International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Decadal Trends in Mineral Resource Production, Economic Value, and Environmental Impact in Tonk District (2011–2020)

Prof. R. N. Sharma[1], Pushkar Singh Bagaria[2]

[1]Professor and Former Head, Department of Geography, University of Rajasthan
[2]Research Scholar, Department of Geography, University of Rajasthan

Abstract

This study investigates the decadal trends in mineral resource production, economic contribution, and environmental impact in Tonk District, Rajasthan, from 2011 to 2020. Tonk is known for its rich deposits of minor minerals such as sandstone, quartz, feldspar, garnet, and aquamarine. Using data from the Department of Mines and Geology, satellite imagery, and environmental assessments, the research reveals a steady increase in mineral extraction, particularly from riverbeds like the Banas, contributing significantly to district revenue—reaching ₹38 crore from Banas river mining alone in 2021. However, this economic growth has coincided with environmental degradation, including groundwater depletion, land erosion, and biodiversity loss. Groundwater levels in some blocks declined by up to 2.29 meters annually5, and water quality deteriorated due to elevated levels of fluoride and nitrate. The study highlights regulatory gaps, especially in controlling illegal mining, and proposes a framework for sustainable mineral governance that balances economic development with ecological preservation.

Keywords: Mineral extraction, Environmental degradation, Sustainable mining, Rajasthan, Groundwater depletion, Economic analysis

