

Read the question carefully and address exactly what is asked, avoiding unnecessary deviation

Start with a clear and relevant introduction that shows understanding of the topic.

Structure the answer logically: introduction, explanation/analysis, and a brief conclusion.

Use correct scientific terminology (e.g., biodiversity, sustainability, carbon cycle, eutrophication)

Explain concepts clearly and accurately, avoiding vague or generalized statements.

Support answers with relevant examples, preferably from Pakistan or global case studies where appropriate.

Include data, statistics, or facts (e.g., temperature rise, deforestation rates) when relevant to strengthen arguments.

Incorporate environmental laws, agreements, or protocols (e.g., Paris Agreement, Kyoto Protocol, SDGs) where applicable.

Show cause-and-effect relationships in environmental processes

PART " II "

Question No 3 (Part a)

EUTROPHICATION:-

(I)

INTRODUCTION:-

Eutrophication is critical environmental issue caused by the nutrient enrichment in aquatic ecosystem, primarily from nitrogen and phosphorus inputs. This process accelerates algal growth, reduces dissolved oxygen and disrupt aquatic biodiversity impacting fisheries, water quality and human health. Globally recognized under frameworks such as Ramsar Convention, SDG 6, and regional water treaties, eutrophication of growing concern in Pakistan polluting the water bodies such as Kawal Lake, Smilli Dam and Ravi River.

(II)

DEFINITION OF EUTROPHICATION

1) **CONCEPTUAL DEFINITIONS:-**

Eutrophication is the enrichment of the water bodies with nutrients, leading to excessive growth of algae and aquatic plants. This phenomenon is widely recognized by the environmental agencies as primary drivers of hypoxia, fish mortality and aquatic ecosystem degradation.

2) **ENVIRONMENTAL SIGNIFICANCE:-**

Unchecked eutrophication leads to oxygen depletion, loss of biodiversity, and altered ecosystem functions. In Pakistan, phosphate runoff in the Rawal Lake have reached 0.42 mg/L, well reaching ecological threshold and signaling early stage eutrophication.

(III) TYPES OF EUTROPHICATION:-

1) NATURAL EUTROPHICATION:-

Natural eutrophication occurs over centuries through soil runoff and organic decay slowly transforming oligotrophic lakes into nutrient rich systems.

2) CULTURAL (ANTHROPOGENIC) EUTROPHICATION:-

Cultural eutrophication is accelerated by agricultural, sewage and industrial effluents. Nutrient load in the Ravi River has reached approximately 50% by the human activity.

(IV) PROCESSES OF EUTROPHICATION:-

1) NUTRIENT ENRICHMENT AND ALGAL BLOOM:-

Nutrient enrichment stimulates the algal overgrowth, blocking sunlight, reducing photosynthesis and worsening under warm stagnant conditions, as seen in Karachi reservoirs.

2) OXYGEN DEPLETION AND ECOSYSTEM COLLAPSE:-

Algal decay consumes dissolved oxygen, causing hypoxia, fish killing and biodiversity loss. FAO reports approximately 25% decline in freshwater fishes due to hypoxia in South Asia.

(IV) CONTROLLING MEASURES OF EUTROPHICATION:-

1) NUTRIENT MANAGEMENT AND POLICY INTERVENTION:-

Limiting nutrient input via optimized

fertilizer use, buffer strips and wetlands restoration is essential, supported by Ramsar Convention and PEPA 1997.

2) WASTEWATER TREATMENT AND ECOSYSTEM RESTORATION

Treating urban and industrial wastewater and using restoration, dredging or biological remediation restores water quality. Pakistan treat only about 30% of urban sewage.

(V)

CONCLUSION:-

Eutrophication disrupts ecosystem and reduces human and economic well being with natural and cultural types accelerating oxygen depletion and biodiversity loss. Effective control through nutrient management, wastewater treatment and ecosystem restoration supported by laws and international agreements is vital for sustainable aquatic ecosystem management in Pakistan.

