

Mining Problem Forecast System and Risk Analyzer

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Abstract - The project *Mining Forecast* is developed to help users predict the success rate of mining operations by analyzing key environmental and operational factors. It works as a simple and effective tool for decision-making in the mining field. The system allows users to use forecast modules, maps, and calculators to understand results clearly. Its main aim is to make mining analysis easier and more understandable for anyone interested in the field. By presenting accurate and organized data, the project helps users plan better, manage resources efficiently, and promote safe and sustainable mining practices. Overall, *Mining Forecast* offers an accessible and reliable way to explore and predict mining outcomes.

Key Words: mining, forecasting, prediction, environment, analysis, sustainability.

1.INTRODUCTION

The *Mining Forecast* project is designed to evaluate and predict the performance of mining operations in a simple and organized way. It brings together forecasting tools, data visualization, and easy navigation into one user-friendly platform. Through its main sections such as **Home**, **Calculations**, and **Map**, users can explore data, make predictions, and view environmental impacts. The main goal of this project is to make mining prediction more accurate and visually clear. Even users without much technical knowledge can understand and make use of the data effectively. The design ensures a smooth experience, allowing users to move easily between different parts of the system. Overall, *Mining Forecast* serves as both an educational and practical tool for understanding mining performance and making informed decisions.

2. Body of Paper

2.1 Mining Monitoring and Visualization

The Mining Forecast Monitoring and Visualization System provides an interactive and data-driven interface for tracking mining activities and resource sites worldwide. The visualization map displays key mining zones using custom markers that reveal details such as region, resource type, extraction rate, forecasted yield, and operational status. Building on the motivation outlined in Section 1 for predictive and sustainable mining operations, this section focuses on the

implementation of the visualization layer. The map allows geologists, data analysts, and mining operators to monitor active and potential mining regions, evaluate performance trends, and identify high-yield zones. Users can also filter mining sites by region (e.g., Western Australia, Jharkhand, Nevada) or perform keyword-based searches through an integrated search bar. This monitoring tool transforms complex geospatial and analytical data into a clear, visual format that supports real-time decision-making.

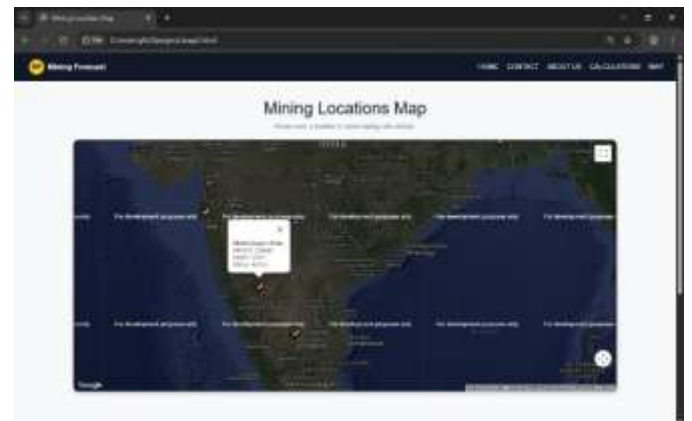


Fig-1: Mining Monitoring and Visualization

2.2 Resource Yield and Impact Calculator

A core component of the Mining Forecast platform is the **Resource Yield and Impact Calculator**, designed to estimate extraction potential and environmental influence based on user inputs. The calculator employs validated predictive algorithms to simulate mining output and sustainability metrics. The **yield prediction model** uses geological and operational parameters to forecast the total extractable volume of minerals over time, factoring in extraction efficiency and deposit density. A **depletion model** then estimates how long a site can sustain production under current mining rates. Additionally, an **environmental impact estimator** quantifies effects such as soil degradation or energy consumption, helping users balance productivity with sustainability.



Fig-2: Mining Yield and Impact Calculator

2.3 Data Inputs and Output Metrics

The calculator requires two primary user inputs: ore type (e.g., iron, copper, coal) and extraction rate (in tons/day). Each ore type is assigned distinct geological and economic parameters such as mineral density, energy requirement, and market value coefficient. These values feed into computational models that produce three key outputs:

1. **Estimated Yield (tons/year)** – predicts the total quantity of extractable resources.
2. **Resource Longevity (years)** – estimates how long the resource will last under the current extraction rate.
3. **Environmental Index** – quantifies the operational footprint based on energy use and waste generation. These outputs provide clear metrics for evaluating mine efficiency, profitability, and sustainability. Users can adjust parameters to simulate different operational strategies and instantly compare results through the intuitive interface.

