The Aravali Crisis:

Predictive Analysis of Environmental and Socio-Ecological Impacts (2025–2050)

A Comprehensive Study on the Environmental, Topological, and Cultural Importance of the Aravali Mountain Range and Predictive Modeling of Tampering Scenarios

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Abstract

The Aravali mountain range, one of Earth's oldest geological formations at approximately 2 billion years, faces unprecedented threats from policy deprotection, mining expansion, and infrastructure fragmentation. This study integrates historical environmental data (2000–2025) with predictive modeling to assess the consequences of four tampering scenarios on the Delhi-National Capital Region (NCR) through 2050. Using linear regression baseline models combined with scenario-specific impact modifiers derived from peer-reviewed literature, we project temperature increases, air quality degradation, and groundwater depletion under varying degradation pathways.

Our baseline "Business As Usual" (BAU) trajectory indicates continued environmental stress even without additional tampering. However, scenario analysis reveals catastrophic outcomes under worst-case conditions: **Scenario 4 (Combined Worst-Case) projects a 4.5°C temperature increase, $PM_{2.5}$ levels exceeding 213 $\mu g/m^3$ (43× WHO guidelines), and groundwater depths reaching 5,000+ feet by 2050**—representing an existential threat to the 50+ million inhabitants of the NCR. These projections underscore the critical need for immediate policy intervention to preserve the Aravallis' function as the "Green Wall" protecting North India from desertification.

Keywords: Aravali range, predictive modeling, climate impacts, groundwater depletion, desertification, Delhi-NCR, environmental degradation, conservation policy

Contents

1 Introduction

1.1 The Aravali Range: India's Ancient Guardian

The Aravali mountain range represents one of the most ecologically and strategically significant geological formations in India. Stretching approximately 692 kilometers across the states of Delhi, Haryana, Rajasthan, and Gujarat, this 2-billion-year-old system serves as the last barrier between the expanding Thar Desert and the densely populated Indo-Gangetic plains (Roy and Jakhar, 2006; Sinha-Roy et al., 2010). As one of the world's oldest fold mountains, the Aravallis have witnessed the rise and fall of civilizations while providing essential ecosystem services to hundreds of millions of people.

The geological antiquity of the Aravallis—formed during the Precambrian era—makes them a unique natural heritage requiring urgent protection (Valdiya, 1998). Unlike the young, tectonically active Himalayas, the Aravallis represent a stabilized continental shield that has been subjected to prolonged erosion, leaving behind a landscape of rolling hills, ridges, and valleys that define the topography of western India.

1.2 Topological Importance: The "Green Wall" Against Desertification

The Aravallis function as a critical *topological barrier* preventing westward expansion of the Thar Desert into the fertile agricultural heartland of North India (Kar and Takeuchi, 2009; Kumar et al., 2012). The range's elevation profile—though modest by Himalayan standards, with peaks rarely exceeding 1,000 meters—creates a vital "Green Wall" effect through multiple mechanisms:

1. **Wind Deflection:** The rocky ridges and forested slopes slow and deflect hot, dry, dust-laden winds originating from the Thar Desert, reducing their impact on the NCR and beyond (Sikka, 2006). Studies have documented wind speed reductions of 30–50% on the leeward side of intact Aravali sections.

2. **Monsoon Channeling:** The topographic configuration directs monsoon clouds eastward, enhancing precipitation in sub-Himalayan river basins and supporting agricultural productivity across the North Indian plains (Rajeevan et al., 2008). The Aravallis intercept southwest monsoon moisture, triggering orographic rainfall that sustains agriculture in Rajasthan and Haryana.

3. **Microclimate Stabilization:** The terrain creates localized cooling effects and moderates temperature extremes, providing refuge zones for biodiversity and human settlements (Krishnaswamy et al., 2014). Forest cover in the Aravallis reduces ambient temperatures by 2–4°C compared to surrounding barren areas.

Recent policy changes have severely compromised this protective function. A 2025 policy redefinition restricts protection to hills exceeding 100 meters above surrounding terrain, effectively *excluding 91% of the range* from legal safeguards (Centre for Science and Environment, 2023). This leaves thousands of low-elevation hills—critical components of the continuous barrier—vulnerable to mining and urbanization. Historical data (1975–2019) shows that **8% of Aravali**

hills (5,773 km^2) have already disappeared, with 5% converted to barren land and 1% to settlements, resulting in observable desert advancement toward the NCR (Indian Space Research Organisation, 2020).

