

Evaluation of industrialization and its impact on change in environmental conditions in Jharkhand: A Survey Based Exploration

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ABSTRACT

Jharkhand's rapid industrialization, driven by its mineral wealth, has led to significant economic benefits, including job creation and infrastructure development. However, this growth has come at a considerable environmental cost. The state's air quality has deteriorated due to emissions from industrial activities, leading to health issues for residents. Water resources are polluted by industrial effluents, impacting aquatic ecosystems and reducing clean water availability. Soil degradation and biodiversity loss are also critical concerns, exacerbated by deforestation and habitat destruction. This study evaluates these environmental impacts and highlights the need for a balanced approach to industrial growth. Strategies such as stricter environmental regulations, adoption of clean technologies, effective waste management, and community engagement are essential to mitigate adverse effects and promote sustainable development. By addressing these challenges, Jharkhand can aim for economic advancement while safeguarding its environmental and public health.

Keywords: *Industrialization, Environmental Impact, Sustainability.*

I. INTRODUCTION

Jharkhand, endowed with rich mineral resources, has undergone significant industrialization, reshaping its economic and environmental landscape. The drive towards industrial growth, primarily in mining and metallurgy, has brought about substantial economic benefits, including job creation, infrastructure development, and increased state revenue. However, this rapid industrial expansion has not been without environmental costs, leading to a pressing need for a balanced evaluation of its impacts. Industrial activities in Jharkhand have led to severe air pollution, primarily due to emissions from factories and vehicular traffic. Pollutants such as sulphur dioxide, nitrogen oxides, and

particulate matter have increased, deteriorating air quality and posing serious health risks to the local population. Water bodies have also suffered from industrial effluents, leading to contamination of rivers and groundwater. This has adversely affected aquatic life and reduced the availability of clean drinking water for communities. Soil degradation is another critical issue, resulting from deforestation, mining activities, and the disposal of industrial waste. The loss of fertile topsoil and contamination with heavy metals have negatively impacted agriculture, which is a primary livelihood source for many residents. Additionally, the state's rich biodiversity is under threat due to habitat destruction caused by expanding industrial zones and infrastructure projects. Many species face the risk of extinction, disrupting the ecological balance. Despite these challenges, there have been efforts to mitigate the environmental impact. Government regulations, such as stricter emission norms and effluent treatment requirements, aim to control pollution. Some industries have adopted cleaner technologies and better waste management practices. Community-led initiatives and NGO activities have also played a role in advocating for sustainable practices and raising awareness about environmental conservation. While industrialization in Jharkhand has spurred economic growth, it has also brought significant environmental challenges. A sustainable approach, integrating economic development with environmental protection, is essential to ensure the well-being of both the environment and the people of Jharkhand. Continued efforts in policy implementation, technological innovation, and community engagement are crucial for achieving this balance.

1.1 Overview of industrialization in Jharkhand

Jharkhand, one of India's youngest states, was carved out of Bihar in 2000. Rich in mineral resources, the state quickly became a focal point for industrial development, particularly in mining and metallurgy. Jharkhand's industrial landscape is dominated by large-scale industries, including steel, coal, iron ore, copper, and aluminium production. Major industrial hubs like Jamshedpur, Bokaro, Dhanbad, and Ranchi have become synonymous with these sectors, hosting some of India's largest industrial units such as Tata Steel, Steel Authority of India Limited (SAIL), and Coal India Limited. The state's abundant natural resources have attracted significant investments, leading to rapid industrial growth. Jharkhand produces a substantial portion of India's total mineral output, with the coal, iron ore, and mica industries playing crucial roles in its economy. The availability of raw materials has facilitated the establishment of numerous ancillary industries, further boosting employment and economic activities in the region. Industrialization has brought infrastructural developments, including improved transportation networks and urbanization, contributing to the state's modernization. However, this industrial boom has not been without its challenges. The environmental impact of mining and industrial activities has been profound, leading to deforestation, soil erosion, air and water pollution, and loss of biodiversity. The displacement of local communities and the degradation of their traditional livelihoods have also been significant social issues. Despite these challenges, the government has been proactive in promoting sustainable industrial practices. Policies aimed at environmental conservation, stricter regulations on industrial emissions, and efforts to rehabilitate mined areas are steps towards mitigating the adverse effects of industrialization. In recent years, Jharkhand has also been exploring opportunities in the IT and service sectors, aiming to diversify its industrial base. Initiatives to develop industrial parks, special economic zones (SEZs),

and improve ease of doing business are part of the state's strategy to attract more varied investments. The emphasis on skill development and education is also helping to create a workforce better equipped for new industrial demands. Thus, while Jharkhand's industrial journey is rooted in its rich mineral wealth, the state is gradually steering towards a more diversified and sustainable industrial future.

1.2 Importance of The Study

The study of industrialization's impact on Jharkhand's environmental conditions is crucial for several reasons. It provides insights into the balance between economic growth and environmental sustainability, essential for informed policymaking. By identifying the specific environmental challenges associated with industrial activities, the study can guide effective mitigation strategies and regulatory measures. Additionally, understanding these impacts helps in addressing the social consequences for local communities, promoting more sustainable development practices. Ultimately, this research supports the formulation of policies that align industrial growth with environmental stewardship, ensuring long-term ecological health and community well-being in Jharkhand.

1.3 Environmental Conditions in Jharkhand

Jharkhand's environmental conditions are intricately linked to its rich mineral resources and rapid industrialization. The state's diverse landscapes include dense forests, rivers, and hilly terrains, which support a range of ecosystems and biodiversity. However, the environmental balance has been significantly disrupted due to industrial activities.

- **Air Quality:** Industrial emissions from coal mining, steel production, and other industries have led to deteriorating air quality in Jharkhand. High levels of pollutants such as sulphur dioxide, nitrogen oxides, and particulate matter are common, resulting in smog and respiratory issues for residents. Urban areas, particularly around industrial hubs, experience higher pollution levels, impacting public health and the environment.
- **Water Resources:** Water bodies in Jharkhand are heavily affected by industrial effluents and mining runoff. Rivers and streams often suffer from contamination with heavy metals, chemicals, and sediments, which impair water quality and affect aquatic life. This pollution also compromises the availability of clean drinking water for local communities and contributes to waterborne diseases.
- **Soil and Land Degradation:** Mining and industrial activities have led to significant soil degradation. Deforestation for mining operations and the dumping of industrial waste have caused soil erosion, loss of fertility, and contamination. This affects agricultural productivity, which is crucial for the livelihoods of many residents.
- **Biodiversity:** Jharkhand's rich biodiversity faces threats from habitat destruction caused by expanding industrial areas and deforestation. Forests that once supported diverse flora and fauna are being cleared for mining and industrial development, leading to loss of species and disruption of ecological balance.

- **Climate Impact:** The industrial sector's greenhouse gas emissions contribute to climate change, impacting local weather patterns and potentially altering ecosystems. Increased temperatures and irregular rainfall patterns are observed, affecting both natural and human systems.

1.4 Impact of Industrialization on Environmental Conditions

Industrialization in Jharkhand, driven by its abundant mineral resources, has had profound effects on the region's environmental conditions, manifesting across several dimensions:

Air Quality: The surge in industrial activities, including mining, steel production, and power generation, has significantly deteriorated air quality in Jharkhand. Factories and power plants release pollutants such as sulphur dioxide, nitrogen oxides, and particulate matter, leading to smog and respiratory problems among residents. The cumulative impact of these emissions has resulted in hazardous air quality levels, particularly around major industrial hubs like Jamshedpur and Bokaro.

Water Resources: Water bodies in Jharkhand have been heavily impacted by industrial effluents and runoff from mining operations. Rivers and streams often carry contaminants, including heavy metals and chemicals, which degrade water quality and harm aquatic ecosystems. The pollution also affects the availability of clean drinking water, leading to health issues such as waterborne diseases among local communities.

Soil Degradation: Mining activities and industrial waste disposal have caused significant soil degradation. Deforestation for mining operations has led to soil erosion and loss of fertility. Contaminants from industrial waste further contribute to soil pollution, impairing agricultural productivity. This is particularly problematic for rural communities that rely on farming for their livelihoods.

