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Computerization and Digitalization in the Indian Mining Industry

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THE MINING GEOLOGICAL & METALLURGICAL INSTITUTE OF INDIA
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THEME

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PRESIDENT'S MESSAGE

COMPUTERIZATION AND DIGITALIZATION IN THE INDIAN MINING INDUSTRY

Computerization and digitalization-based innovation is now more important than ever in today's world. To stand out in a competitive market, business leaders need to focus on different ways they can keep up with evolving demand. With technological advances disrupting all industries, companies must innovate in order to stay relevant and not be left behind. In fact, innovative companies are rewarded for being ready for the future.

India is one of the biggest mining hubs of the world. It is the second biggest producer of coal, fourth biggest iron ore and Zinc producer and second biggest Aluminum producer. Pro-growth government policies aim to promote "ease of doing business" and realize the vision of "Make in India". The increased focus on infrastructure development ($1.4 trillion in 2019-23) will fuel a demand growth of power, steel and cement.

The mining industry is considered a traditional and conservative industry with respect to innovation. Unlike other industries, mining is highly variable and hazardous. Mining operations often take place in extreme environments and in far-flung locations. Smart planning and coordination of activities are required to mitigate variability caused by external forces.

Coal mining and oil & gas extraction are taking a new path, where safety and sustainability are dominating the narrative. On the one hand they need to ensure energy security, on the other hand they have to reduce carbon footprint. The industry as a whole is working towards a redefined purpose to manage resources and make the world a better place for all. The future for mining lies in computerization and digitalisation. Globally, the mining industry is under pressure to integrate digitalization into core business operations.

The changes today are being driven by two forces – fast pace of technological development and miniaturisation of enabling devices. Proof of concept initiatives of yesteryears have become business as usual for numerous organisations. Digital innovation is pivotal in the development of mining industry. The next phase of mining is being called – Mining X.0. Mining X.0 will embrace cyber security, big data and analytics, internet of things (IOT), artificial intelligence, cloud computing, block chain, mobility and autonomous systems. Recently a major mining player experienced a complete shutdown for seven days as a result of cyber attack on the organisation.

Recent trends in global mining space to tackle digital disruption include

i. **Advancing the future of mining :** Leveraging digital and technological changes including advance analytics to revolutionise working ways, build competencies and provide a boost to productivity.

ii. **Fostering the power of eco-systems and Joint ventures :** Strategic partnerships to develop and operate mining assets for diversifying risks and returning exponential value.

iii. **Reducing the carbon footprint :** Transition to a low carbon economy to comply with the enhanced Environmental, Social and Governance standards. In a time when India is aiming to achieve net zero emission by 2070, environmental innovation is very important for companies, as more companies cut down on business practices that are harsh for the planet. The demand for autonomous haulage systems (AHS) is on the rise as major mining companies have started deploying AHS to improve the efficiency, safety and maintenance of mining operations. Rio Tinto and Caterpillar has recently teamed up for zero-emission autonomous trucks. Rio Tinto will deploy 35 new 793 zero-emission autonomous haul trucks from Caterpillar at the Gudai-Darri iron ore mine in Western Australia. Earlier this year, Rio Tinto agreed to deploy fully autonomous water trucks from Caterpillar at the Gudai-Darri mine in an effort to increase productivity. In August-21, mining firm BHP also joined forces with Caterpillar to develop and deploy zero-emissions trucks at mining sites to reduce emissions.

iv. **Enhanced focus on safety and health :** Safety and health is being augmented by new technologies and data analytics to ensure safe working conditions and zero fatalities.

v. **Foster reliability amidst volatility :** Dynamically adjust supply chain and digital operations.

COVID-19 has further emphasized the need for miners to become resilient. Strong demand pushed almost all commodity prices higher. This has worked in the favour of mining companies. Emphasis is now on shifting to local suppliers, thereby de-risking supply chain. Leading companies switched to remote workforce and controlled operations from outside the mines. Rio Tinto and Fortesque Metal group invested heavily in digital infrastructure to manage operations remotely. 14 miners established Electric Mine Consortium to decarbonise operations. There was 40% increase in digital investments for health and safety of employees. 35% CAGR is expected between 2020-25 for automated mining equipment.

A survey of 201 CXOs in the mining and metal industry was conducted across Australia, Brazil, India, Chile, Canada, China, Indonesia, Singapore, South Africa and the United States. The annual revenues of these farms varied from $500 million to $20 billion. Four major technological areas the global leaders are adopting are:

i. Automation and robotics
ii. Digitally enabled workforce
iii. Analytics and digital support
iv. Integrated enterprise and platform

Many mining companies were running pilot programmes on Remote Operating centres. This survey revealed that adoption of digital system improved equipment performance, resulted in cost savings and increased ROI and led to better decision making. The mining industry is increasingly using artificial intelligence (AI) as a tool to optimize processes, enhance decision-making, derive value from data, and improve safety. AI makes sure equipment is in the right place at the right time, ensures equipment meets the day's production targets, responds to disruptions like break downs or delays. Using AI, we can predict what's going to happen, before it happens down to the second. AI anticipates problems and helps us prevent them.

Coal India has adopted digital transformation programme. The company has appointed M/s Accenture Solutions Pvt. Ltd. as a consultant for performance enhancement through Digital Trans-

formation in 3 mines of SECL and 4 mines of NCL. The focus is on digitalization of 7 mega projects of Gevra, Dipika, Kusmunda, Nighai, Jayant, Dudhichua and Khadia. The aim of this mega digital transformation is production enhancement and creating "Digitally Integrated Islands of Excellence". These islands of excellence can be replicated in other companies in the second phase. Key focus area is – integrated planning and scheduling, drone surveying, drill and blast optimization, slope monitoring, asset health monitoring and predictive maintenance, 3D stockpile mapping and digital yard management and integrated health and safety management.

Some other digital initiatives of CIL include :

i. Enterprise Resource Planning (ERP) implementation is going on.

ii. CCTV, RFID, based boom barrier and Vehicle tracking system

iii. 3D Terrestrial Laser Scanner (TLS) and Drone survey

iv. Seismic Data Processing & Interpretation Centre

v. SAMVAAD App, a platform that connects stakeholders and employees

vi. CIL signed a Memorandum of Agreement with IIT (ISM) Dhanbad to setup a CIL Innovation & Incubation Centre (CII Centre) to create a platform to promote entrepreneurship, innovation and support startups in core business areas of CIL, through NITI Aayog's 'Atal Innovation Mission'.

There is still a long way to go. The ability to innovate – to evolve, adapt, and improve – is indispensable for survival.

P.M. Prasad
President, MGMI

FROM THE DESK OF EDITOR

TAKING STOCK AND MOVING FORWARD : A VISION FOR MGMI PUBLICATIONS

It is my great privilege to take over as the Editor of MGMI's publications. Based on the extraordinary credentials of my predecessors and the rich history of this organization, I am humbled to be asked to serve in this role. Specifically, I am thankful to Professor Khanindra Pathak, who has been an illustrious collaborator and leader during my time as the Associate Editor. I also thank MGMI's President, Mr. P.M. Prasad and other council members for their confidence in me.

Let me first take the opportunity to introduce this special issue on computerization and digitalization of mining operations in India. This theme has been undergoing great transformation for the past three decades. Let me reflect on some key recommendations of a US-India Seminar on Computer Methods in the Mineral Industry, convened by Professor R.V. Ramani in 1991. Several key themes were outlined in this area. For instance, development of national mineral industry databases was repeatedly stressed upon. Indeed, we have seen a lot of this data becoming open-access with the internet revolution. One thing that remains, though, is the streamlining of this data and its easier accessibility through a national portal. Consider the inventory of coal resources in India, which is annually compiled by the Geological Survey of India or the Indian Bureau of Mines' Mineral Yearbook. Can a more visually-appealing portal be developed for improved exposition and illustration of these databases?

At least two major problems in my own research area may be solved through preparation of such national databases in open-access. For instance, India likely has abundant geologic pore space for injection of CO_2. However, inconsistencies in data reporting have made a robust assessment challenging (Singh U, et al, 2021, Frontiers in Climate, 3, 708320). Another key area where data gaps have been encountered is the preparation of inventory of fugitive methane emissions from India's oil and natural gas systems. Monitoring and detecting methane leaks is a critical but expensive step in this process. Having a guiding set of leakage rates from different components from existing facilities could enable much more accurate estimation in this area (IPCC, 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories). Through this editorial, I invite letters to the editor from our august membership outlining a similar "wish list" where they are interested in seeing national inventory databases. I believe MGMI could demonstrate great leadership by compiling a set of such research questions.

Interestingly, this leads to the first area where I wish to see a change in the way we operate MGMI publications. Currently, we have a unidirectional flow of information where the editorial board invites manuscripts on special themes, and authors submit their work. Over the next year, we should seek to develop a more interactive mechanism of working, where the readership (especially from the industry) advises us on the key issues where they wish to see a greater thrust in MGMI publications.

Two other domains specified in this report I quoted above are (1) hardware/software development and acquisition, and (2) incorporating geostatistics in mine planning. It is heartening to see that ongoing work reported in this special issue actively incorporates these areas. For instance, the paper by Samarth Singh uses an evolutionary multi-objective direct policy search in optimizing hydrological reservoir operations. This also utilizes the open-access data from the representative concentration pathways and the shared socioeconomic pathways, used by the integrated assessment modeling community. Indeed, the mining community should similarly leverage similar cutting-edge tools and replicable datasets to come up with increasingly relevant industry solutions. The paper by Bhardwaj and Dey uses an illustrative framework to automate mine life-cycle. Other two papers also involve a review of the industry state-of-the-art in this area. I complement the Guest Editor of this special issue, Professor N.C. Dey in compiling this special issue.

The backbone of any journal are the authors but also the reviewers who assure that the review process is robust. In some special issues in the past, we have been able to maintain global best-practices in academic reviewing. We need to make this more consistent as we move forward, and we need help from the MGMI community in making this possible.

In this vein, I invite voluntary contributions from experts, especially early-career professionals, who are able to spare time to be reviewers for MGMI News and Transactions of MGMI. Having a qualified reviewer pool is of essence in further improving the quality of our publications. We will find ways of recognizing your efforts and excellence in reviewing, at par with other peer-reviewed journals.

Finally, there is an important role – in my view – in ensuring that MGMI publications represent the gold standard of industry-academia-policy interaction. MGMI has typically done very well in facilitating discourse between the industry and academia. Over the past few issues, however, we have increasingly sought to build strong policy linkages as well. This is reflected in our interviews with experts who have served in senior government roles (for instance, Professor Samir K. Brahmachari, former Secretary of the Department of Scientific and Industrial Research, Mr. D.N. Prasad, former Advisor, Ministry of Coal, and so forth). The two immediate past special issues also are illustrative of these efforts. In the April-June 2021 issue, we showcased international decarbonization efforts being carried out in the multi-country DDP-BIICS project. This was followed-up with a special issue on net-zero greenhouse gas emissions and how that pertains to the Indian coal sector's future in the June-September, 2021. This aligned with Prime Minister Modi's commitment at COP-26 for India to achieve net-zero emissions by 2070.

I strongly believe that further integrating interesting policy work in our publications will be pivotal in solidifying MGMI's position as a unique professional society, the kind of which is seen rarely. The support of senior government leaders, as high as the cabinet ministerial levels, shows that we are uniquely poised to in a position to inform policy-making proactively. As such, I invite the readership to provide suggestions on future interviews and perspective pieces that can enable fulfilling of this aspiration.

I would like to conclude with a quote from my two illustrious colleagues, Professor Leon Clarke and Professor Yi-Ming Wei, who serve as Editors-in-Chief of Energy and Climate Change – a journal where I also happen to sit on the editorial board. They have written on what it means to be truly interdisciplinary in character, "Simply mixing articles together does not render an interdisciplinary perspective, just as setting different ingredients on the counter is not the same as making a meal. It's only after the ingredients are brought together, and frequently heated, that they blend together to create something new". As MGMI strives to bring in novel dimensions from industry, academia and policy, we have to make sure that this does not simply mean having few articles of each category. Instead, we have to be proactive in identifying work that blends these dimensions in a holistic way. We are interested in providing a greater coverage to such research in the future. Many of us will be attending MGMI's flagship conference, the 9th Asian Mining Congress in February, 2022. Please reach out to members of the editorial board at this conference and provide your ideas in making MGMI a leader in work of interdisciplinary character.

Ajay K. Singh
Honorary Editor, MGMI
Former Scientist and Head Degasification
CSIR - CIMFR

GUEST EDITOR COLUMN

Prof. Netai Chandra Dey

It is a great privilege to edit the present issue of MGMI News Journal on Computerization and Digitalization in the Indian Mining Industry. Today, the mining industry is undergoing digital transformations, and different terminology have emerged in the media, on the internet, and at conferences to describe these technical advancements and the resulting changes. Authors may freely use the terms "fourth industrial revolution," "digital revolution," "digitalization," "digital transformation," "intelligent mining," "smart mining," or "mining 4.0" in this context. Unfortunately, despite significant variances in the original definitions, these phrases are employed inconsistently.

- "Robotics" is concerned with the creation and application of robots, whereas "automation" is concerned with the operation of existing machines.The haulage process makes extensive use of automation, or more accurately, autonomy technologies. However, the loading of ore and garbage by mobile equipment is still not fully automated.
- "Automation" is the most frequently mentioned technology, and it has already had an impact on the mining industry. The ego-networks "robotics" and "automation" are linked to the same technologies as "artificial intelligence," "machine learning," and "3D printing". Robotics is frequently regarded as the digital's last manifestation.
- The "Internet of Things" (IoT) is a concept in which physical objects are interconnected and may communicate and be controlled remotely from any location via the internet. The Internet of Things (IoT) is used in mining to track the location and loading status of trucks, which aids in the coordination of mobile equipment. There are also measures in place to trace people in case of an emergency. In underground mines, "IoT" monitoring devices are also used to monitor rock stability and movement. The Internet of Things, in example, enables the linking of low-cost sensors to send data to a central location and serve as a cross-platform system.
- **Industry Challenges Revisited :** Several of the fundamental difficulties facing the global mining and metals industry, as stated at the outset of this editorial, will be exacerbated and accelerated by the digital revolution.
  - Digital technology, on the other hand, can give mining and metals industries with capabilities to minimize and prevent these threats.
  - As a result of digitally enabled consumer sharing models (e.g., Uber), "products as services," greater supply-chain efficiencies, and the rise of the circular economy, digital is predicted to contribute to lower worldwide

demand for major metals-derived products.

- The mining and metals industry's output will continue to be needed around the world, but per - capita consumption in both mature and developing countries is declining.

- **Digital Adoption Considerations :** Our value-at-stake analysis revealed a significant range in the projected adoption rates for the digital projects we evaluated, affecting their ability to unlock value for the sector and society.

  - Adoption rates for certain technologies and the overall digital transformation of the mining and metals industry will be influenced by a variety of factors.

  - We have calculated the time required to bring the digital efforts detailed in this section of the study to scale in the mining and metals industry.

  - Because digital technologies that connect workers and hardware are easier to implement, they are likely to become more extensively utilized in the near future.

- **Digital Transformation and Industry Restructuring :** The deployment of digital technologies will change and speed up the structure of the metals and mining industries. However, because there are various, and sometimes contradicting, developments ongoing, it is not yet possible to establish a single, overarching trajectory or ultimate state.

  - Digitally enhanced operating and commercial capabilities will put pressure on existing business models, particularly at the boundaries of value chain stages.

  - The same pressures at value-stage boundaries may also lead to increased vertical integration.

  - The mining and metals industry has a long history of vertical-integration cycles: periods of scarce "upstream" supply and high prices leads to backward integration by midstream companies; periods of slow demand growth and over-supply lead upstream producers to forward integrate.

  - Digital has the potential to strengthen the trend toward vertical integration as a strategy for some companies to respond to industry disruptions.

  - Opportunities for virtual M&A – both horizontal and vertical – will become more prevalent on the back of digitalization.

- A profusion of new business models, commercial and technical platforms will emerge during the next decade, resulting in a somewhat jumbled industry structure. These shifts, however, are likely to crystallize into one of three scenarios that could play out inside the mining and metals value chain.

  - Low Disruption, the status quo is maintained by the delayed adoption of technology and the slow pace of change, while a small number of medium and big enterprises control their respective, specialized areas of the value chain.

