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An Assessment of Environmental Monitoring in Sandur Schist Belts of Iron Ore Mines Area using Geoinformatics Techniques

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Abstract:

The exploitation of iron ore resources in the Sandur Schist Belts poses significant challenges to the surrounding environment, necessitating rigorous monitoring and assessment to ensure sustainable mining practices. This research investigates the application of geoinformatics techniques in the evaluation of environmental impacts associated with iron ore mining activities in the Sandur Schist Belts. The study employs a multidisciplinary approach that integrates remote sensing, Geographic Information System (GIS), and field data to comprehensively assess the environmental dynamics and the efficacy of monitoring strategies. Remote sensing satellite imagery serves as a primary tool for mapping land-use changes and detecting alterations in vegetation cover over time. GIS facilitates spatial analysis and the creation of detailed maps that aid in visualizing the spatial distribution of environmental variables. Field data collection supplements satellite information, providing ground truthing and validation for remote sensing and GIS outputs. The combination of these techniques enables a holistic evaluation of the ecological consequences of mining activities, including deforestation, soil erosion, and changes in water quality. Furthermore, the study investigates the effectiveness of existing environmental monitoring protocols and proposes enhancements based on geoinformatics findings. This involves the development of predictive models for environmental impact assessment and the establishment of an integrated monitoring framework. The research contributes valuable insights to the field of environmental management by offering a robust methodology for assessing the cumulative impact of mining operations on the Sandur Schist Belts. Ultimately, this research aims to inform policy decisions and industry practices to foster sustainable development in iron ore mining regions. By leveraging geoinformatics techniques, the study provides a comprehensive understanding of the intricate relationships between mining activities and environmental changes, paving the way for proactive and informed decision-making in the realm of resource management and environmental conservation.

Keyword: Environmental, land use, geoinformatics, mining, iron ore

Introduction

The Sandur Schist Belts, nestled in the heart of iron ore-rich regions, have become focal points for industrial activities, particularly iron ore mining. The burgeoning demand for iron ore, driven by global economic development, has led to increased mining operations in these ecologically sensitive areas. Consequently, the environmental repercussions of such activities necessitate robust monitoring and assessment strategies to ensure sustainable resource management and mitigate adverse impacts on the ecosystem.

Mining operations often alter the landscape, impacting vegetation, soil quality, and water resources. The Sandur Schist Belts, characterized by unique geological and ecological features, present a complex scenario where the delicate balance of the ecosystem is susceptible to disruption. Recognizing the need for a comprehensive evaluation of environmental changes induced by iron ore mining, this research focuses on assessing the efficacy of environmental monitoring in the Sandur Schist Belts, employing advanced geoinformatics techniques. Geoinformatics, a multidisciplinary field encompassing remote sensing, Geographic Information System (GIS), and spatial analysis, offers powerful tools for monitoring and understanding environmental changes at various scales (Hatti and Nijagunapp, 2011). Remote sensing satellites provide a synoptic view of the landscape, enabling the detection of land-use changes and vegetation dynamics. GIS facilitates the integration of diverse spatial datasets, allowing for a spatially explicit analysis of environmental variables. The combination of these techniques offers a holistic approach to environmental monitoring, providing valuable insights into the cumulative impact of mining activities. This research builds upon the work of previous studies in the fields of environmental monitoring, geoinformatics, and resource management. Notable contributions include research on the application of

remote sensing in environmental assessment (Jensen, 2007; Lu and Weng, 2007; Hutti and Nijagunappa, 2012), GIS-based analysis of land-use changes (Foody, 2002; Turner et al., 2015; Hutti and Nijagunappa, 2015), and studies specifically addressing the environmental impacts of mining activities (Kumar et al., 2018; Singh et al., 2020). By leveraging the strengths of geoinformatics, this study aims to advance our understanding of the environmental dynamics in the Sandur Schist Belts, critically evaluating existing monitoring protocols and proposing enhancements for sustainable resource management in iron ore mining areas. The findings are expected to contribute to the broader discourse on responsible mining practices and environmental conservation in the context of mineral resource extraction.