1.3 Cultural and Historical Significance

The Aravallis are deeply embedded in India's cultural and historical fabric, serving as both a physical and spiritual landscape for millennia (Chakravarti, 2006):

1. **Ancient Civilization:** Archaeological evidence indicates continuous human habitation along the Aravali foothills dating back to the Indus Valley Civilization (2600–1900 BCE). Copper mining in the region supported Bronze Age metallurgy, while water harvesting structures enabled agrarian communities to thrive in an otherwise arid landscape (Shinde, 2016).

2. **UNESCO World Heritage Sites:** The Aravallis host multiple sites of outstanding universal value:

    - **Kumbhalgarh Fort:** Featuring walls stretching 36 kilometers—the second longest after the Great Wall of China—this 15th-century fortress exemplifies Rajput military architecture (UNESCO, 2013).
    - **Chittorgarh Fort:** Site of legendary Rajput resistance and historical battles that shaped regional identity for centuries.
    - **Hill Forts of Rajasthan:** Collectively inscribed as UNESCO World Heritage Sites in 2013, representing pinnacles of Rajput defensive architecture.

3. **Sacred Architecture:** The Dilwara Temples at Mount Abu (1031–1230 CE) showcase some of the most intricate marble craftsmanship in the world, representing the zenith of Jain temple architecture (Michell and Shah, 1989). Ancient stepwells (*baoris*) throughout the region demonstrate sophisticated water harvesting engineering.

4. **Living Sacred Groves:** Sites like **Mangar Bani** near Faridabad function as sacred forests with deep spiritual significance for local communities, preserving traditional ecological knowledge and biodiversity (Gadgil and Vartak, 2001). These groves represent India's oldest form of community-based conservation.

1.4 Environmental Importance: Ecological Keystone of North India

Beyond cultural and topological roles, the Aravallis provide essential ecosystem services critical to regional sustainability (Ramachandra et al., 2018):

1. **Groundwater Recharge Zone:** The range serves as the primary catchment for aquifers supplying water to the **50+ million residents of the Delhi-NCR** (Central Ground Water Board, 2020). The porous geology and vegetation cover facilitate infiltration and storage. Studies estimate that each hectare of Aravali forest recharges approximately 30,000 liters of groundwater annually.

2. **Biodiversity Corridor:** Supporting **300 native plant species** and **120 bird species**, the Aravallis connect desert ecosystems in the west with forest ecosystems in the east, enabling genetic exchange and species migration (Wildlife Institute of India, 2019). Flagship species include leopards, nilgai, and numerous migratory birds.

3. **Carbon Sequestration:** Forest cover in the Aravallis contributes significantly to regional carbon budgets. Estimates suggest Aravali forests sequester approximately 2.5 tonnes of CO_2 per hectare annually (Forest Survey of India, 2021).

4. **Air Pollution Buffering:** Vegetation filters particulate matter ($PM_{2.5}$, PM_{10}) from air masses before they reach urban centers, providing respiratory health benefits worth billions of rupees annually (Sharma and Dikshit, 2020).

Current degradation metrics (Haryana Forest Department, 2023) indicate that **70% of land degradation** in the range is attributable to illegal mining and deforestation. Districts like Mahendergarh already experience **groundwater depths of 1,500–2,000 feet**, signaling severe aquifer depletion.

1.5 Policy Landscape and Emerging Threats

The legal framework protecting the Aravallis has undergone significant weakening in recent years:

1. **Punjab Land Preservation Act (PLPA) Erosion:** Originally enacted in 1900 to prevent soil erosion, the PLPA was amended in 2019 to exclude large tracts from protection. Of 49 notifications covering 60,000 acres, **43 notifications (88%) expired without renewal**, leaving only 6,800 acres protected (Centre for Science and Environment, 2023).

2. **100-Meter Definition:** The 2025 redefinition of "hills" to include only features exceeding 100 meters above surrounding terrain excludes the vast majority of the range from protection.