Biodiversity Loss: The expansion of industrial zones has led to the destruction of natural habitats, threatening Jharkhand's rich biodiversity. Forests, which once supported diverse flora and fauna, are being cleared for industrial use, leading to habitat loss and species decline. Many native species face the risk of extinction due to this environmental disruption.

Climate Change: The industrial sector's greenhouse gas emissions contribute to climate change, affecting local weather patterns and potentially altering regional climate conditions. Changes in temperature and precipitation patterns can disrupt ecosystems and agricultural cycles, further compounding environmental and socio-economic challenges.

1.5 Mitigation and Adaptation Strategies

Mitigating and adapting to the environmental impacts of industrialization in Jharkhand require a multifaceted approach involving government policies, industrial practices, and community engagement. Here are key strategies:

Government Regulations and Policies:

- **Stricter Environmental Standards:** Implement and enforce stricter regulations on emissions and effluent discharge to limit pollutants released by industries. Regular monitoring and penalties for non-compliance can ensure adherence to environmental standards.
- **Sustainable Development Policies:** Promote policies that integrate environmental protection with industrial growth, such as incentives for industries adopting green technologies and practices. Environmental Impact Assessments (EIAs) should be mandatory for new projects.

Technological Innovations:

- **Clean Technologies:** Encourage the adoption of cleaner and more efficient technologies in industries. This includes energy-efficient machinery, waste recycling systems, and pollution control devices to minimize emissions and waste.
- **Renewable Energy:** Invest in renewable energy sources such as solar, wind, and hydroelectric power to reduce reliance on fossil fuels and lower greenhouse gas emissions.

Waste Management:

- **Effluent Treatment Plants:** Ensure that industries install and maintain effective effluent treatment facilities to treat wastewater before it is discharged into water bodies. This reduces water pollution and protects aquatic ecosystems.
- **Solid Waste Management:** Develop robust systems for the management and recycling of industrial solid waste. Encourage industries to adopt waste minimization practices and promote recycling and reuse of materials.

Reforestation and Land Rehabilitation:

- **Reforestation Projects:** Implement large-scale reforestation and afforestation projects to restore degraded land and combat deforestation. This helps in stabilizing soil, improving air quality, and enhancing biodiversity.
- **Land Rehabilitation:** Develop strategies for rehabilitating mined and industrially impacted lands, including soil conservation techniques and the restoration of natural vegetation.

Community Involvement and Awareness:

- **Local Engagement:** Involve local communities in environmental monitoring and conservation efforts. Raise awareness about the impacts of industrialization and encourage community-led initiatives for environmental protection.
- **Education and Training:** Provide education and training on sustainable practices for both industry workers and local populations to foster a culture of environmental responsibility.

By implementing these strategies, Jharkhand can mitigate the adverse effects of industrialization while adapting to the environmental challenges posed by rapid industrial growth.

1.6 Objective

The objective of this survey was to assess public perceptions regarding the impact of industrial activities on environmental sustainability, resource consumption, pollution, and public health in Jharkhand. The survey aimed to gather opinions on the effectiveness of industrial practices in minimizing resource depletion and pollution, as well as the adequacy of current regulations.

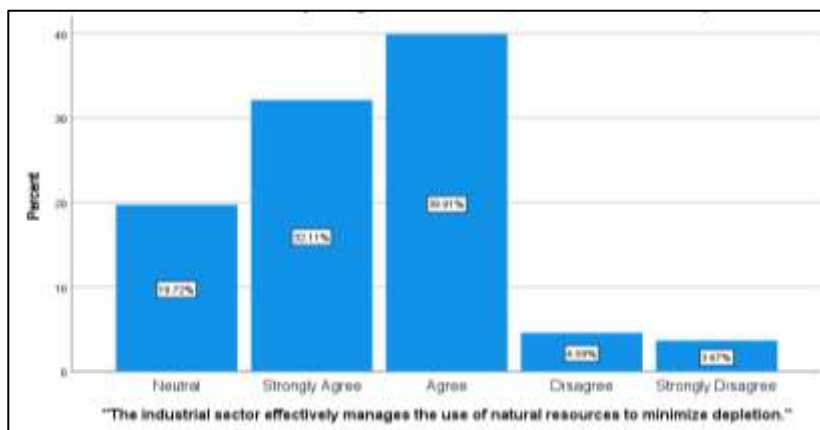
2. LITERATURE REVIEW

Author(s)	Year	Research Area	Location	Methodology	Findings
Ankur et al.	2022	Ecosystem services	Dhanbad, Jharkhand, India	Remote sensing data to evaluate landscape transformation and its impact on ecosystem services	Total ecosystem service value (ESV) loss: \$2251959.76 (1990-2020). Highest ESV loss from agricultural land to built-up area. Per capita ESs decreased by 68.48%. 5 out of 8 spatial units facing negative change, inhabited by over 85% of the population.
Upadhyay & Bhattacharya	2022	Environmental sustainability of coal industry	Dhanbad, Jharkhand, India	Spatio-temporal datasets (2000 and 2020)	Decrease in vegetation (18.89%), increase in built-up land (14.32%) and coalfields (0.9%). Increase in emissions from coal mining activities. 15 indicators suggest urgent need for sustainable coal mining. Changing economic patterns due to industrialization.
Mahto	2018	Indigenous peoples	Global	Literature review	Indigenous peoples face threats to sovereignty, economic well-being, and access to resources. UNDRIP guides national policies. Total population: 220-350 million.
Tirkey et al.	2017	Urbanization and groundwater quality	Ranchi, Jharkhand, India	Sampling from 44 sites, physico-chemical analysis, heavy metals analysis	High levels of toxic metals (As, Ni, Mn, Se) above acceptable limits. 80% of locations have poor water quality. Industrial and commercial zones have degraded water quality.
Barla	2016	Climate change and tribal communities	Jharkhand, India	Literature review	Climate change impacts tribal life, economy, and survival. Increased incidence of drought. Adverse effects on agriculture. Need for policy action for adaptation and sustainable development.
Roy et al.	2014	Industrial development	Jharkhand,	Micro-level	Weak association between infrastructure components and

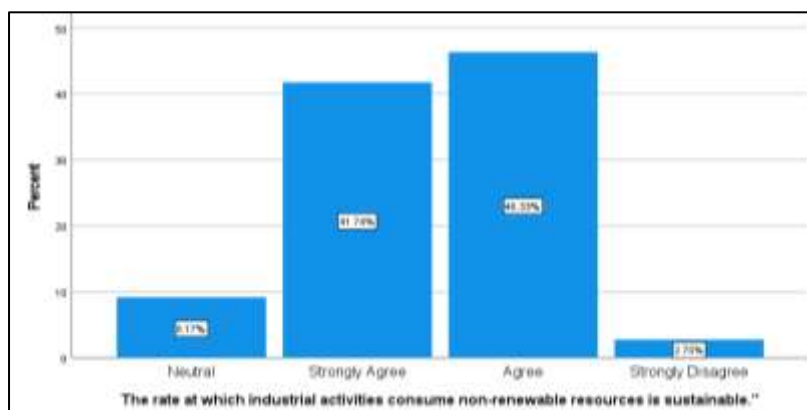


		and infrastructure	India	district analysis	industrial development. Physical and social infrastructure significant in more industrialized districts.
Tigga & Malini	2014	Drought and environmental changes	Jharkhand, India	Literature review	Droughts are linked to climate change, land-use changes, and urbanization. Increased temperature and aerosol emissions affect climate and increase drought vulnerability.
Kumar et al.	2011	Urban sprawl	Ranchi, Jamshedpur, Dhanbad, Jharkhand, India	Visual interpretation of Landsat and IRS-P6 images	Unplanned urban development and densification of urban areas. Built-up land growth at the expense of agricultural land. Need for better land-transformation practices.