  - Medium Disruption, this is the beginning of downstream disintermediation and partnerships that push

metals companies closer to customers and to more value-added production. A smaller, leaner field of low-cost or innovative companies emerges. Larger companies move into the scrap and recycling section of the value chain, enabling them to forge partnerships to provide inputs directly into metals production.

Prof. Netai Chandra Dey

Professor (HAG)
Indian Institute of Engineering Science and Technology, Shibpur
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About the Guest Editor

Dr. N. C. Dey is a graduate of B. E. College Shibpur and stood first class first in Mining Engineering in the year 1986. He started his career in 1986 with Coal India Limited and became Colliery Manager in Central Coalfields Limited in 1994. He joined as Lecturer in Mining Engineering at Bengal Engineering & Science University Shibpur (formerly known as B. E. College Shibpur) in the year 1995 and promoted to the post of Professor in the year 2006. He has completed PhD degree from BESUS in 2000 and supervised 6 doctoral students. He has completed many Govt. funded research projects and published more than 133 articles in various National, International Journals and Conferences and has written 4 books for Mining Professionals. He has been honoured with ten national level awards including JG Kumaramangalam medal and Dr. Rajendra Prasad memorial prize given by the Institution of Engineers (I), for the outstanding contribution in the field of improvement of production and productivity in underground coal mines in India. Prof Dey is currently serving IIEST Shibpur as Professor HAG.

Theme of theNext issue

"Strata Control in Underground Coal Mining"

HEADQUARTERS' ACTIVITIES

Minutes of 889th Council Meeting

(Held through Zoom – Virtual Platform)
https://us02web.zoom.us/j/4997468863?pwd=TXBtUUs3bStXQ1psdk5qTENUS3ljZz09

Date & Time : 07th August, 2021 at 05.30 PM

The report of the 889th Council Meeting (2nd Meeting of 115th Session) at MGMI Bldg., GN-38/4, Sector-V, Salt Lake, Kolkata – 700 091 on 7th August, 2021 at 05.30 PM (Duly approved in the 890th Council Meeting held on 17th October 2021).

PRESENT : Shri P M Prasad, President in the Chair. The meeting was attended by Prof Banerjee Sakti Pada, Prof. Dhar B B, S/Shri Jha N C, Ritolia R P , Saha R K, Goenka J P, Lochan Rajiw, Roy Prasanta, Karmakar Anil Kumar, Dr. Singh Ajay Kumar, Arora V K, Barnwal J P, Biswas Anup, Bose L K, Chakrabarti Smarajit, Prof Dey N C, Prof Karmakar G P, Nag T K, Prof Sarkar Bhabesh Chandra, Dr Sen Kalyan, Singh Anil Kr, Dr Sinha Amalendu, Khuntia G S , Gautam N N, Wadhwa I P and Talapatra Ranajit.

ITEM No. 0 Opening of the Meeting

0.1 The meeting was called to order by the President. The President welcomed the Past Presidents, Branch Chairman, Council Members present in the meeting alongwith invitees. He thanked the Almighty on improvement in current pandemic situation and wished all be healthy and safe. Thereafter, President requested the Hony. Secretary to take up the Agenda for deliberations.

0.1.1 Leave of absence was granted to those who could not attend the meeting.

889.1.0 To confirm the Minutes of the 888th meeting of the Council held on 04th June, 2021 on Virtual Platform

The draft Minute were circulated to all the Council Members. Since, no comments were received, the Council resolved that :

Resolution : The Minutes of the 888th (1st meeting of the 115th Session) Meeting of the Council held on 04th June, 2020 at 6.00 PM on Virtual Platform, be confirmed.

889.1.1 To consider matters arising out of the Minutes.

The Council considered the Action Taken Report in respect of the Minutes of 888th Council Meeting held on 4th June 2021 on virtual platform and further discussion taken up as it was included in Agenda also separately.

Item No. 888. 3.0 Council Election 2021-24

The Board of Scrutineers met three times and last was on 10th July 2021. Notice was issued to members inviting nominations on 18th June 2021. There were total 12 nominations received and all have been accepted as the valid candidates for the election of the Council Members for the term 2021-24. Ballot Papers were issued to all eligible members on 19th July 2021. Ballot Papers were sent by speed post to the eligible Members to their addresses as registered with MGMI. However, wherever there is no availability of speed post, ballot paper was sent by Registered Post. Last date to receive Ballots is on 18th September, 2021. All related information is regularly being updated in MGMI Website for wider coverage among members.

Item No. 888.4.0 Future Programmes

1. Short Term Courses : The respective coordinators of the Short Term Courses have been intimated and requested to finalize the brochure so that MGMI can approach respective organisation to sponsor and nominate participants.

As per Council approval, CIMFR has been approached for further extension of 2 years and they have renewed the terms of the Memorandum of agreement till December 2021 with the same terms and conditions as agreed in the earlier agreement, vide their letter dated 6th August 2021.

2. Technical Paper Sessions : A virtual paper meet was organised on 8th May 2021 wherein 04 papers were presented. All the 04 papers were sent to Dr. Khanindra Pathak, Hony. Editor and Dr. A K Singh, Associate Editor for modifying and editing.

3. A virtual technical presentation was made by CUSMAT Technologies, Hyderabad on 1st August, 2021 at 5.00 PM on "UG Mine Hoists for Drum & Friction Winders based on Simulator (Virtual Reality)". A proposal on joint training programme for haulage Operators has been agreed and placed for Council approval where MGMI will be the lead manager. "A committee may be constituted to work-out details on training module in consultation with CUSMAT Technologies and MGMI".

Item No. 888. 6.0 Any other Matter

Dues of 8th IME : M/s. Tafcon paid Rs. 5 Lakhs less 10% tax on 28th July 2021 and dues of Rs. 13.70 lakhs still remain.

889.1.2 (1) 9th AMC & IME

Mr I P Wadhwa, Managing Partner M/s TAFCON updated the council that now situation is improving and as proposed in the last council meeting, we should consider organizing next edition of IME concurrent with AMC during January 17 (Mon) – 20 (Thu), 2022 as venue is available and he is positive for good participations from abroad or their representatives stationed in India.

He further supplemented that December 2021, is not desirable due to EXCON (which has an overlapping profile) during December 7-11, 2021 at Bangalore and IMME, Kolkata is expected in October 2022. Therefore, MGMI should consider to organize the Biennial event as per practice. He further supplemented that Exhibitors need exhibition venue for a long period of about 21 days (including mounting & dismantling), with lots of efforts. Eco Park authorities have agreed to provide the venue for IME on proposed dates with required days for mounting & dismantling period.

The Council discussed in detail on continuing pandemic condition which led to extra ordinary situation due to surge of corona virus and still uncertain about normalcy to restore for physical gathering due to prevailing natural calamity. It was opined that we may go ahead with proposed dates for preliminary communication, but if government does not permit to organize the event physically, there will not be any financial liability to MGMI. Further, organizing event on virtual mode will not have that much glamour and participation.

Council again showed doubt on participations from abroad considering current situation, restriction on travel and government advisory. It was concluded that on 13th August, 2021 Poland Officials are visiting MGMI, where we may get opinion on other countries participation. Accordingly, the President and Officers of MGMI will take a call on this issue. President agreed to the views of Council members and assured that decision will be taken considering covid protocol, safety and expected foreign participation for 9th Edition of the event.

(2) Workshop

Council was apprised that the Government of India has shown an important thrust on reducig CO_2 and other green house gas emissions as part of the Paris Agreement commitments. Key experts are also considering if these could be supplemented by a net-zero emissions target by a particular year. Currently, coal utilization and production contribute significantly to greenhouse gas emissions and as such, technological and policy solutions would be needed to reduce emissions in this sector. Accordingly, it is proposed to or-

ganize a Webinar on "Reducing CO_2 emissions from the Indian coal sector and transitioning to a net-zero context". International Speaker (1) Mr Toby Lockwood, Senior Analyst, International Centre for Sustainable Carbon, London (UK), (2) Prof Vikram Vishal, Associate Professor, Indian Institute of Technology Bombay, Mumbai (India) and (3) Dr Udayan Singh, Postdoctoral Fellow, North Western University, Evanston, Illinois, USA are available to present their views in the interest of India.

It was agreed that MGMI should organize Webinar on the subject on 17th August on Virtual Platform. Past President, Prof S P Banerjee, Former Director, IIT (ISM) Dhanbad was requested by the Council to be the Moderator of the session which he has accepted.

Council appreciated the effort and approved the proposal to organize in big way on virtual platform which will further enhance visibility of MGMI. Hony Secretary has been assigned to proceed further for the needful.

(3) Training

It was apprised to the Council that MGMI is in receipt of a proposal for organising training programmes jointly with CUSMAT Technologies and MGMI on winder simulator products of CUSMAT Technologies (Hyderabad) for Underground Mine Hoists for Drum and Friction Winders based on Simulator (Virtual Reality).

To evaluate the proposal, a virtual presentation by CUSMAT Technologies was arranged on Sunday the 1st August, 2021 where detailed technical presentation was done by CUSMAT Technologies (Hyderabad) Team on Simulator product viz. "Underground Mine Hoists for Drum and Friction Winders based on Simulator (Virtual Reality)".

Council agreed that a suitable training programme for haulage operators is very important for safety and productivity of any underground mine. The training module developed by CUSMAT Technologies on Virtual Reality (VR) based training systems to train winder operators in underground mines will be beneficial to mining industry.

Council further agreed that such training should be conducted under the banner of MGMI and any Company approaching CUSMAT Technologies for such training would be directed by them to contact MGMI. Accordingly joint training proposal with MGMI as the lead manager is approved by the council.

To proceed further, a committee of following members was constituted to work out on details of the training programme in consultation with CUSMAT Technologies:

1. Sri N C Jha – Chairman
2. Sri R P Ritolia
3. Dr Amalendu Sinha
4. Sri Rajiw Lochan
5. Prof Bhabesh Sarkar

It was further requested that other three Training courses which is approved by MGMI Council, please also be pursued by the respective committee.

889.2.0 The 115th Annual General Meeting of the Institute

It was apprised to the Council that to comply statutory requirements MGMI need to organise the 115th AGM by month September as now Government has also allowed to organize AGM on virtual mode through their accredited agencies. Hony. Secretary updated the Council that last year it was organized in hybrid mode in association with Central Depository Services (India) Limited, (CDSL) and Company Secretary Mr Mohamammad Menazuddin was our scrutinizer for the purpose in line of ROC guidelines. He further proposed that CS Mohamammad Menazuddin may be appointed as scrutinizer on similar terms and conditions. He has been consented by MGMI and confirmation was received from him. His professional fee shall be Rs. 24,000/- for rendering of sectorial services related to conducting AGM through Virtual mode and Issuances of Scrutinizer's Report as per the Company Act, 2013. CDSL will provide with all necessary facilities at the cost of Rs. 30,000/- only to all members of MGMI

which also includes Virtual platform, Remote E-voting system, E-voting on the date of AGM, Entire videography of the meeting, and transcript in English.

Considering the above facts, it was agreed that AGM will be held on Saturday the 25th Sept., 2021 from 10.30 AM in virtual mode which was approved by the Council, however, it was requested that possibility of hybrid mode should also be explored.

889.3.0 To consider and approve the Audited Accounts for the financial year ended on 31st March, 2021.

The Auditor's Report and Audited Accounts for the financial year ended on 31st March 2021, were placed before the Council for consideration. The Council has gone through the Auditor's report, Balance Sheet for 2020-21 and Income & Expenditure Accounts 2020-21 and approved after satisfying the clarification and adopted it for further needful.

889.4.0 To appoint the Institute's Auditor for the financial year 2021 – 22 with their remuneration.

The Council considered the proposal of M/s. Jha & Jha Chartered Accountants Company vide letter dated 6th August 2021 submitted offer to accept appointment as the Auditors of MGMI for the year 2021-22. The Council approved the appointment of M/s. Jha & Jha Chartered Accountants Company as Auditors of MGMI for the FY 2021-22 at a remuneration of Rs. 12,000/- (excluding applicable taxes) for execution of all assignments of Audit, ROC, Annual Filling, IT Returns etc.

889.5.0 To elect the President of the Institute for the year 2021 – 22

It was unanimously proposed by the Council that the present President, Sri P M Prasad should continue as the President of the institute for the year 2021-22. Thereafter, his name was proposed by Dr Amalendu Sinha and seconded by Sri T K Nag. Council unanimously elected Sri P M Prasad as the President of MGMI for the year 2021-22.

889.6.0 To elect the Hony Secretary of the Institute for the year 2021 – 23

It was proposed by Sri J P Goenka that the present Joint Secretary, Sri Ranajit Talapatra should be elected as the Hony Secretary of MGMI for the term 2021-23 which was seconded by Sri Anil Kr Singh. Council unanimously elected Sri Ranajit Talapatra as the Hony Secretary of MGMI for the Year 2021-23.

889.7.0 To consider applications for membership and the membership position of the Institute.

a) Hony Secretary informed the council that Membership record at MGMI has been thoroughly scrutinized. For the convenience of members, an on-line tab has been created on MGMI website https://www.mgmiindia.in/ where members can update their details online which will be incorporated in MGMI record accordingly. There was no new membership application for consideration.

b) The Council noted the present position of membership, which is as follows :

MEMBERSHIP POSITION FOR 889th COUNCIL MEETING
No. of Responsive Members as on 07.08.2021

	04.06.2021	Add	Trans	Loss	07.08.2021
Member	265	-	-	-	41
Life Member	2574	08	-	-	1907
Associate	42	1	-	-	18
Student Associate	07	01	-	-	04
Life Subscriber	32	-	-	-	27
Subscriber	01	-	-	-	01
Life Donor	01	-	-	-	01
Donor	03	-	-	-	01
Patron	04	-	-	-	05
Corporate	08	-	-	-	08
Life Corporate	02	-	-	-	02
	2937				2015

889.8.0 Any other matter with the permission of the Chair.

The Council appreciated the efforts of the Editorial Board and publication of MGMI's News Journals and Transactions even in current pandemic and restrictions imposed to prevent corona virus. It was informed that the following MGMI's News Journals,Transactions were published and uploaded at MGMI website :

- MGMI News Journal Vol 46 No 4, Jan-March 2021, Vol 47 No 1 April – June 2021
- Transaction Vol 116, April 2019-2020
- MGMI Profile, 114th Annual Report 2019-20
- MGMI Memorandum

The Hony. Secretary once again requested Council Members to motivate members in their contact to update their recent communication details through online up-dation tab facility at MGMI Websitehttps://www.mgmiindia.in/. It is very easy to update on-line at the site itself.

Transit House

Sri J P Goenka, expressed that it is found expenditure towards MGMI Transit House for the year 2020-21 is high because booking was negligible due to covid resulted loss to MGMI. In this connection, Past President, Sri R P Ritolia said presently, due to covid many of the Hotels and Guest Houses of West Bengal are not offering accommodation facility to the boarders for the time being due to the Pandemic situation – Covid 19. So, he proposed that MGMI Guest House should be suspended till the situation improved and can start once normalcy restore. After deliberation it was agreed that MGMI Guest House facility will be suspended, however, in the interest of members it will be revived again after normalcy.

Appreciation

Past President Prof. B B Dhar highly appreciated the sincere contribution of Hony Secretary, Sri Rajiw Lochan to MGMI and placed on record that during his tenure MGMI has joined hands with International Agencies and Government Ministries for the betterment of Institute and added many feathers to our cap.

Prof. B B Dhar also appreciated the efforts of Prof. Khanindra Pathak and Dr. Ajay K Singh for their contribution to enhance the quality of MGMI publications.

Past President Prof S P Banerjee recorded his appreciation for Sri Rajiw Lochan's as office bearer of MGMI in different capacities as he gave his best and contributed greatly to the wellbeing of the Institute. "I congratulate him for all success in future endeavours also".

President Sri P M Prasad appreciated contribution of Sri Rajiw Lochan and assured the Council that Sri Rajiw will continue with MGMI to keep continuity of his associationin different capacities in MGMI.

Hony Secretary, Sri Rajiw Lochan thanked each and every member for their nurturing and guidance to perform to everyone's satisfaction.

Sri Ranajit Talapatra thanked the Council members for showing confidence on him and electing him as the Hony Secretary of the institute for the next 3 years.

President, Sri P M Prasad thanked the Past Presidents, Council Members and Branch Representatives to re-elect him as the President of MGMI. He further thanked each one for their active participation in the virtual meeting and hoped to meet everyone in person and wished all to stay healthy and safe till then.

