Proceedings of the 10th World Congress on Mechanical, Chemical, and Material Engineering (MCM'24)
Barcelona, Spain - August 22-24, 2024
Paper No. MMME 126
DOI: 10.11159/mmme24.126

Statistical Analysis of the Subsidence Process in the Catalan Potassic Basin: The Impact of Topography, Drift Roof Depth, and Exploitation Ratio on Subsidence Value

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Extended Abstract

Subsidence, which can be defined as the gradual sinking or caving in of an area of land, imposes significant risks to infrastructure and environmental sustainability, particularly on underground mining sites. Subsidence not only develops on the surface of ore deposits but can also affect surrounding ecosystems or nearby urban areas, making it an essential surface impact to control.

To effectively implement land management initiatives, understanding the factors influencing subsidence can be vital as it could be used to develop mitigation plans to avoid further damage to people and the environment. This investigation was stemmed from previous research that highlights the importance of mining-related factors in subsidence events.

Studies by [1] and [2] have similarly noted the significant impact of mineral exploitation on land stability. Further research [3] and [4] emphasizes the need to identify influencing environmental and operational factors on subsidence models. Therefore, this study focuses on assessing the impact of three key factors—Topography, Drift Roof Depth, and Exploitation Ratio— on the Subsidence Value measured in a potash mining operation.

It has been selected a case study located in northeastern Spain under production for more than 100 years, nowadays its average extraction is approximately 1.5 million tons.

For more than a decade, combined GPS and GIS techniques have been used to extract terrain data, which have been processed to quantify different mining and geological parameters that have been identified as potentially influencing the development of subsidence.

It has been used multiple linear regression analysis, the relationship between these specific variables and subsidence has been evaluated which can provide valuable insights for future land use and mining practices. The primary objective of this research is to analyze the extent to which Topography, Drift Roof Depth, and Exploitation Ratio influence the Subsidence Value. In fact, this study has been conducted to determine which of these variables significantly contributes to subsidence and to what degree. As a result, a predictive model to anticipate subsidence occurrence based on measurable factors has been deployed. Data for this study were collected from 360 observations, including measurements of Subsidence Value (cm), Topography (m), Drift Roof Depth (m), and Exploitation Ratio. The correlation matrix shows that the Exploitation Ratio had the strongest negative correlation with Subsidence Value (-0.711), followed by Drift Roof Depth (-0.481) and Topography (-0.169). Regression analysis showed that the Exploitation Ratio is the only statistically significant predictor of Subsidence Value (P-Value = 0.000), with a coefficient of -0.2606, indicating that an increase in Exploitation Ratio significantly decreases Subsidence Value. Topography and Drift Roof Depth, with P-Values of 0.298 and 0.949 respectively, were not found to be significant predictors. The model summary indicated that the regression model explains 50.77% of the variance in Subsidence Value (R-squared). The adjusted R-squared and predicted R-squared values were 50.36% and 48.86% respectively which can be considered a reasonably good fit of the model to the data. Furthermore, ANOVA results further supported the model's overall significance (P-Value = 0.000). This study identifies the Exploitation Ratio as the key factor influencing subsidence in the selected sample. While the current model explains a significant portion of the variance in Subsidence Value, it can be improved. Future research could focus on identifying additional variables and/or refining the model to reach a higher accuracy rate.

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