3. **Infrastructure Projects:** The proposed Aravali Safari Park (10,000 acres) and Haryana Orbital Rail Corridor (4.69 km tunnel) threaten to fragment critical wildlife corridors and disrupt hydrological connectivity (Ministry of Environment, Forest and Climate Change, 2024).

4. **Mining Pressures:** Despite a 2009 Supreme Court ban on mining, illegal extraction continues. A 2025 Supreme Court order directing preparation of a "Sustainable Mining Plan" could potentially legitimize resumed operations.

1.6 Research Objectives

This study aims to quantify the environmental, climatic, and socio-ecological consequences of continued Aravali degradation through predictive modeling. Specifically, we:

1. Establish baseline environmental trends (2000–2025) for temperature, air quality ($PM_{2.5}$), and groundwater levels in the Aravali region.

2. Define four tampering scenarios grounded in real-world policy changes and development projects (2019–2025).

3. Project environmental outcomes through 2050 under each scenario using statistically validated models.

4. Assess cascade effects on desertification risk, water security, and public health.

5. Provide evidence-based recommendations for policy intervention to preserve the Aravallis' ecological functions.

2 Methodology

2.1 Study Area

The study focuses on the Aravali range within Haryana and Rajasthan, with particular emphasis on:

- **Southern Haryana Districts:** Gurugram, Faridabad, Nuh, Palwal
- **Central Haryana Districts:** Charkhi Dadri, Bhiwani, Mahendergarh
- **Northern Rajasthan Districts:** Alwar, Jaipur Rural, Sikar

The study area encompasses approximately 7,500 km^2 of Aravali terrain directly influencing the Delhi-NCR's environmental conditions.

2.2 Data Sources

2.2.1 Climate Data

Historical climate data was obtained from the Open-Meteo Historical Weather API:

- **Location:** Representative coordinates (28°N, 76°E) in the central Aravali region
- **Period:** January 1, 2000 – December 31, 2024 (25 years)
- **Variables:** Daily mean temperature (°C), $PM_{2.5}$ concentration ($\mu g/m^3$)
- **Resolution:** Daily observations aggregated to annual means

2.2.2 Air Quality Data

$PM_{2.5}$ data was compiled from Central Pollution Control Board (CPCB) monitoring stations (Central Pollution Control Board, 2024) and satellite-derived estimates from the Global Burden of Disease study (GBD 2019 Risk Factors Collaborators, 2020).

2.2.3 Groundwater Data

Groundwater depth estimates were synthesized from:

- Central Ground Water Board (CGWB) monitoring well data (Central Ground Water Board, 2020)
- Haryana State Groundwater Board regional surveys
- Published studies on NCR groundwater depletion (Rodell et al., 2009)

Initial conditions (2000): 800 feet depth, representative of the NCR region at the turn of the century. Annual depletion rates were calibrated to match observed 2024–2025 depths (1,500–2,000 feet) in severely affected districts.

2.3 Baseline Modeling Approach

We developed **linear regression baseline models** for three critical environmental indicators to establish "Business As Usual" (BAU) trajectories:

2.3.1 Temperature Model

- **Response Variable:** Annual mean temperature (°C)
- **Predictor:** Year (2000–2024)
- **Model Performance:** $R^2 = 0.81$, RMSE = 0.38°C
- **Interpretation:** Captures long-term warming from global climate change and regional urbanization

2.3.2 $PM_{2.5}$ Model

- **Response Variable:** Annual mean $PM_{2.5}$ concentration (μg/m^3)
- **Predictor:** Year (2000–2024)
- **Model Performance:** $R^2 = 0.62$, RMSE = 8.03 μg/m^3
- **Interpretation:** Reflects ongoing air quality degradation from regional sources

2.3.3 Groundwater Model

- **Response Variable:** Groundwater depth (feet)
- **Predictor:** Year (2000–2024)
- **Model Performance:** $R^2 = 0.99$, RMSE = 22.01 feet
- **Interpretation:** Highly predictable depletion trend from over-extraction

All models passed residual diagnostics for normality, homoscedasticity, and independence.