The meeting ended at 7 PM with Vote of Thanks to the Chair and others by the Hony Secretary, Sri Rajiw Lochan.

Minutes of 890th Council Meeting

(Held through Zoom – Virtual Platform)

https://us02web.zoom.us/j/83794655553?pwd=aE14eFNwaGlodzNSZHFvL2sxeDZIZz09

Date & Time : 17thOctober, 2021 at 11.00AM

The report of the 890th Council Meeting (1st meeting of 116th Session) at MGMI Bldg., GN-38/4, Sector-V, Salt Lake, Kolkata – 700 091 on 17th October, 2021 at 11.00AM (Duly approved in the 891st Council Meeting held on 11th December 2021).

PRESENT : Shri P M Prasad, President in the Chair. The meeting was attended by Prof Banerjee Sakti Pada, Prof. Dhar B B, Dr. Nanda N K, S/Shri Jha N C , Ritolia R P , Saha R K, Jha Anil Kumar, Goenka J P, Lochan Rajiw, Roy Prasanta, Dr. Singh Ajay Kumar, Singh Chandra Shekhar, Chakraborti Bhaskar, Barnwal J P, Biswas Anup, Bose L K, Chakrabarti Smarajit, Prof Dey N C, Prof Karmakar G P, Nag T K, Prof Sarkar Bhabesh Chandra, Dr Sen Kalyan, Dr Sinha Amalendu, Khuntia G S , Gautam N N, Wadhwa I P and Talapatra Ranajit.

ITEM No. 0 Opening of the Meeting

0.1 The meeting which was held in a hybrid mode due to the still existent virus scare, was called to order by the President. The President welcomed the Past Presidents, Past Secretaries, Present Secretary, Chapter Chair Persons and existing Council Members, newly elected Council Members alongwith invitees who were present physically as well as virtually in the meeting.

0.2 The President welcomed and congratulated Shri Ranajit Talapatra as the Hony. Secretary of MGMI. Thereafter, President requested the Hony. Secretary to take up the Agenda for deliberations.

0.3 Leave of absence was granted to those who could not attend the meeting.

0.4 It was proposed that Shri V. K. Arora and Shri Bhola Singh, Dir(Tech), CCL, may formally be co-opted as Nominee Council Members for one year against the 2 possible nominations allowed in the AoA. The proposal was agreed and approved by the President and the Council with consent of both nominees.

0.5 Hony Secretary, addressing the Council for the first time, thanked and welcomed everyone including the President, Past Presidents, Vice Presidents and Council Members, and read out the names of the following newly elected Council members of MGMI, welcoming them to the Council. S/Shri Pravat Ranjan Mandal, Chadra Shekhar Singh, Dr Kalyan Sen, Anup-Biswas, Dr. Ajay Kumar Singh, BhaskarChakraborti, Nitya Nand Gautam, Prof Bhabesh Chandra Sarkar and Prof Netai Chandra Dey.

890.1.0 To confirm the Minutes of the 889th meeting of the Council held on virtual platform at MGMI Bldg. Kolkata – 700 091 on 7th August, 2021 at 5.30 p.m.

The draft Minutes were circulated to all the Council Members. As no comment was received, the Council resolved that :

Resolution : The Minutes of the 889th (2nd meeting of the 115th Session) Meeting of the Council held on 7th August, 2021 at 5.30 PM on Virtual Platform, be confirmed.

890.1.1 To consider matters arising out of the Minutes.

The Council considered the Action Taken Report in respect of the Minutes of 889th Council Meeting held on 7th August 2021 on virtual platform and concurred.

890.2.0 To discuss about the 9th Asian Mining Congress and Exhibition on 15th – 18th February, 2022.

890.2.1 The Hony Secretary requested Shri I P Wadhwa, Managing Partner, M/s TAFCON to apprise the Council about the progress made so far for organizing 9th IME.

Shri Wadhwa informed the Council that in view of the short time, preparations are being made very fast. Information has been placed on the web site which is fully operational. The same has been circulated through the social media as well. Data base for more than 10,000 companies are ready. Awareness has been created worldwide. Hony Secretary has been requested to draft the initial letter to formally approach the companies. Follow up action is to be taken in the next 2-3 weeks. Current progress will be placed before the Exhibition Committee for their guidance. A time line should be framed to complete certain things before Diwali and something before the New Year. It was informed that a newsletter will be ready for circulation within a week or so with agenda for every month. He requested to convene Organising Committee meetings once in a month or 5-6 weeks to take the stock of meaningful progress. He informed the Council that the details of the next MoU have been discussed in the Exhibition Committee.

Prof. S. P. Banerjee said that Japan, Russia, Iran, Kazakhstan and Indonesia, are the main Asian countries making lots of investments in Mining and that they are interested and have participated in the past. These countries should have some stalls in the exhibition.

Shri Wadhwa welcomed the idea and requested the President to write first letter to the Embassies of mineral rich countries such as Russia, South Africa, Germany, Australia, Czech Republic and Poland for better participation in the Congress and Exhibition. He mentioned that the Minister of Iran was contacted and Indonesia and Kazakhstan have been covered. ShriWadhwa wanted to visit the Congress and Exhibition sites and departed from the meeting with permission of the Chair.

890.2.2 On being requested by the Hony Secretary, Shri Prasanta Roy, Convenor of the Exhibition Committee described that the Exhibition has been outsourced to M/s TAFCON and CEO of the company has already briefed how it is progressing with the foreign countries and domestic companies and the steps to be taken. It was informed that as mentioned earlier, Sri Bhola Singh, DT PP, CCL and newly co-opted Council member, is the Chairman of the Exhibition Committee. The Council was requested to decide and finalize the financial part of the next MoU. It was intimated that while the last time during 8th IME, the minimum guaranteed amount was Rs. 45 lakh, this time for 9th IME, M/s TAFCON proposed the minimum guaranteed amount would be Rs. 30 lakh in view of the prevailing pandemic affected economic situation. The Exhibition Committee have negotiated the amount and Shri Wadhwa has principally agreed to the minimum guaranteed amount of Rs. 40 lakh in place of Rs. 45 lakh subject to review. Other terms and conditions remain the same as that of 8th IME. It was also clarified that M/s. Tafcon has cleared the 8th IME outstanding of Rs. 13.70 lakh. The Council after discussion agreed and approved minimum guaranteed amount of Rs. 40 lakh for the 9th IME, with the rider that the MOU should have it that this is a onetime waiver of escalation and the escalation of 10% will remain in place for next event.

890.2.3 Immediate Past Hony. Secretary and the Convenor, 9th AMC, Sri Rajiw Lochan updated the Council that Shri Prem Sagar Mishra, CMD, ECL and Life Member of MGMI and Dr.Amalendu

Sinha, Council Member and Former Director, CSIR-CIMFR have kindly consented to be the Chairman, Congress and the Chairman, Technical Committee respectively. He informed that the Government of West Bengal has granted approval for organising the 9th Asian Mining Congress at the Biswa Bangla Convention Centre, New Town, Kolkata during February 15 – 16, 2022. The Congress will be held in Hall 4 and F&B arrangements will be provided in Hall 5. MGMI has already paid the booking amount. He also informed that the President, MGMI has proposed that the Congress and Exhibition will be inaugurated by the Hon'ble Union Minister of Parliamentary Affairs, Coal and Mines of India. Past president, MGMI, Sri R K Saha apprised the members that two Australian companies and one Indian company have already agreed to participate in the Exhibition and Congress. One company has offered to host a high tea in the Congress.

Considering the Pandemic situation, the Congress will be organized for two days instead of three days. To promote better participation of foreign delegates, they will be given the option to join online through a virtual platform while Indian delegates will be present physically at the Convention Centre. The Committee is approaching Iran, Kazakhstan, Russia and Indonesia for participation in the Congress. Japan is also being pursued for participation in the Congress. Australia, Poland and Germany have consented for participation in the Congress and the Exhibition. Regarding the Registration fee the Council was informed that it is the same for Indian delegates, while the same has been reduced significantly for overseas delegates for better participation. Special consideration has been given to Indian students. He read out the following Registration Fees:

Indian Delegates :

Indian Delegates	: INR 30,000
Indian Authors	: INR 15,000
Faculty from Academic/Research Institutions in India	: INR 10,000
Research Fellow	: INR 5,000
Students	: INR 2,500
Accompanying Spouse of Indian delegates	: INR 5,000

Overseas Delegates :

Overseas Delegates	: USD 1,000
Overseas Authors	: USD 500
Delegates from Overseas/ SAARC Countries	: USD 750
Accompanying Spouse of Foreigndelegates	: USD 500

Regarding the important dates of paper sub mission, the Council was informed that the time limits are :

Abstract submission due date	: 10th November 2021
Abstract acceptance notification	: 10th December 2021
Full paper submission	: 31st January 2022

It was also informed that the authors will be sent guidelines for submission of full papers with abstract acceptance notification.

There will be no publication of hard copy of the proceedings at the time of organizing the Congress. A reputed publishing house will be engaged for publication of the proceedings subsequent to the Congress. The Council was apprised that the Brochure is ready for printing and the 1st call will be uploaded on the MGMI website in the coming week and circulated subsequently.

890.2.4 Dr. Amalendu Sinha, Chairman, Technical Committee said that it is a challenging task to conduct the technical sessions in one and half days. He requested Senior Council Members to suggest names of experts for good and meaningful presentation from different sectors. He requested Council Members to feel free to write directly to people they knew could present international class papers.

890.2.5 Shri T K Nag suggested approaching the Government of West Bengal as they may be largely interested to showcase their newly formulated Industrial Policy. Hony Secretary mentioned that a letter to Hon'ble Chief Minister has already been sent and requested the members in touch with people of importance in WB govt to kindly follow up in their acquainted spheres.

890.2.6 Council member, Prof Netai Chandra Dey wanted a reduction in Registration fee for the students. He also proposed that, the Conference Proceeding publication should be linked to a reputed publisher like Springer as the tendency of writing papers nowadays is focussed on Scopus and SCI Journals. He also suggested forming a group for researchers and publish their papers. After detailed deliberations, it was decided that the Registration fee may not be reduced in the brochure but the technical committee may take a call on case-to-case basis as requested, like previous years. Regarding the publication, it was summarised that the publication in Scopus and SCI Journals may be discussed in a technical committee meeting first and then put up to the Council.

890.2.7 President desired a meeting of the Core Organising Committee members, immediately after Diwali and Chhat to smoothen out the roadmap for the AMC as there will hardly be any time and advised the Convenors of the Conference and Exhibition to put in extra effort for successful organisation of the event. He asured all support from himself and the Hony Secretary.

890.3.0 To elect office bearers viz Vice-Presidents, Hony. Jt. Secretary, Hony. Treasurer and Hony. Editor amongst Council Members of the Institute for the year 2021 - 2022.

There are four posts of Vice Presidents and one each of Hony Joint Secretary, Hony Treasurer and Hony Editor. The following names were proposed for the above posts :

Vice President	1. Shri Binay Dayal, Director (Technical), CIL 2. Shri J. P. Goenka, Managing Partner, Nanda Miller Co. 3. Shri P. K. Sinha, CMD, NCL 4. Shri Bhola Singh, Director (Technical), P&P, CCL
Hony. Joint Secretary	Shri Chandra Shekhar Singh, Chief Manager, CIL
Hony. Treasurer	Shri Bhaskar Chakraborti, Former DDG, GSI
Hony. Editor	Dr. Ajay Kumar Singh, Former Scientist & Head, Methane Emission & Degasification, CIMFR

The President accepted the names and was unanimously approved by the Council.

890.4.0 To review and consider the proposed Budget for the year 2021-22.

890.4.1 The Hony Secretary informed that the budget has been circulated with a request to provide comments, if any.

890.4.2 Shri R P Ritolia informed that the President Golf Tournament could not be held last year due to pandemic and this should be organized this time for which an amount of Rs. 4.00 lakh should be earmarked to meet the initial expenses. The Hony Secretary responded by saying that this item is separate from day-to-day expenditure budget, which was being placed.

890.4.3 Shri Prasanta Roy suggested that the Transit House on the top floor of MGMI Building has been discontinued and the possibility of renting it out may be explored in order to have some income for MGMI. Many Council Members expressed their opinion that it should be reopened in near future. It should not be rented and MGMI should do some expenditure. Privacy in the building may also be lost if the top floor is rented out to some outsider. The Transit House is very good and purposeful facility for the retired persons as it is safe and homely and therefore, it should be continued. Shri N. C. Jha, one of the Past Presidents wanted to know if any separate accounting has been done for it in the past or any cost benefit analysis has been done. He also sought clarifications regarding percentage of occupancy. Shri Rajiw Lochan, Immediate Past Secretary shared his experience by saying that overhead expenses were very high (almost double) when the services were outsourced as compared to the case when it was run by the contractual staff of MGMI. Few years back, occupancy percentage was very high when there was an arrangement with NEC and others. The same arrangement may be revived in future as well. Shri N. C. Jha expressed that the facility should be self-sufficient. He suggested to form a separate committee to review and take stock of the Transit Accommodation and till then it should continue. Past President, Prof. B. B. Dhar, agreed to the proposal and the President accepted the proposal of Shri Jha and it was decided to constitute a small committee to review the expenses of the Transit House, followed by purposeful discussion on its recommendation in a Council Meeting. It was proposed that till then it should continue with skeletal services by MGMI staff for outstation Council members who wanted to stay during events of MGMI in Kolkata.

890.4.4 The Hony. Secretary informed that MGMI obtained a tenant (M/s. RAC IT Solutions Pvt. Ltd) at a monthly rent of Rs 1,30,000/- only w.e.f. 15th October, 2021 for the space in the basement which had to be taken over from the earlier tenant who had kept 23 months' rent pending even after several verbal and written reminders. The new tenant (M/s. RAC IT Solutions Pvt. Ltd) has deposited four months' rent in advance, which has been kept in a fixed deposit.

890.4.5 The Council considered the facts and figures and approved the budget for the year 2021-2022.

890.5.0 To consider applications for membership and the membership position of the Institute.

Membership Position
(As on 17.10.2021)

	07.08.2021	Add	Trans	Loss	17.10.2021
Member	41	-	-	-	41
Life Member	1907	05	-	-	1912
Associate	18	-	-	-	18
Student Associate	04	-	-	-	04
Life Subscriber	27	-	-	-	27
Subscriber	01	-	-	-	01
Life Donor	01	-	-	-	01
Donor	01	-	-	-	01
Patron	05	-	-	-	05
Corporate	08	-	-	-	08
Life Corporate	02	-	-	-	02
	2015	**05**			**2020**

890.5.1 Hony Secretary informed that five Life Membership Applications have been received.

1. Shri Sabyasachi Mohanty, Director Technical (Operations), Odisha Mining Corporation Limited, Bhubaneswar.
2. Shri Rajesh Mishra, GM (Mining), Odisha Mining Corporation Limited, Bhubaneswar.
3. Shri Dhore Bhageshwar Naik, Dy. Director General (Mech.), Directorate General of Mines Safety (DGMS), Dhanbad.
4. Prof. Mrinal Kanti Mukherjee, Associate Professor, Department of Applied Geology, IIT (ISM), Dhanbad.
5. Dr. Sundaram Karuppanan, Managing Director, Geo Technical Mining Solution.

The Council agreed for membership of MGMI in respect of the above officials and accepted the proposal to allot the membership to the above-named persons.

890.5.2 Prof S. P. Banerjee wanted to know the progress made so far to revise the list of membership. Earlier the Directory was having 2937 membership, which was reduced to about 2000 after scrutiny by the MGMI Office and Mr Ranjit Dutta, which he appreciated as a commendable job. He reminded the council about a letter he wrote a month back where he mentioned a list of 50 members who have expired. MGMI should take up the matter and revise the Directory after verification, if required. He requested other members also to do a similar exercise for a more accurate directory.

890.5.3 Prof. S. P. Banerjee also drew attention of the Council towards the suggestion made by Shri Smarajit Chakrabarti regarding posting of the Directory having details of the members on the MGMI website, which is open to all. The details can be accessed by anyone and therefore it is not safe. The access should be allowed to persons who can login and then access can be made. The Hony. Secretary made an assurance to look into the matter, temporarily remove open access and explore the possi-

bility of formulating restricted access after completion of 9th AMC and IME.