3. ANALYSIS OF DATA

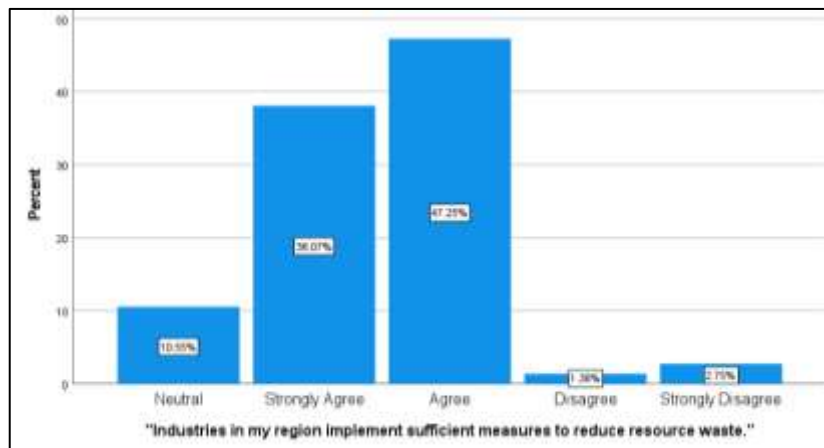


Among 218 respondents, 72% view the industrial sector as effective in minimizing resource depletion, with 39.9% agreeing and 32.1% strongly agreeing. However, 19.7% are neutral, and 8.3% disagree or strongly disagree, indicating mixed opinions and highlighting a need for improved communication and sustainability efforts.

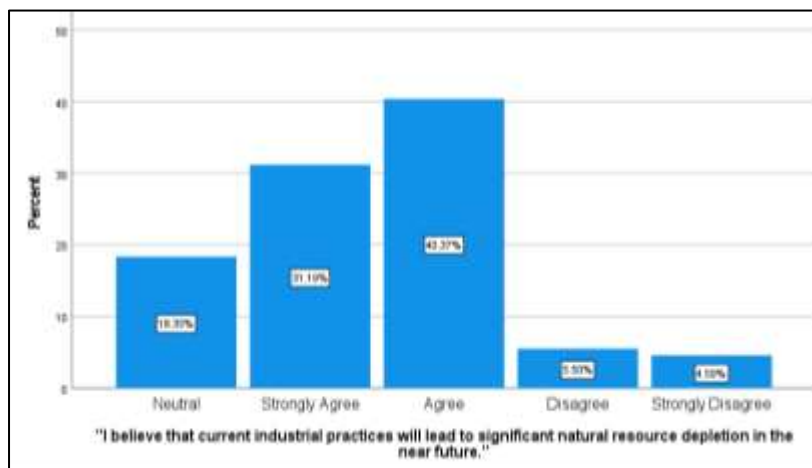




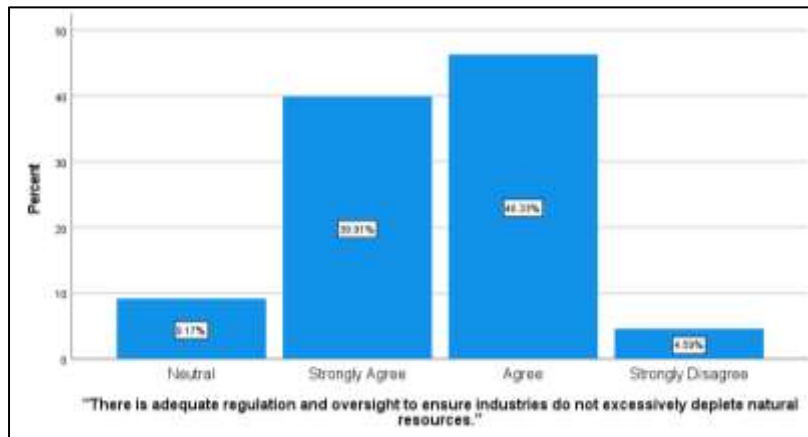
The survey shows 88% of respondents view the rate of non-renewable resource consumption in industrial activities as sustainable, with 46.3% agreeing and 41.7% strongly agreeing. Only 9.2% are neutral, and 2.8% strongly disagree, indicating a general consensus on the sustainability of current consumption rates.



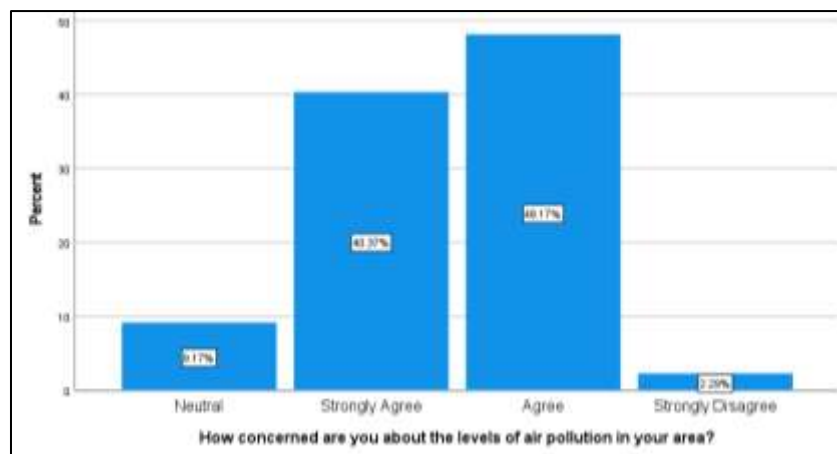
Survey results show that 85.3% of respondents believe local industries effectively reduce resource waste, with 47.2% agreeing and 38.1% strongly agreeing. Only 10.6% remain neutral, while a mere 4.2% disagree. This indicates a generally positive perception of industries' waste reduction efforts.



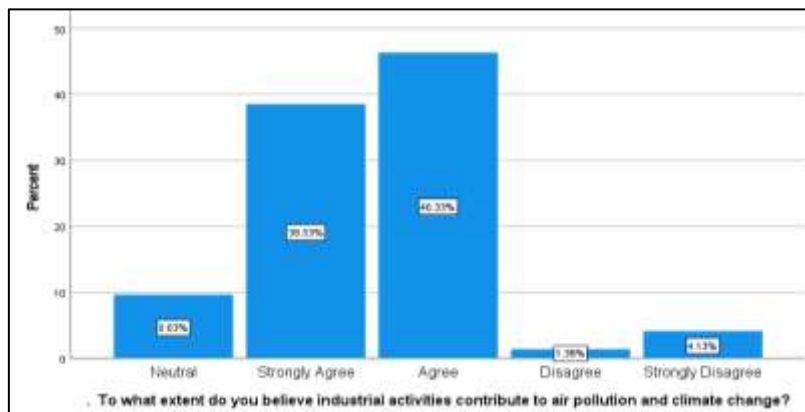
The data shows a strong concern about the depletion of natural resources due to current industrial practices, with 71.6% of respondents agreeing that these methods will significantly impact resource availability. Only 10.1% disagree, while 18.3% are neutral, indicating widespread apprehension about sustainability.



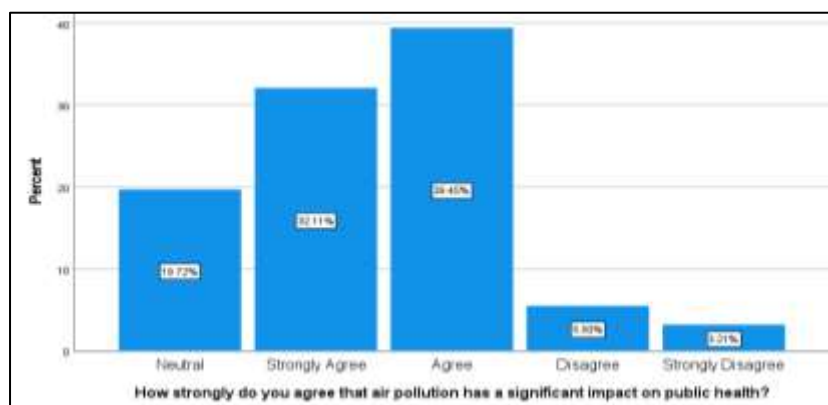
The data shows the perception of regulation and oversight in preventing excessive depletion of natural resources by industries. A significant majority, 46.3% agree and 39.9% strongly agree, indicating confidence in the adequacy of regulatory measures. A smaller portion, 9.2%, remains neutral, while only 4.6% strongly disagree, showing minimal dissatisfaction. This suggests that overall, there is a positive belief in the effectiveness of current regulations and oversight.



