informal meetings are held on a proposal for \$300 billion annually by 2035.
- COP29 adopts a deal for \$300 billion annually to developing countries by 2035, amid criticism over its lack of ambition and provisions.

New Collective Quantified Goal (NCQG)

- One of the central issues at COP29 was the establishment of the New Collective Quantified Goal (NCQG) on climate finance.
- This goal was intended to succeed the \$100 billion per year commitment made by developed countries in 2009 to support climate action in developing countries by 2020.
- However, the outcome fell short of expectations. The NCQG was set at \$300 billion per year by 2035, a figure significantly lower than the demands of developing countries.

Dilution of Financial Commitments

- Developed countries managed to dilute their financial commitments by including contributions from various sources, such as private, bilateral, and multilateral funds, rather than solely from public finance.
- This approach undermines the legal obligation of developed countries under Article 9.1 of the Paris Agreement to provide the entirety of the finance.
- The ambiguity in the goal’s structure raises concerns about accountability and traceability of funds, making it difficult to ensure that the promised finance will be delivered effectively.

Impact on the Global South

- The diluted commitments have severe implications for developing countries, which are already vulnerable to the impacts of climate change.
- Without adequate financial support, these nations will struggle to transition to low-carbon economies and implement necessary adaptation measures.

- The failure to secure a meaningful agreement on climate finance at COP29 represents a missed opportunity to support the Global South in addressing climate challenges.

Role of Developed Nations

- Developed countries, led by the European Union, proposed a lower target of \$1.3 trillion annually by 2035, with contributions from various sources.
- This proposal was far below the demands of developing countries, which called for \$600 billion annually in public finance from developed nations alone.
- The reluctance of developed countries to commit to higher financial targets reflects a broader trend of shirking historical responsibilities and prioritizing short-term economic interests over long-term climate goals.

Climate Finance Fund

- **Key Outcome:** Developed countries to take the lead in providing \$300 billion a year by 2035 to New Collective Quantified Goal.
 - A Baku to Belém Roadmap by COP30 to scale up the \$300 billion figure to \$1.3 trillion by 2035.
- **Gaps:** \$300 billion is an unambitious finance commitment, marginally higher than the previous \$100 billion goal, adjusted for inflation by 2035.
 - The responsibility to meet the \$1.3 trillion target has been shifted to “all actors,” instead of just developed countries.

Carbon Market

- **Key Outcome:** Rules adopted for Articles 6.2 and 6.4 after a decade of negotiations.
- **Gaps:** Adopted rules flagged as flawed, with no safeguards to prevent countries from trading in low-quality carbon credits

Mitigation and Adaptation

- **Key Outcome:** Mitigation Work Programme saw a deadlock and is on the verge of collapse

Procedural texts released on Global Goal on Adaptation and National Adaptation Plans.

- **Gaps:** No progress made on UAE dialogue on implementing Global Stocktake. Adaptation finance is far from sufficient. Adaptation Fund sees new pledges of just \$61 million against target of \$300 million

Push For Action

- The COP29 Presidency announced **14 global initiatives under its Action Agenda**, with an aim to advance climate efforts.

Sector: Defence

- **Purpose:** Reduce global military activities that contribute 5.5% of annual global emissions—higher than those of the aviation and shipping sectors combined—during the month of the conference.
- **Signatories:** 132 countries.
- **India’s position:** Signatory

Sector: Tourism

- **Purpose:** Promote sustainable tourism practices by reducing emissions and increasing resilience—ultimately positioning tourism as a key component of climate solutions
- **Signatories:** More than 60 countries
- **India’s position:** List of countries not released yet

Sectors: Energy & Industry

- **Purpose:** Endorsers commit to scale up renewable, clean/zero-emission and low-carbon hydrogen production and accelerate the decarbonisation of existing hydrogen production from unabated fossil fuels
- **Signatories:** 45 countries endorsed the declaration at COP28. No new countries added at COP29
- **India’s position:** Signatory

Sector: Reducing Methane From Organic Waste

- **Purpose:** Countries must set sectoral targets to reduce methane from organic waste within their future nationally determined contributions

- **Signatories:** 30 countries, collectively responsible for nearly half of the global methane from organic waste emissions, have endorsed the declaration.
- **India's position:** Has not endorsed the declaration

Declaration on Water For Climate Action

- **Purpose:** Countries commit to taking integrated approaches to combat the causes and impacts of climate change on water basins, paving the way for greater regional and international cooperation.
- **Signatories:** Nearly 50 countries
- **India's position:** List of countries not released yet

Declaration on Green Digital Action

- **Purpose:** To address challenges toward achieving sustainable, climate resilient and healthy cities, leveraging each sector's opportunities and technical capacities.
- **Signatories:** Endorsed by 90 countries
- **India's position:** List of countries not released yet

Declaration on Multi-Sectoral Actions Pathways (MAP) To Resilient & Healthy Cities

- **Purpose:** To serve as a strategic guide to enhance resilience and health in urban areas
- **Signatories:** Endorsed by 40 countries
- **India's position:** List of countries not released yet

needed to keep global warming within 1.5°C above pre-industrial levels.