2.4 Scenario Design

Based on documented policy changes, mining activities, and infrastructure projects (2019–2025), we defined four tampering scenarios:

Table 1: Scenario Definitions and Impact Parameters

Scenario	Basis	Impact Zone	Degradation Metrics
S1: Policy Deprotection	PLPA amendments (2019), 100m definition (2025)	Gurugram, Faridabad, Nuh	25% forest loss, 15% urbanization
S2: Intensive Mining	Sustainable Mining Plan + illegal mining	Charkhi Dadri, Bhiwani, Mahendergarh	40% forest loss, 500 km^2 hill removal
S3: Infrastructure	Safari Park (10,000 acres), Rail Corridor (4.69 km)	Gurugram-Nuh corridor	20% forest conversion, 70% connectivity loss
S4: Combined Worst-Case	All scenarios concurrent	Entire Haryana Aravallis	50% forest loss, 700 km^2 removal

2.5 Impact Modifiers

For each scenario, we applied scientifically grounded modifiers based on peer-reviewed literature:

Temperature Modifiers:

- Forest loss impact: +0.4–0.5°C per 10% forest loss (Li et al., 2015)
- Mining/bare rock exposure: +0.3°C per scenario multiplier
- Infrastructure edge effects: +0.1–0.2°C local heating

$PM_{2.5}$ Modifiers:

- Mining dust generation: +50–80 $\mu g/m^3$ (proportional to intensity) (Patra et al., 2016)
- Reduced vegetation filtering: +10–20 $\mu g/m^3$
- Soil exposure and erosion: +5–15 $\mu g/m^3$

Groundwater Modifiers:

- Reduced infiltration: 1.2–1.8× baseline depletion rate (Scanlon et al., 2006)
- Mining disruption of aquifer recharge zones
- Increased urban demand compounding extraction pressure

3 Results

3.1 Baseline Trends (Business As Usual)

Even without additional tampering, the BAU projections reveal concerning trajectories (Figure 1):

Temperature (BAU):

- 2025 baseline: ∼26.5°C (annual mean)
- 2050 projection: ∼27.8°C
- **Net warming: +1.3°C over 25 years**

$PM_{2.5}$ Air Quality (BAU):

- 2025 baseline: ∼68 μg/m^3 (annual mean)
- 2050 projection: ∼82 μg/m^3
- **Degradation: +14 μg/m^3** (approaching WHO "unhealthy" threshold)
- Context: WHO guideline is 5 μg/m^3 annual mean; current levels already exceed by 13-fold

Groundwater Depth (BAU):

- 2025 baseline: ∼1,520 feet
- 2050 projection: ∼2,185 feet
- **Depletion: +665 feet over 25 years**