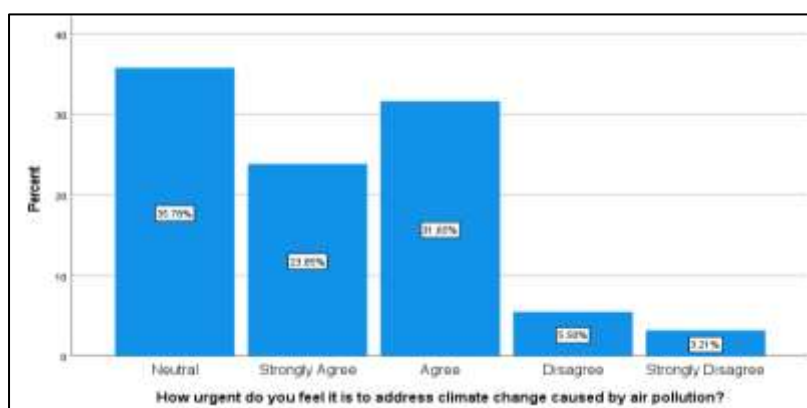
The survey results indicate a high level of concern about air pollution among respondents. A significant majority, 88 (40.4%) strongly agree and 105 (48.2%) agree, totalling 193 respondents (88.6%) expressing concern. Only 20 (9.2%) are neutral, and a minimal 5 (2.3%) strongly disagree. This shows that nearly 90% of the participants are worried about air pollution in their area, highlighting the importance of addressing air quality issues.



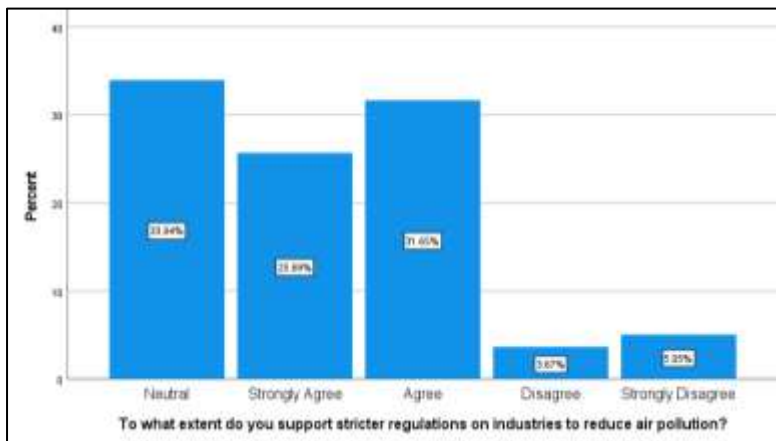
The data indicates that a significant majority of respondents believe industrial activities contribute to air pollution and climate change. Specifically, 46.3% strongly agree, and 38.5% agree, making a cumulative 84.8% in consensus. Meanwhile, 9.6% are neutral, 4.1% disagree, and only 1.4% strongly disagree. This highlights a prevalent perception of the negative environmental impact of industrialization, with over 85% acknowledging its contribution to air pollution and climate change.



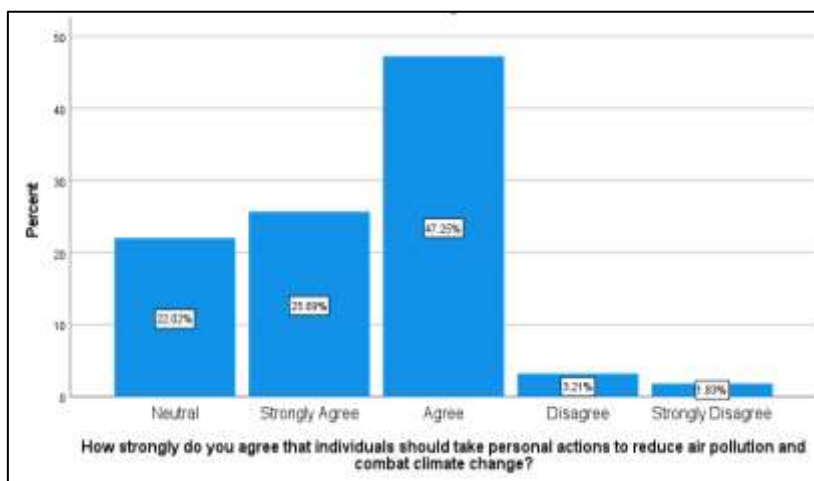
The survey shows 71.5% of respondents recognize the significant impact of air pollution on public health, while only 8.7% disagree. With 19.7% neutral, the data strongly supports the view that air pollution poses serious health risks, emphasizing the need for effective control measures and public health interventions.



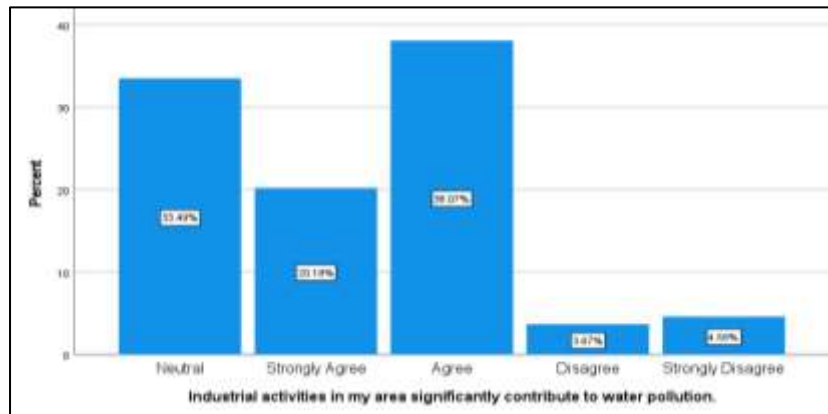
Data shows 55.6% of respondents feel urgency about climate change due to air pollution, with 23.9% strongly agreeing and 31.7% agreeing. However, 35.8% are neutral, and 8.7% disagree. This indicates a need for enhanced awareness and education on air pollution's impact on climate change.



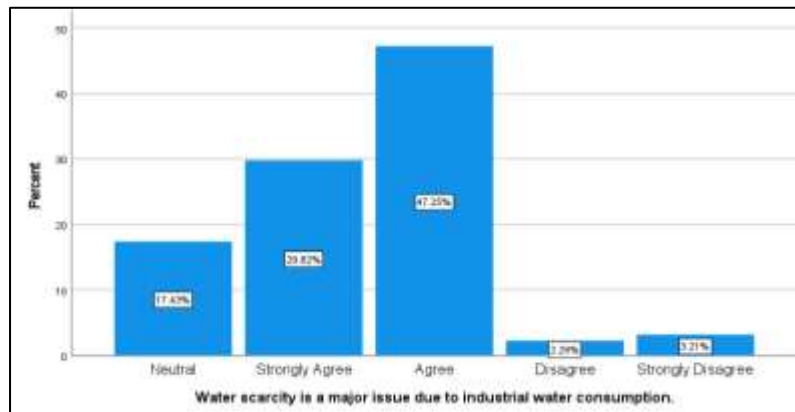
Data shows strong support for stricter industry regulations to reduce air pollution, with 57.4% of respondents either agreeing or strongly agreeing. Only 8.7% oppose, while 33.9% are neutral. This indicates a broad consensus on the need for tougher controls to address air pollution effectively.



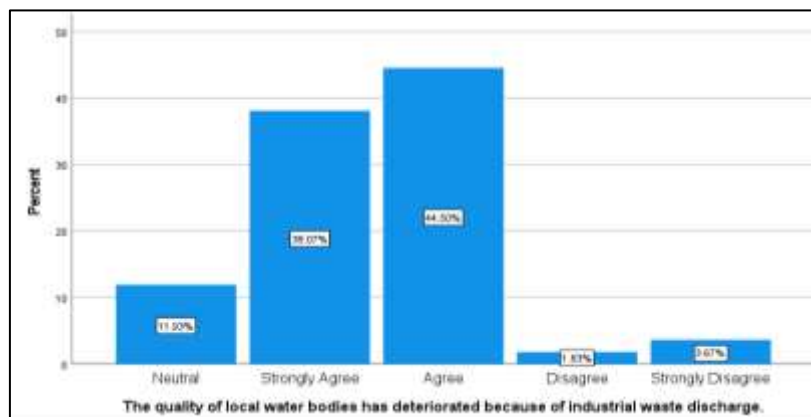
Data reveals strong support for individual efforts in reducing air pollution and climate change, with 72.9% agreeing on its importance. Only 5% oppose this view, and 22% are neutral. This indicates a broad consensus on personal responsibility in environmental conservation, despite some remaining uncertainty.



