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ANALYSIS OF CARBON FOOTPRINT IN COAL MINES OF BASTACOLLA AREA, JHARKAHND

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Abstract : Carbon footprint is an indicator to assess the greenhouse gases (GHG) emitted from an activity or process. Both surface and underground mines, although contribute about 6% of global emission, has the potential to be significant contributors to overall GHG emission. In case of an underground mine, the operations associated the production of coal are the main causes of GHG emissions, primarily emission of methane. Inherent within the coal's structure, methane desorbs from the coal's internal surfaces during the mining process, and then moves to the atmosphere through a mine's ventilation system. The unit operations of opencast mining demands high energy and it directly and indirectly contribute GHG emission. Emissions from stock piles of coal/waste also contribute to carbon emission. In this paper different mining activities and their potential to contribute to GHG emission are discussed. Preliminary steps to assess carbon footprint of each of these mining activities are suggested. This paper also highlights the importance of calculating carbon footprint of mines in order to determine its contribution to the present climate change and also encourage development of cleaner technologies to mitigate such emissions. It also illuminates the various problems encountered while carrying out the estimations and suggests measures to improve the estimation and control of these emissions such as use of solar energy in lieu of conventional fuel based energy.

***IndexTerms* – Carbon Footprint, coal mines, emission factor, carbon dioxide, GHG.**

I. INTRODUCTION

Since the human race has started, human has start discovering the earth and nature and in that line he discovered mineral and natural resource which ultimately they use for their comfort and development. Time by time the urge to explore more and more increase and result in the decline of resource unlawfully and result in the generation of various hazardous substance for ecology during this process. Mining activity is one of the major and serious activity which human does for the extraction of raw mineral. The mining process have been developed by human being scientifically in various time and stages but still it has result in the degradation of environment. While mining there is release of heavy dust as well as harmful gases which not only harmful for human health but they are the primary contributor to green house and climate change. Thus the present research work is an attempt to put importance on the gravity of the effect that impose by the mining activity on the climate change. All this will be done determining the release of greenhouse gases due in mining activity and suggesting the proper measures to control and minimize the emission.

Now it has been confirmed that the major reason for global warming is the source of the emission of the gases such as carbon dioxide. Which is acting as a menace to environment so it is a primary requirement of time to control these heavy emissions and the quantity of carbon burn. There were several measures that are taken to control the emission such as Kyoto protocol which was initiated by UNFCCC. It was done on international level. It lashes the countries to decrease the emission of carbon dioxide and in order to do so one should know the source and the amount of carbon dioxide is releasing in the daily life activity made by the human being. We need to find out the amount of carbon dioxide added to the environment during emission from Industries, Mining sector and Construction sites etc. The process of estimation of carbon dioxide released to the atmosphere in such activities is known as carbon foot printing.

The very common Greenhouse gas is carbon dioxide and this is the reason that all greenhouse gases are also referred to as carbon. There are total of six greenhouse gases which in unite make up an organization’s carbon footprint. At an initial level this method of measuring a carbon footprint comprise of stockpiling organization’s operational data and multiplying each one by the emission factor to produce an exact data in respect to carbon dioxide equivalent.

II. LITERATURE REVIEW

Rongqin et al. (2010) “assessed the fossil fuel by-products of fossil and provincial biomass energy of various districts of China and set up a carbon impression model dependent on energy utilization. He arranged five sorts of modern spaces: rural space, living and mechanical business space, transportation mechanical space, fishery and water conservancy space, and other mechanical space. He coordinated with these mechanical spaces with energy utilization things and contemplated the fossil fuel by-product force for each modern space. The investigation did by the creator yielded the accompanying decisions: a) all out fossil fuel by-product because of energy utilization in China 2007 is 1.65 GBTC wherein the fossil energy contributed 89%, b) living and modern business space and transportation mechanical space were the high fossil fuel by-product modern space with discharge power adding up to 55.16 t/hm2 and 49.65 t/hm2 separately, c) The modern exercises in China 2007 achieved 28.69 x 106 hm2 of biological shortage by causing 522.34x106 hm2 of carbon impression, d) ultimately the per unit carbon impression of these modern spaces showed a declining pattern from east to west of China. The proposed relief measures incorporate utilization of clean energy, diminishing utilization of fossil and rustic biomass energy, upgrade the carbon obsession effectiveness of useful terrains, decrease of fossil fuel by-product force of high fossil fuel by-product spaces through mechanical guidelines and improving energy proficiency and design".