Question No. 3 (Part b):

GHE AND DEPLETION OF THE OZONE LAYER IN RELATION WITH GLOBAL WARMING:

(I)

INTRODUCTION:-

Global warming is primarily driven by the Greenhouse Effect (GHE) and aggravated by the ozone layer depletion, both of which disrupts Earth's climate system. These phenomena contribute to effecting temperature rise, weather extremes and human health and are addressed globally through agreements like the Kyoto Protocol, UNFCCC and Montreal Protocol.

(II)

GREENHOUSE EFFECT (GHE)

1) CONCEPT OF GHE:-

The Greenhouse effect is a natural process by which the greenhouse gases trap the infrared radiations in the atmosphere, maintaining Earth's temperature. Excessive emission of the CO_2 , CH_4 , N_2O intensify this effect & contributing to anthropogenic global warming.

2) CAUSES OF ENHANCED GREENHOUSE GASES (GHE) :-

Industrialization, deforestation and fossil fuel combustion increases greenhouse gas concentration, with the global CO_2 level rising from 280 ppm (pre-industrial) to 410 ppm in 2023. Pakistan contributes through energy intensive sectors and agricultural methane emission.

3) IMPACTS OF GHE ON CLIMATE AND ECOSYSTEM :-

Enhanced GHE cause rising temperatures, melting glaciers and altered precipitation patterns. In Pakistan this manifests as heatwaves, glacial retreat in Himalayas and increased frequency of floods and droughts.

4) MITIGATION STRATEGIES FOR GHE :-

Reducing fossil fuel use, promoting renewable energy, reforestation, and implementing Nationally Determined Contributions (NDCs) under UNFCCC can curb GHE. Pakistan's renewable energy projects, such as solar and wind farms aim to reduce CO_2 emission by 5-7% by 2030.

(III)

OZONE LAYER DEPLETION:-

1) CONCEPT OF OZONE LAYER DEPLETION

Ozone depletion is the thinning of the stratospheric ozone layer caused by CFCs, halons, and other ozone-depleting substances (ODS). It increases the penetration of the harmful ultraviolet (UV-B) radiation to Earth's surface.

2) CAUSES AND SOURCES OF ODS

Major causes include refrigerants, aerosols, foam blowing agents, and industrial solvent. In Pakistan, increased use of the old refrigeration system contributes to regional ozone depletion risks.

3) IMPACTS ON CLIMATE AND HUMAN HEALTH

Ozone depletion amplifies UV radiation exposure, causing skin cancer,

cataracts and affecting crop productivity. It also interacts with the climate change, influencing stratospheric temperature, wind patterns, and exacerbating global warming.

4) INTERNATIONAL PROTOCOLS AND CONTROL MEASURES

The Montreal Protocol (1987) mandates the phase-out of ODS globally, which has led to the recovery of the ozone layer. Pakistan has ratified the protocol, replacing CFCs, HCFCs, and natural refrigerant, aligning ozone protection with climate mitigation goals.

(IV)

CONCLUSION

The GHGs and Ozone layer depletion are interconnected drivers of the global warming and climate disruptions. Enhanced GHG raise temperature and extreme weather while ozone depletion increase UV exposure, affecting health and ecosystem.

Question No. 5 (A)

CLIMATE CHANGE, IT'S POSSIBILITIES AND HINDRANCES:

(I)

INTRODUCTION:

Climate change refers to long term shift in temperature, precipitation and weather patterns caused primarily due to human activity including greenhouse gas emission and deforestation. It poses global risk to ecosystems, economies and human health with Pakistan being particularly vulnerable to floods, heatwaves, glacial retreats and water stress.

(II)

CLIMATE CHANGE:

1) CONCEPT OF CLIMATE CHANGE:-

Climate change is significant

alteration of the Earth's climate system over decades, driven by both anthropogenic and natural factors. Human induced emission of CO_2 , CH_4 and N_2O have accelerated warming, leading to extreme weather events worldwide.

2) GLOBAL AND REGIONAL MANIFESTATION:

Average global surface temperature have risen by approximately 1.5°C since pre-industrial times. In Pakistan, rising heat, glacial melts in Himalayas, and erratic monsoon pattern reveals regional climate vulnerabilities.