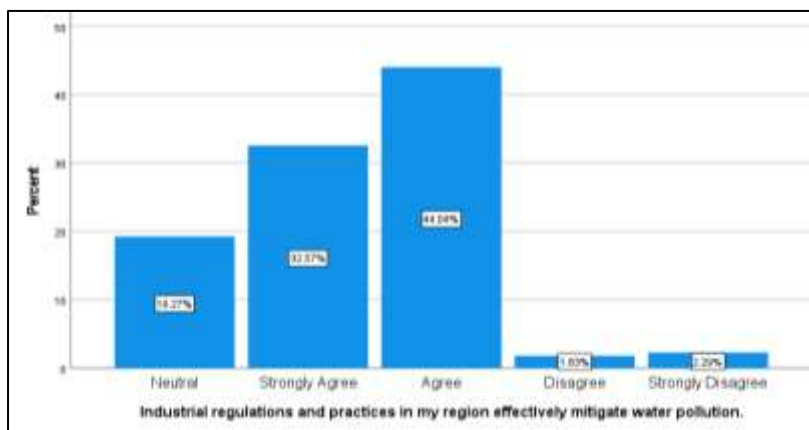
Survey results show a strong perception of industrial activities contributing to water pollution, with 58.3% of respondents agreeing or strongly agreeing. Only 8.3% disagree or strongly disagree, and 33.5% are neutral. This indicates significant concern among residents about industrial impact on water quality, highlighting the need for further investigation.



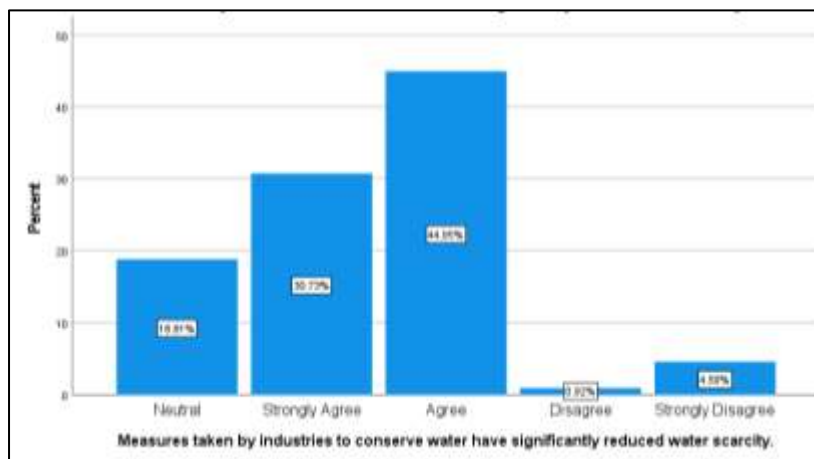
Data shows 77% of respondents believe industrial activities significantly contribute to water scarcity, with 47.2% agreeing and 29.8% strongly agreeing. Only 5.5% disagree or strongly disagree, indicating widespread concern about the issue. This underscores a strong consensus on the urgency of addressing industrial water consumption.



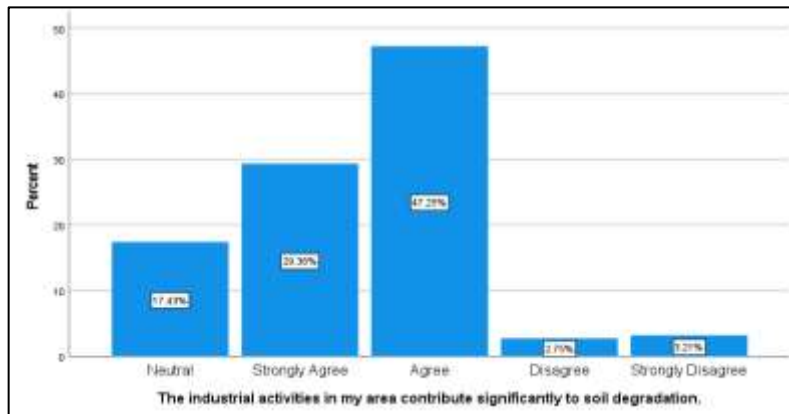
A survey reveals 82.6% of respondents believe industrial waste significantly harms local water bodies, with only 5.5% dissenting. The 11.9% neutral responses indicate some uncertainty. This strong consensus underscores the urgent need for effective measures to tackle water pollution caused by industrial activities.



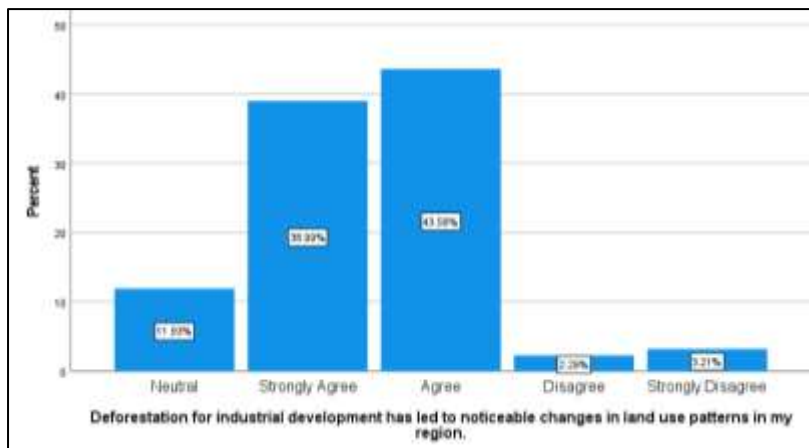
The survey shows that 76.6% of respondents view industrial regulations and practices positively in controlling water pollution, with 32.6% strongly agreeing and 44.0% agreeing. Only 4.1% are skeptical, while 19.3% are neutral. Overall, there's strong support for the effectiveness of these measures, despite some dissent and uncertainty.



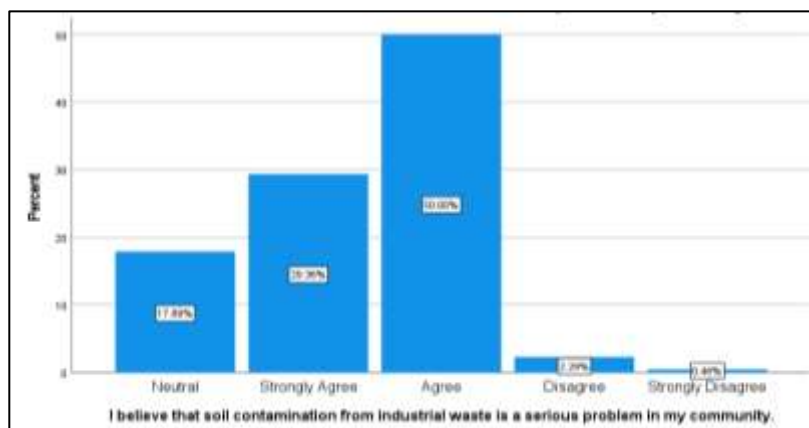
Survey results show broad support for industrial water conservation measures, with 75.7% of respondents agreeing or strongly agreeing on their effectiveness in addressing water scarcity. Only 5.5% express disagreement, while 18.8% are neutral. This indicates strong approval and minimal skepticism regarding the impact of these conservation efforts.



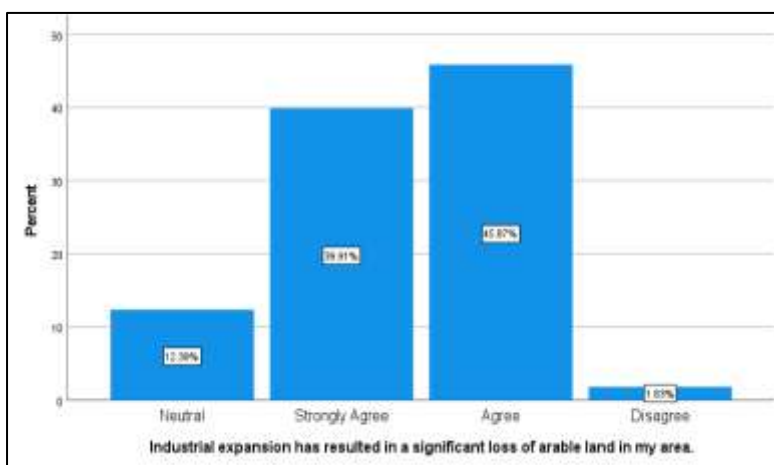
A significant 76.6% of respondents agree or strongly agree that industrial activities contribute to soil degradation, highlighting widespread concern. Only 13% disagree or strongly disagree. This data underscores the urgent need to address soil health issues linked to industrialization in the area.