890.6.0 Any other matter with the permission of the Chair.

Reappointment of Administrative staff

Hony Secretary informed the Council that due to exigencies of work, Mrs. Tanusri Dutta, Ex-employee of MGMI, who had retired earlier this year, has been re-appointed at a consolidated salary of Rs. 18,000/- per month w.e.f. 7th October, 2021. It is agreed for initially one year only. The Council ratified the appointment.

Refund of Award money

The existing award of MGMI have been consolidated to four coveted MGMI awards only. Some of the contributors have agreed to the proposal and some of them kept silent without any comments. However, Mrs. Raj Bhatnagar w/o. Late R.P. Bhatnagar and Mrs. Dr.Meena kshi Singh w/o. Late Dr. Mahendra Pratap Singh wanted to have the refund of the endowment amount i.e. Rs. 1,25,000/- and Rs. 5,00,000/- respectively.

It was proposed that as decided by a committee, the endowment amount deposited for the R.P. Bhatnagar and Dr. Mahendra Pratap Singh awards of Rs. 1,25,000/- and Rs. 5,00,000/- respectively, may be refunded to Mrs. Raj Bhatnagar w/o. Late R.P. Bhatnagar and Mrs.(Dr) Meenakshi Singh w/o. Late Dr. Mahendra Pratap Singh.

MGMI Chapter Activities

Dr. Nanda, Past President spoke that most of the chapters of MGMI are inactive. The chapters should be activated and election of the Executive Committee should be conducted as per the constitution, as it is seen that in most of the chapters there is no Executive Committee, President and Hony. Secretary. The Chapters should be re-activated and if necessary, previous office bearers of the Chapters may be called to the Council for discussion one to one or with a few chapters at a time. This was agreed by the members.

The Hony. Secretary requested the President to formally close the meeting with a few words. The President thanked all present once again for sparing their valuable time and for taking part in the deliberations.

The meeting ended at 1.00 PM with Vote of Thanks to the Chair and others present both physically and virtually by Hony. Secretary, Shri Ranajit Talapatra.

NEW MEMBER

As approved in Council Meeting on

As Life Member

17. 10. 2021

10863 – LM, Shri Sabyasachi Mohanty, B.Tech (Min) MBA (Operation), Director (Tech) Operation, Odisha Mining Corpn. Ltd. Arconretreat, Flat No. 512 Patia Square Patia, Bhubaneswar – 751 024 Ph: 7381007215 (M) 0674 2377522
email: sabyasachi.mohanty@odishamining.in

10864 – LM, Shri Rajesh Mishra, BE(Min) PGDMM(Mkt.) General Manager (Min), Odisha Mining Corpn. Ltd., House No 104, Oditech Lagoon, BDA Colony, Chandrasekharpur, Bhubaneshwar 751016 Ph :8763545981/ 0674-2377437 email: rajeshmishra@odishamining.in

10865 – LM, Shri Dhore Bhageshwar Naik, BE(Mech) MBA PGD (Human Resource) DDG Mines Safety (Mech) DGMS Govt of India, Hirapur, Dhanbad, Jharkhand – 826 016
Ph: 0326 2221002 (M) 9471192475,
email :dbnaik74@gmail.com

10866 – LM, Dr Mrinal Kanti Mukherjee, MS (Tech) Ph.D (Appl Geol) Associate Professor and HOD (Appl Geo) Dept of Applied Geology, Indian Institute of Technology (ISM) Dhanbad, Jharkhand – 826 004 Ph: 9431711148 /0326 2235472 email:mrinal_km67@yahoo.co.in

10867 – LM, Dr Sundaram Karuppanan, M.Sc (Apl. Geol) Ph.D (Geology), Managing Director, Geo Technical Mining Solution, Ground Floor, ½ 13B, Natesan Complex, Oddapatti, Collectorate Post ofice, Dharamapuri – 636 705, Tamil Nadu (M) : 7010076633 (M) 9443937841
email: info.gtmsdpi@gmail.com

11. 12. 2021

10868 – LM, Shri Shreekanta SH Roy, BE(Min) EPBM (Business Management) FCC(Coal), General Manager(Mining), Coal India Limited (HQ), JC-7/5, Nilanjana Co-operative Housing Society, Sector – III, Salt Lake City, Kolkata - 700106 Ph : 9433007096, 9158003839 email:sshroy@coalindia.in,
shreekant.roy 1968@gmail.com

10869 – LM, Dr Abhay Kumar Soni, BE(Mining), MS(S&T) Ph. D (Mining), Chief Scientist, CSIR-Central Institute of Mining and Fuel Research (CSIR-CIMFR) Nagpur – 440001, Maharashtra Ph: 0712-2510604 Extn. 205 (M) 9403209934 email : aksoni@cimfr.nic.in,abhayksoni@gmail.com

10870 – LM, Dr Hemant Agarwal, B.Tech(Min) M.Tech(Min) Ph.D(Min), Dy Manager(Mining) CMPDI, Ranchi 1C/4S, CMPDI Colony, Kanke Road, Ranchi, Jharkhand 834 008 (M) 8552880806 email: hemant.ism@gmail.com

10871 – LM, Shri Sachida Nanda Sahu, B Tech (Chem) M Tech, Ph D (Chem) continue, Principal Scientist, CSIR-Institute of Minerals and Materials Technoloy, Mineral Processing Dept (MPD) CSIR- IMMT, Bhubaneswar 751013 Ph: 0674 2379525/9861140160
email: sachi@immt.res.in

10872 – LM, Shri Pritam Kumar Sinha, B Tech (Min) M Tech (Min) FCC(Coal) Dy Executive Engineer(Min), Neyveli Lignite Corporation India Limited, Flat No. 101, Saraswati Enclave, Dhanakauda, Sambalpur 768006, Odisha, Ph : 8404925938 email: pritam.sinha7@gmail.com

10873 – LM, Shri Hemant Kumar, B Tech (Min) FCC, Executive Director, Neyveli Lignite Corporation India Limited, Block D-1(A), Flat No. 404, Green Park Residency, Circus Padia Sakhigopinath,Sambalpur–768001 Ph:9442569665 email: hkhemantratna@gmail.com

NEWS ABOUT MEMBERS

As on 01.10.2021

Shri Vinay Prakash Sinha (4864-LM) MMGI is now Jt MD, NVL Coal Washery Construction "Sinha Villa", Plot No. 86 A, Gajanan Nagar, Wardha Road, Nagpur, Maharashtra – 440015, Ph: 0712-2250221/9326656195
email: sinhavp@yahoo.com

Shri R V Ringe(10686-LM) MMGI is now GM Subhadra Area, Qr. No D 15 Dera Colony, Dera, Talcher, Dist. Angul Odisha 759103
email: rvringe@yahoo.com

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INTERVIEW

LEADERSHIP IN COMPUTATIONAL GEOSCIENCES

Professor T.N. Singh

Professor T.N. Singh has recently assumed charge as the Director of the Indian Institute of Technology Patna. MGMI's Honorary Editor, Dr. Ajay Kumar Singh took this opportunity to interact with him on multiple topics of interest to this journal's readership. A geologist by training, Professor T.N. Singh completed his BSc, MSc and PhD degrees from BHU Varanasi before serving as a faculty member there. Subsequently, he carried forward his research career at IIT Bombay serving at various levels, including as the Institute Geoscience Chair Professor and Head of the Earth Sciences Department there. During 2018-2021, he led the Mahatma Gandhi Kashi Vidyapeeth, an Uttar Pradesh State University, as its Vice Chancellor. During his career, he has received several important recognitions such as the National Mineral Award, ISRMTT Contribution to Rock Mechanics Award, ISCA Young Scientist Award and MGMI's Sukumar Rakshit Award. He has also published more than 300 papers and supervised over 30 PhD theses. As such, MGMI's readership can benefit from his rich insights in teaching, research and academic administration.

Tell us a bit about your career in academics and how you developed an interest in earth sciences?

Earth is mother for all the inhabitants and its surrounding environment. The curiosity to understand various phenomena related to earth from origin to dynamic changes has always fascinated me from day one of my educational career. Secondarily, I am also eager to understand the abundant wealth given by earth for survival of all, how it happens and its distribution on a global level. The various activities going on the earth and its response mechanism is also mesmerizing to me all the time and it has all landed me to understand the earth's mechanisms. I remember, Author Homes "One can understand the rock mass, when one should sleep and dream over it". While that is exactly required, but we failed at many fronts and it resulted in disaster at various kinds and modes. One should understand that the earth does not belong to us but we belong to the earth. Mahatma Gandhi said "Earth provides enough to satisfy every man's need but not greed". As such, earth science is a science for everyone who wishes for the good health of the earth as well as their own health. The volatile environmental issues, changing price and geo-political issue always focused on accurate and appropriate operation of excavation to ensure maximum resource recovery. Once the useful ores/minerals/rock are depleted, it may not be possible to revisit it for extraction. The cost and time do not permit us to do so. Prior to planning ground excavation, we have to think about digitalization through computerization to make the mining operation have higher optimum productivity.

How has your career evolved as a professor to later, an academic administrator as the Vice Chancellor of MGKVP and now Director of IIT Patna?

My journey as a student, then faculty, various administrative positions, later full-fledged academic and administrative heads of a University and now Director is based on a few key prin-

ciples which are very operational guides to me throughout. You have to give time in all of your assignments and always fix timelines to complete the work and give 100% in achieving it. During my tenure as Vice-Chancellor, Gross Enrolment Ratio increased manifold, several processes were automated and academic calendar was properly followed. I have joined IIT Patna in Sept'21 with my entire academic and administrative learning working to make IIT Patna a full-fledged top ranking IIT.

What are the challenges in developing a new IIT to its full potential?

IIT Patna is going on its development stage. Our own campus is functional since 2015. It will take some time to have full strength and capacity. IITs have their own brand name but definitely there are new challenges and opportunities also. New challenges are to retain good faculty members, open new courses and attract the best ranked students. To recruit and retain them, we have to develop and provide various facilities like good atmosphere, academic, social and cultural as well as good schooling facilities for their kids.

We shall try to keep the campus green and work in a sustainable way to retain its identity. Already, we have taken care of wastewater treatment and reuse it for gardening. Thus, like other waste, we wish to have our campus fellow zero waste disposal concept. Providing 24 X 7 library to students and faculty, computer centre, library to give them an opportunity to perform their best to keep IIT Patna page high. My role as Director is to facilitate and to have maximum utilization of their energy, betterment of institute with greater sense of responsibility of surrounding society also.

We wish not to grow alone but keep all other technical institutions of the state on the right path on their education system with the help of the state government and we are working in this direction. Let's go ahead with a positive mind set and resolve the issue which will come in the way of the journey to make this institute more to solve problems related to society than only academic in nature.

Coming to the theme of this special issue, what role do you foresee in the intersection of geosciences and computation?

Information cited decision is now one of the important tools to make the project self-sustainable, stable, safe and secure. Computational knowledge is crucial these days in all-round development particularly in the area of geosciences. The activities draw a diverse set of skills due to its complex process. Geoscience's development and its analysis is very critical and crucial for decision to go-ahead for exploration, exploitation or not of the minerals/metals which were earlier due to non-availability of technology not extractable, now have possibility to exploit with aid of technology and better analysis of data with advancement of computational method with safety.

New tools like soft computing, numerical methods, and empirical analysis have boosted Geoscientists to think to resolve the outstanding question in a different fashion than earlier traditional ways. Now, it is possible to make the first virtual show prior to going to actual ground conditions. Some areas of geoscience are very crucial in terms of its importance like safe disposal of nuclear waste/spent waste. As we know, even spent fuel has some kind of decay of energy which transfers heat to the surrounding. How they react with rock or other barriers? The thermal mechanical and hydro thermal behavior of rock should be studied here as the best way to go far with numerical simulation, rather than actual small model tests to save time. So, computational techniques have made many problem-solutions easy, accurate and authenticated.

Can information technology help in improving the efficiency of mining operations for coal and non-coal resources? We would appreciate a few examples.

Information technology is now a part and parcel of all walks of life and similarly it has improved productivity, reduced the loss of production, improved the economics and enhanced the

safety of man and machinery. The mining and mineral industries are aggressively using soft computing tools to optimize operational processes, accelerate the decision-making process, extract and derive values from data and improve safety. Computational methods have reduced the loss of productivity, many examples are there, computerized blast designs have reduced the quantity of explosive charges and subsequently provide better fragmentation and enhance the excavability too. Such results were reported by several researchers. Handling huge data sets of blast induced ground vibration, computation model provides, how to reduce the vibration and other associated ill effects. There is the possibility to predict various complex parameters, which are time consuming and costly, and can be predicted by simple parameters with greater accuracy and better confidence.

How well would you say the Indian geoscience data is available to researchers, and what may be some paths forward?

Geoscience data are available to researchers in the Geological Survey of India, Indian Institute of Remote Sensing, DST and many other sources which are very accomplished with geo-science data.

GSI is generating almost all baseline geo-science data e.g. geological, geochemical, geophysical and aero-geophysical which are of paramount importance for effective mineral exploration. GSI is taking a leading role in the process of setting up of the National Geo-science Data Repository (NGDR) for benefit of all stakeholders wherein all mineral exploration data of the country will be made available at one platform.

Recently, the Minister of Science and Technology, Government of India has said, "All geospatial data produced using public funds, except classified geospatial data collected by security/law enforcement agencies, have been made accessible for scientific, economic and developmental purposes to all Indian Entities and without any restrictions on their use. Government agencies and others need to collaborate and work towards open linked geospatial data". He added that "stakeholders benefitted will include practically every segment of society, from industry to academia to government departments".

Please talk about your own work fusing various soft-computing techniques with novel geology problems.

Geology problems are never simple ones, they have various complexity and uncertainty. Very difficult to replicate geological phenomena in laboratory scale or down scale in true sense. Here, nature is a laboratory and one can try to resolve some of the outstanding problems which need proper studies. Understanding the rock mass response behavior is very crucial due to variation of material properties, stress environment, dynamic forces, in-situ stress etc. Earth scientists generate huge data like geo-mechanical, geo-chemical, geo-physical etc. Management of data sets are challenging tasks.Soft computing tools and techniques are more popular and have capacity and capability to resolve complex, tedious problems related to dynamic earth problems.

Our group tried to use these tools long back in 1999-2000 to predict peak particle velocity after blast induced ground vibration. How to increase the utilization of explosives? Earlier, it was an empirical base and other parameters were ignored in soft computing, we have used 12 parameters to predict peak particle velocity. Then, we have used it in various fields of geo-sciences to predict slopes and stability, underground excavation, spent fuel disposal, time dependent rock behavior etc.

At present, many researchers are using these tools because it allows them to learn or recognize the pattern from a pool of data set which can be either from instrumentation or histories also without being programmed. One can use either alone or hybrid mode of tool like artificial neural network (ANNs), Fuzzy Logic (FL) or Genetic Algorithms (GA), Multivariate Adaptive Regression

Splines (MARS), Support Vector Machine (SVM), Adaptive Neuro Fuzzy Inference System (ANFIS), Gene Expression Programming (GEP), Random Forest Method (RFM), Decision Tree (DT), Logistic Regression (LR)etc. It provides good accuracy, self-validation and error estimate. There is scope to introduce more complexities and difficulties for decision making within a shorter time.

As the director of IIT Patna, what are some avenues you are leading to develop computational and software techniques at the undergraduate and postgraduate levels?

At IIT Patna, we are emphasizing on each department to use computational and software techniques in their teaching and research. During COVID-19 time, we are adaptable to various new teaching methods. Apart from this we are also teaching practical courses through simulation to UG and PG students.

IIT Patna provides a wide variety of fields for students who want to work for their own start-ups. We have TIH funded by the Department of Science and Technology, Government of India. The innovation hub will emphasize speech, video, and text analytics. In IIT Patna, there are several notable research centres or research facilities including Incubation Centre on Electronic System Design and Manufacturing (ESDM) focusing incubations in the field of medical electronics, Technology Business Incubator focusing research in the field of manufacturing and agriculture, Centre for Earthquake Engineering Research, Pandit Madan Mohan Malviya National Mission on Teachers and Teaching (PMMMNMTT) for Internet-of-Things, Sophisticated Analytical Instrumentation Facility (SAIF) Centre, Centre for Endangered Language Studies, Elsevier Centre of Excellence for Natural Language Processing, CDAC-IIT Patna Centre on Digital Forensic, IIT Patna Centre of Excellence on Women and Child Safety etc.

We know that your group has been active with reservoir studies in CO_2 storage. What are some of the potential challenges and opportunities in pursuing geologic CO_2 storage in India?