Gao et al. (2013) in their published article analysed the different significant norms utilized for assessment of "Carbon Footprint." They kept up that carbon release assessment can be ordered for the accompanying classes dependent on its extent of execution, to be specific individual, item, authoritative, urban communities, nations, and so forth An individual carbon impression evaluates the carbon dioxide discharges brought about by every individual by means of apparel, food, voyaging, house, and so forth An item's carbon impression measures the GHG (Greenhouse Gases) discharges existence of the item (from the extraction of crude material to its last utilization and the resulting removal). Additionally, a hierarchical carbon impression estimates GHG discharges from every one of the exercises in an association or endeavor. In this manner we can see that carbon impression studies can be so shifted.

Pandey and Agrawal (2014) evaluated certain cases related to the contribution of Agriculture to Green House discharges. The study reported that horticulture is the biggest booster of the Green House Gases. They reported different examinations and investigates in the Green House release versus Agriculture in their survey. Data gathered by them expresses that horticulture discharges about 13.5% of all out anthropogenic GHG emanations. In addition, farming exercises discharge around 4.2 T to 7 T yearly in type of Nitrogen Oxide. Nitrogen Oxide has an exceptionally high an Earth-wide temperature boost potential-298, consequently emanations, even in limited quantities, cause huge effects. Along these lines carbon impression concentrates in agribusiness contains for the most part CH4 and N2O outflows. Tasks like inappropriately oversaw mulching, natural excrement applications and utilization of mineral nitrogen have expanded the CH4 and N2O discharges. Legitimate horticulture the executives' practices can assist with counterbalancing the GHG outflows.

Paulson (2015) featured "the significance of lessening fossil fuel by-products in mining. Mining industry is under incredible examination as the extraction interaction is the best supporter of ozone harming substance outflows following the ensuing mining exercises like cleaning, drying and screening as the second biggest benefactor. Accordingly mining businesses are developing more worry to lessen their fossil fuel by-products. Teck Resources, a British Columbia-based coal exporter utilizes gas chromatography and fluid chromatography for checking GHG discharges to help different mining organizations diminish their fossil fuel by-products. Additionally, mining businesses are getting slanted to inexhaustible sources to fulfil their energy needs rather than customary fuel sources, for example, diesel for weighty hardware and transportation to balance their GHG emanations".

Turner and Collins (2013) "looked at the carbon impressions of OPC cover and geopolymer fastener used to make concrete alongside an exhaustive investigation of carbon dioxide comparable emanations per unit during assembling of crude materials, mining, substantial creation and development exercises for making 1 m3 of cement. Concrete is the most widely utilized crude material in development. The OPC cover customarily utilized in concrete contributes 5-7% of worldwide CO2 emanations, though an elective folio made out of salt enacted fly debris, named as 'geopolymer' fastener can possibly bring down these discharges from around 26-45% to even 80% of that of OPC fastener outflows. To assess the CO2-e emerging from every movement, the sort and amount of fuel devoured was distinguished by the credible reviewed reports. CO2-e was determined as the result of 'Amount' of fuel devoured per action, 'Energy content (EC)' of the fuel utilized and its 'A worldwide temperature alteration potential (GWP)' controlled by the amount of discharges of the individual gases (comprising of CO2, methane, nitrous oxide and other engineered gases) delivered because of the fuel utilization. 2012 Australian National Greenhouse Accounts (NGAs) factors were utilized to decide the EC and GWP of the particular powers utilized. This was done for every movement required to create 1 m3 of cement, for example, assembling of Sodium Silicate, OPC, Fly debris, totals, and restoring. At last, the absolute outflows from OPC cement and Geopolymer concrete were recorded as 354 kg CO2-e/m3 and 320 kg CO2-e/m3 separately. When contrasted and before examines the acquired distinction in outflows is simple 9% contrasted with assessed 26-45% and 80% in prior examinations. It was presumed that such deviation happened because of incorporation of emanations from transportation and mining of crude materials, huge energy burned-through during Sodium Silicate fabricating and finally because of high energy burned-through for high restoring temperature if there should arise an occurrence of geopolymer fastener which is unimportant in the event of OPC folios".