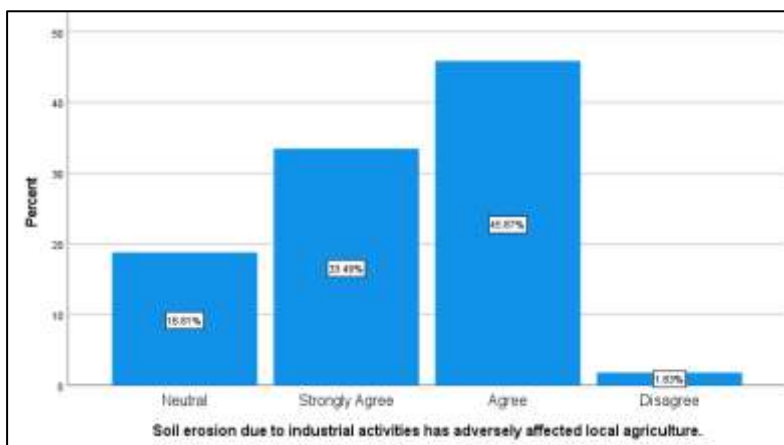
The data shows 82.6% of respondents believe deforestation for industrial development has significantly altered land use patterns in their region, with 39% strongly agreeing and 43.6% agreeing. Only 5.5% disagree, highlighting widespread recognition of the environmental and socio-economic impacts of industrial expansion.



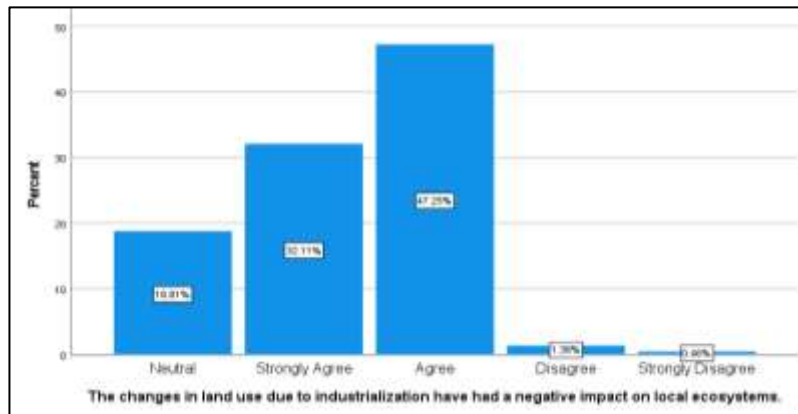
A strong consensus exists on soil contamination from industrial waste, with 79.4% of respondents acknowledging it as a serious issue. Only 2.8% dissent, indicating minimal opposition. This widespread concern underscores the urgent need for stricter industrial waste management and environmental regulations to protect community health and environmental quality.



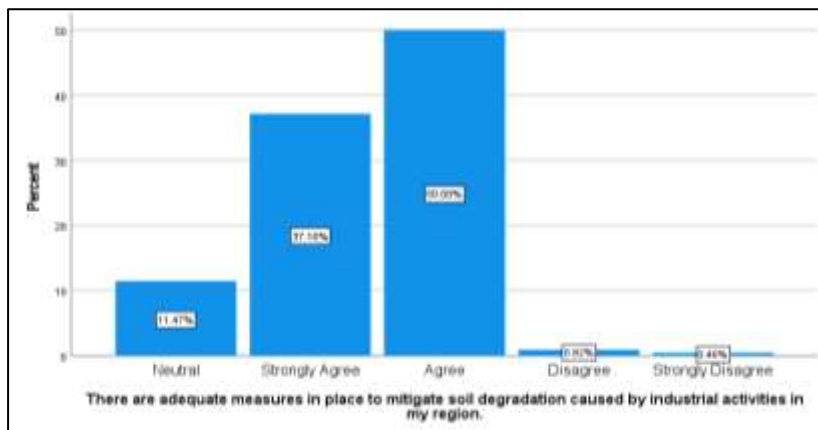
Industrial expansion has significantly impacted arable land, with 85.8% of respondents agreeing or strongly agreeing on the issue. Only 1.8% disagree, and 12.4% remain neutral, indicating a clear consensus. This underscores the urgent need for balanced development strategies to mitigate land loss while supporting industrial growth.



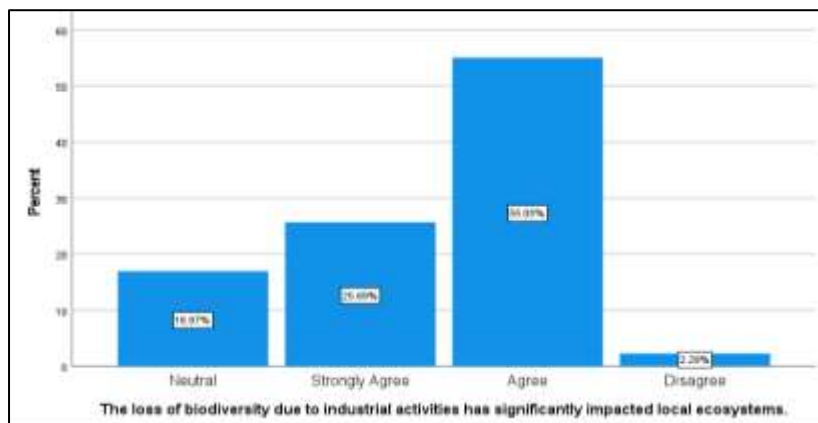
A significant 79.4% of respondents agree or strongly agree that industrial-induced soil erosion negatively impacts agriculture, highlighting widespread concern. Only 1.8% disagree, indicating minimal opposition, while 18.8% are neutral, possibly due to a lack of strong opinion or insufficient information. This data underscores agriculture's challenges from soil erosion.



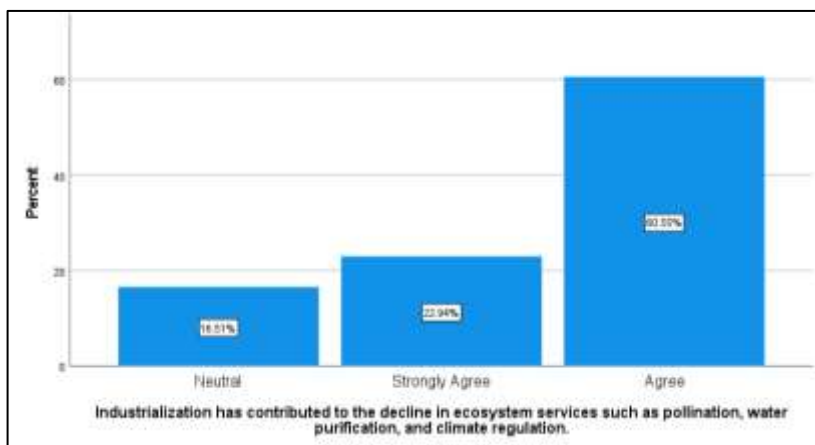
The data shows a strong consensus on the negative impact of industrialization on local ecosystems, with 79.3% agreeing or strongly agreeing, and only 1.9% dissenting. This underscores significant concern about environmental harm linked to industrial activities, reflecting widespread acknowledgment of industrialization's detrimental effects on ecosystems.