Study Area:

The Sandur Schist Belt in the Dharwar Craton region of India is a significant mining area, where mining of iron ore and manganese ore has been carried out for many decades (Rout et al., 2016). The Sandur Schist Belt is located in the northern part of the Dharwar Craton, covering an area of approximately 280 square kilometers (km2) (Ravikumar et al., 2012). The Sandur Schist Belt is situated between the latitudes of 15° 31' N to 15° 41' N and longitudes of 76° 23' E to 76° 33' E (Figure 1). These belts are situated in the southern part of India, primarily spanning across the states of Karnataka and Andhra Pradesh. The geological characteristics of the Sandur Schist Belts make them crucial sites for iron ore extraction, attracting extensive mining operations.

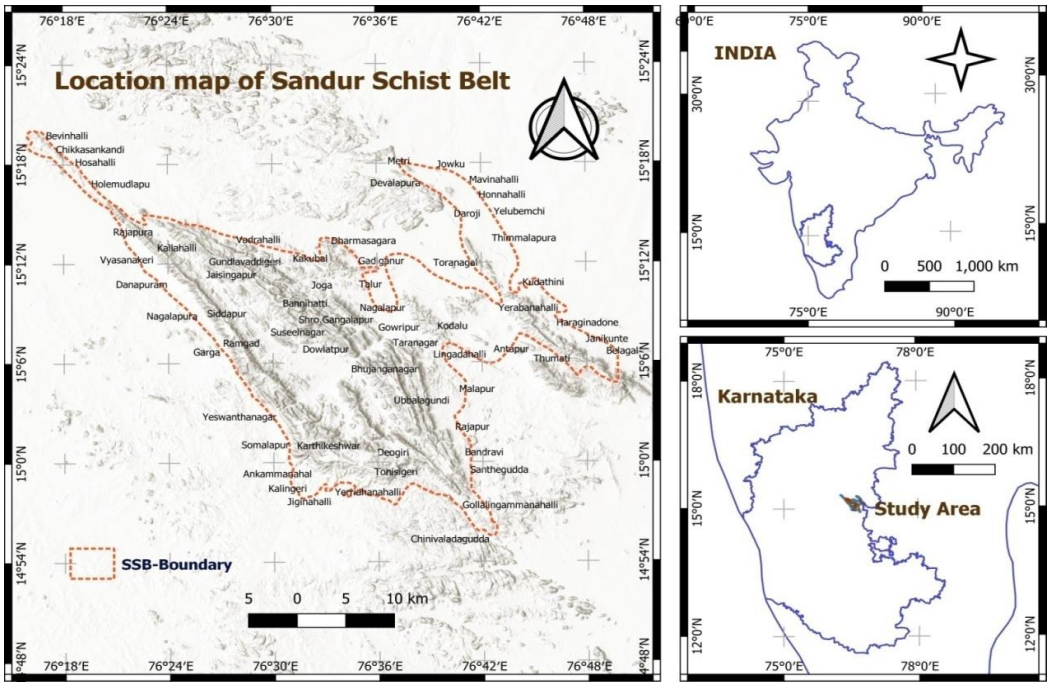

Figure 1: Location of Sandur Schist Belt study area

The Sandur Schist Belts are characterized by a complex geological formation, featuring schist rocks and associated mineral deposits, including iron ore. The topography is diverse, ranging from hilly terrains to plains, and the region is endowed with a variety of flora and fauna. The unique ecological features of the area contribute to its biodiversity, making it an ecologically sensitive zone. Iron ore mining activities in the Sandur Schist Belts have been a focal point of economic development in the region, providing raw materials for the iron and steel industry. However, the extraction and processing of iron ore in this ecologically significant area have raised concerns about potential environmental impacts. The study area encompasses multiple mining sites within the Sandur Schist Belts, representing the diversity of mining operations and their associated environmental challenges. Fieldwork within the study area involves on-site data collection, including ground truthing and validation of remote sensing and GIS data. The research team will traverse the mining landscapes, collecting data on land-use changes, vegetation cover, soil quality, and water resources. Additionally, the study will explore the impact of mining activities on the surrounding ecosystems, considering factors such as deforestation, habitat disruption, and changes in water quality.