As you know climatic changes are dynamic in nature and main contributors are CO_2 or equivalent gases. India climatic conditions have a wide range due to varied topography and abrupt change in weather conditions. We have warm conditions and flooding and excessive rain. It is clear that the uniqueness in geological set up will strongly affect the climatic condition.

India is one of the developing countries and we are a coal-based energy providing country followed by others like hydro, nuclear, wind, solar, biomass etc. Roughly 75% share in production is from coal. It releases CO_2 in the atmosphere and increases its percentage. From 180 ppm during Holocene and Pleistocene to 280 ppm in the time of the interglacial periods. As the industrial revolution started, CO_2 concentration touched 400 ppm and continues to be increasing at a faster rate. Today we have 418.44 ppm and change reported in one year is about 3.54 ppm (0.85%). As per international pressure as well as keeping climatic detonation under control, our group initiated the research work to find the suitable safe and secure place for disposal of CO_2 or sink the CO_2 in geological reservoir like decoaled mine, oil and gas field as well as saline aquifers in foot hills of high mountain chains. There are challenges knowing all locations, suitable site selection is challenging but equally challenging work is to capture CO_2 from the atmosphere, separate it from other gases and associated material. The geo-mechanical, geo-chemical understanding of the particular site is very pertinent and important. There is a need to have proper scientific understanding about the site as well as trapping capacity and sealing mechanism must be ensured prior to thinking of CO_2 sink in coal mines. There is a need to understand the permeability and porosity of coal and its response be-

havior under higher confining pressure. In spite of the challenge, there is a huge possibility to identify the space for sinking of CO_2 without hampering the local and global problem at the site. We have published an edited book named Geological Carbon Sequestration, where we have discussed all possibilities, opportunities and challenges one should foresee while selecting the site for CO_2 sinks.

What are some key pieces of advice you would give to earth science students reading this journal?

The Mining, Geological and Metallurgical Institute of India is one of the oldest and was established way back in 1906. The Journal provides excellent information about recent advancement in mineral Industries scientific changes and other issues related to development. As technology moves fast at a faster place, this Journal provides quick updated information to all. I request students of Geo-sciences, mineral engineering to follow this Journal to understand and appreciate the advancement in the area, news and views of eminent persons from the industries, academic and R&D organization. These kinds of journals always provide some new ideas, problems to resolve by scientists and academic people to resolve the problems faced by the industries from time to time.

The Seminar/Symposia conference/technology exchange program/technical meetings always give an opportunity to present research findings in front of experts and receive their comments are always ascents for new scientists and professionals.

I strongly believe that students should follow the journals and associated activities to upgrade and enhance their knowledge base.

PERSPECTIVE PIECE

TOOL TO FACILITATE DECISION MAKING IN ALTERING DIKE'S HEIGHT IN THE RED RIVER BASIN UNDER DEEP UNCERTAINTY OF CLIMATE CHANGE

Samarth Singh[1]

Introduction

Human societies, especially low-income countries, face significant challenges from intra-annual and interannual hydrologic variability. Specifically, they lack in necessary infrastructure and funding to adapt to these variable hydrologic conditions (Hall et al., 2014). This variability will be further worsened with climate change which leads to change in the water flow of the rivers and other water sources, further leading to more severe floods and droughts (Trenberth, 2011). Recent studies have already confirmed these changes (Coumou and Rahmstorf, 2012, Huntington (2006)). A number of studies also confirm that the low income countries and societies are hit the worst (Hallegatte et al., 2015).

One such country is Indonesia, situated in southeastern Asia on the South China Sea. Specifically, the case study for our analysis is Red River Basin in East Asia. It starts in southern China and ends in the South China Sea. 51% of this lies in Vietnam which would be the major region of our analysis. This serves a vital agricultural and economic resource to the nation. Reservoirs constructed in the basin serve as a resource to generate Hydropower which accounts for 46% of the electricity in the country (Schaner and Das, 2016). It also serves as a major source of irrigation for agriculture which accounts for 70% of the country's employment (Nguyen et al., 2002). Consequently, protection against droughts is also critical in this country. However, at the same time, flood protection during heavy monsoon is essential to protect basin's infrastructure. These conflicting objectives pose a significant quandary as serving the irrigation and hydropower generation needs require the water level in the dams to be high. However, during heavy floods, dams need to have less water in them so that they have enough space to store the extra flood water.

The city in question for our analysis is the Capital city of Hanoi. The city is protected by 470km of dikes which are classified into four grades, fromIII, II,I and "special". Grade I and "special" comprises 250km of the total length of dikes. In the past, most of the dikes, which were not high enough, failed mainly due to overflowing; therefore, the area was usually threatened with flooding. Nowadays, as a result of many measures that have been imposed in the delta such as strengthening the dike systems, constructing the dams in the upstream river for multiple purposes, the flood risk in the area is reduced significantly.

Based on the previous developments, the current dike height is 13.4m (Quinn et al., 2017) and in most conditions is able to curb the flood damages right now. But with Climate change, this may not be sufficient as the changing pressure and temperature would change the mean water streamflow, its variance, the inter and intra- annual seasonality, which in turn would worsen(or definitely change) the flood situation in the city. The floods which are taken care of right now, may pose severe threat in the next 25 years and thus the city council and the mayor of the city of Hanoi have the tough decision to make, which is, whether to increase the height of the dike or not. This decision is very important as it will directly lead to welfare of the people and if not taken correctly, may either lead to huge loss of people and property, or lead to unnecessary investment which would come out of city council's treasury.

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That's where this decision tool comes in. This would quantify the cost (or loss) of flood damages under different climatic conditions(RCPs) and the corresponding cost of raising the dike per km during the year. Comparing these costs, the mayor can easily make a decision whether to or by how much the dike should be raised.

Model of the decision problem

Formalism :

States of the world(Θ): Different Climate Projections namely RCP 2.6, RCP 4.5, RCP 6.0 and RCP 8.5. Θ={RCP 2.6, RCP 4.5, RCP 6.0, RCP 8.5}

$$\theta \subset \Theta$$

where θ is the state of world.

Action Set : A: {Dike height increased(Y), Dike height not increased(N)}

Cost Function: U(a,θ): where

$$a \in A$$

and

$$\theta \in \Theta$$

The cost of U(Y|θ)= Cost of raising a dike by 1m per km. This is because we are assuming cost of raising the dike will be independent of climate change. In Vietnam this is 0.9-1.6 Million Dollars per km for one metre. We will take 0.9 million Dollars per km for one metre. We can denote this cost by C_dikes. Also, the cost of all the grades will be considered same to simplify our calculations.

The cost of U(N|θ)= Costs beared by the flood damages. This will be conditioned on the climate scenarios, and we will get this value through our optimization model, where we optimize flood, hydro power and water deficit objectives. Through this we will get J_flood which gives the height of the flood in the dams and will be converted to costs in dollars through another function Z_(Hanoi(t)). The function is a piece wise polynomial and can be found in (Quinn et al. 2017). So, total flood damages would be calculated by E[U(N|θ)].We can denote this cost by $C_{-flood.}$

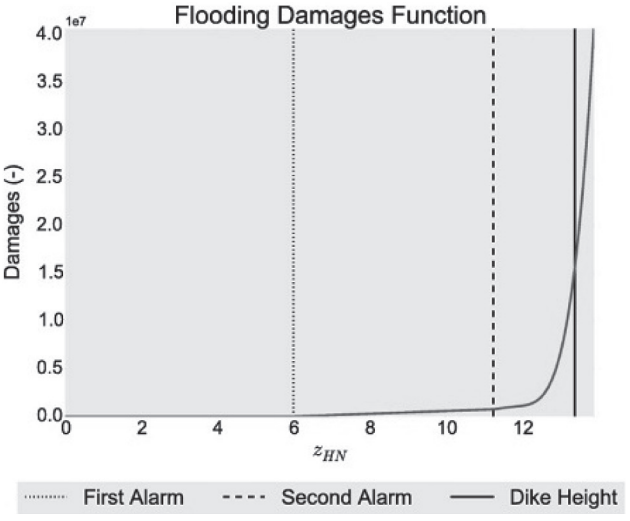

Figure 1. The flood damages function for the city of Hanoi (Quinn et al. 2017). The damages increase exponentially after the flood height crosses the height of the dikes.

Therefore, if $C_{-flood} > C_{-dikes}$, the model would advocate to increase the height of the dike, else not. That is, if

E[U(Y|θ)]>E[U(N|θ)],a*=N

Predictive Model

Following is the schematic diagram of the area under analysis (Quinn et al. 2017).

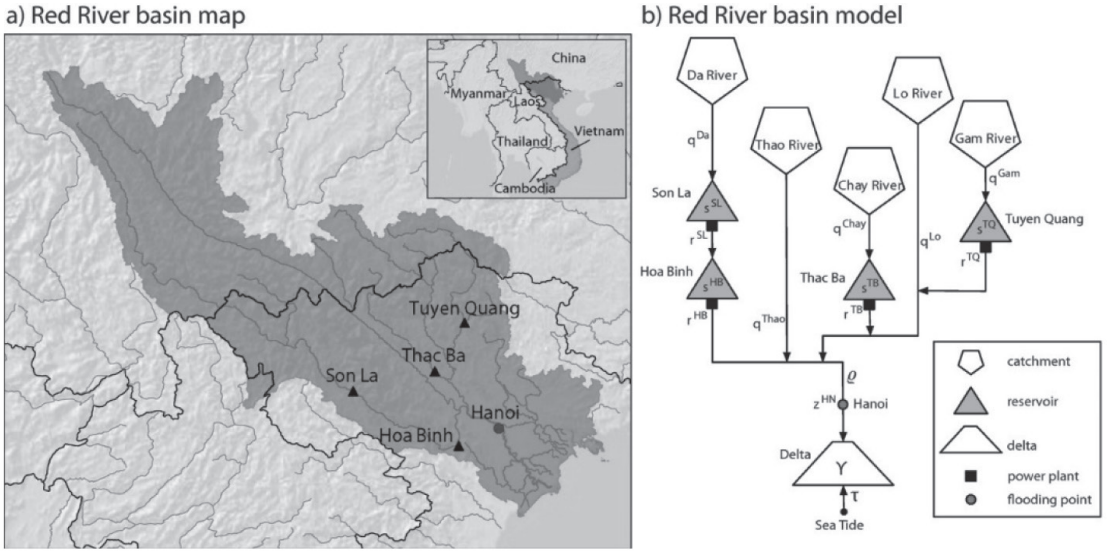

Figure 2. (a) Map of the Red River basin and (b) schematization of the main components of the Red River basin model. The inflows shown in panel b are generated synthetically, the releases at each of the reservoirs are determined by the optimized operating policies, and subsequent flows through the delta are modelled by a dynamic emulator of a MIKE 11 simulation of the downstream hydraulics.

Following are the equations which describe the Red River Water System as portrayed in Figure 2 (Quinn et al., 2017) .

$$s_t^{SL} = s_{t-1}^{SL} + q_t^{Da} - r_t^{SL} - e_t^{SL} S(s_{t-1}^{SL})$$

$$s_t^{HB} = s_{t-1}^{HB} + q_t^{Da,lat} + r_t^{SL} - r_t^{HB} - e_t^{HB} S(s_{t-1}^{HB})$$

$$s_t^{TB} = s_{t-1}^{TB} + q_t^{Chay} - r_t^{TB} - e_t^{TB} S(s_{t-1}^{TB})$$

$$s_t^{TQ} = s_{t-1}^{TQ} + q_t^{Gam} - r_t^{TQ} - e_t^{TQ} S(s_{t-1}^{TQ})$$

Figure 3. The above mass balance equations define the Red River Model, where SL, HB, TB, TQ and Da mean Son La, HoaBinh, Thaq Ba, Tuyen Quang and Da River respectively. Also, s,q,r e and S mean storage,inflow, release, evaporation and surface area respectively.

Thus, considering our introduction and utilities of the hydropower systems being to serve Hydropower, irrigation and flood protection, there are 3 different conflicting objectives we would optimize for this water system management. For this optimization, we simulate data over T years and run the algorithm over N years. So, any objective which is part of the multi-objective optimization will be defined as :

$$J_d = \Upsilon_{i\in(1,2,..,N)}[\Phi_{t\in(1,2,..,365T)}[g_d(t,i)]]$$

where g_d (t,i) is the value of the d-th objective on day t of the i-th ensemble member, Φ is an operator for the aggregation of g_d (t,i) over time, such as the Σ and Υ is a statistic used to filter the noise across ensemble members, such as the expected value E. We will not go into the exact formulation of each of these metrics here as it is outside the scope. Correspondingly, we willhave J_{Flood}, J_{Hydro} and $J_{Deficit}{}^2$ for the optimization.

$$J = \begin{bmatrix} -J_{Hydro}(\theta) \\ J_{Deficit^2}(\theta) \\ J_{Flood}(\theta) \end{bmatrix},$$

$$J_{Flood} = \text{quantile}_N \left\{ \max_{365T} \left(z_{t,i}^{HN} \right), 0.99 \right\},$$

$$J_{Deficit^2} = \text{quantile}_N \left\{ \mathbb{E}_{365T} \left(D_{t,i}^2 \right), 0.99 \right\},$$

$$J_{Hydro} = \text{quantile}_N \left\{ \mathbb{E}_{365T} \left(\sum_k \eta_{t,i}^k \right), 0.01 \right\},$$

Figure 4. The multiple objectives under optimization using EMODPS

To optimize reservoir operating policies for the Red River, we use Evolutionary Multi-objective Direct Policy Search (EMODPS; M. Giuliani et al. (2016)). This method uses multi-objective evolutionary algorithms (MOEAs) to discover nondominated parameterizations of operating policies that optimize system performance over multiple objectives computed during simulation with these policies. To allow for flexible operating behavior, nonlinear approximating networks are used to describe the reservoir operating policies. It is a simulation-based optimization method. The equations described in Figure 3 are used to create simulations for the model. EMODPs defines reservoir policies using radial basis functions (RBFs) that calculate reservoir storages and the day of the year. It provides a set of pareto optimal operating policies after optimization. The major advantages of this method are that it adapts to system state, and it allows for optimization over multiple objectives.

Now, the robustness of the optimized policies will be tested on the effects of changing monsoonal patterns and evolving socioeconomic demands to attain satisfactory performance. These changes can specially be escalated with climate change. Flood damages, hydropower production and nonagricultural water demands are affected by both streamflows and human decisions, we will use Latin hypercube samples to sample the factors which will change with Climate Change. The different ranges of variables for Latin hypercube samples are described in Table 1 and 2.

Table 1 : Latin Hypercube sample ranges of Stream flow parameters for Uncertainty Analysis

Table 1
Ranges of Hydrologic Factors Sampled in Our Scenario Discovery Analysis

Deeply uncertain factor	Lower bound	Upper bound	Change to hydrograph
Log-space mean multiplier, m_μ (–)	0.05	1.05	Decreases or increases all flows year-round
Log-space std multiplier, m_σ (–)	0.5	1.5	Decreases or increases interannual variability
Log-space C_1 multiplier, m_{C_1} (–)	0.5	1.5	Decreases or increases amplitude of annual monsoonal cycle
Log-space C_2 multiplier, m_{C_2} (–)	0.5	1.5	Decreases or increases amplitude of semiannual monsoonal cycle
Log-space ϕ_1 delta, d_{ϕ_1} (radians)	$-2\pi/12$	$+2\pi/12$	Shifts annual monsoonal cycle earlier or later
Log-space ϕ_2 delta, d_{ϕ_2} (radians)	$-2\pi/12$	$+2\pi/12$	Shifts semiannual monsoonal cycle earlier or later
Evaporation delta, d_e (mm/day)	−0.5	+1.0	Decreases or increases evaporation year-round

Note. States of the world are generated from a Latin hypercube sample across all hydrologic and socioeconomic factors, with each factor sampled uniformly within its bounds. However, since multipliers are applied in log-space, the samples are not uniform in real-space.

Table 2 : Latin Hypercube sample ranges of Economic Development parameters for Uncertainty Analysis

Table 2
Ranges of Socioeconomic Factors Sampled in Our Scenario Discovery Analysis

Deeply uncertain factor	Lower bound	Upper bound
Agricultural demand multiplier, m_{ag} (–)	0.5	1.5
Aquaculture demand multiplier, m_{aq} (–)	0.5	2.0
Other demand multiplier, m_o (–)	0.5	5.0
Demand delta, d_D (days)	−30	+30

Note. States of the world are generated from a Latin hypercube sample across all hydrologic and socioeconomic factors, with each factor sampled uniformly within its bounds.