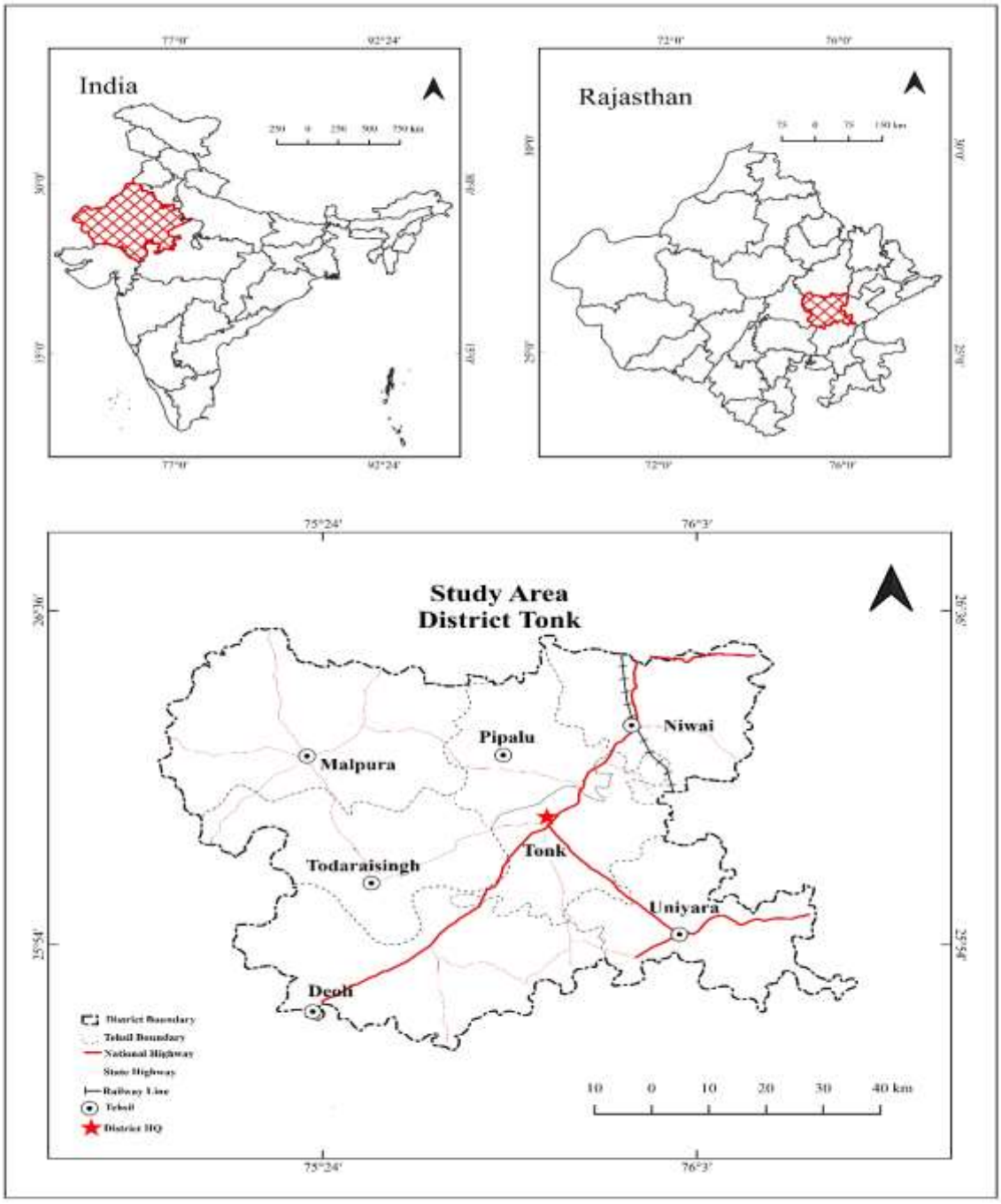
Introduction

Mineral resources serve as the backbone of regional development in geologically diverse regions, with Tonk District in Rajasthan exemplifying this relationship. Covering 7,194 sq. km, Tonk houses substantial deposits of minor minerals—sandstone, quartz, feldspar, garnet, aquamarine, and building stone—that support construction, manufacturing, and local livelihoods. The decade from 2011 to 2020 witnessed unprecedented mineral extraction driven by infrastructure expansion and market demand, contributing significantly to Rajasthan's mineral revenue.

The district's mineral wealth generated substantial economic returns, with the Banas river alone contributing ₹38 crore in 2021. However, this economic boom masked severe environmental consequences. Mining activities, particularly illegal and unregulated operations, triggered land degradation, groundwater depletion, and ecological disruption. Groundwater monitoring reveals declining trends with annual drops exceeding 2 meters in critical areas, while water quality assessments show elevated fluoride, nitrate, and total dissolved solids levels, rendering significant portions of groundwater unsuitable for consumption.

These impacts are amplified by weak regulatory enforcement and limited institutional capacity, creating an urgent need for sustainable mineral resource management that balances economic benefits with environmental stewardship.

Map 1: Location Map of Study Area



Source: District Census Handbook, Tonk, 2011

Objective

- To analyze comprehensive production volumes, area coverage, and employment generation across key minor minerals in Tonk District from 2011 to 2020.
- To evaluate the complete economic contribution including production values, sale values, and revenue generation from mineral extraction.
- To assess employment patterns and labor market impacts of the mining sector.
- To document environmental degradation trends and correlate them with mining intensity.
- To propose evidence-based policy recommendations for sustainable mineral resource management.

Data Collection and Methodology

This study employs a comprehensive mixed-methods approach integrating quantitative data analysis, spatial mapping, and qualitative policy evaluation to assess mineral resource extraction trends and impacts in Tonk District over the 2011-2020 decade.

Production and Economic Analysis: Primary data were obtained from the Department of Mines and Geology (DMG), Rajasthan, encompassing detailed records of:

- Annual lease allocations by mineral type
- Area coverage in hectares for each mineral category
- Production volumes in tons across all major minerals
- Complete financial records including sale values and government revenues
- Employment statistics across different mining operations

Environmental Impact Assessment: The study utilized satellite imagery from Bhuvan (ISRO) and Google Earth Engine to analyze spatial expansion of mining zones, particularly along riverbeds and ecologically sensitive areas. Groundwater data from the Central Ground Water Board (CGWB) and Rajasthan State Pollution Control Board (RSPCB) were examined to evaluate water level changes and quality deterioration, focusing on fluoride, nitrate, and total dissolved solids parameters.

Regulatory Evaluation: Qualitative analysis of policy documents including the Mines and Minerals (Development and Regulation) Act, 1957, and Rajasthan Minor Mineral Concession Rules, supplemented by interviews with local officials, mining contractors, and community members to identify enforcement challenges and governance gaps.