Geoinformatics techniques, including remote sensing and GIS, will play a pivotal role in analyzing and interpreting spatial data within the study area. Satellite imagery will be used to monitor changes in land cover and vegetation over time, providing a synoptic view of the environmental dynamics. GIS will facilitate the integration of various spatial datasets, enabling a comprehensive spatial analysis of the environmental variables associated with iron ore mining in the Sandur Schist Belts.

Material and Methods:

The material and methods outlined in this research aim to provide a systematic and integrated approach to assess the environmental monitoring of iron ore mining in the Sandur Schist Belts, utilizing geoinformatics techniques for a comprehensive understanding of the complex interactions between mining activities and the surrounding environment of following points are adopted to the research:

Study Design and Area Selection: The study design involves a comprehensive assessment of environmental monitoring in the Sandur Schist Belts, focusing on iron ore mining areas. Selection of the study area is based on the geographical distribution of mining operations within the Schist Belts in Karnataka and Andhra Pradesh, India.

Data Collection:

Remote Sensing Data: High-resolution satellite imagery will be acquired from relevant sources covering multiple time periods to capture temporal changes in land cover and vegetation.

GIS Data: Existing GIS datasets related to topography, hydrology, and land use will be sourced and integrated into the analysis.

Field Data: On-site data collection involves ground truthing, including vegetation sampling, soil quality analysis, and water sample collection. Field surveys will cover multiple mining sites representative of the diverse topography within the study area.

Image Processing and Analysis: Remote sensing data will undergo pre-processing steps, including atmospheric correction and image enhancement, to ensure accurate analysis. Image classification techniques, such as supervised and unsupervised classification, will be applied to delineate land cover categories and identify changes over time. GIS analysis will include spatial overlay operations, terrain modeling, and generation of thematic maps to visualize the spatial distribution of environmental variables.

Environmental Impact Assessment: Geoinformatics techniques will be employed to quantify and qualify the environmental impact of iron ore mining activities. This includes assessing changes in vegetation cover, land use, and water quality over time. Indices such as Normalized Difference Vegetation Index (NDVI) will be calculated to gauge vegetation health and changes.

Integration of Data: Remote sensing and GIS outputs will be integrated with field data to validate and refine the accuracy of the environmental impact assessments. The integrated dataset will be used to develop spatial models that predict the potential environmental impacts of mining activities in different areas of the Sandur Schist Belts.

Monitoring Protocols Evaluation: Existing environmental monitoring protocols will be reviewed and evaluated in light of geoinformatics findings. Recommendations for enhancing monitoring strategies will be proposed based on the integration of remote sensing, GIS, and field data

Results and Discussion

Land Cover Changes: Remote sensing analysis revealed significant land cover changes in the Sandur Schist Belts over the study period. The classification of satellite imagery indicated alterations in land use, with notable shifts from natural vegetation to mining areas. The results highlight the spatial extent of the impact of iron ore mining on the landscape area are shown in figure 2.

