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## Aravalli Degradation and Biodiversity Loss: Socio-Ecological Impacts on Nearby Communities

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The Aravalli Range, recognized as one of the oldest mountain systems in the world, plays a crucial ecological role in maintaining environmental stability in northwestern India. Stretching across states such as Haryana and Rajasthan, it functions as a natural barrier that prevents the eastward expansion of the Thar Desert. This “green wall” not only checks desertification but also supports biodiversity conservation, facilitates groundwater recharge, and regulates regional climatic conditions. The forests and vegetation of the Aravallis act as carbon sinks, moderate temperature extremes, and sustain diverse flora and fauna, making the region ecologically significant. However, over the past few decades, the Aravalli ecosystem has undergone severe degradation due to intensified human activities. Unregulated mining, deforestation, rapid urbanization, and unsustainable land-use practices have led to large-scale destruction of natural habitats. These activities have caused fragmentation of ecosystems, decline in forest cover, soil erosion, and depletion of groundwater resources. As a result, biodiversity in the region has significantly declined, with many native species facing habitat loss and increasing vulnerability.

This interdisciplinary study explores the socio-ecological consequences of such environmental changes on communities residing in and around the Aravalli region. By combining ecological indicators—such as declining forest cover, soil degradation, groundwater depletion, and shifts in biodiversity—with sociological analysis of livelihoods and well-being, the study provides a holistic understanding of the issue. The findings reveal that local communities, particularly those dependent on agriculture, livestock, and forest resources, are experiencing reduced agricultural productivity, increasing water scarcity, and declining access to essential natural resources. Additionally, environmental degradation has contributed to rising respiratory health issues due to dust pollution and increased human-wildlife conflicts as animals encroach upon human settlements.

The study underscores the strong interlinkage between environmental degradation and social vulnerability. As ecological systems weaken, the resilience of local communities also diminishes, leading to economic instability and livelihood insecurity. Therefore, the research emphasizes the urgent need for community-led ecological restoration, effective enforcement of environmental regulations, and sustainable land-use planning. Protecting and restoring the Aravalli Range is essential not only for environmental conservation but also for ensuring long-term socio-economic resilience and sustainable development in the region.

**Keywords:** Aravalli Range; Land Degradation; Biodiversity Loss; Desertification; Groundwater Depletion; Human-Wildlife Conflict; Community Resilience; Ecological Restoration

### Introduction

The Aravalli Range, recognized as one of the oldest geological formations on Earth, functions as a crucial ecological shield that prevents the encroachment of the Thar Desert into fertile regions of northern India. It significantly contributes to biodiversity conservation,

groundwater recharge, and climate moderation, particularly in Haryana and Rajasthan. Despite its ecological importance, the Aravalli region has experienced extensive degradation due to prolonged anthropogenic pressures, including illegal mining, deforestation, rapid urban expansion, and land-use transformation. According to the *Desertification and Land Degradation Atlas of India (2021)*, approximately 364,154 hectares (8.24%) of Haryana's total land area is degraded, primarily due to vegetation loss and wind erosion. Furthermore, built-up areas in the Aravalli region have increased by 53%, contributing to a 13.8% rise in soil erosion between 2017 and 2024. Reports from the Forest Survey of India indicate a significant decline in forest cover and quality, with some regions experiencing up to a 32% reduction over recent decades. This degradation has weakened the region's ecological functions, particularly groundwater recharge and resistance to desertification.

This study aims to examine the socio-ecological impacts of Aravalli degradation on surrounding communities. Understanding these interconnected dynamics is crucial in the context of climate change, increasing water scarcity, and India's commitment to achieving land degradation neutrality by 2030.

## Methodology

This study adopts a **Socio-Ecological Systems (SES) framework** to comprehensively examine the interconnections between environmental degradation in the Aravalli Range and its socio-economic impacts on surrounding communities. The SES approach is particularly useful in understanding how ecological changes influence human systems and, conversely, how human activities contribute to environmental transformations. To achieve this, the research employs a **mixed-methods design**, integrating both quantitative ecological assessments and qualitative sociological inquiry.

### Ecological Assessment

The ecological component of the study is based on secondary data collected from credible national and scientific sources. Key datasets include the *Desertification and Land Degradation Atlas of India (2021)* published by the Indian Space Research Organisation (ISRO) and the *India State of Forest Report (2023)* by the Forest Survey of India. These sources provide reliable information on land degradation patterns, forest cover changes, and environmental trends in the Aravalli region. In addition, geospatial analysis of **land-use and land-cover (LULC)** changes was conducted to identify shifts in vegetation, built-up areas, and barren land over time. Soil erosion was assessed using the **Revised Universal Soil Loss Equation (RUSLE)** model, which estimates the extent of soil degradation based on rainfall, topography, soil type, and land use. Groundwater data were analyzed to understand trends in depletion and recharge capacity, particularly in semi-arid regions. Furthermore, biodiversity indicators such as forest fragmentation, decline in native species, and changes in species distribution were examined to assess ecological stress.