Production Trends Analysis

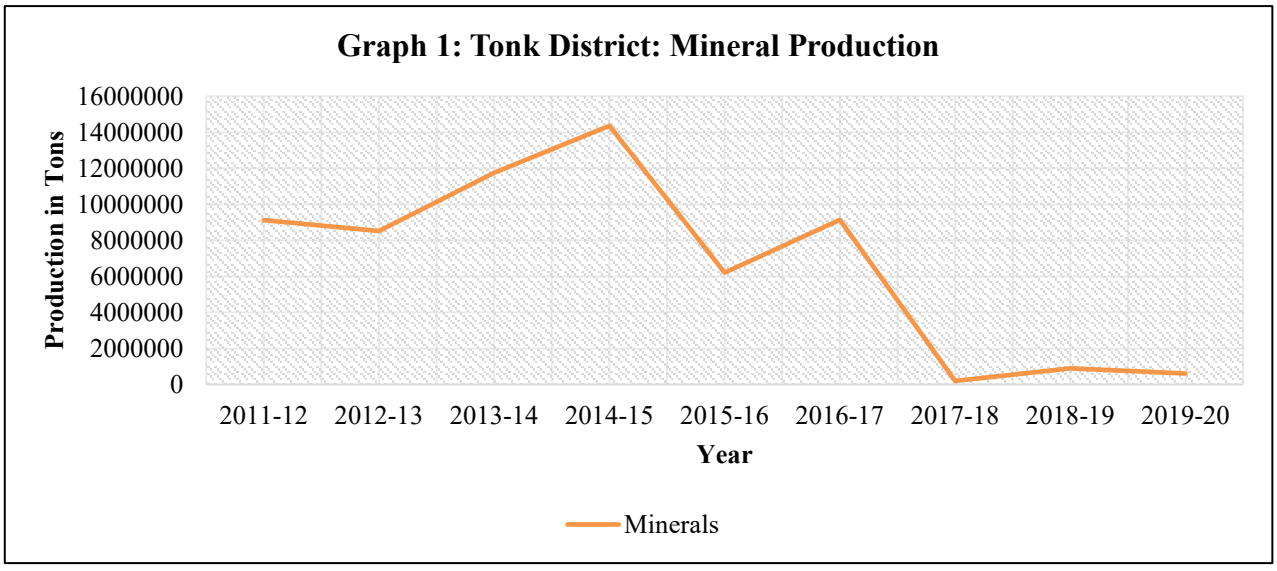
The decade reveals dramatic shifts in mineral extraction patterns across Tonk District. Masonry Stone maintained consistent lease allocation with 59-67 leases annually, covering 51.22-89.08 hectares, while Quartz showed remarkable growth from 45 to 63 leases, representing a 40% increase. Most significantly, Granite mining commenced in 2019-20 with 27 new leases covering 42.5 hectares.

Table 1: Tonk District: Mineral Production in tons

Minerals	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Masonary Stone	245011	716929	199006	66285	103703	20284	54288	305440.37	108676
Phylite-shist/Patti	14475	8950	15525	525	5760	0	248	321.81	4862

Katla									
Brick Earth	125052	110105	50880	82200	29600	90825	36540	49560	36540
Granite	0	0	0	0	0	0	0	68733.45	97210
Slate Stone	537	1200	833	0	0	0	0	0	0
Quartz	112925	99330	154652	151175	74224	254321	103838	411620.67	274805
Felspar	3000	2875	15200	21575	31809	8154	0	49435.28	77812
Silica Sand	2100	0	0	0	0	0	0	67.91	0
Kankar-Bajri	8622336	7572192	11320179	14041330	5960526	8771055	0	0	0
Total	9125436	8511581	11756275	14363090	6205622	9144639	194914	885179	599905

Source: Department of Mines & Geology , Udaipur



Production volumes exhibited extreme volatility, with total mineral output ranging from a low of 194,914 tons in 2017-18 to an unprecedented peak of 14.36 million tons in 2014-15. This dramatic fluctuation reflects market demand cycles and regulatory enforcement periods. Kankar-Bajri emerged as the dominant mineral by volume, contributing up to 14.04 million tons in peak years, while traditional minerals like Masonry Stone showed declining production from 716,929 tons in 2012-13 to 108,676 tons in 2019-20.