- The frustration over the slow pace of negotiations and the lack of a unified global authority to enforce climate actions was palpable.

Key Expectations at COP-30

- **Representation and Inclusivity:** There is a push for more inclusive representation in climate negotiations.
 - It includes giving a voice to non-human entities like the Amazon rainforest, which could be a significant step forward in recognizing the rights of nature.
- **Climate Finance:** The “road to Belém” initiative established at COP29 will continue to be a major focus.
 - It involves negotiating better climate finance deals, especially for African countries, to ensure they receive adequate support for climate adaptation and mitigation.
- **Ambitious Emission Targets:** Nearly 200 countries are required to submit updated national CO₂-cutting pledges by COP30.
 - It is seen as a crucial opportunity to prevent global warming from exceeding 1.5°C, a target that is becoming increasingly challenging to meet.

COP-30 OF UNFCCC

Context

- The global community turns its attention to **COP30**, set to take place in **Belém, Brazil, in 2025**. The stakes are higher than ever, with the urgency to address climate change intensifying amidst increasing extreme weather events and rising global temperatures.

Reflections on COP29

- COP29 was marked by mixed outcomes. While some progress was made, particularly in terms of climate finance for developing countries, many felt that the summit fell short of the ambitious targets

- **Global Collaboration:** The UAE, Azerbaijan, and Brazil, as hosts of COP28, COP29, and COP30 respectively, have formed a “troika” to push for more ambitious climate goals.
 - It aims to maintain momentum and ensure that significant progress is made in global climate action.

Road to COP30

- **Enhanced Representation:** One of the critical discussions leading up to COP30 is the concept of representation.
 - Inspired by innovative methodologies from past conferences, there is a push to grant equal rights and voices to non-human entities such as

the atmosphere, oceans, and soil in climate negotiations.

- It aims to ensure that the interests of the planet are adequately represented.
- **Ambitious Emission Targets:** Nearly 200 countries are required to submit updated national CO₂-cutting pledges by COP30.
 - This round of targets is seen as a crucial last chance to prevent global warming from exceeding 1.5°C.
 - The focus will be on ensuring that these pledges are not only ambitious but also actionable and transparent.
- **Climate Finance:** Ensuring adequate climate finance for developing countries remains a priority.
 - The discussions at COP29 highlighted the need for a new global target for climate finance, which will be a significant agenda item at COP30.
- **Political Will and Global Cooperation:** The success of COP30 will heavily depend on the political will of participating countries.
 - The formation of a “troika” by the UAE, Azerbaijan, and Brazil to push for more ambitious climate goals is a positive step.
 - However, overcoming political push-back on climate policies in some countries will be a significant challenge.

Looking Ahead

- COP30 represents a pivotal moment in global climate diplomacy. With the world watching, it is imperative that the conference not only sets ambitious targets but also lays out clear, actionable plans to achieve them.
- The lessons from COP29 and the innovative approaches to representation and negotiation can provide a roadmap for a more inclusive and effective climate summit.

Prelims

STATE OF THE CLIMATE 2024: UPDATE FOR COP29

Context

- According to the World Meteorological Organization (WMO), 2024 is on track to be the hottest year on record as warming temporarily hits 1.5°C.

About the State of the Climate 2024

- As the world gathers for **COP29 in Baku, Azerbaijan**, the urgency of addressing climate change has never been more apparent.
- The **World Meteorological Organization (WMO)** has released its “**State of the Climate 2024**” report, highlighting alarming trends and the critical need for immediate action.
- It emphasizes that the ambitions of the **Paris Agreement** are in jeopardy. To limit global warming to well below 2°C, and ideally to 1.5°C, immediate and sustained efforts are required.

Record-Breaking Temperatures

- The year 2024 is on track to be the warmest year on record, with global mean surface air temperatures from January to September averaging 1.54°C above pre-industrial levels.
- It is largely **driven by a strong El Niño event**, exacerbating the long-term warming trend caused by rising greenhouse gas concentrations.