The Pareto-approximate set of Red River operating policies discovered from the optimization described is shown in Figure 5 on a parallel axis plot. In this figure, each line represents a different operating policy that crosses each vertical axis at the objective value it achieves in the base State of the World (SOW), with the favorable direction along each axis being down. The color of the line represents the percent of generated SOWs in which the policy is able to simultaneously meet each of the performance satisficing thresholds: $J_{Flood} \leq 2.15$m, $J_{Hydro} \leq 25$ Gwh/dayand $J_{Deficit}{}^2) \leq 350$m^3/s. Robustness is defined as percentage of SOW's in which the particular policy is able to satisfy these thres holds. This is finally used to select the most robust solution.

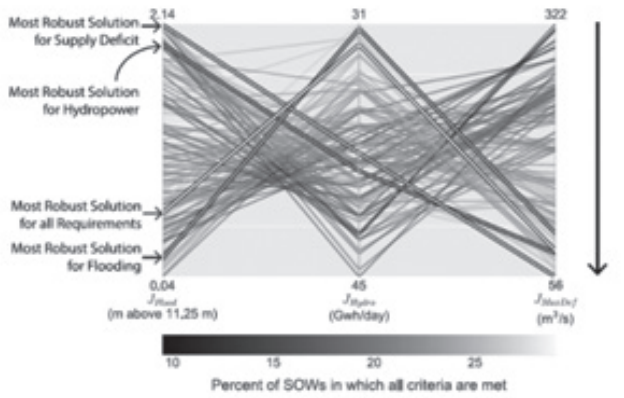

Figure 5. Parallel axis plot of the trade-off set in the base state of the world (SOW), with each solution shaded by its robustness across all system objectives. The shading for robustness corresponds to the percent of generated SOWs in which each solution meets all of the minimum performance criteria for the three objectives.

The success and failure of these SOWs based on changes in m_{μ},m_{σ} and m_{C1} (each are mutlipliers of streamflow's mean, standard deviation and amplitude of anuual monsoonal cycle) are showed in figure 6. A particular SOW is classified as a success or failure using Logistic Regression. Also, the LH samples are used to create a Linear Regression model to predict J_{Flood} in terms of m_{μ},m_{σ} and m_{C1}. This model will be used to predict J_{Flood} given values of mu,sigma and amp1, which will be used in our next step of the analysis.

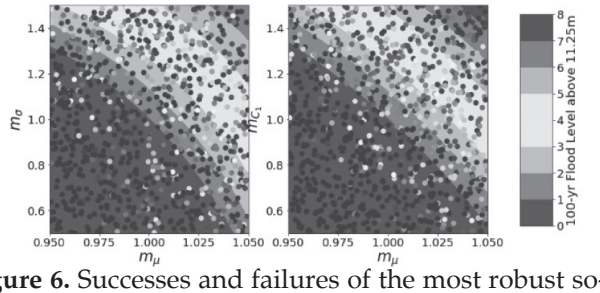

Figure 6. Successes and failures of the most robust solution for flooding. The log-space mean multiplier(m_{μ}), amplitude of the first harmonic multiplier (m_{C1}) , and standard deviation multiplier (m_{σ}) are the most important factors controlling performance.

All the states defined in our state space(i.e the various RCPs) are not equally likely to occur. But we can calculate the probability of these states using a Joint Normal Distribution plotted over m_{μ},m_{σ} and m_{C1}. These multipliers are found using the projections from 34 GCMs in the CMIP5 multimodel ensemble from 18 different institutions. The tables of these GCMs are listed in Table 3 and well described in supplement information of Quinn et al. (2018). The Pressure and Temperature data from the climate projections using these models are taken and run them through a statistical hydrologic model to predicts flows, and tracked how the log-space mean, standard deviation and amplitude of the first harmonic changed over time. So, we get a yearly time-series of these multipliers across different GCM-RCP model combinations. Then a for a particular year y, Multivariate Normal distribution(MVN) across all these multipliers (m_{μ},m_{σ} and m_{C1}) are fit to calculate the pdf. Multivariate is similar to a univariate normal distribution, but here the parameters are a vector of mean, and instead of variance, we pass a variance-covariance matrix. These pdfs are used then to find the probability of occurrence of a particular tuple (m_{μ}(i,y), m_{σ}(i,y),m_{C1})(i,y)) where i is one of the 220 GCM-RCP model combinations(S) and y is year. So, for a particular year y, we calculate :

$$\sum_{j \in S} P(i) * J_{flood}(i)$$

to get the expected flood damages across the entire state space.

For the year 2054. We calculate the flood damages before and after raising the dike. E[U(Y|θ)] was calculated as sum of flood damages with raising dikes and costs of raising the dike. E[U(N|θ)] was calculated as flood damages without raising dikes. Comparing, we got that optimal action is Y. Similarly, we can perform this analysis for any year between 2005 and 2100.

Conclusion and Future Work

The model adds value in the form of information we are getting in the form of costs of flooding and raising the dike. The difference between C_{flood} and C_{dikes} gives us the money saved on making a particular direction. Also, this can be extended to find the height of the dike to be increased, which would provide even more insight. Also, there are some drawbacks like we are considering only

flood activity while comparison and we haven't considered discounting of money while cost analysis. These drawbacks will be improved in our future works.

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TECHNICAL NOTE

COMPUTERIZATION AND DIGITIZATION OF INDIAN MINING INDUSTRIES : AN OVERVIEW

Darshan Deep Bhardwaj[1], Professor N.C. Dey[2]

Digital transformation is emerging as a driver of sweeping change in the world around us. Connectivity has the potential to empower millions of people, while providing businesses with unparalleled opportunities for value creation and capture. Indian Mining Industry is making use of this Computerization and Digitization, may it be production planning, operation management and its day-to-day business performances. Computerization and Digitization have resulted in better utilization of mineral resources and thereby contributing in the growth of the nation. Within the mining and metals industry, digitalization will be a force that changes the nature of companies and their interaction with employees, communities, government and the environment at every step of the value chain. From mineral exploration and valuation, through mining, ore processing and metals production, to down-stream sales and distribution, digitalization is blurring traditional industry lines and challenging the business models of the past. In this paper the concept of Computerization and Digitization in the mining sector, is key to the future of mining industry, wherein almost all the process will be in digital form and would lead in better efficiency in term for optimal utilization of its mineral resources for the benefit of humankind. The technical mineral regulatory agency in India i.e Indian Bureau of Mines (IBM) is also committed in adopting latest technology in order to meet the need of the hour. In the recent past IBM has developed Mining Surveillance System (MSS) in collaboration with Bhaskaracharya National Institute for Space Applications and Geo-informatics (BISAG-N), which makes the use of space technology by using Satellite Images in facilitating the detection of illegal mining in the country and is a transparent & bias-free system, having a quick response time and capability of effective follow-up. IBM is also in the process of implementing, the Mining Tenement System (MTS),which would primarily involve automating the entire concession life-cycle, starting from identification of area and ending with closure of the mine; and connecting the various stakeholders for real-time transfer of electronic files and exchange of data. This shall enable effective management of mineral concession regime and transparency in operations at the Centre as well as States. At the tactical level, efficiency of operations increases and at the strategic level, management information is available at click of a button for interventions and policy decisions.

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Digitization is the conversion of data into a digital form with the adoption of technology. Digitization reduces chance of human errors and thus more transparent and unbiased system. "Digitalisation in mining refers to the use of computerised or digital devices or systems and digitised data that are to reduce costs, improve business productivity, and transform mining practices. Mining techniques and technologies have evolved and improved over time (e.g. the introduction of explosives and the use of mechanised and motorised mining equipment during the Industrial Revolution). In the past, each technical achievement and its implementation at mine sites led to better practices and strong industrial growth. Today, the mining sector faces the implementation of digital innovations, and various terms have proliferated in the media, the internet and at conferences, describing these technological advances and associated imminent changes" [1]. Mining Surveillance System (MSS) is system which utilizes the space Technology in facilitating the detection of illegal mining in the country and is a transparent & bias-free system, having a quick response time and capability of effective follow-up. The deterrence effect of 'Eyes watching from the Sky' has been extremely fruitful in facilitating the State Governments in curbing instances of illegal mining. The system checks a region of 500 meters around the existing mining lease boundary to search for any unusual activity which is likely to be illegal mining. Any discrepancy if found is flagged-off as a trigger. The system is first of its kind, where space technology is being used for detecting the instances of illegal mining in the country. The mechanism is robust, with minimum human interference and more transparent. The remote and inaccessible areas like hilly terrain etc. can be easily monitored using the MSS.

Any activities within this 500m buffer zone and outside the lease boundary were closely monitored and any unusual activities noticed were flagged off as the trigger.

Advantages of MSS

The MSS is having following distinct advantages:

- The system of detection of illegal mining has become more transparent where the finding is based on comparing the satellite images of different time span in order to understand the changes in the ground and thus unbiased recording.
- The mining area located in Remote & inaccessible areas can be approached without any difficulty.
- The Mining Surveillance system involved the Integration of information from multiple sources- satellite imagery, cadastral plan, etc. and hence now all these records can be accessed just by click of the mouse.
- It has been effective tool for monitoring of illegal mining- location, extent and trends can be monitored by comparing the satellite image of different years.
- The various MIS reports can be easily generated now from the system within fraction of second and hence reduced the time required to prepare the reports.
- Citizen participation achieved in the governments endeavour to control illegal mining. Curbing illegal mining, would abate
  - risk to health and safety of people undertaking it;
  - curtail economic losses and;
  - also curb the detrimental impact on environment and people.

Impact of Mining Surveillance System

The MSS is a transparent & bias-free system, having a quicker response time and capability of effective follow-up. The Deterrence Effect of 'Eyes Watching from the Sky' would be extremely fruitful in curbing instances of illegal mining. The mechanism is robust, with minimum human in-

terference and more transparent. The remote and inaccessible areas like hilly terrain etc. can be easily monitored using the MSS. The latest satellite imagery is utilized by way of transposing on the digitized mining leases for detecting any unauthorized mining within buffer zone of 500m from lease area. The satellites imagery of Cartosat-1 are being used having repetivity of 126 days for MSS project. Cartosat-1 carries two state-of-the-art panchromatic (PAN) cameras that take black and white stereoscopic pictures of the earth in the visible region of the electromagnetic spectrum with spatial resolution is 2.5 metres. In order to ensure the system to be completely transparent and bias free, the mobile technology having GIS & geotagging capability has been utilized by way of ensuring the trigger field verifications to be done by the inspecting officials through a mobile app.

Mining Tenement System (MTS)

"Establishing the Mining Tenement System (MTS) would primarily involve automating the entire concession lifecycle, starting from identification of area and ending with closure of the mine; and connecting the various stakeholders for real-time transfer of electronic files and exchange of data. This shall enable effective management of mineral concession regime and transparency in operations at the Centre as well as States. At the tactical level, efficiency of operations increases and at the strategic level, management information is available at click of a button for interventions and policy decisions.

The key objectives of MTS are to :

- Facilitate the applicant in identifying suitable and available area for obtaining mineral concession
- Automate entire concession life-cycle, starting from identification of area and ending with closure of the mine
- Ensure transparency in mineral application processing
- Create databases and generate MIS reports to facilitate reporting to Ministry, IBM and State DMGs
- Online submission of notices and returns and status tracking for concessionaires
- Monitor and evaluate the mining scenario, operational as well as strategic, for each State as well as Country as a whole
- To provide GIS enabled platform for integrated location specific services for mineral inventory as well as transaction based geo-enabled services for MTS" [2]

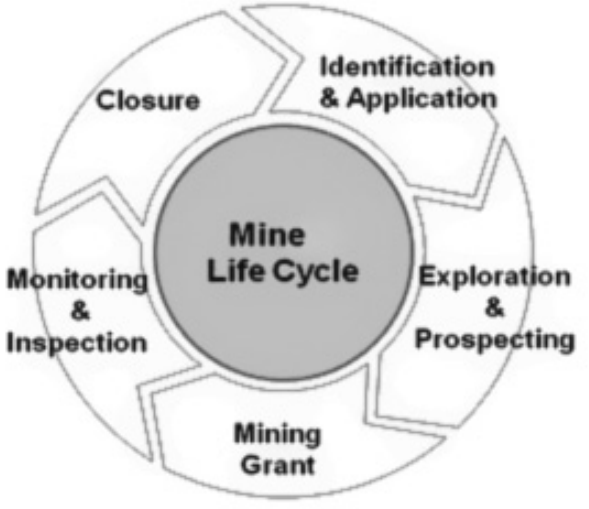


Figure 1. Mine life cycle

Thus, we can say that MTS aims to establish the entire life cycle of mine (Figure 1) in the online mode, from identification of lease area to final closer of the mine, thus at each stage the processes would be online, more transparent and would be a revolutionary step in computerization and digitization in the field of mining.

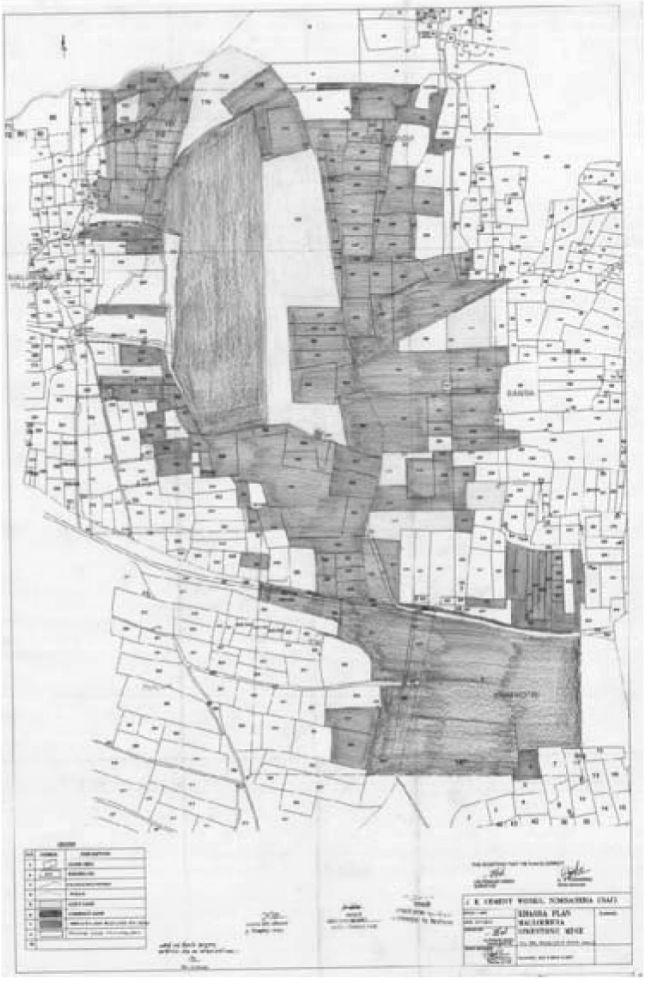
Conclusion

Mining Surveillance system will go a long way in facilitating the State in detection of illegal mining. The deterrence of the MSS project - 'Eyes watching from the Sky' is credible and can be seen from drastic decrease in the cases of illegal mining of major minerals in the country and thus successful in substantially curbing illegal mining. Thus, Mining Surveillance is very important tool developed for minimizing the illegal mining by making use of transparent satellite-based technology, which is a revolutionary step in the Computeriza-

tion and Digitization of the mineral sector. "Even in the emerging world of e-commerce and the digital economy, the hardware will retain a central position as will the surrounding infrastructure and support systems, in particular energy supply, and create additional demand for materials"[3]. There will be continued need for mineral resources even to support of the growth of digital world and in order to support this,the mineral sector itself needs to adopt increasing use of digitization and computerization.