Economic Impact Assessment

The economic contribution of mineral extraction shows remarkable variation, with total sale values fluctuating from ₹70.46 crores in 2017-18 to ₹1,455 crores in 2014-15. Kankar-Bajri dominated

economic returns, generating ₹1,404 crores in sale value during 2014-15 alone, representing 97% of total mineral sales that year.

Table 2: Sale Value (in Rs)

Minerals	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Masonary Stone	12250550	12250550	9950300	3314250	5185150	1014200	2714400	15272019	5433800
Phylite-shist/Patti Katla	2895000	1790000	3105000	105000	1152000	0	49600	64362	972400
Brick Earth	125052000	110105000	50877000	8200000	29600000	90825000	36540000	4956000	3654000
Granite	0	0	0	0	0	0	0	240567075	48605000
Slate Stone	107000	240000	166600	0	0	0	0	0	0
Quartz	21568675	23640540	36807176	34165550	22267200	76296300	31151400	123486201	82441500
Felspar	1179000	575000	4225600	5134850	9542700	2446200	0	14830584	23343600
Silica Sand	560700	0	0	0	0	0	0	20373	0
Kankar-Bajri	431116800	378609600	566008950	1404133000	298026300	438552750	0	0	0
Total	594729725	527210690	671140626	1455052650	365773350	609134450	70455400	399196614	164450300

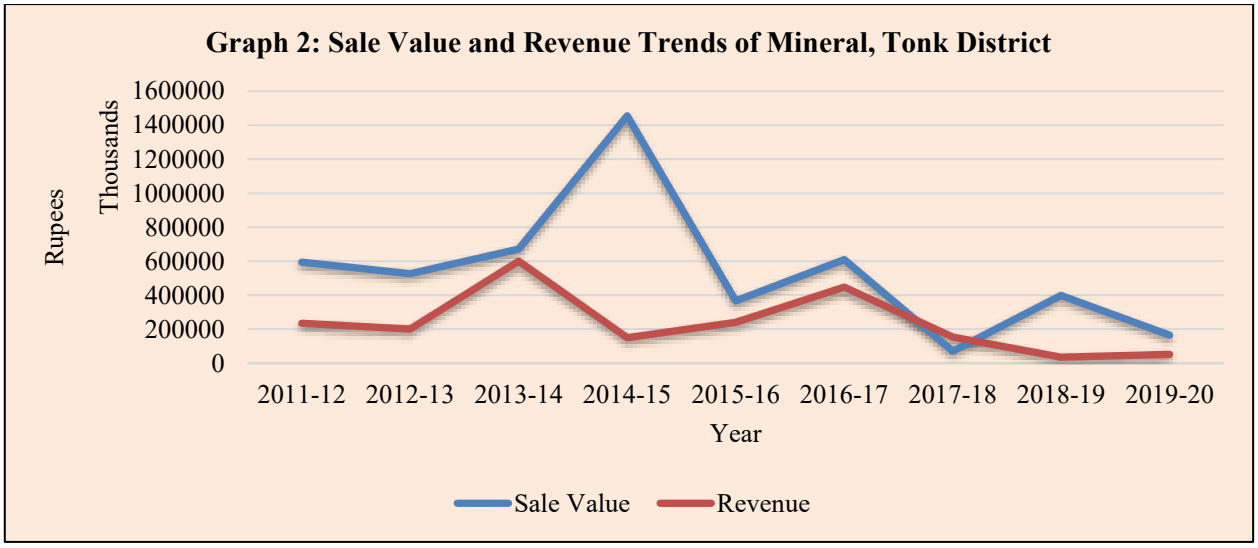
Source: Department of Mines & Geology , Udaipur

Table 3: Revenue (in Rs)