(III)

POSSIBILITIES IN COUNTERING CLIMATE CHANGE:

1) INTERNATIONAL CLIMATE AGREEMENTS:

UNFCCC, Paris Agreement and Kyoto

Protocol provides platform for mitigation and adaptation. Pakistan's NDCs focus on emission reduction and climate resilience through renewable energy resources and reforestation.

2) RENEWABLE ENERGY AND LOW CARBON TECHNOLOGY:

Scaling up solar, wind and hydro-power reduces fossil fuel dependence. Pakistan's CPEC energy project aims at generating 3000+ MW of low-carbon electricity by 2030.

3) CLIMATE ADAPTATION AND DISASTER RISK REDUCTION:

Community based adaptation, flood defense and early warning systems mitigate climate impacts. Pakistan's NDMA and provincial authorities enhance resilience to floods

droughts and heatwaves.

4) PUBLIC AWARENESS AND POLICY INTEGRATION:

Environmental education, campaigns and integration of the climate policies and planning strengthens mitigation. SDG 13 emphasize climate action at local and national levels.

(IV)

HINDRANCE IN COUNTERING CLIMATE CHANGE:

1) ECONOMIC CONSTRAINTS AND DEVELOPMENT PRESSURE:

Limited financial resources, poverty, and fossil fuel dependence hinder climate action. Fossil fuel finance from the Green Climate Fund is underutilized due to technical and institutional gaps.

2) GOVERNANCE, COORDINATION AND GLOBAL INEQUALITIES

Weak institutional capacity, fragmented enforcement and global inequalities impede effective climate governance. Pakistan faces challenges in sub-provincial coordination and implementing regulations.

(V)

CONCLUSION:

Climate change is a global and urban regional challenge requiring mitigation and adaptation efforts. While international agreements, renewable energy, and adaptation strategies offer possibilities, financial, governance and capacity constraints hinder progress.

Question No. 5 (Part B)

DISASTER RISK MANAGEMENT: OPPURTUNITIES AND CHALLENGES IN PAKISTAN:

(I)

INTRODUCTION:

Disaster Risk Management (DRM) involves systematic identification, assessment and reduction of the risk from natural and man made hazards. It aims to minimize loss of life, property and economic damage, particularly in disaster prone countries like Pakistan.

(II)

DISASTER RISK MANAGEMENT:-

1) DEFINITION:

DRM is a strategic process of reducing vulnerability and enhancing preparedness against disasters. It integrates prevention,

mitigation, preparedness & response to protect lives and livelihoods of people.

2) SIGNIFICANCE OF DRM IN PAKISTAN:

Pakistan stands among the top 20 countries most affected by climate related disasters. Between 1970-2020, floods, earthquakes & water crises caused over 150,000 deaths and \$ 40 billion economic loss pushing Pakistan further into dangerous waters.

(III)

OPPORTUNITIES IN DISASTER RISK MANAGEMENT:

1) STRENGTHENED INSTITUTIONAL FRAMEWORK:

NIDMA and provincial Disaster Management Authorities provide structural cooperation for disasters

response and mitigation. Pakistan has established early warning systems for floods and cyclones on major river basins.

2) EARLY WARNING SYSTEMS AND TECHNOLOGY USE:

Integration of satellite monitoring, GPS mapping and mobile alerts improve preparedness. Pakistan Meteorological Department now issues real-time local and floods alerts reducing potential casualties.

3) COMMUNITY BASED RISK REDUCTION:

Community participation in hazard mapping, drills and local planning increases resilience. Programs in Sindh and Khyber Pakhtunkhwa have trained over 50,000 volunteers in disaster response and first aid.

4) INTERNATIONAL COOPERATION AND FUNDING:

Global framework like Sendai framework and partnerships with UNDRR, WB and Red Cross provide funding and technical support. Pakistan receives disaster risk reduction grants for flood protection and early warning system.

(IV) CHALLENGES IN DISASTER RISK MANAGEMENT.