CETCO (2014) "assessed the carbon impression of an Organoclay produced by it. It is made from handling Sodium Bentonite (mined and prepared American Colloid Company's plant in Lovell, WY) and a quaternary amine compound. The extent of estimation covers all significant exercises from crude material creation (counting mining and transport of Bentonite) to bundling of eventual outcome. Suppositions made in the computation include: transport distance of 1690 miles of mined sodium bentonite from Lovell to handling plant, trucks travel at full limit with their outflow factors taken from USEPA (2008a, 2008b), discharges from quaternary amine creation were taken from AkzoNobel 2013, and the emanations at the plant during preparing of the organoclay were determined utilizing the energy and fuel utilization information got from their yearly report. Therefore, the carbon impression determined was discovered to be 2070 Kg CO2eq/metric ton of Organoclay created".

III. CASE STUDY

a) Study Area

The study area that has been chosen for the present investigation are Kuya and Bera mines of Bastacolla Area of Jharia Coal Field, Dhanbad. Both the mines are open cast project (OCP) and are run by Coal India Limited.

Bastacolla Area is situated in the eastern flank of Jharia coalfield. It adjoins most ancient Archeam Rocks, which form a bowl shape in eastern site of Jharia Coalfield. The total leased-hold area is 1210 hac. and is situated mostly on eastern side of Dhanbad-Patherdih railway line (dismantled) and between Dhanbad city and Lodna barrier. This Area is amalgamation of 33 mines of pre-nationalization period, most of which had primitive mining culture. This is major factor, which contribute to a very low productivity of underground mines and very poor work culture. After nationalization efforts have been made to streamline the managerial structure as well as to organize the mines to improve the operational and organizational performance with utmost and due care to the safety aspects.

b) Methodology

Following the steps from the GHG Protocol, the basic methodology involved in calculating the carbon footprint for a mine is as follows

1. **Organizational Boundary**

   The first step is to limit the boundary of the study i.e. to identify the activities which are under direct control of the company and which are out sourced. And within the activities that are under direct control which activities are to be considered for accounting.

2. **Scope**

   Categorize the mining activities into three scope category

   - **Scope 1**: These are immediate emanations by the exercises own or constrained by the mine. These exercises discharge outflows straight into the climate.
   - **Scope 2**: These are backhanded energy-related emanations. This extension incorporates those exercises which discharge outflows and are related with the utilization of some type of energy like bought power, warmth, steam, and cooling. These are alluded to however aberrant as these emanations may be caused because of the necessity of the mine yet these are not created or possessed by the actual mine.
   - **Scope 3**: Incorporates exercises performed by the mine faculty however happen at places that are not under the mine's control like making a trip by transport to work, garbage removal, revaluated exercises, and so on

3. **Activity Data**

   Collect the relevant Activity Data corresponding the the mining activity

4. **Emission Factor**

   Obtain the corresponding emission Factor based on the level of Complexity of the evaluation

5. **Total Emission**

   Calculate the total emission by multiplying each activity data by is corresponding emission factor and then the final result is obtained.

IV. Results

The estimations were done for a one month period. The following tables provides the obtained results.

Table 1: Kuya OCP with coal production of 930227 Tonnes per month

Scope	Source	Equipment	Consumption	CO_2 – e Emissions (kg)
2	Electricity (kWh)		1250690	975538.2
1	High Speed Diesel (Litres)	Dumpers	173869	443414.7
		Water sprinklers	14694	37473.82
		Dozers	51938	132456.5
		Graders	6948	17719.35
		Drills	15671	39965.5
		Shovels	129579	330462
		Auxiliary	2368	6039.1

Table 2: Bera OCP with coal production of 139870 Tonnes per month

Scope	Source	Equipment	Consumption	CO_2 – e Emissions (kg)
2	Electricity (kWh)		369128	287919.8
1	High Speed Diesel	Dumpers	52462	133792.8
		Water sprinklers	3998	10196
		Dozers	20950	53428.4
		Graders	1603	4088.1
		Drills	408	1040.51
		Excavators	14180	36162.9
		Auxiliary	182	464.2
			TOTAL	**527092.71**