Minerals	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Masonary Stone	4480700	4304793	2912700	1856000	2800000	1907000	9471000	7805086	3771251
Phylite-shist/Patti Katla	579000	358000	621000	518000	635000	519000	502000	484800	291742
Brick Earth	2251000	1981900	915800	2255000	740000	427000	740000	39375	39375
Granite	0	0	0	0	0	0	0	15641392	22844582
Slate Stone	43000	72000	50000	42000	21000	65000	11000	85000	50000
Quartz	4517000	3973200	6222313	6047000	6362000	14582000	9954000	5796283.5	16488339
Felspar	120000	115000	608000	863000	2160000	1252000	1651000	2716816.8	4668741.8

Silica Sand	645000	115000	10000	6156000	0	0	0	2491056.8	3663066.8
Garnet(Abr.& Crude)	38000	94000	94000	0	63000	0	63000	292117	15000
Kankar-Bajri	222764000	189304800	588946200	131803000	227822000	429336000	130886000	0	0
Total	235437700	200318693	600380013	149540000	240603000	448088000	153278000	35351927	51832097.25

Source: Department of Mines & Geology , Udaipur



Government revenue collection followed similar patterns, ranging from ₹35.35 crores in 2018-19 to ₹600.38 crores in 2013-14. The revenue-to-sale-value ratio varied significantly across minerals and years, indicating fluctuating royalty rates and collection efficiency. Granite mining, despite starting only in 2019-20, immediately contributed ₹22.84 crores in revenue, demonstrating high-value mineral potential.

Employment Generation Patterns

Mining sector employment showed considerable instability, fluctuating from 655 persons in 2018-19 to 1,936 persons in 2016-17. Kankar-Bajri mining provided the largest employment base, peaking at 1,350 workers in 2015-17, while Granite mining rapidly generated 300 jobs in its inaugural year. The employment-to-production ratio varied dramatically across minerals, with Masonry Stone maintaining relatively stable employment (150-200 workers) despite production volatility.

Table 4: Employment (in Rs)

Minerals	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Masonary Stone	150	192	150	170	155	155	165	200	165
Phylite-shist/Patti Katla	80	50	80	10	85	85	55	25	55

Brick Earth	80	90	80	200	225	225	150	150	110
Granite	0	0	0	0	0	0	0	85	300
Slate Stone	5	5	5	0	3	3	3	0	3
Quartz	115	122	140	170	105	105	120	120	120
Felspar	20	7	55	7	0	0	0	65	0
Silica Sand	15	0	0	0	0	5	0	0	0
Garnet(Abr.& Crude)	0	0	0	0	0	8	13	10	7
Kankar-Bajri	350	429	350	850	1350	1350	1350	0	0
Total	815	895	860	1407	1923	1936	1856	655	760

Source: Department of Mines & Geology , Udaipur

Environmental Degradation Analysis

Environmental monitoring reveals severe ecological consequences of intensive mineral extraction. Groundwater levels in mining-intensive blocks like Todaraisingh and Malpura declined by up to 2.29 meters annually, indicating severe over-extraction and recharge imbalance. Water quality assessments document elevated fluoride levels exceeding 1.5 mg/L in multiple areas, alongside high nitrate concentrations linked to mining-induced soil leaching and vegetation loss.

Remote sensing analysis demonstrates progressive expansion of mining footprints into ecologically sensitive zones, with visible land degradation and vegetation cover loss. Spatial correlation analysis reveals strong relationships between high-extraction areas and declining water tables, particularly in Kankar-Bajri mining zones that showed the highest production volumes.

Regulatory and Governance Challenges

The study identifies significant discrepancies between licensed mining zones and actual extraction activities observed through satellite imagery, particularly along riverbeds and forest margins. Illegal mining intensified during peak demand periods (2013-15), often bypassing environmental safeguards and regulatory oversight. Community interviews reveal widespread environmental degradation awareness but limited participation avenues in decision-making processes.