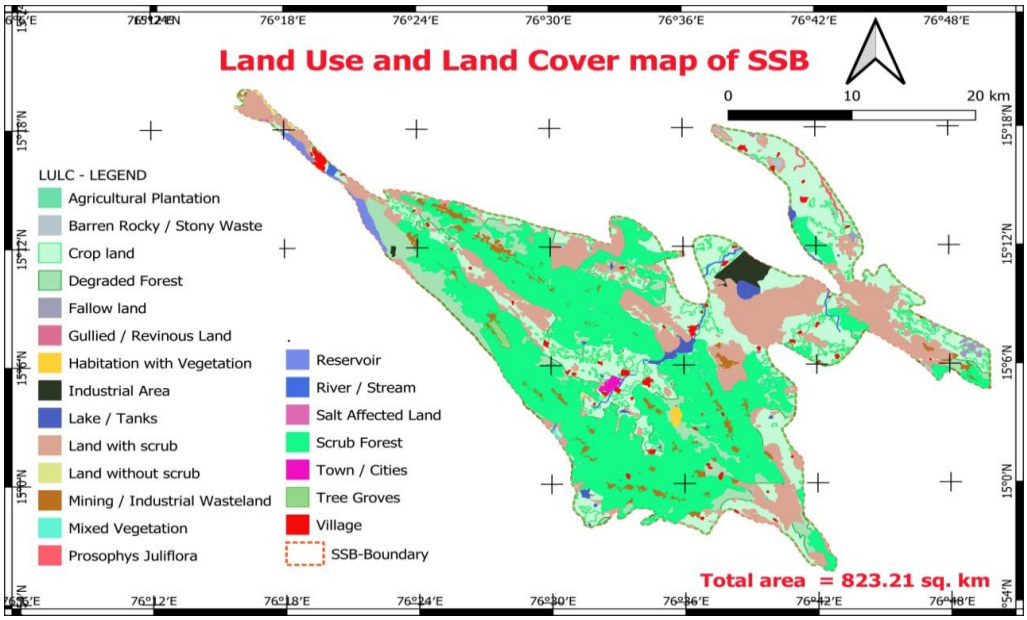

Figure 2: Land use and land cover of Sandur Schist Belt area

Vegetation Health and Dynamics: The application of the Normalized Difference Vegetation Index (NDVI) demonstrated varying levels of vegetation health across different mining sites. Areas undergoing active mining operations exhibited lower NDVI values, indicating stress on vegetation.

Furthermore, temporal analysis illustrated fluctuations in vegetation dynamics, emphasizing the need for continuous monitoring to assess recovery and rehabilitation efforts.

Soil Quality Assessment: Field surveys and soil sample analyses identified changes in soil quality parameters within the mining areas. Increased levels of heavy metals and altered soil composition were observed, emphasizing the potential long-term consequences of mining activities on soil fertility. The integration of field data with GIS analysis allowed for the spatial visualization of soil quality variations are highlighted in figure 3.

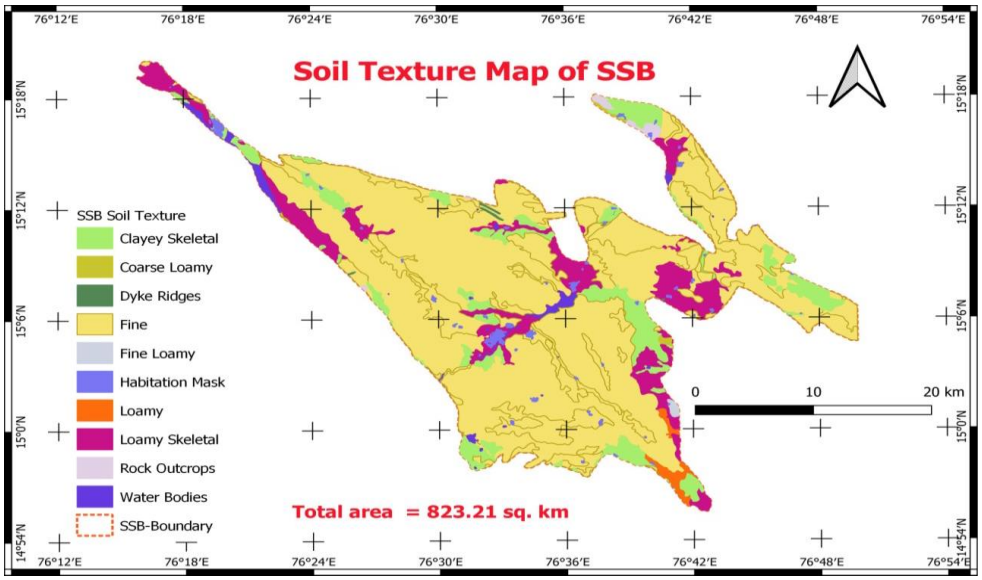

Figure 3: Type of soil texture in Sandur Schist Belt area

Water Quality Analysis: Water samples collected from rivers and streams in proximity to mining activities underwent laboratory analysis. Results indicated alterations in water quality parameters, with increased sedimentation and elevated levels of certain pollutants downstream from mining sites. This underscores the direct impact of mining operations on aquatic ecosystems water resources are shown in figure 4.