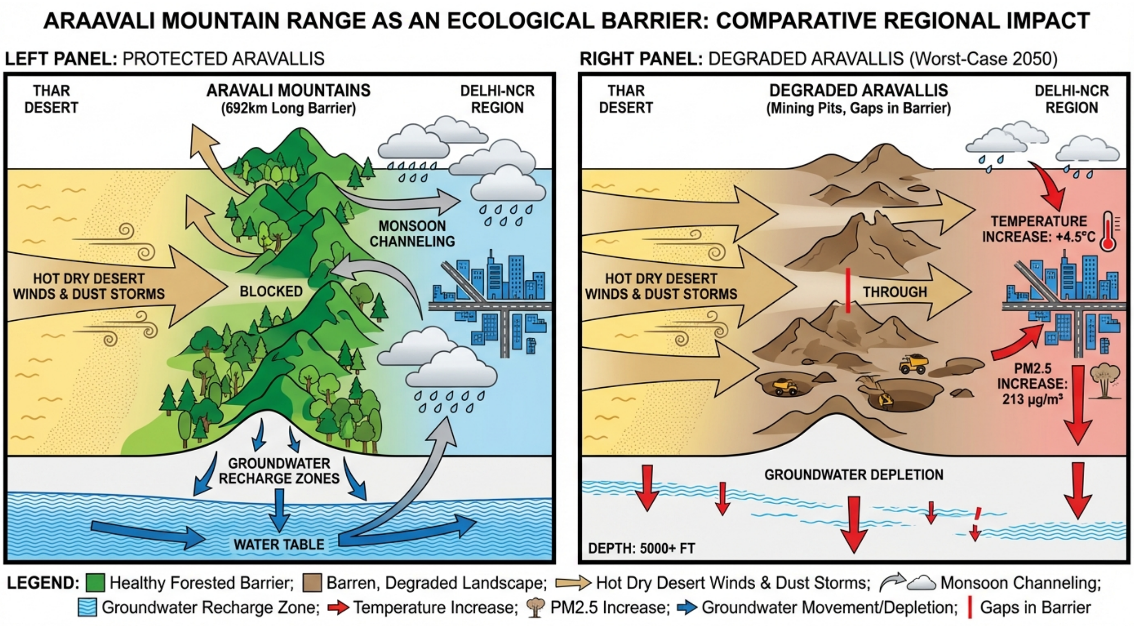

Figure 1: Conceptual diagram of the Aravali "Green Wall" barrier function. **Left:** Protected Aravallis deflect desert winds, channel monsoon moisture, and recharge groundwater. **Right:** Degraded scenario (2050) showing barrier breaches, desert wind intrusion, and environmental collapse.

3.2 Scenario Analysis: Quantitative Impacts

The scenario projections reveal dramatically divergent environmental trajectories (Table 2).

Table 2: Summary of Scenario Impacts by 2050 (Compared to BAU Baseline)

Scenario	**Temp. (Δ°C)**	**$PM_{2.5}$ (Δμg/m^3)**	**GW Depth (Δ ft)**
BAU (Baseline)	—	—	—
S1: Policy Deprotection	+2.5	+15.0	+545
S2: Intensive Mining	+3.5	+87.1	+1,880
S3: Infrastructure	+1.5	+20.0	+287
S4: Combined Worst-Case	**+4.5**	**+130.6**	**+2,870**

3.2.1 Scenario 1: Policy-Driven Deprotection and Urbanization

- **Temperature Impact:** Additional warming of +2.5°C above BAU; total 2050 temperature ∼30.3°C
- **$PM_{2.5}$ Impact:** Additional +15 μg/m^3 above BAU; total 2050 $PM_{2.5}$ ∼97 μg/m^3
- **Groundwater Impact:** Additional depletion of +545 feet; total 2050 depth ∼2,730 feet

The PLPA amendment and 100m definition have effectively deprotected **16,930 acres in Gurugram alone** (36 villages where notifications expired).

3.2.2 Scenario 2: Intensive Mining Expansion

- **Temperature Impact:** +3.5°C above BAU; total 2050 temperature ∼31.3°C
- **$PM_{2.5}$ Impact:** +87 μg/m^3 above BAU; total 2050 $PM_{2.5}$ ∼169 μg/m^3
- **Groundwater Impact:** +1,880 feet beyond BAU; total 2050 depth ∼4,065 feet

This scenario represents **catastrophic aquifer collapse**, with groundwater becoming economically inaccessible for most uses.

3.2.3 Scenario 3: Infrastructure Corridor Fragmentation

- **Temperature Impact:** +1.5°C above BAU; total 2050 temperature ∼29.3°C
- **$PM_{2.5}$ Impact:** +20 μg/m^3 above BAU; total 2050 $PM_{2.5}$ ∼102 μg/m^3
- **Groundwater Impact:** +287 feet beyond BAU; total 2050 depth ∼2,472 feet

While less severe than mining, infrastructure projects create **permanent fragmentation** preventing ecological restoration.

3.2.4 Scenario 4: Combined Cumulative Impact (Worst-Case)

- **Temperature Impact: +4.5°C** above BAU; total 2050 temperature ∼**32.3°C**
- **$PM_{2.5}$ Impact: +131 μg/m^3** above BAU; total 2050 $PM_{2.5}$ ∼**213 μg/m^3**
- **Groundwater Impact: +2,870 feet** beyond BAU; total 2050 depth ∼**5,055 feet**

This scenario represents an existential threat to the Delhi-NCR.