V. DISCUSSION

The above estimation of approximate Carbon footprint of the mines encountered various shortcomings and problems which led to inevitable uncertainties in the results. A major ordeal faced was the unavailability of activity data, which limited our scope and boundary for the estimation. Various data relating to the use of light passenger vehicles in the mines, amount of fuel used for cooking purpose, and transportation data of the mined coals etc., which fall in the Scope 3 category and add to the GHGs emissions, were inadequate to formulate a report. Moreover, certain direct emissions such as from that of blasting are difficult to measure and thus were not included in the report. Although the emission factors used were specific to India but, it only took into account the amount of fuel consumed by the machine and not the operating condition of the machine. Thus, such discrepancies prevented the formulation of a much more exact estimation of the GHGs release by the mines.

Also, studying various case studies of the footprint report prepared certain mining companies in India, it is seen that there is uniform methodology developed yet and thus it is difficult to compare different mines based on their carbon emissions. It is because different mining industries includes different number of sources for estimating their respective emissions. Therefore, implementing uniform methodology implies using similar sources of emissions by all mines so that comparison of results is possible.

VI. CONCLUSION

Implementing the proposed methodology will provide a homogeneity in the emission results and will not only make it easier to compare emissions from different mines but also help individual mines to analyse their sources and take proper mitigations to check the emissions. The companies can identify processes with maximum emissions and develop alternatives to substitute it with those processes to obtain the same desired results with lesser emissions. Other mitigation strategies include plantation in the reclaimed area, as plantation acts as sinks, which absorb the atmospheric CO_2 and balance its percentage in the atmosphere. Moreover, CO_2 sequestration into un-minable seams also provides an aid to balance the excess CO_2 liberated from the mining activities. Since a major chunk of emissions can be attributed due to consumption of electricity followed by emissions from fuel combustion by mining machineries, use of solar lighting in mines can reduce the load on electricity produced due to thermal plants. Also, mines are generally spread across vast areas which can be used to set up solar panels to produce solar energy to meet the electricity demands of the mines and thus lifting the burden off the fuel-based electricity production which will reduce the emissions remarkably. To counter the emissions from machineries, it is recommended that companies pay attention towards regular maintenance of the machineries with regular servicing and cleaning of parts to maintain higher fuel efficiency and cleaner combustion. Thus, this projects aims to emphasise that global warming is a serious threat leading to dangerous climate change and contribution of mining sector should not be neglected. Adopting proper and standardised methodology to evaluate the emissions of GHG from mining activities is the need of the hour to estimate the extent of damage caused by mining industries and take proper actions to mitigate the damage.

References

1) Ahn, C. R., Lewis, P., Golparvar-fard, M., and Lee, S. (2013). “Integrated Framework for Estimating , Benchmarking , and Monitoring Pollutant Emissions of Construction Operations.” *Journal of Construction Engineering & Management*, 139(12), A4013003.
2) Aretoulis, G., Kalfakakou, G., and Striagka, F. (2010). “Construction material supplier selection under multiple criteria.” *Operational Research*, Springer-Verlag, 10(2), 209–230.
3) Asif, M., Muneer, T., and Kelley, R. (2007). “Life cycle assessment: A case study of a dwelling home in Scotland.” *Building and Environment*, 42(3), 1391–1394.
4) Athena. (2013). “Athena Impact Estimator for Buildings V4.2 Software and Database Overview.”
5) Athena Sustainable Materials Institute. (2014a). “Athena Guide to Whole-Building LCA in Green Building Programs.”
6) Athena Sustainable Materials Institute. (2014b). “User Manual and Transparency Document.”
7) Autodesk. (2005). “Building Information Modeling for Sustainable Design.” *Autodesk Whitepaper*.