Spatial Distribution of Environmental Variables: GIS analysis facilitated the creation of spatial distribution maps for environmental variables, providing a comprehensive overview of the spatial patterns of impact. Hotspots of environmental stress were identified, guiding targeted interventions and remediation efforts.

Evaluation of Monitoring Protocols: The study critically assessed existing environmental monitoring protocols employed by regulatory bodies and mining companies. The results revealed gaps in the current monitoring strategies, particularly in terms of spatial coverage and frequency are shown in figure 5. Recommendations were made for the enhancement of monitoring protocols, emphasizing the integration of geoinformatics techniques for a more accurate and comprehensive assessment.

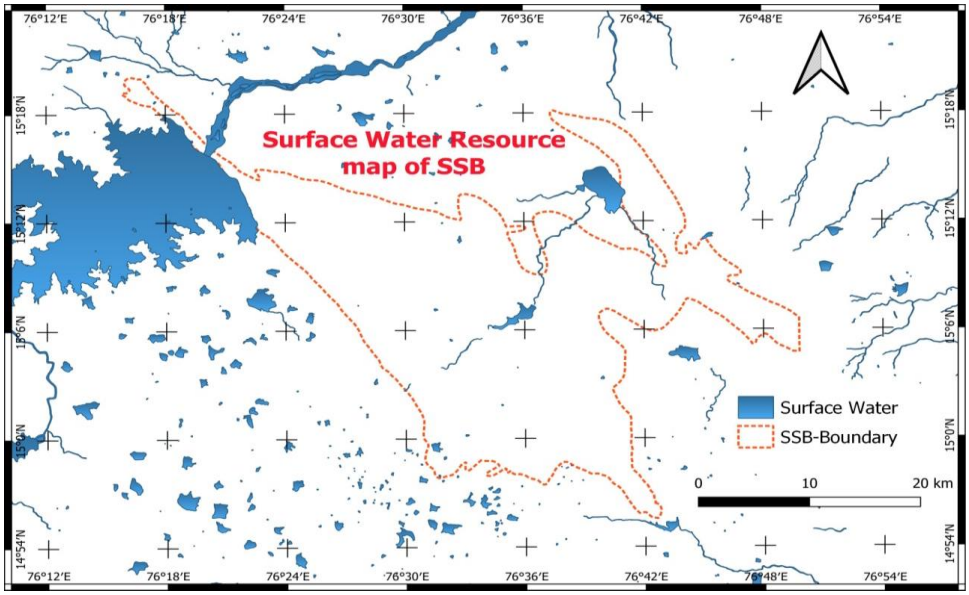

Figure 4: Water resources in Sandur Schist Belt area

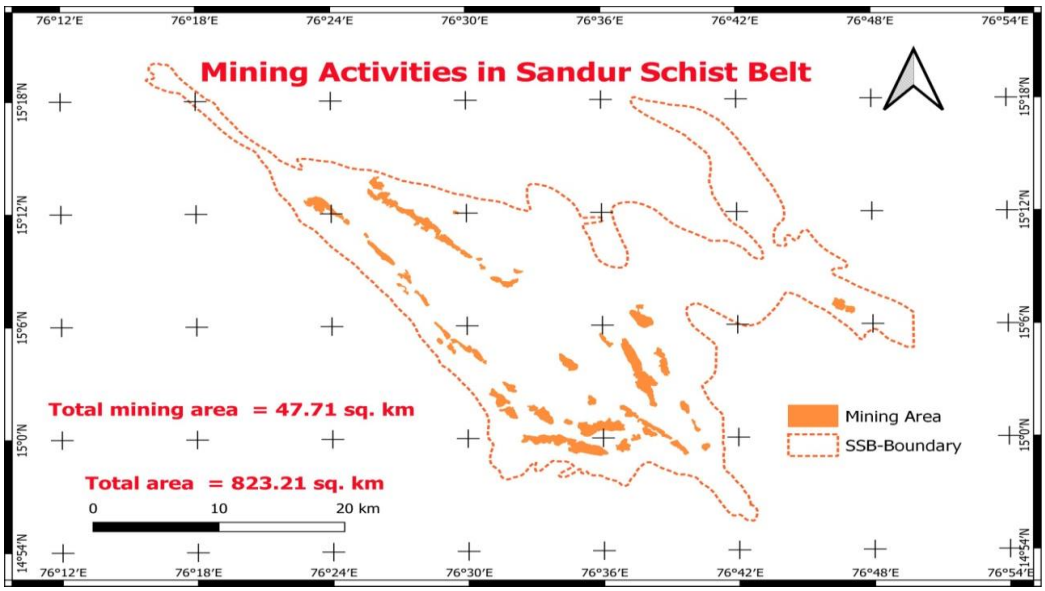

Figure 5: Mining activities in Sandur Schist Belt area

Predictive Modeling:

Spatial models were developed to predict potential environmental impacts in areas with ongoing or planned mining activities. These models, based on historical data and environmental variables, offer a proactive approach to identify potential areas of concern, enabling targeted pre-emptive measures.

Discussion:

The results of this research underscore the intricate relationship between iron ore mining activities and environmental changes in the Sandur Schist Belts. The observed land cover changes, vegetation dynamics, and alterations in soil and water quality collectively emphasize the need for robust environmental monitoring. The integration of geoinformatics techniques, including remote sensing and GIS, provided a holistic understanding of the spatial patterns of environmental impact, enabling informed decision-making. The findings also highlight the importance of adaptive and dynamic monitoring strategies. The dynamic nature of the environmental changes necessitates continuous surveillance to capture evolving patterns and facilitate timely interventions. The evaluation of monitoring protocols revealed the potential for improvement, advocating for a more integrated approach that leverages the strengths of geoinformatics.

Moreover, the spatial models developed in this study offer a forward-looking perspective, enabling stakeholders to anticipate and mitigate potential environmental impacts in areas earmarked for future mining operations. This research contributes valuable insights to the broader discourse on sustainable mining practices, emphasizing the pivotal role of geoinformatics in enhancing environmental monitoring and management strategies in iron ore mining regions.