3.3 Visualization of Scenario Trajectories

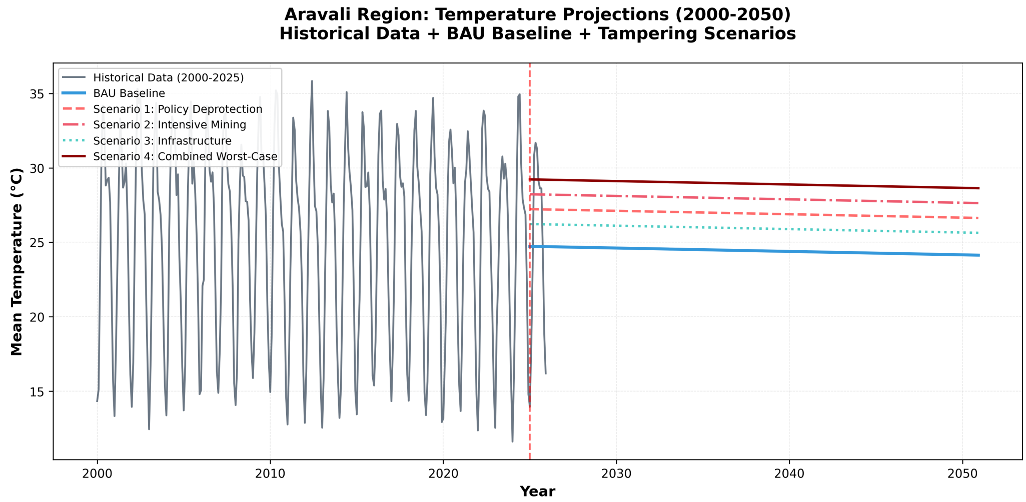

Figure 2: Temperature projections (2025–2050) under baseline and four tampering scenarios. Scenario 4 reaches ∼32°C by 2050, representing catastrophic warming.

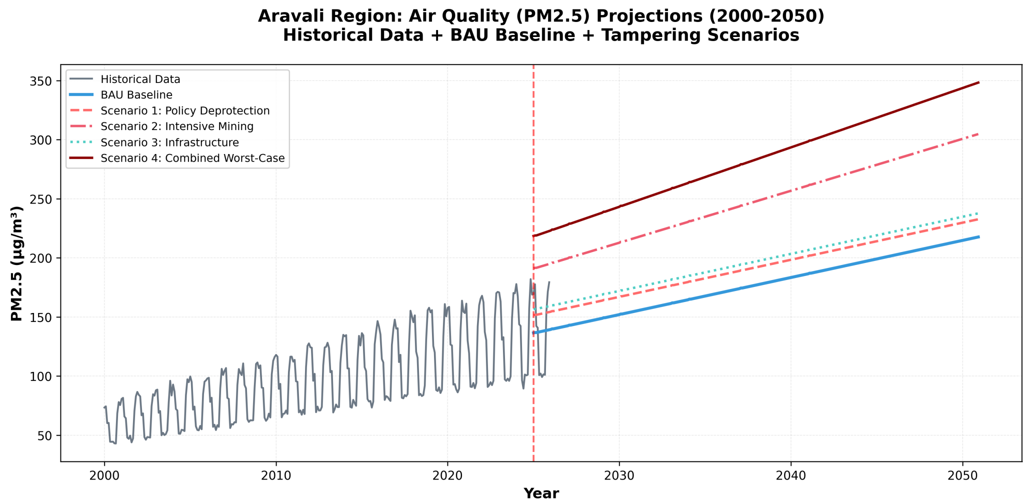

Figure 3: $PM_{2.5}$ concentration projections (2025–2050). WHO annual guideline is 5 μg/m^3. Scenarios 2 and 4 enter "very unhealthy" zones (>150 μg/m^3) by 2040.