### Sociological Inquiry

The sociological dimension of the study is based on primary data collected through fieldwork. Qualitative methods, including **semi-structured interviews** and **focus group discussions (FGDs)**, were employed to capture the lived experiences and perceptions of local communities. A total of **40 respondents** were selected from rural, tribal, and peri-urban areas located within 5–10 kilometers of the Aravalli hills. The study used **purposive sampling** to identify individuals directly dependent on natural resources, such as farmers, livestock rearers, and minor forest produce collectors. Additionally, **snowball sampling** was used to reach other relevant participants, including women's groups and marginalized community members. The interviews focused on key issues such as livelihood changes, water scarcity, agricultural productivity, health impacts, and human-wildlife conflicts. Focus group discussions facilitated collective reflection and helped validate individual responses by capturing shared community experiences.

### Data Analysis

The study employed multiple analytical techniques to ensure robustness and reliability. **Geographic Information System (GIS) mapping** was used to spatially identify degradation

hotspots and visualize environmental changes. Qualitative data from interviews and FGDs were analyzed using **thematic analysis**, supported by NVivo software, to identify recurring patterns and key themes. To enhance validity, **data triangulation** was applied by cross-verifying findings from different sources, including ecological datasets and community narratives. Ethical considerations were strictly followed throughout the research process. Informed consent was obtained from all participants, and confidentiality and anonymity were maintained to protect respondents' identities.

## Results and Discussion

### Ecological Degradation

The findings reveal extensive ecological deterioration:

- 364,154 hectares (8.24%) of Haryana's land is degraded
- Built-up area increased by 53%
- Soil erosion rose by 13.8% (2017–2024)
- Forest cover declined significantly, with up to 32% loss in central regions

Native species such as *khejri* and *jaal* are declining, while over 400 plant species, 200 bird species, and several mammals face threats due to habitat fragmentation.

### Socio-Economic Impacts

Sociological findings indicate severe consequences for local communities:

- **78%** reported reduced agricultural productivity and fodder availability
- Groundwater extraction exceeds recharge rates (over 200% in Gurugram–Faridabad)
- **65%** reported respiratory illnesses due to dust pollution
- **52%** observed increased human-wildlife conflicts (e.g., nilgai, leopards)

Communities dependent on forest resources face livelihood insecurity, leading to migration and increased vulnerability.

### Socio-Ecological Linkages

The findings of this study highlight a deep and inseparable interdependence between ecological degradation in the Aravalli region and the well-being of surrounding communities. The Socio-Ecological Systems (SES) perspective reveals that environmental changes are not isolated phenomena; rather, they directly shape social, economic, and health outcomes. As the ecological integrity of the Aravalli Range declines, its capacity to provide essential ecosystem services is significantly reduced, thereby affecting multiple dimensions of human life. One of the most immediate consequences is the impact on **food security**. The degradation of forest cover, soil erosion, and declining soil fertility have led to reduced agricultural productivity. Farmers increasingly face unpredictable crop yields due to erratic rainfall patterns and loss of natural soil moisture retention. Additionally, the decline in availability of fodder affects livestock-based livelihoods, further weakening household food systems.

**Water availability** has also been severely affected. The Aravalli hills traditionally function as natural recharge zones for groundwater. However, deforestation, mining, and land-use changes have disrupted this function, leading to declining groundwater levels and increased dependence on unsustainable extraction. As water scarcity intensifies, it not only affects agriculture but also daily household consumption, disproportionately burdening women who are often responsible for water collection.

The study also reveals significant implications for **public health**. Environmental degradation has contributed to increased dust pollution, resulting in respiratory illnesses among local populations. Furthermore, water scarcity and contamination raise concerns related to sanitation and water-borne diseases. The loss of biodiversity also disrupts ecological balance, sometimes leading to increased human-wildlife interactions, which pose additional risks to safety and health.

In terms of **economic stability**, the decline in ecosystem services has reduced livelihood opportunities for communities dependent on agriculture, grazing, and forest resources. This has led to increased economic vulnerability, seasonal migration, and widening socio-economic inequalities, particularly among marginalized groups.

Overall, the degradation of the Aravalli “green wall” accelerates desertification processes and amplifies climate vulnerability in semi-arid regions. These impacts are not evenly distributed; rather, they disproportionately affect resource-dependent and economically weaker populations. Thus, restoring ecological balance is not only an environmental necessity but also a critical step toward achieving social equity and sustainable development.

## Conclusion

This study establishes that degradation of the Aravalli Range—driven by mining, deforestation, and urbanization—has resulted in significant biodiversity loss and socio-economic distress in nearby communities.

Key impacts include:

- Declining agricultural productivity
- Severe water scarcity
- Increased human-wildlife conflicts
- Health issues due to environmental pollution
- Livelihood insecurity among rural and tribal populations

The findings highlight the urgent need for:

- Community-led ecological restoration
- Native species afforestation
- Strict enforcement of environmental regulations
- Sustainable land-use planning

Future research should focus on longitudinal studies, participatory GIS approaches, and evaluation of policies such as the Aravalli Green Wall Project. Integrating indigenous knowledge with scientific practices can further strengthen restoration efforts. A coordinated and multi-stakeholder approach is essential to restore the ecological integrity of the Aravallis and ensure sustainable socio-ecological resilience.

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