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Q8

Seawater intrusion in the coastal aquifers is a major concern in India. What are the causes of seawater intrusion and the remedial measures to combat this hazard?

UPSC Civil Services Mains 2025 · GS III · 10 marks · Environment and Conservation

Conservation, environmental pollution and degradation, environmental impact assessment.

Core demand of the question

- Explain seawater intrusion as saltwater moving into coastal aquifers
- **Give causes:** over-pumping, sea-level rise, canals, storms, lost recharge
- **Give remedies:** regulate pumping, recharge, barriers, land use

Revision summary

A coastal aquifer holds a freshwater lens in balance with seawater.

Pumping, sea-level rise, storms and lost recharge let the salt water move inland.

Gujarat, Tamil Nadu and other coasts already report saline wells.

Remedies start with less pumping and more recharge, then barriers and, where needed, desalination.

Mangroves and open recharge land are part of the same defence.

Introduction

A coastal well should taste of **fresh groundwater** that has slowly filled from rain. When it tastes of the **sea**, the freshwater lens has been **invaded**. That is **seawater intrusion**. In India it is already a fact on stretches of **Gujarat, Tamil Nadu, Andhra, Odisha and the islands**, not a textbook drawing.

Body

Causes

Fresh water in a coastal aquifer floats in a balance with denser seawater (the **Ghyben-Herzberg** idea). **Heavy pumping** for cities, industry and monsoon-failure irrigation **lowers the freshwater head**, and the salt water creeps inland. **Sea-level rise** and **storm surge** push the same interface. **Reduced recharge** - paved cities, dying tanks - weakens the freshwater side. **Aquaculture ponds**, poorly lined canals, and **tsunami or cyclone** floods can salt a shallow lens in a week. Sand mining and lost **mangroves** remove buffers.

Remedies

- **The first remedy is** less greed at the pump: licensing, electricity reform so that free power does not mean a dry, salty well, and **shifting water-hungry crops**. The second is **recharge**: check dams, spreading basins, and **injection wells** of treated water where geology allows. The third is **engineering**: subsurface **barriers**, and in extreme cases **desalination** for drinking

(costly, energy-heavy). The fourth is **land**: protect recharge areas, restore mangroves, stop building on every dune. **Monitoring** - a salinity map that a panchayat can see - is the unglamorous core.

Without cutting extraction, a barrier is a delay. With only lectures, the next summer still tastes of the tide.

Flow diagram

Over-pumping -> Intrusion
Sea-level rise storms -> Intrusion
Lost recharge -> Intrusion
Regulate pump -> Fresh lens
Recharge barriers -> Fresh lens

Conclusion

Seawater intrusion is salt water replacing fresh coastal groundwater, mainly because of over-pumping, weaker recharge and a rising sea. Remedies are regulated pumping, recharge, careful barriers and honest land use, not a single wall.

Facts & figures

Ghyben-Herzberg relation

A simple hydrostatic idea: a thick freshwater column is needed to hold back denser seawater.

Chennai hinterland

A much-cited Indian example where urban and farm pumping has pulled salinity inland.

Managed aquifer recharge

Putting rain or treated water back underground to rebuild the freshwater head.

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