1) FINANCIAL AND RESOURCE CONSTRAINTS:

Limited budget, poor infrastructure and lack of equipments hinder any effective DRM. Only 25-30% of Pakistan's disaster response funds are allocated to prevention and preparedness measure.

2) GOVERNANCE AND POLICY GAPS:

Fragmented governance, weak enforcement, and interprovincial coordination issue reduces DRM efficiency. Many urban and rural areas still lack integrated hazard mapping and emergency response planning.

(V) CONCLUSION:

DRM is crucial in Pakistan to minimize losses from floods, earthquakes, and heatwaves. While institutional framework, technology and integration community engagement provide opportunities, financial governance and coordination challenge limit effectiveness.

Question No. 8 (Part A):

AGENDA 21:

(I)

INTRODUCTION:

Agenda 21 is the ^{comprehensive} global action plan adopted at 1992 UN Earth Summit in Rio De Janeiro to promote sustainable development. It addresses environmental protection, social equity and economic growth serving as a ~~map~~ ^{framework} for national and local level policies worldwide.

(II)

OVERVIEW OF AGENDA 21:

1) CONCEPT OF AGENDA 21:

Agenda 21 is non binding action oriented framework for achieving sustainable development globally, nationally and locally. It emphasize environment protection, resource efficiency and participatory governance.

2) GLOBAL SIGNIFICANCE:

Adopted by 178 countries, Agenda 21 guides the integration of environmental and development policies. It provides framework for climate, biodiversity, water, energy management supporting SDGs 6, 7 and 13.

(III)

PRINCIPLES AND OBJECTIVES:

1) ENVIRONMENTAL PROTECTION AND CONSERVATION:

It prioritizes pollution reduction, biodiversity conservation, and ~~sustainable~~ ^{sustainable} resource use. It aligns with the convention on Biological Diversity and promotes renewable energy adoption.

2) SOCIAL ECONOMIC DEVELOPMENT:

It focuses on poverty eradication, equity promotion, quality of life improvement through sustainable

agri culture, education and health program.
In Latin America and Africa it
has improved livelihoods.

3) PARTICIPATION AND GOVERNANCE:

It encourages engagement of communities,
NGOs and governments in planning
and implementation. In Pakistan
pilot program in Punjab and Sindh
integrate community participation
in forests and water management.

4) INTEGRATION WITH GLOBAL AGREEMENTS:

Agenda 21 complements Rio declaration
UNFCCC, Kyoto Protocol framework
promoting synergy between development
and environmental protection.

(IV) IMPLEMENTATION AND CHALLENGES

1) OPPORTUNITIES FOR NATIONAL IMPLEMENTATION

Countries can adopt Agenda 21 for urban
planning, disaster risk management and
climate adaptation. Pakistan renewable
energy policies and wetland conservation
reflect these practices.

2) HINDRANCES AND CONSTRAINTS:

Limited funding, weak institutional
capacity, low public awareness
the effectiveness in Pakistan fragmented
governance, insufficient monitoring
reduce impact at provincial and
local level.

(V)

CONCLUSION:

Agenda 21 is comprehensive framework
guiding development through environmental
protection, social equity and economic growth.

Question No. 8 (Part B)

EUTROPHICATION:-

(I)

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(II)

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(IV)

CAUSES OF EUTROPHICATION.

1) NUTRIENT LOADING FROM AGRICULTURE:-

Excessive use of fertilizers containing nitrogen and phosphorus in farming lands leads to nutrient runoff. Agricultural land contributes major nutrient load to River Ganges and Indus river annually.

2) INDUSTRIAL AND DOMESTIC WASTEWATER:-

Untreated industrial effluents and domestic sewage introduces high nutrient loads to water bodies. In Urban areas like Karachi and Lahore only ~ 30% of sewage is treated before discharge, worsening eutrophication.

(V)

EFFECTS AND SOLUTIONS

1) ECOLOGICAL AND ECONOMIC IMPACTS:-

Eutrophication causes algal growth in water, leading to fish kills, biodiversity loss impacting fisheries and tourism. FAO reports ~ 20-25% decline in freshwater fish productivity in South Asia due to nutrient overloading.

