5. Land Subsidence - Environment

Study estimates 900 square kilometres of land across 5 Indian megacities subsiding, A Nature Sustainability study reveals that India's major cities, especially Delhi and Chennai, are sinking primarily due to massive groundwater over-extraction, causing infrastructure damage and flood risks. Conversely, Dwarka in Delhi has experienced land uplift, demonstrating that aquifer recharge measures like rainwater harvesting can reverse the trend.

Study Warns of Sinking Land in Major Indian Cities

Source - A study published in the journal Nature Sustainability.

Warning - The study warns that land beneath India's five largest cities—Delhi, Mumbai, Kolkata, Chennai, and Bengaluru—is sinking (though to varying degrees).

Key Findings of the Study

Extent of Subsidence - A significant area of 878 sq km of urban land has been identified as having sunk. This subsidence exposes 1.9 million people to high subsidence rates, defined as exceeding 4 mm per year.

Overall Impact - Across all identified subsiding areas, a total of over 13 million buildings are affected. Nearly 80 million residents are living in these subsiding areas.

City-wise Observations

1. Delhi

Cause - The primary cause is the compaction of alluvial deposits (sediments from rivers).

Driver - This compaction is driven by the massive withdrawal of groundwater.

Chennai -

Driver - The sinking is primarily driven by groundwater extraction.

Geological Factor - This extraction leads to the compaction of Holocene alluvium, a type of soil composed of sandy clay and silt.

2. Kolkata

Cause - The subsidence is linked to the compaction of Pleistocene and Holocene sediments.

Bengaluru -

Current Status - The city shows minimal subsidence at present.

Reason for Stability - This is because the city is built on strong igneous and metamorphic bedrock.

Emerging Risk - A risk is developing due. to increasing groundwater extraction that has been observed since 2022.

3. Mumbai

Current Status - The city is relatively stable overall.

Localized Issues - However, areas like Dharavi and other high-density informal settlements are facing localised subsidence.

Causes of Subsidence (Identified in the Study)

Primary Cause - The over-extraction of groundwater, which is worsened by the presence of millions of unregulated borewells.

Secondary Causes

Structural Load - The cumulative load (weight) of urban structures (buildings, roads, etc.) exerts significant downward pressure on the subsurface soil layers.

Geology - The natural compaction of alluvial and fluvial sediments (soils deposited by rivers and streams).

Case Study of Localised Uplift - Dwarka, Delhi

Observation - The Dwarka region in Delhi recorded an uplift rate of 15.1 mm/yr (meaning the ground level rose).

Time Period - This was observed between 2005 and 2015.

Reason for Uplift - The uplift is attributed to successful aquifer recharge measures, which include - Widespread implementation of rainwater harvesting.

Enforcement of groundwater regulation to reduce extraction.

Land Subsidence

Definition - Land subsidence is the gradual sinking or lowering of the Earth's surface.

Mechanism - It is caused by the removal or displacement of underground materials (like water, oil, or minerals) or by natural geological processes.

General Causes of Subsidence

Groundwater Extraction - Excessive withdrawal of groundwater is a major cause (e.g., in cities like Delhi, Kolkata, and Mexico City).

Mining Activities - The physical removal of underground minerals or coal.

Oil and Gas Extraction - Pulling oil and gas from underground reservoirs.

Natural Compaction - The natural settling of sediments over time.

Karst Processes - The dissolution of underground rock like limestone, which can lead to sinkholes.

Tectonic Activity - Earthquakes or the slow movement of tectonic plates.

Impacts of Land Subsidence

Infrastructure Damage - It causes structural deformation in buildings, roads, bridges, and underground pipelines. This manifests as cracks, tilting, and potential collapse. Example - Around 2,200 buildings in Delhi are estimated to face a high risk due to uneven sinking.

Flooding and Waterlogging - The lowering of land elevation disrupts natural drainage patterns. This significantly heightens the risk of flooding and leads to prolonged waterlogging during heavy rains.

Groundwater and Environmental Degradation - Subsidence can result in the irreversible loss of aquifer storage capacity (the compacted ground cannot hold as much water). It also promotes saline water intrusion (saltwater entering freshwater aquifers), especially in coastal regions.

Economic and Social Impacts - Leads to declining land values in affected areas. Can cause reduced agricultural productivity. May result in the forced displacement of communities.

Disaster Vulnerability - Subsidence increases an area's susceptibility to secondary hazards. These include landslides, sinkholes, and urban infrastructure failures. Examples - This vulnerability has been observed in regions like Joshimath (India) and Jakarta (Indonesia).

Land Uplift

Definition - Land uplift is the upward rise or elevation of the Earth's surface.

General Causes -

Tectonic Uplift - Caused by the movement of the Earth's crust along fault lines. (e.g., The Himalayas, which were formed by the Indo-Eurasian plate collision).

Isostatic Rebound - The uplift of land after the melting and removal of heavy ice sheets (e.g., post-glacial rebound in Scandinavia).

Volcanic Uplift - Caused by the accumulation of magma beneath the surface, pushing the ground upward.

Source - https - //www.deccanherald.com/science/study-estimates-900-square-kilometres-of-land-across-5-indian-megacities-subsiding-3777967