

Q.2: a. What were the main objectives of clean development Mechanism? also explain the reasons for the criticism on Kyoto protocol by the developed countries.

Climate change Mitigation

CDM Objectives

Sustainable Development promotion

Global cost efficiency

The clean Development Mechanism (CDM), established under Article 12 of The Kyoto protocol, had three primary objectives:

1: **Climate change Mitigation:** To assist developed (Annex 1) countries in meeting their emission reduction targets by allowing them to implement emission-reduction projects in developing countries, where abatement costs are typically lower. This created a market for Certified Emission Reductions (CERs) where 1 CER = 1 tonne of CO₂ equivalent reduced.

2: **Sustainable Development Promotion:** To foster environmentally sustainable development in host developing countries through technology transfer, investment in clean energy infrastructure, & capacity building. Projects ranged from renewable energy installations to methane capture at landfills.

3: Global Cost Efficiency: To achieve emission reductions at the lowest possible global cost by leveraging comparative advantages nations, while establishing a framework for international cooperation on climate action.

The CDM operated on the principle of "common but differentiated responsibilities" recognizing that developed nations should take the lead in combating climate change due to their historical emissions and greater resources.

Criticism of the Kyoto protocol by Developed Countries.

Developed nations raised several substantive criticisms of the Kyoto protocol framework:

1: Uneven Burden sharing: The protocols binary division between Annex I (developed) and non-Annex I (developing) countries exempted major emerging economies (China, India, Brazil) from binding targets despite their rapidly growing emissions. By 2012, non Annex I countries accounted for 58% of global emissions yet faced no reduction obligations.

2: Competitive Disadvantage: Energy-intensive industries in developed countries argued that carbon constraints increased production costs, leading to "carbon leakage" - relocation of industries to unregulated countries. The EU estimated potential job losses of 1.7 million in carbon-exposed sectors.

3: **Effectiveness Concerns:** The absence of the United States (never ratified) & Canada's withdrawal (2012) significantly diminished the protocol's coverage. By 2016, participating Annex 1 countries represented only 12% of global emissions, undermining environmental effectiveness.

4: **CDM Implementation flaws:**

(i) **Additionality Issues:** Up to 30% of CDM projects may have occurred without carbon financing.

(ii) **Verification challenges:** Inconsistent monitoring in developing countries.

(iii) **Market Oversaturation:** 2.9 billion CERs issued by 2012, crashing prices to $\leq \text{€1/ton}$.

(iv) **Limited Technology Transfer:** Only 12% of projects included substantial tech transfer.

5: **Economic Burden:** Implementation costs were disproportionately high for developed nations. The EU's Emission Trading System incurred €210 billion in compliance costs during 2008-2012 while developing countries received financial flows through CDM without binding commitments.

(b) **Differentiate between Sanitary & industrial landfills, also describe the land selection criteria for landfills.** (5 marks)

1. **Sanitary Vs. Industrial landfills:**

Key Differences:

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Criteria.	Sanitary landfill.	Industrial landfill. (i)
Purpose	Disposal of municipal solid waste (e.g., household, commercial)	Disposal of hazardous non-hazardous industrial waste (e.g., chemicals, ash, sludge).
Waste type	Non-toxic, biodegradable waste (food, paper, plastics)	Toxic/non-toxic industrial residues (heavy metals, solvents, incinerator ash)
Engineering Design.	clay/geosynthetic liner, leachate collection system, methane vent	Multi-layer composite liner (clay + HDPE); leak detection systems; chemical-resistant barriers.
Environmental Risk.	Groundwater contamination, methane emissions	soil/water toxicity, heavy metal leaching.
Regulatory standards.	Pak-EPA's Municipal Waste Rules.	NEQS (National Environmental Quality standards) for hazardous waste.
Location.	Peri-urban areas (e.g., Lahore's Lakhadai)	Remote industrial zones (e.g., Port Qasim, Karachi)

2: Landfill Site Selection Criteria:

(Per Pakistan's Environmental Protection Agency Guidelines)

Environmental Factors:-

(i) Hydrogeology:-

- Minimum 5m depth to groundwater table
- Avoid floodplains, wetlands, or seismic zones.

(ii) Soil Type:-

- Clay-rich soils (permeability $< 10^{-7} \text{ m/sec}$) to prevent leachate seepage.

(iii) Ecology:-

- Exclude protected areas (e.g. national parks, wildlife reserves).

Socio-Economic Factors:-

(a) Proximity to population:-

- $> 500 \text{ m}$ from residential areas (to mitigate odor/health impacts).
- Accessible to waste transport routes.

(b) Land Ownership:-

- Government-owned acquired land to avoid displacement.

Technical Feasibility

(a) Site Capacity:- Minimum 20-year operational lifespan.

(b) Topography:- Gently sloping terrain (5-10% gradient) for drainage.