2.4 Historical Data, Search, and Filtering

The system also features a comprehensive historical mining database, listing past and ongoing operations with details such as site location, start date, mineral type, production rate, and forecast accuracy. A built-in search and filter function enables users to identify mines by region or resource, facilitating easy retrieval of relevant records. This capability enhances pattern recognition and long-term performance tracking across different mining zones. Together, these components make the Mining Forecast system an essential platform for mining analysts, planners, and researchers seeking to combine live data visualization with data-driven forecasting.

2.5 Formula

i). Air Pollution

The formula calculates the Air Quality Index (AQI) by comparing the measured pollutant concentration to the standard safe limit. It expresses the result as a percentage:

$$AQI = \frac{\text{Pollutant concentration}}{\text{Standard limit}} \times 100$$

If the AQI value exceeds 100, it indicates pollution levels above the safe threshold, and an alert should be issued to warn the community of potential health risks.

ii). Water Pollution

The Water Quality Index (WQI) formula combines the ratings of various water quality parameters (like pH and

metal content) with their assigned weights to determine the overall quality of water:

$$WQI = \frac{\sum(Q_i \times W_i)}{\sum W_i}$$

Here, Q_i is the quality rating of each parameter, and W_i is its importance. If $WQI < 50$, it means the water is unsafe for consumption, and authorities or NGOs should take corrective action, such as installing a filtration or purification system.

iii). Noise Pollution

The Noise Exposure formula calculates sound intensity compared to a reference level:

$$\text{Noise Exposure} = 10 \times \log_{10} \left(\frac{\sum P_i}{P_{ref}} \right)$$

If the noise level exceeds 85 dB for 8 hours, it is considered unsafe, and the mining company must install sound barriers or provide ear protection to workers.

iv) Health risk

The **Disease Prevalence (%)** formula measures how widespread a disease is in a population:

$$\begin{aligned} \text{Disease Prevalence (\%)} &= \left(\frac{\text{Number of affected people}}{\text{Total surveyed}} \right) \\ &\times 100 \end{aligned}$$

If more than 20% of the population is affected, it indicates a health concern requiring immediate medical attention or community intervention.

3. CONCLUSIONS

The Mining Forecast Monitoring and Visualization System serves as an innovative digital platform for real-time mining site monitoring, resource estimation, and environmental analysis. By integrating an interactive visualization map, historical mining data, and a scientifically modeled yield and impact calculator, the system effectively addresses key challenges in mining management and sustainability. Its ability to forecast extraction potential, estimate environmental impacts, and provide site-specific insights makes it a valuable tool for researchers, mining engineers, and policy regulators.

This project demonstrates that a web-based intelligent system, combining user-friendly interfaces with dynamic analytical models, can transform complex geological and environmental data into actionable insights. It enhances decision-making by offering transparency, operational efficiency, and predictive foresight for mining operations. The platform also promotes responsible mining practices by identifying

high-risk zones and supporting environmental compliance through data visualization

The system's online accessibility allows researchers, engineers, and policymakers to easily engage with its interactive analytics and visual reports. The platform's modular design supports future scalability, enabling integration with emerging technologies such as IoT-based monitoring, AI-driven predictive modeling, and automated sustainability assessments. With these advancements, the Mining Forecast System can evolve into a comprehensive decision-support tool that promotes efficiency, transparency, and environmentally responsible mining operations.

ACKNOWLEDGEMENT

We extend our heartfelt gratitude to our honorable Chairman, **Dr. S. Thangavelu** for providing a wonderful platform to educate our minds, inculcate ideas and implement the technological changes in the real-world environment.

Deepest thanks to our dynamic Joint Secretary, **Mr. T. Sheelan** for monitoring the infrastructure and for providing the work atmosphere to implement the project and providing an excellent and maintaining the decorum and discipline of the students.

We are tremendously thankful to our beloved Principal, **Dr. N. K Sakthivel, M.Tech., Ph.D.** for his incredible support to make us follow ethics and morality in our life and also for allocating sufficient time and resources.

A big salute to our vibrant Head of the Department, **Dr. S. Prakash** for imbuing scope of the project and systematic procedure in execution. We express our genuine thanks for encouraging us throughout the project period to complete it successfully.

Our great thanks to the Project mentor, **Mrs.I.A.Jannathul Firthous** for her ever lasting contribution in making the project a smooth journey and also for her valuable guidance and for making us realize our potential and be successful.

Our great thanks to the Project Co-Ordinator, **Dr. M. Deepa** for her ever lasting contribution in making the second year project phase a smooth journey and also for her valuable guidance and for making us realize our potential and be successful. We also thanks for her kind help and Cooperation throughout the research period to make us a grant successful completion of project..

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