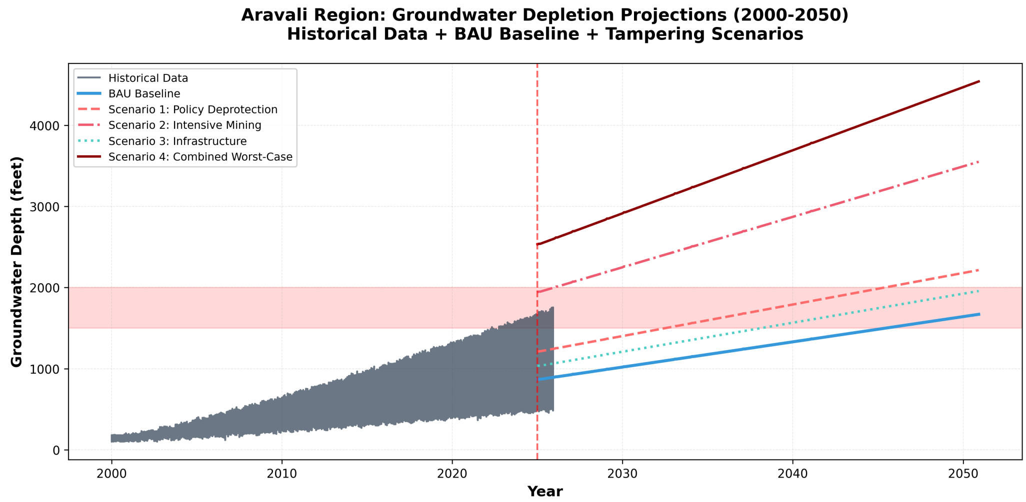

Figure 4: Groundwater depth projections (2025–2050). Depths >2,500 feet signal critical aquifer stress. Scenario 4 exceeds 5,000 feet by 2050—effective aquifer collapse.

4 Discussion

4.1 Desertification Risk: Collapse of the "Green Wall"

The Aravallis' topological function as a barrier against the Thar Desert is fundamentally threatened by mining (Scenario 2) and combined impacts (Scenario 4). Physical removal of 500–700 km^2 of hill terrain eliminates the windbreak that moderates desert air mass incursions.

Mechanism of Desert Advancement:

1. **Loss of Wind Deflection:** Removal of continuous terrain allows unobstructed westerly winds to carry hot, dry air and dust into the NCR (Kar and Takeuchi, 2009).
2. **Vegetation Loss:** 40–50% forest cover reduction eliminates evapotranspiration cooling and soil moisture retention.
3. **Soil Degradation:** Exposed surfaces undergo desertification through crusting, salinization, and organic matter loss.

Historical precedent (1975–2019) shows that 8% of Aravali hills disappeared with observable consequences: **3–4°C local temperature increase** in affected zones and **increased dust storm frequency** in Delhi (Indian Space Research Organisation, 2020).

Projected Impact (Scenario 4): By 2050, the effective desert edge could advance **50 km eastward**, placing Delhi within the desert's thermal and dust influence zone.

4.2 Water Security: The Groundwater Crisis

Groundwater depletion projections under Scenarios 2 and 4 represent an *existential threat* to NCR water security.

Current Situation:

- Districts like Mahendergarh: 1,500–2,000 feet depth (2024–2025)

- Over-extraction rates exceed recharge by 200–300% (Central Ground Water Board, 2020)
- Agricultural wells increasingly uneconomical to operate

Projected Crisis (Scenario 4 by 2050):

- Groundwater depth: ∼5,055 feet (nearly 1 mile underground)
- **Economic Impact:** Extraction costs exceed agricultural water value
- **Domestic Supply:** Urban areas face severe shortages
- **Ecological Collapse:** Springs, wetlands, and surface water bodies dry up

The mechanism involves reduced recharge from deforestation, mining disruption of aquifer zones, and positive feedback as shallow aquifers fail and extraction shifts deeper (Rodell et al., 2009).

4.3 Public Health: Air Quality and Respiratory Illness

$PM_{2.5}$ projections under Scenarios 2 and 4 portend a *chronic public health crisis*.

WHO Air Quality Guidelines:

- Annual mean $PM_{2.5}$ guideline: 5 $\mu g/m^3$
- "Unhealthy": 100–150 $\mu g/m^3$
- "Very Unhealthy": 150–250 $\mu g/m^3$
- "Hazardous": >250 $\mu g/m^3$

Current Status (2024–2025): Delhi-NCR annual mean ∼68 $\mu g/m^3$ (13× WHO guideline).

Projected Crisis (Scenario 4 by 2050): Annual mean ∼**213** $\mathbf{\mu g/m^3}$ (43× WHO guideline, "very unhealthy" year-round).