Accelerating Climate Indicators

- **Greenhouse Gas Concentrations:** Levels of carbon dioxide, methane, and nitrous oxide have reached new highs, continuing to drive global warming.
- **Ocean Heat Content:** The oceans have absorbed significant amounts of heat, contributing to sea level rise and more intense storms.

- **Sea Level Rise:** Accelerated melting of glaciers and ice sheets has led to rising sea levels, threatening coastal communities worldwide.
- **Sea Ice Extent:** Both Antarctic and Arctic sea ice extents have been well below average, with the Antarctic sea ice reaching its second-lowest extent on record.

Extreme Weather Events

- The past year has seen a surge in extreme weather events, including record-breaking rainfall, devastating floods, intense tropical cyclones, deadly heatwaves, and relentless droughts.
- These events have caused massive economic and human losses, underscoring the urgent need for robust climate adaptation and mitigation strategies.

Path Forward

- **Reducing Greenhouse Gas Emissions:** Rapid and significant cuts in emissions are essential to slow down the pace of climate change.
- **Enhancing Climate Resilience:** Strengthening climate services and early warning systems can help communities better prepare for and respond to extreme weather events.
- **Promoting Renewable Energy:** Accelerating the transition to renewable energy sources is crucial for reducing dependence on fossil fuels and lowering emissions.

STATE OF THE CRYOSPHERE 2024

Context

- The ‘State of the Cryosphere 2024’ report released at the just concluded 29th Conference of Parties (COP-29) to the UNFCCC.

About the State of the Cryosphere 2024 (Lost Ice, Global Damage)

- It presents a stark warning from over 50 leading cryosphere scientists about the accelerating losses in the world’s snow and ice regions and their profound impacts on the global economy and environment.

- This annual report by the **International Cryosphere Climate Initiative (ICCI)** underscores the urgent need for immediate and substantial climate action to mitigate these effects.

Importance of Cryosphere

- It includes **all areas on Earth** where water exists in its *frozen form (such as glaciers, ice sheets, snow, sea ice, and permafrost)*, and plays a crucial role in our planet’s climate system.
- **Climate Regulation:** The cryosphere helps regulate Earth’s temperature by reflecting solar energy back into space due to its high albedo (reflectivity).
- **Water Storage:** It stores about 69% of the world’s freshwater in ice sheets, ice caps, and glaciers. This frozen water is a critical resource for ecosystems, agriculture, and human consumption.
- **Sea Level Regulation:** Melting ice contributes to sea level rise, which can have significant impacts on coastal communities and ecosystems. The cryosphere’s state directly influences sea level changes.
- **Ecosystem Support:** Many plants and animals are uniquely adapted to cold environments. The cryosphere provides essential habitats for these species, supporting biodiversity.
- **Impact on Weather Patterns:** The cryosphere affects atmospheric circulation, precipitation, and cloud formation. These interactions influence regional and global weather patterns.
- **Indicator of Climate Change:** Changes in the cryosphere, such as melting glaciers and shrinking ice sheets, are clear indicators of global warming. Monitoring these changes helps scientists understand and predict climate trends.

Key Findings

- **Accelerated Ice Loss:** The Greenland Ice Sheet is losing ice at an alarming rate of 30 million tons per hour.
 - Northern Greenland’s ice shelves have diminished by 35% in volume since 1978.

- **Sea-Level Rise:** The rate of global sea-level rise has doubled over the past 30 years and is projected to reach 6.5 mm/year by 2050 if current trends continue.
 - It poses significant risks to coastal communities worldwide, threatening infrastructure and livelihoods.
- **Ocean Currents and Climate Feedbacks:** Melting ice sheets in Greenland and Antarctica may be slowing critical ocean currents, potentially leading to a much colder northern Europe and greater sea-level rise along the U.S. East Coast.
 - Thawing permafrost and loss of sea ice are expected to exacerbate climate change, making mitigation efforts more challenging and costly.
- **Impact on Ecosystems and Communities:** Mountain glaciers and snowpacks are rapidly diminishing, with nearly all tropical and mid-latitude glaciers facing eventual complete loss.
 - This loss will have severe consequences for water resources, agriculture, and disaster risk, particularly in regions dependent on glacial meltwater.

Economic and Social Implications

- The report highlights that the economic costs of cryosphere loss will be immense, affecting everything from agriculture to infrastructure.
- The social impacts will be equally severe, with millions of people facing displacement due to rising sea levels and increased frequency of extreme weather events.