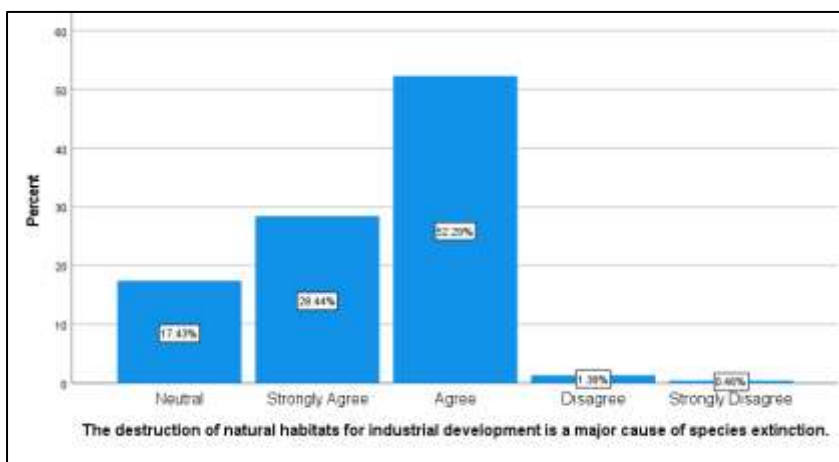
Data indicates strong confidence in soil degradation mitigation measures, with 87.2% of respondents (37.2% strongly agree, 50% agree) expressing belief in their adequacy. Only 1.4% disagree, showing minimal scepticism. With 11.5% neutral, overall consensus is positive, reflecting confidence in current management strategies.



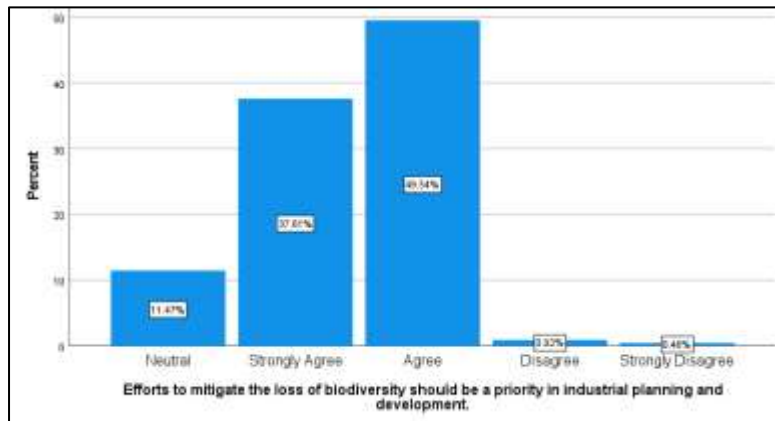
Data shows that 97.7% of respondents have noticed significant biodiversity loss due to industrial activities, with 55% reporting severe impacts. Only 17% saw minimal effects, and 25.7% observed moderate impacts. This highlights the urgent need for conservation efforts and stricter regulations to address the ecological damage.



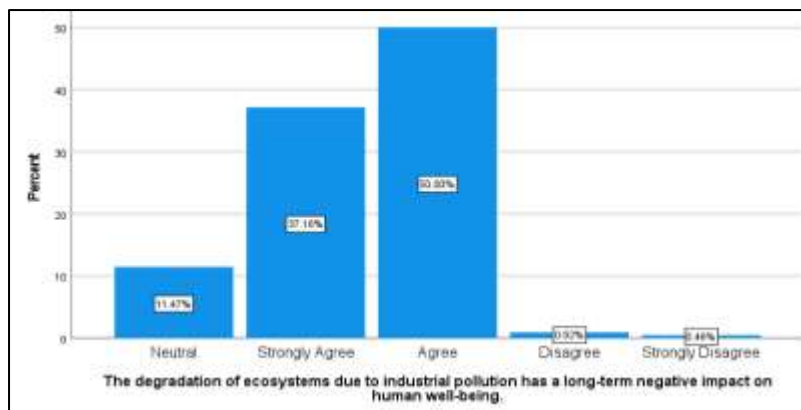
Data shows a clear consensus on the negative impact of industrialization on ecosystem services, with 83.5% of respondents acknowledging adverse effects on pollination, water purification, and climate regulation. This highlights the urgent need for strategies to mitigate environmental damage and balance industrial development with ecological health.



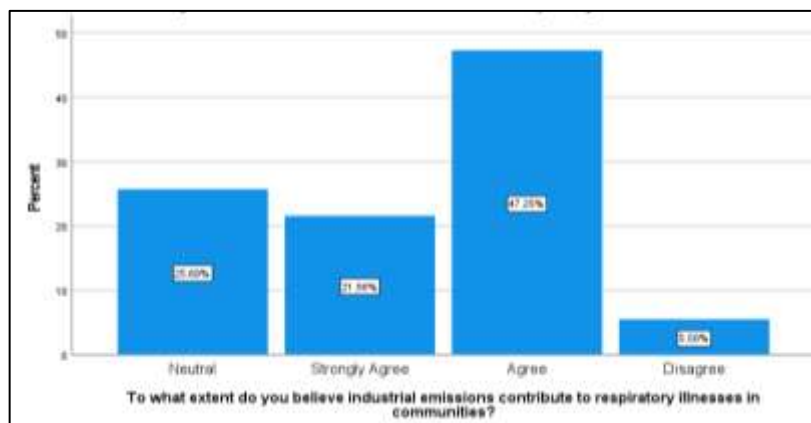
Data shows a strong consensus (80.7%) that industrial development causes species extinction due to habitat destruction, with 52.3% agreeing and 28.4% strongly agreeing. Only 1.9% disagree or strongly disagree, highlighting widespread recognition of industrialization’s negative impact and the need for sustainable practices to protect biodiversity.



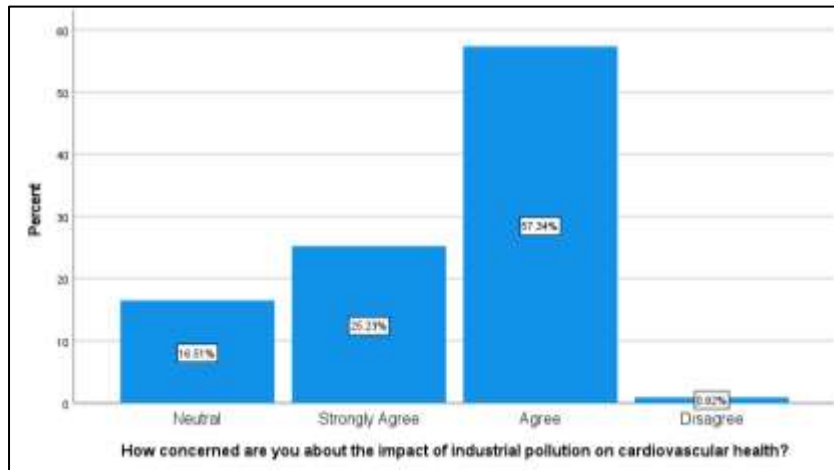
Data shows strong support for integrating biodiversity conservation into industrial planning, with 87.1% agreeing or strongly agreeing on its importance. Only 1.4% opposed this view, highlighting broad consensus on balancing industrial growth with environmental protection for sustainable development and ecological balance.



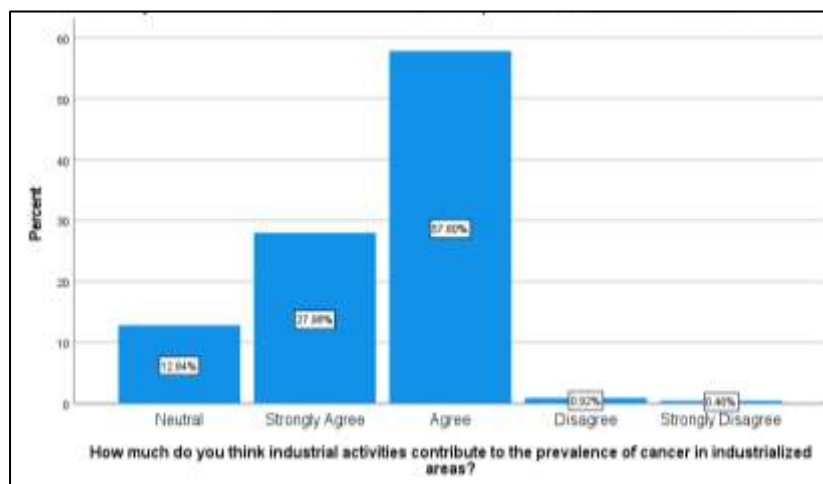
The data reveals that 87.2% of respondents recognize the long-term negative impact of industrial pollution on human well-being, with 50% strongly agreeing and 37.2% agreeing. Only 1.4% disagree, highlighting widespread awareness of ecosystem degradation and its significant implications for future health.