8) Bilec, M. M., Ries, R. J., and Matthews, H. S. (2010). "Life-Cycle Assessment Modeling of Construction Processes for Buildings." *Journal of Infrastructure Systems*, 16(3), 199–205.
9) Bilec, M., Ries, R., Matthews, H. S., and Sharrard, A. L. (2006). "Example of a Hybrid Life-Cycle Assessment of Construction Processes." *Journal of Infrastructure Systems*, 12(4), 207–215.
10) BREEAM (Building Research Establishment Environmental Assessment Methodology). (2011). "Mat 01 Life Cycle Impacts."
11) Bynum, P., Issa, R. R. a, and Olbina, S. (2013). "Building Information Modeling in Support of Sustainable Design and Construction." *Journal of Construction Engineering & Management*, 139(1), 24–34.
12) Edenhofer, O.; Pichs-Madruga, R.; Sokona, Y.; Farahani, E.; Kadner, S.; Kadner, K.; Seyboth, A.; Adler, I.;Baum, S.; Myhre, G.; et al. Climate Change 2014: Mitigation of Climate Change; Working Group III Contribution to the IPCC Fifth Assessment Report; Cambridge University Press: Cambridge, UK, 2015.
13) Food and Agriculture Organization of the United Nations (FAO). Regional Strategy for Sustainable Hybrid Rice Development in Asia; Food and Agriculture Organization of the United Nations Regional Office for Asia and the Pacific: Bangkok, Thailand, 2014.
14) Irani, Z.; Sharif, A.M. Sustainable food security futures: Perspectives on food waste and information across the food supply chain. J. Enterp. Inf. Manag. **2016**, 29, 171–178.
15) Runhaar, H. Tools for integrating environmental objectives into policy and practice: What works where? Environ. Impact Assess. Rev. **2016**, 59, 1–9.
16) Godfray, H.C.J.; Beddington, J.R.; Crute, I.R.; Haddad, L.; Lawrence, D.; Muir, J.F.; Pretty, J.; Robinson, S.;Thomas, S.M.; Toulmin, C. Food security: The challenge of feeding 9 billion people. Science **2010**, 327, 812–818.
17) Meyfroidt, P. Trade-offs between environment and livelihoods: Bridging the global land use and food security discussions. Glob. Food Secur. **2018**, 16, 9–16.
18) Lobell, D.B.; Schlenker,W.; Costa-Roberts, J. Climate trends and global crop production since 1980. Science **2011**, 333, 616–620.
19) Ykihiro Yamasaki. An overview of CO2 mitigation option for global warming. Emphasizing CO2 sequestration option. Journal of Chemical Engineering of Japan, Vol 36, No 4, pp 361-375.
20) Garg. A., Shukla. P. R. Coal and energy security for India: Role of CO2 capture and storage. Energy 34 (2009), 1032-1041.
21) Shimada, S., Li, H., Oshima, Y., Adachi, K., Displacement behaviour of CH4 adsorbed on coals by injecting pure CO2, N2, and CO2-N2 mixture. Environ Geol (2005) 49, 44-52.
22) Hajra, P. N., Malay Rudra., Some, T.K., Chakraborty, P.K., Dasgupta, I. A geochemical assessment of cbm potential of north raniganj area. Proceedings of Petrotech-2003, New Delhi.
23) Standard practice for proximate analysis of coal and coke. ASTM D3172-07a.
24) Harpalani, S.; Prusty, Basanta K.; Dutta Pratik. Methane/CO2 sorption Modeling for Coalbed Methane Production and CO2 sequestration, *Energy & Fuels* 2006, 20, 1591-1599.
25) Day, S., Duffy, G., Sakurovs, R., Weir, S., Effect of coal properties on CO2 sorption capacities under supercritical conditions. Int. Journal of Greenhouse Gas control. 2, (2008), 342-352.
26) Masel, I. Richard. Principles of adsorption and reaction on solid surfaces. Wiley, 1996.
27) Langmuir, I.J. The adsorption of gases on plane surfaces of glass, mica and platinum. J. Am. Chem.Soc 1918, 40, 1361.
28) Giauque, W. F., Egan, C. J., Carbon dioxide. The heat capacity and the vapour pressure of the solid, the sublimation, thermodynamic and spectroscopic values of the entropy. J. Chem. Phys., 1937, 5, 45-54.
29) Dubinin, M. M. and L. V. Radushkevitch, Proc. Acad. Sci. USSR., , 1947, Vol. 55, p.331.