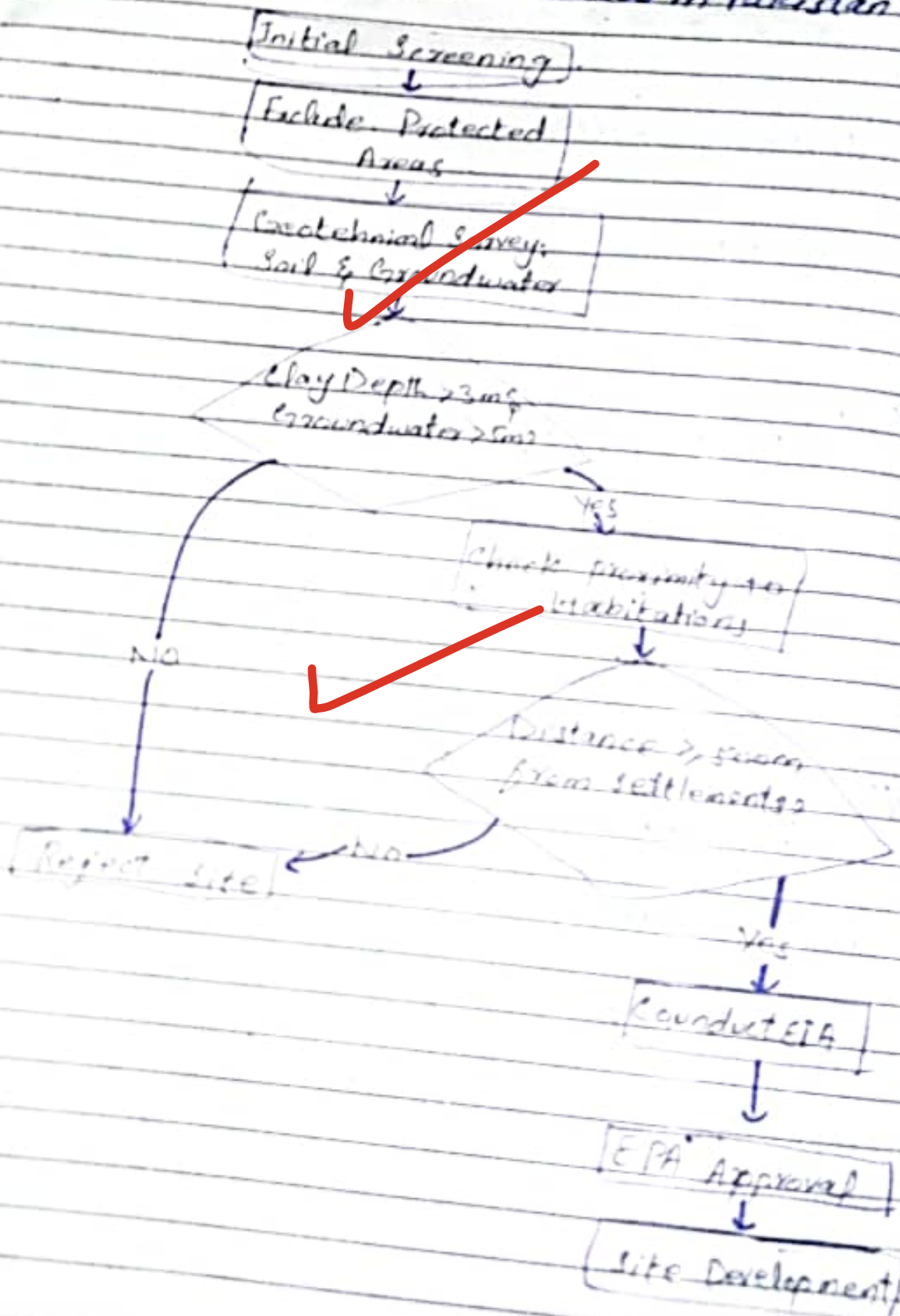
(c) Climate:- Low rainfall regions ($< 500 \text{ mm/year}$) preferred.

Regulatory Compliance:-

- Environmental Impact Assessment (EIA) mandatory under PEPA 1997.
- Approval from Provincial EPA (e.g. Punjab EPA).

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3 Landfill Site Selection Process in Pakistan.



3: Pakistan

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(ii) Industrial

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- Illegal costs

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3: Pakistan-specific challenges:-

(i) Sanitary Landfills:

- Only 12% of 37M tons/year MSW reaches proper landfills (Lahore, Faisalabad).
- Most sites (e.g., Karachi's Grandpass) operate as open dumps.

(ii) Industrial landfills:

- Limited facilities; <5% of hazardous waste treated (Pak - EPA 2023).
- Illegal dumping common due to high disposal costs.

Conclusion: Sanitary landfills prioritize municipal waste containment with basic engineering controls, while industrial landfills demand advanced barriers for hazardous materials. In Pakistan, site selection must rigorously apply hydrogeological and socio-economic criteria under PPDA 1997 to mitigate groundwater overcoming institutional contamination & public health risks. Overcoming institutional gaps & enforcing EIA compliance remain critical for sustainable waste management.

Map of Major Landfills in Pakistan.

Lahore: Larkhoadair & Karachi: Grandpass
& Islamabad: Sangjani &

Symbol: Δ = Sanitary $\odot$ = Industrial.

Note: No operational $\odot$ landfills; hazardous waste exported/sealed in situ.

good answers!!!!