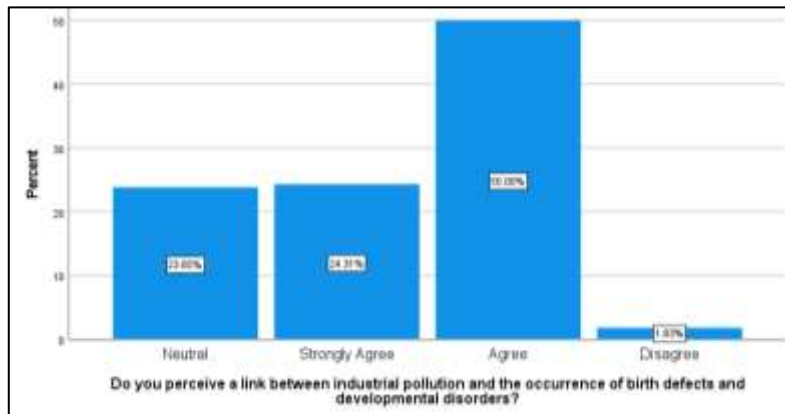
The survey shows 68.8% of respondents believe industrial emissions harm respiratory health, with 47.2% agreeing and 21.6% strongly agreeing. Only 5.5% disagree, and 25.7% are neutral. This strong consensus underscores the need for effective pollution control to safeguard community health.



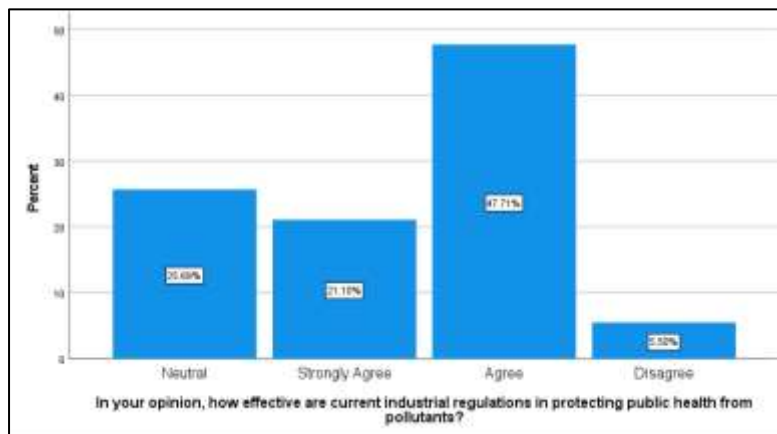
Data shows strong concern about industrial pollution's impact on cardiovascular health, with 57.3% agreeing and 25.2% strongly agreeing. Only 0.9% disagree, and 99.1% are neutral or agree. This highlights widespread apprehension and underscores the need for enhanced public health measures to mitigate pollution's health risks.



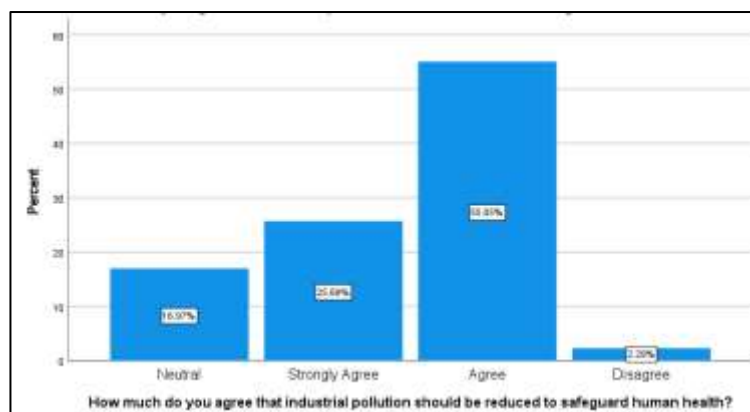
Data shows that 85.8% of respondents believe industrial activities significantly contribute to cancer rates due to pollutants. With only 1.4% disagreeing, there's a strong public concern about the health impacts of industrialization. This highlights the need for more research and stricter regulations to mitigate potential health risks.



Data reveals a strong consensus on the link between industrial pollution and birth defects or developmental disorders, with 98.2% acknowledging the connection. Specifically, 50% strongly agree, 23.9% agree, and 24.3% are somewhat confident. This widespread concern underscores the need for stricter environmental regulations and health interventions.



The majority of respondents view current industrial regulations positively, with 47.7% agreeing and 21.1% strongly agreeing on their effectiveness. However, 25.7% are neutral and 5.5% disagree, indicating some concerns. This suggests that while there is general support, ongoing evaluation and improvement are needed for better public health protection.



With 80.7% of respondents agreeing or strongly agreeing on reducing industrial pollution, there is clear support for stricter environmental regulations. Only 2.3% disagree, indicating minimal opposition. The 17% neutral responses suggest some uncertainty, but the overall consensus underscores the importance of effective pollution control for public health.

4. SUMMARY

The survey collected responses from 218 participants, focusing on their views regarding the industrial sector's impact on environmental and public health issues. Key areas of concern included resource depletion, air and water pollution, soil degradation, and the overall effectiveness of regulations. The data highlights mixed opinions, with notable concerns about the sustainability of industrial practices and their long-term effects on the environment and health.

5. FINDINGS

The survey findings reveal significant public concern regarding the environmental and health impacts of industrial activities in Jharkhand. While a majority believe that industries are effective in minimizing resource depletion (72%) and reducing waste (85.3%), there is strong apprehension about air pollution (88.6%), water pollution (58.3%), and soil degradation (76.6%). Notably, 97.7% recognize significant biodiversity loss due to industrial activities, and 87.2% acknowledge the long-term negative impact of industrial pollution on human well-being. There is broad support for stricter regulations to mitigate these impacts, with 57.4% advocating for tougher air pollution controls and 80.7% emphasizing the need to reduce industrial pollution for better public health.

6. CONCLUSION

Jharkhand's industrial expansion has significantly contributed to economic development but has also resulted in substantial environmental degradation. The decline in air and water quality, soil erosion, and biodiversity loss illustrate the pressing need for effective mitigation strategies. Implementing stricter environmental regulations, advancing clean technologies, and improving waste management are critical for reducing the environmental impact. Additionally, reforestation efforts and community involvement play vital roles in promoting sustainability. A balanced approach that integrates economic growth with environmental protection is essential for ensuring the long-term well-being of both the environment and the residents of Jharkhand. Through concerted efforts in policy enforcement and community engagement, Jharkhand can achieve a sustainable industrial future.

REFERENCES

1. Ankur, P., Chatterjee, S., & Gupta, K. (2022). Evaluation on the change characteristics of ecosystem service in Dhanbad district of Jharkhand, India based on land use change. *GeoJournal*, 87(Suppl 4), 413-437.
2. Upadhyay, Y., & Bhattacharya, T. R. (2022). Impact of Expanding Coal Industry on the Regional Environment in an Indian Coal-Belt-A Case Study from Jharkhand, India. *Regional Economic Development Research*, 53-72.



3. Mahto, N. N. (2018). Industrialization Problems of The Indigenous People in Jharkhand. *International Journal of Innovative Research and Advanced Studies*, 5(9), 207-210.
4. Tirkey, P., Bhattacharya, T., Chakraborty, S., & Baraik, S. (2017). Assessment of groundwater quality and associated health risks: a case study of Ranchi city, Jharkhand, India. *Groundwater for sustainable development*, 5, 85-100.
5. Barla, M. (2016). Impacts on climate change on tribal economy: a study of Jharkhand state of India. In *Proceedings of the International Conference on Poverty and Sustainable Development* (Vol. 3, No. 1, pp. 25-36).
6. Roy, B. C., Sarkar, S., Mandal, N. R., & Pandey, S. (2014). Impact of infrastructure availability on level of industrial development in Jharkhand, India: a district level analysis. *International Journal of Technological Learning, Innovation and Development*, 7(2), 93-123.
7. Tigga, A., & Malini, B. H. (2014). Impact assessment of environmental changes on droughts over Ranchi city, Jharkhand, India. *International Journal of Multidisciplinary Educational Research*, 3(9), 4.
8. Kumar, A., Pandey, A. C., Hoda, N., & Jeyaseelan, A. T. (2011). Evaluation of urban sprawl pattern in the tribal-dominated cities of Jharkhand state, India. *International Journal of Remote Sensing*, 32(22), 7651-7675.