2) MITIGATION AND

CONTROL MEASURES:-

Control requires nutrient management, buffer zones, wetland restoration and wastewater treatment.

VI

CONCLUSION:-

Eutrophication disrupts aquatic ecosystems, reduce biodiversity and affects human and economic wellbeing. Both natural and induced types contribute to oxygen depletion and fish mortality.

Question No. 4

ERA OF GLOBAL WARMING
HAS ENDED, THIS IS THE
ERA OF GLOBAL BOILING:

(I)

INTRODUCTION:-

The planet Earth is experiencing unprecedented temperature extremes with 2023 marking among some of the hottest years on record globally. Scientists now describe this as an act of "global boiling", where rapid warming, heatwaves and ecosystem stress surpasses historical global warming impacts. Pakistan, experiencing heatwaves exceeding 50°C in Sindh and Balochistan exemplify regional vulnerability.

(II)

JUSTIFYING THE ERA OF
GLOBAL BOILING:

1) INTENSIFYING HEATWAVES:-

Global heatwaves have increased in intensity and frequency with 2023 recording over 200 million people affected worldwide. Pakistan faced extreme heat in Karachi and Sukkur with temperatures exceeding historical average by $5-7^{\circ}\text{C}$.

2) ACCELERATED GLACIAL AND ICE MELTS:-

Rapid melting of the glaciers in Himalayas and ice sheets in Greenland and Antarctica accelerate sea levels rise. Pakistan's coastal retreat at $\sim 0.3\text{m}$ per year threatens Indus River flows.

3) EXTREME WEATHER EVENTS:-

The rise in cyclones, storms and

floods signals boiling climate conditions. The 2022 Karachi flood repeated monsoon anomalies in Pakistan highlights intensified weather extremes.

4) RECORD BREAKING TEMPERATURE:-

Global land and surface temperatures have risen sharply with July 2023 being the hottest month recorded. South Asia including Pakistan sustained temperature surge above 50°C impacting human health and agriculture.

5) OCEAN WARMING AND ACIDIFICATION.

Oceans absorb over 90% of the heat during global warming, leading to bleaching and acidification. Coral reefs in the Indian Ocean and fisheries across Pakistan

coastal belts are under extreme stress affecting livelihood.

6) DROUGHT AND WATER SCARCITY:-

Prolonged drought affect water security. This reservoir and groundwater depletion. Pakistan faces 33% reduction in Indus water flow during peak summer impacting agriculture and energy production.

7) ECOSYSTEM COLLAPSE AND BIODIVERSITY LOSS:-

Intense heat and altered rainfall pattern disrupts ecosystems. The Himalayan forests and Indus Delta mangroves face severe degradation threatening endemic species and ecological services.

(III)

MEASURES TO COMBAT ECOLOGICAL BOILING:-

1) TRANSITION TO RENEWABLE ENERGY

Phasing out fossil fuels and scaling up solar, wind and hydropower can reduce greenhouse gas emissions. Pakistan's CPEC aims to generate 3000+ MW energy.

2) CLIMATE RESILIENT AGRICULTURE:

Implementing drought resistant crops, drip irrigation, soil conservation and reduce climate vulnerability. Punjab and Sindh have introduced climate smart wheat and rice varieties to mitigate heat stress.

3) URBAN PLANNING AND HEAT MITIGATION

Urban greening, reflective surface and sustainable infrastructure can reduce urban heat islands. Karachi, Lahore and Islamabad are piloting

Urban forestry and cool roof initiatives to combat rising air temperature.

4) GLOBAL COOPERATION AND POLICY IMPLEMENTATION:

Adherence to UNFCCC, Paris Agreement and enhanced NDCs is crucial for coordinated action. Pakistan's climate policy integrate adaptation, mitigation and disaster management aligned with global climate framework.

(IV)

CONCLUSION:-

The era of global boiling is characterized by extreme heat, accelerated glacial melts, intense weather events and ecosystem collapse. Immediate measures using renewable energy, climate resilient agriculture, urban planning and global cooperation is essential.