Conclusions:

The results of the assessment revealed significant land cover changes, shifts in vegetation health, alterations in soil quality, and changes in water quality within the study area. The spatial distribution maps and analyses provided by geoinformatics techniques served as valuable tools for understanding the extent and patterns of environmental impact. The findings underscore the urgent need for proactive and adaptive environmental monitoring strategies to ensure sustainable resource management. The evaluation of existing monitoring protocols highlighted areas for improvement, emphasizing the importance of incorporating geoinformatics methodologies for enhanced spatial analysis and accurate assessment of environmental variables. The study recommends a holistic and integrated approach to monitoring that considers the dynamic nature of environmental changes associated with mining operations.

Furthermore, the development of predictive spatial models offers a forward-looking perspective, enabling stakeholders to anticipate potential environmental impacts in areas targeted for future mining activities. These models contribute to the proactive management of environmental resources, allowing for the implementation of targeted mitigation measures. The research contributes not only to the understanding of the environmental impacts of iron ore mining in the Sandur Schist Belts but also provides practical insights for sustainable resource management. By leveraging geoinformatics techniques, this study offers a valuable framework for future monitoring and assessment endeavors in mining regions, facilitating informed decision-making and the development of effective environmental conservation strategies.

In essence, the assessment presented in this research contributes to the broader discourse on

responsible and sustainable mining practices. It emphasizes the crucial role of geoinformatics in advancing environmental monitoring methodologies and advocates for the integration of these techniques into regulatory frameworks to ensure the long-term ecological integrity of iron ore mining regions. Ultimately, the study calls for collaborative efforts among stakeholders, including government bodies, mining companies, and environmental agencies, to implement effective monitoring protocols and promote environmentally conscious practices in the Sandur Schist Belts and similar mining landscapes worldwide.