Call to Action

- The State of the Cryosphere 2024 report calls for immediate and decisive action to reduce carbon emissions and limit global warming to below 1.5°C.
- It emphasizes that current climate commitments are insufficient and that delaying meaningful mitigation efforts will only increase the long-term costs and damages.

GLOBAL CARBON BUDGET 2024

Context

- Recently, the Global Carbon Budget of 2024 was released by the Global Carbon Project.

About the Global Carbon Budget 2024

- It was released in conjunction with the **29th Conference of Parties (COP29)** to the UNFCCC, presenting a stark picture of our planet's carbon emissions.
- According to the report, total carbon dioxide (CO₂) emissions for 2024 are projected to reach a staggering 41.6 billion tonnes, up from 40.6 billion tonnes in 2023.

Key Findings

- **Fossil Fuel Emissions:** Fossil CO₂ emissions are expected to contribute 37.4 billion tonnes to the total, driven by increased use of coal, oil, and gas.
 - It marks a significant rise, exacerbated by the El Niño climate event of 2023-2024, which has intensified drought conditions and forest degradation fires.
- **Land-Use Change:** Emissions from land-use changes, such as deforestation, are also on the rise, contributing to the overall increase in CO₂ levels.
 - It highlights that deforestation and forest degradation fires have been particularly severe this year.
- **Global Warming:** The World Meteorological Organization (WMO) has warned that 2024 is set to be the hottest year on record, with temperatures temporarily hitting 1.5°C above pre-industrial levels.
 - It underscores the urgent need for global action to mitigate climate change.
- **Carbon Budget:** The report emphasizes that the world has only six years left to limit global warming to 1.5°C, with the carbon budget for this target rapidly depleting.
 - If current emission levels persist, the budgets for limiting warming to 1.7°C and 2°C will be

exhausted within the next 14 and 27 years, respectively.

Implications and Urgency

- The findings of the Global Carbon Budget 2024 highlight the critical need for immediate and sustained action to reduce carbon emissions.
- The long lifetime of CO₂ in the atmosphere means that the temperature increases we are witnessing today will have long-lasting impacts, locking in warming for generations to come.
- The report calls for a concerted global effort to transition to renewable energy sources, enhance energy efficiency, and implement policies that promote sustainable land use.
- Without such measures, the goal of limiting global warming to 1.5°C will remain out of reach, with severe consequences for ecosystems, economies, and communities worldwide.

Subjective Questions

1. To what extent does the Anthropocene Epoch represent a fundamental shift in the Earth's geological history, and what are the ethical implications of human dominance over the planet?
2. Discuss the increasing frequency and intensity of heatwaves globally, and analyze how climate change is exacerbating this phenomenon. Explore the potential impacts of these extreme heat events on human health, ecosystems, and infrastructure.
3. How does the role of atmospheric moisture as a potent greenhouse gas, often overlooked in climate change discussions, contribute to the acceleration of global warming?
4. Discuss the potential impacts of extreme rainfall events on urban infrastructure, agriculture, and human health. How can communities and governments mitigate these risks and build resilience to such events?
5. How does drought impact the socio-economic fabric of a region, and what are the long-term consequences of such disruptions?

MCQs

1. Recently, the *Global Risks Report 2024* was released by:
 - (a) United Nations Environment Programme (UNEP)
 - (b) World Meteorological Organization (WMO)
 - (c) World Economic Forum (WEF)
 - (d) Intergovernmental Panel on Climate Change (IPCC)
2. The term '*New Collective Quantified Goal (NCQG)*' was in news, is primarily related to:
 - (a) Cutting Greenhouse Gases
 - (b) Climate Finance
 - (c) Carbon Offset
 - (d) Climate Adaption
3. The '*Conference of Parties-30 (COP-30)*' of United Nations Framework Convention on Climate Change (UNFCCC) is expected to held at:
 - (a) Bloemfontein in South Africa
 - (b) Belo Horizonte in Brazil
 - (c) Salta in Argentina
 - (d) Belem in Brazil
4. The '*State of the Climate 2024: Update for COP29*' was released by:
 - (a) World Meteorological Organization (WMO)
 - (b) United Nations Environment Programme (UNEP)
 - (c) Intergovernmental Panel on Climate Change (IPCC)
 - (d) Global Environment Facility (GEF)

Answer Keys: 1 (c) 2. (b) 3. (d) 4. (a)