Appendix 1. Illustrating the processes involved in MSS

Step 1. Scanning of Khasra Map



Khasra Map of Malia Khera
Limestone Mining
Village : Maliya Khera
Tehsil : Nimbahera
District : Chhitorgarh
State : Rajasthan

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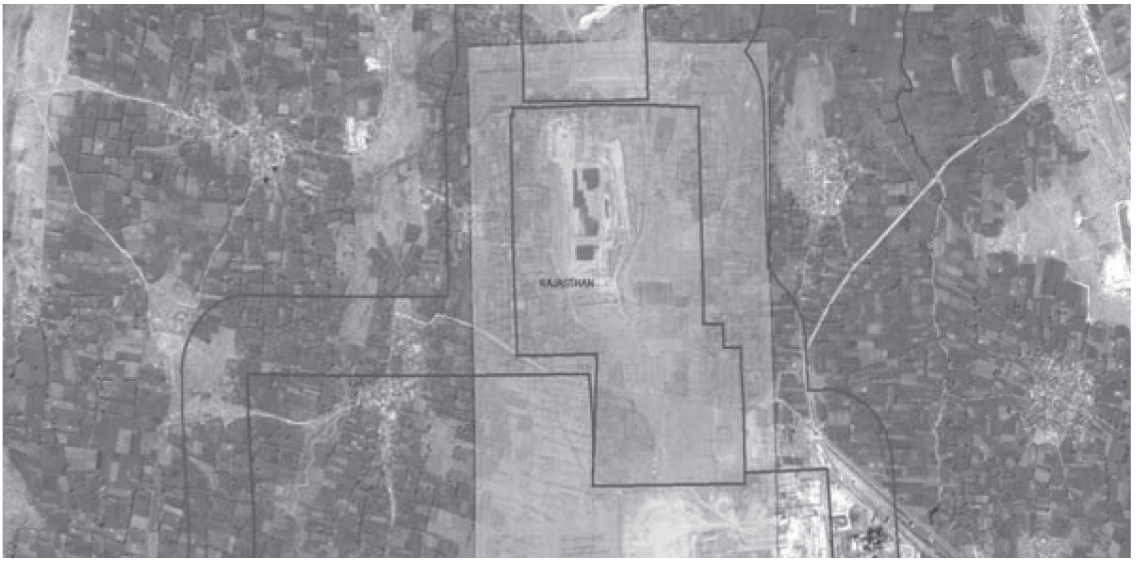
Step 2. Process of geo-referencing of Khasra map on Cartosat satellite image

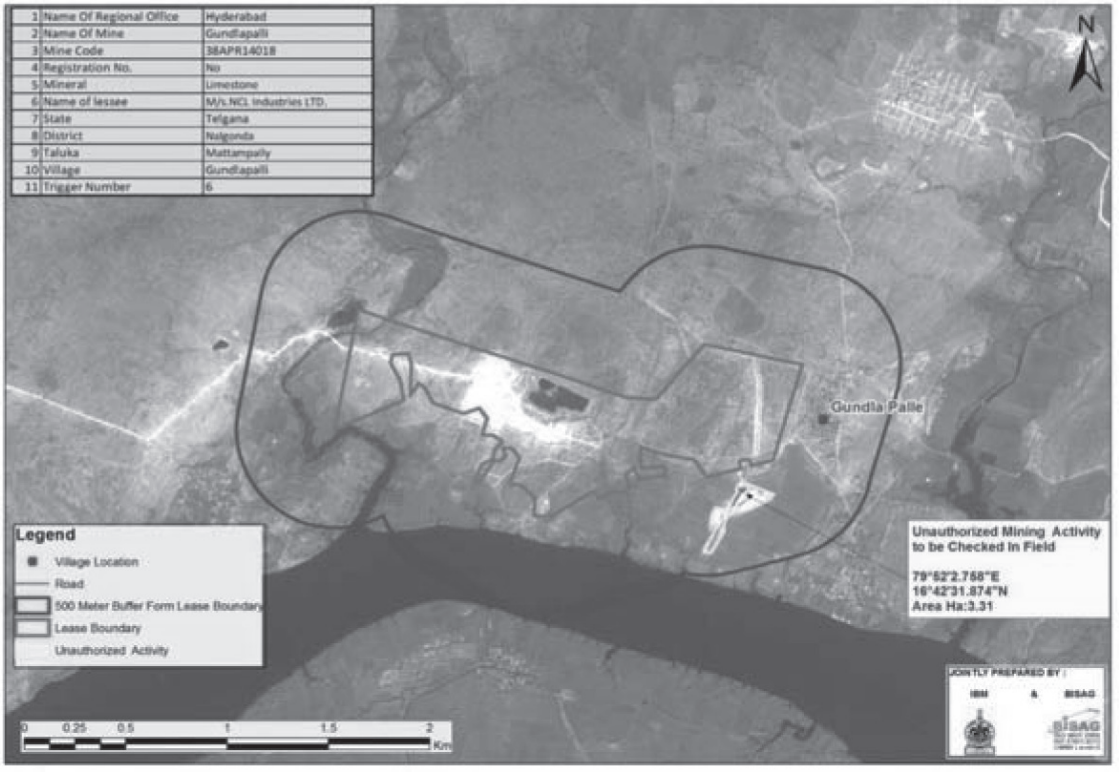
Step 3 . Digitization of Khasra numbers using geo-referenced Khasra map

Lease boundary superimposed on Khasra numbers

Step 4. Creation of buffer zone from lease boundary



Step 5. Trigger Generation



TECHNICAL NOTE

DIGITALIZATION POSSIBILITIES IN MONITORING OF INDIAN MINES

Subhankar Ghosh[1] and Ritwick Ghosh[2]

This paper aims to propose a multi - level digitalized geo-monitoring system with monitoring, database handling, modelling and intervention of expert opinions for Indian mining conditions. The proposed system designed in this paper is based on the principle of synchronization of inter-branch research, which includes data and survey reports of subsurface, surface, aerial, and remote sensed imaging, as well as geodetic survey, geo-mechanical, geophysical, and geotechnical measurements on the ground surface. The system combines geo-technical & geo-mechanical models with intelligent new-age elements like Machine Learning, Data Analysis, Big Data and Cloud Service to provide geo-monitoring investigations at many levels: distant, air, surface, subsurface, and computer. In computer modelling, the multi-level technique is suggested: geo-dynamic models with hierarchically layered systems.

1. Introduction

In India, the mining sector is a key economic activity that contributes significantly to the country's economy. The mining industry's GDP contribution ranges from 2.2 percent to 2.5 percent, but when compared to the whole industrial sector's GDP, it provides roughly 10% to 11%. Even small-scale mining accounts for 6% of the overall cost of mineral production. The essential concept of monitoring, modelling and safety control of mining operation is long-term and strategic decision-making on mechanical stability and long-term operation of facilities subjected to natural and man-made influences. Setting up systematic geo-monitoring of mining items and nearby rock masses at various scales and instrumental levels can successfully solve problems of geodynamic and environmental safety. This type of geo-monitoring will reveal dangerous geo-mechanical processes and allow for early prediction of dynamic phenomena (earthquakes, faulting, surface rupture, rock bumps, slip, subsidence, changes in groundwater circulation and shorelines, and so on), which is necessary for timely protection and mitigation.

In section 2, we discussed some relevant old studies and literature that motivated and helped us in conducting this study. In section 3, we showed through a block diagram how monitoring, data storage, modelling and expert opinion could be incorporated together in final decision making. In sections 4 & 5 respectively, we discussed about different level of monitoring options and modelling options available. In section 6, we discussed how Machine Learning, Big Data and Cloud Computing could help data handling, data insight mining and overall final decision making. In section 7, we mentioned how this model could be a practical possibility to develop a digital twin model of a mining operation.

2. Literature Review

The Big Data concept – flows of big collections of varied data on mining, is linked to the described difficulty and its potential in mining geo-information science. With case studies, the authors describe Big Data technology and its broad application on mini-clusters utilizing Hadoop and MapReduce. (Bychkov I.V. et al.).

Differential Synthetic Aperture Radar Interferometry (DInSAR) is a space-geodetic technology that permits centimeter-level detection of minute surface displacements over large areas. Because of these distinguishing qualities, the DIn SAR

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technique outperforms traditional geodetic monitoring systems in terms of anticipating high-risk situations. It has been successfully employed in various fields of earth and environmental sciences throughout the last few decades. (Hartwig, M. E., 2016)

The conceptual foundation and practical implementation of operational river flood forecasting systems are detailed, based on the combined use of state-of-the-art information technology and hydrological simulation approaches. They demonstrate the practical application of an interdisciplinary approach that makes extensive use of Earth's remote sensing data, service architecture–based forecasting systems, and an intelligent interface to select the type and parameters of hydrological models, as well as the interpretation, user-friendly representation, and accessibility of forecast results as web services. (Alabyan, A.M. et al.,2016).

Many research concentrating on static safety risk identification and evaluation indicates the concern for employees' safety in the construction industry. However, research on real-time safety risk assessment targeted at decreasing uncertainty and facilitating rapid response is scarce. This research proposes a method for Real-Time Safety Risk Assessment (RTSRA) to implement a dynamic evaluation of worker safety conditions on construction sites. The strategy provides construction managers in charge of safety with more detailed information, which helps to reduce site uncertainty. (Jiang, H. et al., 2014).

Process interactions and chain reactions, the current shift of cryospheric hazard zones due to atmospheric warming, and the potential far-reaching impact of glacier disasters necessitate the use of modern remote sensing techniques to assess glacier and permafrost hazards in high-mountain environments. Associated hazard source sites are typically located in remote areas that are difficult to access due to physical and/or political constraints. an overview of airborne and spaceborne remote sensing approaches for glacier and permafrost hazard assessment and disaster management is presentedin this paper. High-mountain danger investigations are aided by a variety of picture categorization and change detection approaches. One of the most essential data sets for studying high-mountain dynamics is Digital Terrain Models (DTMs), which are produced from optical stereo data, synthetic aperture radar, or laser scanning. Fusion of satellite stereo-derived DTMs with the Shuttle Radar Topography Mission (SRTM) DTM offers a viable option to integrate the benefits of both technologies. (Kozhaev, Zh.T. et al., 2017).

In two case studies of landslides in the Northern Caucasus, in the region of Kepsha and Mamaika villages in the vicinity of the railway tunnels, the problems of processing and interpreting the data provided by radar satellite interferometry for the conditions of landslides covered by vegetation are examined. The method of persistent scatterers, which is implemented in the StaMPS programmed package, is used to estimate the displacement fields. The five-year experience of landslide monitoring reveals that in adverse satellite radar interferometry settings, competent satellite image processing technique selection is critical. The crop selection, master picture selection, reference area selection, and digital elevation model selection are all discussed in detail in this work. We used data from the ascending and descending tracks of the long-wavelength ALOS and shorter-wavelength ENVISAT satellites to model the landslide in the sparsely populated region near Kepsha hamlet. (Mikhailov, V.O. et al, 2016).

3. Decision-making model diagram

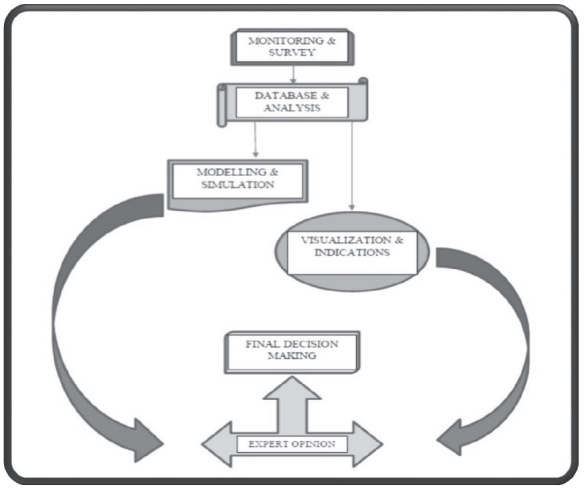

Figure 1. Decision Making Block Diagram with Monitoring, Modelling & Expert Opinions Steps

In the flow diagram in Fig. 1, it clearly shows how multi-level monitoring and survey data need to store in a database, how the archived data can be used for modelling, simulation, visualizations of insights and evaluation of indicators & how expert should be consulted according to the inside models to make the final decision. This diagram also shows how digitalized & automated data and modelling should be incorporated with expert opinions to minimize any unforeseen circumstances.

4. Monitoring

Using modern geo-monitoring techniques we can monitor, survey and collect data of a mining operation from sub-surface, surface, aerial & space level.

4.1. Sub-Surface Monitoring

Surveys & data of sub-surface or underground geological & hydrological conditions are very important to monitor any ongoing mining operations.

4.1.1. Hydrological Survey

Movement, flow and amount of natural ground water in any mining area could be studied and mapped through Geo-Hydrographic surveys. Water in-rush is a very common hazard in open cast & underground mines.

4.1.2. Seismic Tomography

Seismic tomography is a method of viewing the Earth's subsurface using seismic waves generated by earthquakes or explosions. Based on seismic wavelength, wave source distance, and seismograph array coverage, P-, S-, and surface waves can be employed for tomographic models of various resolutions. The data from seismometers are utilized to solve an inverse problem that determines the locations of the wave routes' reflection and refraction. This method can be used to generate three-dimensional visualizations of velocity anomalies, which can be interpreted as structural, thermal, or compositional. Ground Penetrating Rader Survey can easily update about water saturation and mechanical properties of rocks for seismic tomography, up-to 40m.

4.2. Surface Monitoring

4.2.1. Conventional Geodetic Survey

Geodetic surveys use a satellite-based global positioning system (GPS) in conjunction with terrestrial base stations to research earth's geodynamical phenomena (e.g., crustal motion, gravitational field). At the mm-scale, geodetic surveys measure three-dimensional variations in crustal motion. Measurements are usually taken across a large region and over a long period of time.

4.2.2. Laser & Radar Survey

Lidar is a technique for determining ranges (varying distance) that involves using a laser to target an object and measuring the time it takes for the reflected light to return to the receiver. Due to variances in laser return durations and changing laser wavelengths, Lidar may also be used to create computerized 3-D renderings of places on the earth's surface and ocean bottom. It has uses on the ground, in the air, and on mobile devices. Lidar is widely utilized in surveying, geodesy, geomatics, archaeology, geography, geology, geomorphology, seismology, forestry, atmospheric physics, laser navigation, aerial laser swath mapping (ALSM), and laser altimetry to create high-resolution maps.

4.3. Aerial Monitoring

4.3.1. Near Surface Monitoring

Popular ways of doing near surface aerial survey are using drones & small air-crafts. Air-borne surveys includes digitally processed multi-band radar images, advanced 3-D photo-geometry. For near surface aerial surveys advanced cameras, new age photo geometry software, Infra-red & other types of remote sensors & advanced GPR sensors can be used.

4.3.2. Satellite Level Monitoring

GPS or GNSS based static surveying & optical and multi-spectral remote sensing & Radar interferometry can be considered as space level monitoring of mining area.

5. Modeling and Simulation

Modeling with special software should be included in integrated geo-monitoring for anticipating the geo-mechanical status of natural and technical objects and possible changes.

5.1. 2-D & 3-D Modelling

As new instrumental geo-mechanical, geodetic, radar, and groundwater survey data become available, digital 2D and 3D models should be generated and updated at least once a year.

5.2. Geo-Mechanical & Geo-Fluid Dynamic Modelling

Geo-mechanical modelling seeks to forecast a natural-and-technical object's mechanical state and estimates its reliability. The geofluid-dynamic modelling is done by combining geological (geological and spatial characteristics of rocks), geomechanical (mechanical properties and effective stresses), hydrostatic (water saturation, pressure gradients between aquifers, and depression plane position) and fluid dynamics (formation of percolation zones, flow speed, and pressure) conditions. This enables for both geo-mechanical and hydraulic calculations, as well as the evaluation of natural and technical object integral reliability.

6. Data to decision modelling

In the diagram of Figure 2, we propose various modern ways and technologies that can help to derive insights from our collected data, modelling and decision making. New age technologies like Machine Learning can provide detailed insight than any conventional or manual strategy. Modelling Techniques technology might be the solution for handling a large amount of data derived by monitoring of mining operation. Using Machine Learning, Big Data and Cloud Computing we can profoundly minimize thechances of error and enhance efficiency of modelling in a large extent.