References:

1. Basavaraj, Hutti and Sharath Kumar, P., "Geology and Geochemistry Investigation of Banded Iron Formations from Haraginadoni copper Mountain Range of Sandur Greenstone Belt, Dharwar Craton, India", *Journal of Emerging Technologies and Innovative Research*, 6(6). 476-482. 2019.
2. Jensen, J. R. (2007). Remote Sensing of the Environment: An Earth Resource Perspective. Prentice Hall.
3. Lu, D., & Weng, Q. (2007). A survey of image classification methods and techniques for improving classification performance. International Journal of Remote Sensing, 28(5), 823-870.
4. Foody, G. M. (2002). Status of land cover classification accuracy assessment. Remote Sensing of Environment, 80(1), 185-201.
5. Turner, W., Spector, S., Gardiner, N., Fladeland, M., Sterling, E., & Steininger, M. (2015). Free and open-access satellite data are key to biodiversity conservation. Biological Conservation, 182, 173-176.
6. Kumar, R., Singh, R. K., & Shekhar, S. (2018). Environmental impact assessment due to iron ore mining in Chhattisgarh, India. Environmental Monitoring and Assessment, 190(11), 647.
7. Singh, A., Agrawal, M., & Singh, R. K. (2020). Assessment of environmental impacts by mining activities: A case study from Jhansi open cast mining site in Uttar Pradesh, India. Environmental Monitoring and Assessment, 192(3), 155.
8. Mishra RN, (1976) Iron ore deposits of Bellary-Hospet Region. Proc. Symp. Geol. Etc., of ferrous and ferro-alloy minerals, pp. 4549.
9. Roy, A and Biswas, AK. 1983. Stratigraphy and structure of Sandur schist belt, Karnataka. Jour. Of GSI. V.24, No.1., pp. 19-28.
10. Sadasivaiah, MS and Karisiddaiah, SM. 1976. The occurrence of Aegirine and Riebeckite in the Banded Ferruginious Quartzite of Sanjeevarayanakota. Bellary. Karnataka., Jour., of Karn., uni. V.21., pp. 65-70.
11. Iyengar, SVP. 1976. The stratigraphy, structure and correlation of the Dharwar Supergroup. GSI. Misc. Publ. V.23, pp. 515-55.
12. Basavaraj, Hutti and Nijagunappa, R., "Geoinformatics Technology Application in North Karnataka for Water Resources Management", *Universal Journal of Environmental Research and Technology*, Eurasian Publications, 1(3). 222-232. 2011.
13. Basavaraj, Hutti and Nijagunappa, R., "Development of Groundwater Potential Zone in North-Karnataka Semi-Arid Region Using Geoinformatics Technology", *Universal Journal of Environmental Research and Technology*, Eurasian Publications, 1(4). 500-514. 2011.
14. Basavaraj, Hutti and Nijagunappa, R., "Identification of Groundwater Potential Zone using Geoinformatics in Ghataprabha basin, North Karnataka, India", *International Journal of geomatics and geosciences*, Integrated Publications, 2(1). 91-109. 2011.
15. Basavaraj, Hutti and Nijagunappa, R., "Geoinformatics Based Decision Support System Tools for Water Resources Management in North Karnataka, India", *International Bimonthly, Indian Journal of Natural Sciences*, 2(10). 779-791. 2012.
16. Basavaraj, Hutti and Nijagunappa, R., "Applications of Geoinformatics in Water Resources Management of Semi-Arid Region, North Karnataka, India", *International Journal of geomatics and geosciences*, Integrated Publications, 2(2). 371-382. 2015.
17. Chernyshova, I.V., Hanumantha Rao, K, Vidyadhar, A., 2000. Mechanism of Adsorption of Long-Chain Alkylamines on Silicates. A Spectroscopic Study. 1. Quartz. Langmuir 16, 8071–8084.