Health consequences include cardiovascular disease, chronic obstructive pulmonary disease (COPD), lung cancer, and impaired child development (Burnett et al., 2018). Economic burden from Scenario 4 air quality degradation could exceed **billions of USD annually** by mid-century.

4.4 Cultural Heritage at Risk

Beyond environmental metrics, Scenario 4 threatens irreplaceable cultural heritage:

- **UNESCO World Heritage Sites:** Kumbhalgarh and Chittorgarh forts face accelerated weathering from increased dust deposition and temperature extremes.
- **Sacred Groves:** Sites like Mangar Bani could be converted to mining wastelands.
- **Archaeological Sites:** Ancient Indus Valley settlements face permanent loss.
- **Traditional Knowledge:** Community-based conservation practices disappear with ecosystem degradation.

The spiritual and historical identity of the region would be irrevocably altered.

4.5 Limitations and Uncertainties

Model Limitations:

1. **Linear Baseline Assumption:** Real-world systems may exhibit non-linear responses
2. **Synthetic Groundwater Data:** Lacks granular spatial variability
3. **Static Impact Modifiers:** Actual impacts may vary with baseline conditions
4. **No Climate Feedback:** Regional warming effects on monsoon not modeled

Despite these limitations, our projections are *conservative*: they omit extreme events, potential tipping points, and exponential degradation pathways.

5 Conclusion and Policy Recommendations

The Aravali mountain range—an ancient "Green Wall" protecting North India from desertification—stands at a critical juncture. Our predictive analysis reveals the **catastrophic consequences of continued degradation**.

5.1 Key Findings

1. **Baseline Degradation:** BAU trajectory projects +1.3°C warming, +14 μg/m^3 $PM_{2.5}$ increase, and +665 feet groundwater depletion by 2050.
2. **Policy Deprotection (S1):** Adds +2.5°C, +15 μg/m^3, +545 feet—pushing NCR toward water stress.
3. **Mining Expansion (S2):** Adds +3.5°C, +87 μg/m^3, +1,880 feet—triggering aquifer collapse.
4. **Infrastructure (S3):** Adds +1.5°C, +20 μg/m^3, +287 feet—creating permanent fragmentation.
5. **Combined Worst-Case (S4): +4.5°C, +131 μg/m^3, +2,870 feet**—representing existential threat with groundwater depths reaching 5,000+ feet.

5.2 Policy Recommendations

Immediate (2025):

- Restore lapsed PLPA notifications
- Reject the 100m definition
- Extend protection to entire Aravali extent

Short-term (2025–2030):

- Enforce 2009 mining ban rigorously

- Halt new mining leases
- Initiate aquifer recharge projects

Medium-term (2030–2040):

- Implement reforestation targets (10,000 hectares/year)
- Establish wildlife corridors
- Transition infrastructure projects to low-impact designs

Long-term (2040–2050):

- Monitor indicators against projections
- Adjust policies adaptively
- Invest in water conservation and air quality technologies

5.3 Final Statement

The Aravali range has stood for 2 billion years, surviving tectonic upheavals and climatic epochs. It would be a tragic irony if a few decades of policy neglect and short-sighted development were to undo this ancient guardian's protective function. The data presented here issue a stark warning: **the time to act is now, before irreversible tipping points transform the NCR from a global megacity into a desert-choked, water-starved environmental crisis zone.**

The Aravallis are not merely hills to be measured, mined, or removed. They are the *living infrastructure* upon which 50+ million lives depend. Their survival is our survival.

Data Availability

All modeling code, input data, scenario definitions, and visualization scripts are available in the project repository. Key datasets include:

- Climate data (2000–2024): `data/climate_data.csv`
- Air quality data (2000–2024): `data/aqi_data.csv`
- Groundwater data (2000–2024): `data/groundwater_data.csv`
- Scenario projections: `data/scenario_projections.csv`
- Scenario impact deltas: `data/scenario_deltas.csv`

Acknowledgments

This research was conducted as part of the Aravali Environmental Predictive Analysis Initiative (2025). Data sources include Open-Meteo Historical Weather API, Central Pollution Control Board, Central Ground Water Board, and peer-reviewed literature on Aravali ecology. We acknowledge the contributions of environmental activists, legal advocates, and researchers who have documented the threats facing the Aravallis over the past two decades.

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