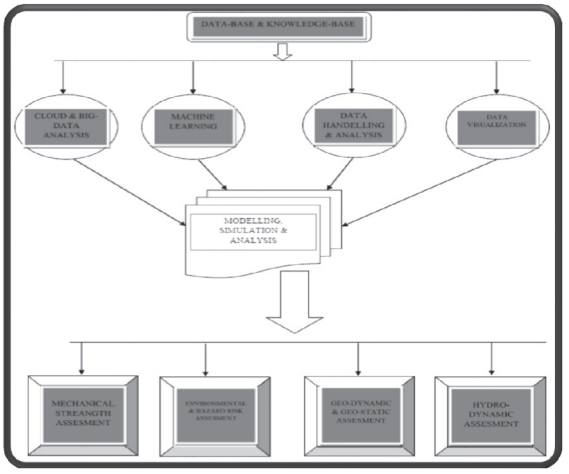

Figure 2. Database to Decision Making Advanced Model Diagram

7. Scope of future work and Conclusion

In further industrial implementation this proposed model should be enough to design a digital twin model of a running mining project. In a digital twin model, the collection of monitoring data and upgradation of model should be done nearly real-time basis. Digital twin model of a mining operation can give us real-time insights and update of a running mine. In this study we developed an integrated multilevel system based on the principle of multidisciplinary synchronized research implementation. Geo-monitoring at various levels enables for the early detection of potentially dangerous deformation and fluid flow dynamics surrounding natural and technological objects in a running mining operation, as well as quick response and administrative decision-making for emergency prevention and mitigation. Without proper monitoring and precautious actions, the geodynamic phenomena may cause damage to mines, resulting in social and economic losses: destruction of mining infrastructure and populated areas, human life risks, suspension of mining and processing operations, toxic element pollution of land, rivers, and lakes, and resulting economic losses in the hundreds of millions of dollars.

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TECHNICAL NOTE

SUSTAINABILITY IN MINING AND POSSIBLE APPROACHES

Surajit De[1] , Supriyo Sengupta[2] , Sanjay Guhathakurta[3]

Introduction

With an increasing worldwide awareness about severe impact of climate change, mining companies are also gearing up to practice a proper sustainable development approach by protecting environment, people, and society. Sustainability generally refers as fulfilling our own needs without compromising the ability of future generations to meet their own needs.

What is Sustainability?

Sustainability generally refers as fulfilling our own needs without compromising the ability of future generations to meet their own needs. There is three main pillars of sustainability – environmental sustainability, economic sustainability, and social sustainability. Sustainable development requires an integrated approach that takes into consideration environmental concerns along with economic development for the whole society.

UN Sustainable Development Goals

With broad objective to protect the people & environment of the planet, United Nations General Assembly in the year 2015 adopted 17 Sustainable Development Goals (SDGs), also referred as Global Goals. Many of these goals are interconnected and any progress or action in one goal may reflect outcome in goals of other areas. United Nations not only just outlined the goals, but also adopted Resolution by the General Assembly in the year 2017 to make the goals more actionable. This resolution has placed appropriate targets for all the development goals and ensured to measure the progress of all the development goals by appropriate indicators. The development of all the goals should put balance on social, environmental, and economic sustainability so that a peaceful environment for the people of the planet can be achieved by 2030.

Goals Agreed at COP26 Glasgow Conference

World's top leaders and activist joined in the global climate summit COP26 in Glasgow 2021, organized by the UN. These leaders, activists and several delegates agreed to outline four key climate change related goals at this summit. To ensure global net zero by mid of the century (2050) and thereby to keep the target of restricting global temperature rise by 1.5 degree Celsius as achievable. The world should come forward to adapt to protect its communities and all the natural habitats by building defense, warning systems, especially for the regions / countries that are affected by climate change. To mobilize enough funds, such as 100 Bn Dollar in climate finance per year, so that other goals can be delivered. The whole world should collaborate by working together to achieve the other goals by finalizing Paris Rulebook and accelerating actions related to climate crisis.

Decarbonization Challenge for Mining Industry

Over the last decade, most of the mining organizations' CEOs are facing the questions about the impact on climate change and how best his / her organization is equipped to handle it. Most of the mines are being operated in a challenging inhospitable condition. Expected climate change impacts, such as heavy precipitation, drought, rise in temperature etc. will bring more significant chal-

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lenges to operate the mines. As part of 2015 Paris Climate Agreement, 195 nations have pledged to limit global temperatures to less than 2.0°C, and ideally not more than 1.5°C as compared to pre-industrial era. This initiative would now manifest in decarbonization across industries, creating major shifts in commodity demand for the mining industry. Mining organizations are facing continuous push from different segments like government authorities, investors, society etc. to reduce the impact on climate change. Mining sector is currently responsible for 4 to 7 percent of greenhouse-gas (GHG) emissions globally. Scope 1 and Scope 2 CO2 emissions from the sector (those incurred through mining operations and power consumption, respectively) amount to 1 percent, and fugitive-methane emissions from coal mining are estimated at 3 to 6 percent.

Sustainability Impact of Mining

Mining operations have impacts from both environmental and social perspective and hence it attracts several SDG (Sustainable Development Goals) initiatives. The leaders in the mining industry have already started to realize that sustainability would be the key enabler for operational efficiency, which in turn would lead to short and long-term benefits for the organizations and on the overall society.

Most applicable SDG Goals for the Mining Industry are –

- SDG3 - Good Health & Well-being
- SDG4 – Quality Education
- SDG 5 - Gender Inequality
- SDG6 - Clean Water & Sanitation
- SDG9 - Industry, Innovation & Infrastructure
- SDG12 - Responsible Consumption & Production
- SDG16 – Life on Land

Overall sustainability challenges for mining industry can be categorized broadly into two segments –

- Environmental Impact caused due to mining operations
- Need for community support as part of corporate social responsibility

Environmental Impact Caused Due to Mining Activities

Most of the mining activities including exploration, operation, expansion, abandonment etc. can causea local, regional, or global scale impact on environment. Examples for some of those environmentalimpacts could be – land degradation, soil pollution, ground & surface water pollution, air pollution dueto dust & emissions, noise pollution, wildlife & overall ecological disturbance due to infrastructure builtto support mining activities etc.

	Category	Impact Sub-Category
Environmental Impact	Water	• Ground water contamination • Surface water contamination • Wastage of water
	Land	• Deforestation • Biodiversity • Soil contamination
	Air	• Emissions of gases – SOx, Nox, methane • Emissions of particulate matters • Dust emissions

The overall environmental impact from mining can be summarized as below :

1. Water : Ground and surface water contamination in mining industry is a serious concern as mining operations has very high possibilities to intersect with the water bodies, in and around the mining area. As of April 2020, more than 15 million people in India have been impacted due to overall ground water contamination. Acid mine drainage, resulting from several mining activities, such as ore washing, waste dump etc., contains heavy metals, which thereby can contaminate with ground and surface water. Some of the specific mining related processes such as leaching, ore processing by chemical agents can lead into a toxic ground or surface water condition in and around the mine. Improper maintenance of mining sites (pits), haul roads, waste dumps can lead into erosion of soil, rocks etc., which can be sedimented into the nearby rivers, lakes etc.

2. Land : Mining requires large amount of land (topsoil) to be removed, which ultimately needs large scale deforestation and thereby may lead to loss of biodiversity. As per an article published in 2020, there are approximately 3,500 mining leases in India across 23 states covering an area of 316,290.55 hectares. Erosion of exposed hillsides, waste dumps, tailing dams of a mine can significantly contaminate the solid of the surrounding areas.
3. Air : Mining, is one of the major contributors of air pollution due to emissions of particulate matters and gases including SOx, NOx, methane etc. Overall, mining industry is currently responsible for 4 to 7 percent of greenhouse-gas (GHG) emissions globally. Most of the major mining operations, such as – drilling, blasting, loading, hauling etc., are the sources of dust, SPM, SOx, NOx. In-pit hauling of HEMMs is the major contributor of air pollution out of all the mining operations.

Need For Community Support as Part of Corporate Social Responsibility

Most of the mining companies now a days, are investing considerable number of resources forprotecting environment, people & society, with several regulatory bodies continuously improving andthereby enforcing various laws & policies to protect environment & people, especially in around themining areas. The collective spent of Coal India Limited along with its subsidiaries during the period (FY16-17 and FY 19-20) was 1,977.76 crore over and above the collective statutory requirement of Rs 1,575.98 crore.

As per the company's annual report, Tata Steel Ltd spent around INR 3.15 billion on its corporate social responsibility (CSR) activities during the FY 2018-19. The spending was over 282% of its original prescribed limit of INR 824 million. Hence, community support has been the key initiatives of all the key mining organization.

	Category	Impact Sub-Category
Social Impact	Socio-Economic	• Education and skill development • Job creation • Infrastructure development
	Health & Safety	• Workplace injuries • Workplace fatalities • Illness
	Quality of Life	• Noise pollution • Ground vibration • Visual impact on landscape

All the aspects mentioned in the above table are highlighted in the different SDGs (Sustainable Development Goals) – SDGs 3,4,5,6 & 9. Mining while being a key GDP contributor for a nation, is also one of the key contributors to pollution that directly or indirectly have impacted human life within the vicinity of mines. As a responsibility to the society, mining companies need to work for socioeconomic benefits in form of rehabilitation of land, direct and indirect job creation, provision of holistic education, & ensuring health-care facilities to the entire community involved within the mining ecosphere.

Path Towards Sustainable Mining – Some Suggested Solutions

Let's look at some of the mining majors and their initiatives in sync with the Climate change goals -

1. Newcrest Mining : An Australian-based mining giant which is involved in the exploration, development, mining and sale of gold and gold-copper concentrate. It plans to reduce emissions intensity per tonne of ore treated by 30%, by 2030 against FY 18 baseline.

Key Actions taken so far –

- ❏ Site water efficiency plans developed and implemented
- ❏ Develop Biodiversity Action Plans for all operational sites
- ❏ Develop and implement site greenhouse gas emissions reduction plans (develop renewableenergy solutions for Cadia)

2. Teck Resources : Canada based diversified natural resources company engaged in mining and mineral development, including coal for the steelmaking industry, copper, zinc, and energy.

Key Actions taken so far –

- ❏ Sourced 100% renewable energy at Teck's Carmen de Andacollo (CdA) Operations (started in 2020), that had eliminated approximately 200,000 tonnes of GHG emissions annually.
- ❏ Chilean operations implemented a range of water projects that achieved a peak reduction of 13% in fresh water use. A significant increase in water recovery from the tailings thickener wasachieved at Carmen de Andacollo.
- ❏ Improved dust management at CdA

3. OCP Group : OCP Group is a Morocco based state-owned mining organization. It performs mining for phosphate rock and thereby produces phosphoric acid and phosphate fertilizer.

Key Actions taken so far

- ❏ Mandated a 25% reduction in total CO2 emissions by 2030 by ensuring investments in R&D aimed at monitoring emissions from operations
- ❏ Use of wind power at mining sites aimed at improving the use of renewable energy
- ❏ Real-time energy allocation based on plant wise utility requirement to improve energy efficiency
- ❏ R&D investment aimed at optimized water usage for operations and targeted zero water intake by 2030

Role Played by Mining Community in Tackling Downstream Industry Emissions

As a responsible stakeholder to the entire value chain, world's biggest iron ore miners are now having a direct stake in solving the problem of downstream industry emissions.
Few examples could be –

- ❏ BHP has done commitment for over US$ 400 million fund to help new technologies and at the same time, Rio Tinto is also forming partnerships with few of China's biggest steelmakers.
- ❏ Vale has agreed with Kobe Steel and Mitsui & Co to start a new venture to supply low - CO_2 iron metallics and iron-making solutions to the downstream steel industry. Vale has also invested in Boston Metal along with BHP for similar purpose.

This marks a strategic shift from the paradigm of the last two decades, which had seen major mining companies refrain from investing in down stream industries.

Corporate Social Responsibility of mining companies

As a social responsibility, objective of mining companies is to ensure social, environmental, and economic benefits to the communities in which it operates. Most of the mining companies support the development of community by improving quality of life for the people directly or indirectly related to the organization.

- ❏ Health care – Setting up primary health centres, reproductive & child health centres as well as super - speciality hospitals
- ❏ Education – Setting up schools and colleges in the adjoining neighborhood.
- ❏ Water – Providing access to water infrastructure to people living in far - flung areas by installing water sources, thereby providing drinking water access
- ❏ Model Villages/ Cities- Habitat being identified as "Model Village/ City" with an objective to bridge the

gap between rural and urban areas and to provide comprehensive development of both physical and social infrastructure.

- Vocational Training - Villagers are being provided vocational training for livelihood.

Conclusion

Mining industry's contribution for the world's economy and modern society is unquestionable. Even though mining industry is a key revenue earner for a nation, still it is subjected to follow stringent environmental rules and regulations. Mining companies have observed the direct linkage of sustainable development to their short-term and long-term benefits. Mining activities should have the objective to maximize social and economic benefits and should minimize negative environmental and social impact.

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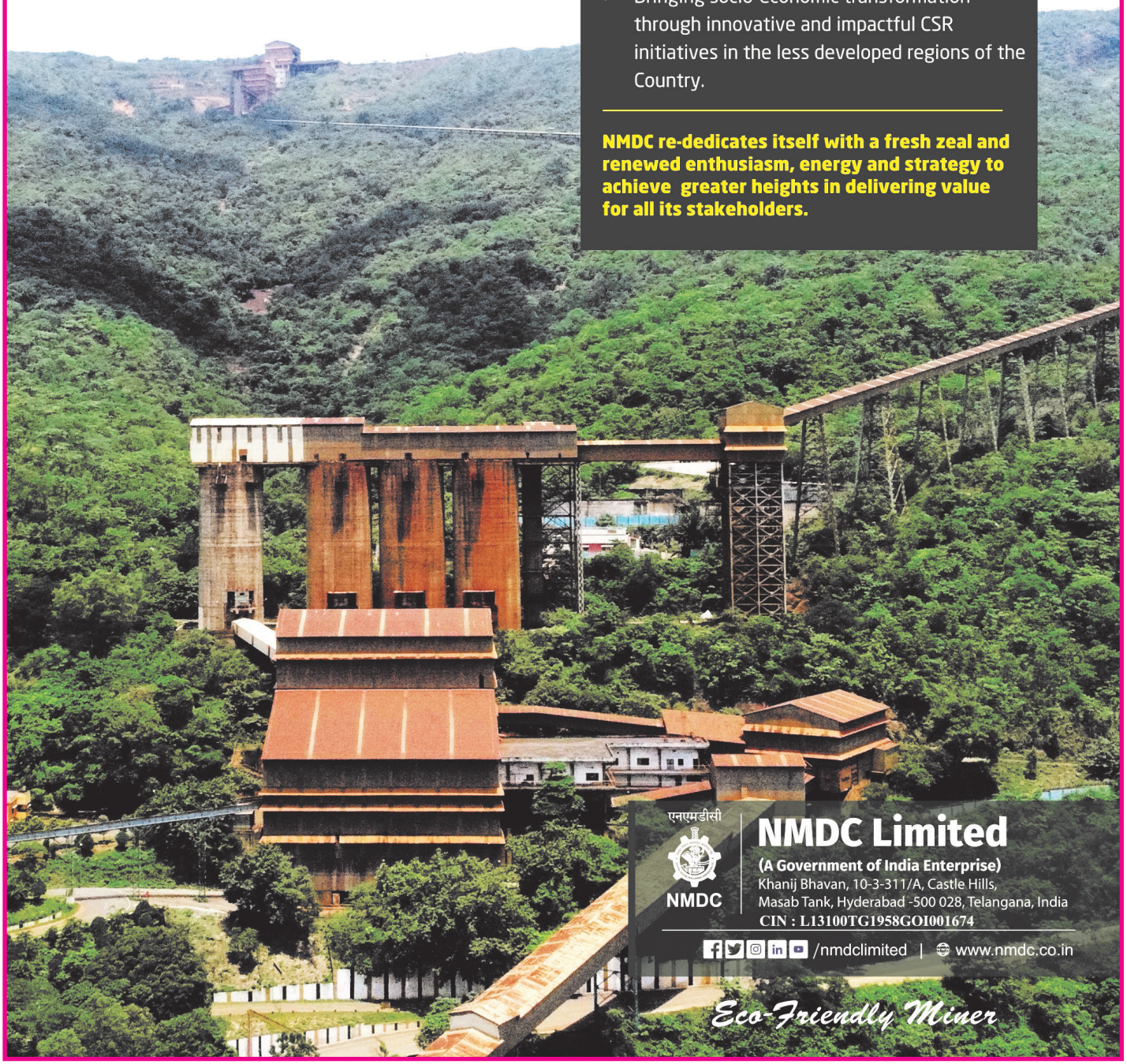

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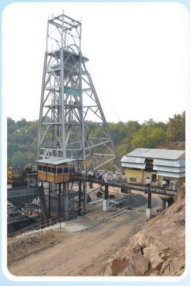

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