Key Findings and Implications

- **Economic-Environmental Trade-offs:** The data reveals a stark trade-off between economic gains and environmental costs. The highest production years (2014-15) coincided with maximum environmental stress, while the lowest production period (2017-18) corresponded with reduced environmental pressure. This pattern suggests that current extraction practices are fundamentally unsustainable.
- **Mineral-Specific Impacts: Kankar-Bajri** extraction, while economically dominant, poses the greatest environmental threat due to its massive scale and riverbed location. **Granite** mining, though recently introduced, shows potential for high-value, lower-volume extraction that might offer better environmental outcomes. Traditional minerals like **Masonry Stone** and **Quartz** demonstrate more stable, manageable extraction patterns.
- **Employment Sustainability:** The extreme volatility in employment (ranging from 655 to 1,936 workers) indicates lack of sustainable livelihood opportunities in the mining sector. This instability

undermines long-term community development and suggests need for diversified economic strategies.

Policy Recommendations

Based on comprehensive data analysis, the study proposes a multi-dimensional policy framework:

1. **Production Volume Regulation:** Implement annual extraction quotas based on environmental carrying capacity rather than market demand, with **Kankar-Bajri** requiring immediate volume restrictions given its environmental impact scale.
2. **Revenue Optimization:** Establish differential royalty structures encouraging high-value, low-volume minerals like **Granite** while discouraging environmentally destructive bulk extraction. Implement performance-based revenue sharing with local communities.
3. **Employment Stabilization:** Create minimum employment guarantees for mining operations and establish skill development programs for transitioning workers during low-production periods.
4. **Environmental Integration:** Mandate environmental impact assessments for all lease renewals, with particular focus on groundwater impact evaluation. Establish mining-free zones around critical water recharge areas.
5. **Technology Enhancement:** Deploy real-time monitoring systems for production tracking and environmental parameter assessment, enabling dynamic adjustment of extraction permissions based on environmental conditions.
6. **Community Participation:** Establish local mineral governance committees with representation from affected communities, ensuring participatory decision-making in lease allocations and environmental protection measures.

Conclusion

The decade from 2011 to 2020 represents a critical period in Tonk District's mineral resource exploitation, characterized by extreme production volatility, significant economic contribution, and severe environmental degradation. While mineral extraction generated substantial revenue (₹1,455 crores peak sale value) and employment (1,936 workers maximum), it imposed unsustainable environmental costs including groundwater depletion, water quality deterioration, and ecological disruption.

The analysis reveals that current extraction patterns are economically unstable and environmentally destructive. The dominance of **Kankar-Bajri** mining, while economically lucrative, poses the greatest threat to district ecology. Conversely, emerging **Granite** mining demonstrates potential for high-value, lower-impact extraction models.

Moving forward, Tonk District requires fundamental transformation in mineral resource governance, emphasizing production sustainability over volume maximization, environmental protection integration, and community participation enhancement. The proposed policy framework offers actionable pathways toward sustainable mineral resource management that preserves ecological integrity while supporting economic development.

This research contributes crucial empirical evidence to the discourse on environmental justice and sustainable resource management in India's mineral-rich regions, providing quantitative foundation for evidence-based policy formulation and implementation.

References

1. Department of Mines and Geology, Rajasthan. (2011–2020). *Annual Mineral Production Reports*. Jaipur: DMG Rajasthan.
2. Central Ground Water Board (CGWB). (2020). *Groundwater Yearbook of Rajasthan*. Ministry of Jal Shakti, Government of India.
3. Rajasthan State Pollution Control Board (RSPCB). (2019). *Water Quality Monitoring Reports*. Jaipur: RSPCB.
4. Mines and Minerals (Development and Regulation) Act, 1957. Government of India.
5. Rajasthan Minor Mineral Concession Rules, 2017. Government of Rajasthan.
6. ISRO Bhuvan Portal. (2020). *Remote Sensing Data for Land Use Analysis*.
7. Singh, R., & Sharma, P. (2018). "Environmental Impacts of Mining in Rajasthan: A Case Study of Tonk District." *Journal of Environmental Geography*, 12(3), 45–56.
8. World Bank. (2021). *Managing Mining for Sustainable Development: A Sourcebook*. Washington, D.C.