Carbon Footprint Calculation of Coal Mining Industry

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ABSTRACT: - There is an increase in the global temperature in last couple of decades by 2-3 degrees and this happens due to global warming. The topic of global warming is talk of town for the environmentalist as well as climate scientist all over the world. The lobby of environmentalist and scientist claim that the emission of GHG gases to the environment is the prime reason for climate change. All anthropogenic activity by human being should be scrutinized and it is the demand of hour. As per the census data India is the third largest emitter of greenhouse gases in the world after China and United States. Thus, it is required to take action against it in order to decrease the emission of GHGs to the environment. Among all the sector, Mining sector is one of the largest sectors in India, which supply the raw material to all the sector and industries and major part of the energy requirement is also fulfil by this sector only. Mining sector not only fulfil the requirement, but it is also a major contributor of Green House Gases. Mining sector requires a huge amount of electrical energy and fuel for mining activity. Moreover, after burning huge amount of fuel and consuming electricity it add GHGs to environment and add CH_4 and other gases by its blasting activity. Mineral processing plants also emit greenhouse gases in huge quantity and many other sources for GHGs are also there. Due to this reason emission from the mines can't be ignored and it is the major contributor. This investigation of the present research work is highlighting the importance of carbon footprint and its calculation for mines as to find out the contribution made by mining activity to the global warming.

Keywords: Carbon Footprint, coal mines, emission factor, carbon dioxide, GHG

I. INTRODUCTION

With the increase in the industrialization and evolution of technology, cause the increase in the environmental pollution and this cause a serious problems to human being and nature. Due to these pollution and many hazardous substance cause the problems of global warming. The problem of global warming will last longer and human being are much more concern about its effect around the globe and on human being and other living being. These days it is very common to relate global warming with change of climate even though it is a very wide phenomenon. Climate change refer to as the change in all the components of climate such as ocean, precipitation, wind, temperature etc. whereas global warming refers to as the increase in the temperature of earth surface, which has happened in the last couple of decades.

With the dawn of 21st century the scientist all over the world bring this in notice that the global warming is happening and it is causing the increase in the earth's temperature, the climate studies that was done comes with an evidence that the rise in temperature of the earth is because of release of greenhouse gases in a huge quantity to atmosphere due to human being day to day activity. This leads the scientist to research furthermore and estimate the impact of this disaster it is going to leave on the human being, as of concentration of carbon dioxide is getting multiplied which leads to the increase in the temperature by 1-4 degrees and it will further cause the rise in the sea level by 0.4-0.6 m which will ultimately invite disaster. It was clear that the global warming has been the serious threat to the living being and all due to the unceasing emission of greenhouse gases. Therefore, it is required for the welfare of living being to be cognizant of its mechanism, emission of gases and its challenges and solution regarding to the change of climate. Suitable information regarding the saviour threat was cropped up by the several research institute such as union of concern scientists, carbon offset research and education, global change research information office and intergovernmental panel on climate change. Extracting all the relevant and important information regarding the change of climate by assessing the scientific points, future and present risk assessment and its mitigation is done by intergovernmental panel on climate change (IPCC).

Since the establishment, IPCC has published a total of five assessment report till now its first assessment report was published in the year 1990. As per the fifth assessment report that in the last three decades the temperature of earth is quite warmest as compared to the Global earth temperature and it was notice to a rise of 0.6 +0.2 degree Celsius in temperature. As far as greenhouse gases are concerned in the report it has been mention that the concentration of greenhouse gases there is a spike increase in the concentration of these gases to an unprecedental level. The carbon dioxide has increased by 45% when it is compared by the before industrial period. Human activities has also contributed much in rising the concentration of these gases. it has been found that the greenhouse gases like carbon dioxide, Methane and Nitrogen dioxide has increased just because of human activity and they were found to be 393, 1809 and 320 ppb in the year 2011.

It is now quite evident that the primary cause of the recent global warming menace is the CO_2 emissions. Thus it is required to curb these emissions and control the amount of carbon burnt. There were many initiatives taken to regulate carbon emissions like the Kyoto Protocol which is linked to the United Nations Framework Convention on Climate Change (UNFCCC). It is an international treaty that binds the countries to limit or reduce their Carbon emissions. In order to regulate the amount of CO_2 released in the atmosphere, it is required that we should be aware of how much quantity of CO_2 is actually emitted in the various day to day activities carried out by human beings respectively. That is we need to determine how much CO_2 is added up in the atmosphere during each activity (such as industrialisation, mining, construction work, daily household chores etc.). This estimation of CO_2 emitted in the respective activity is known as Carbon Footprinting. A carbon footprint, or Corporate

Greenhouse Gas (GHG) Inventory, is an accounting of a company's operational emissions. The most common GHG is carbon-dioxide (CO_2), which is why greenhouse gases are often referred to as "carbon", however there are six different GHGs that make up an organization's carbon footprint.

II. LITERATURE REVIEW ON CARBONFOOTPRINT

"It is by a long shot set up that the danger of a dangerous atmospheric deviation is genuine and is valid, on an ascent. Passing by the colloquialism that what is quantifiable can be sensible, it is along these lines prescribed to monitor the emanations that are accepted to be an essential driver of environmental change. It is this bookkeeping of ozone harming substance discharges from different human exercises, which is alluded to as "Carbon Impression".

Carbon Footprint measurement and impact analysis is an evolving area, extensive research in this filed is still ongoing. Due to this, extensive research in this field is not yet published. The sources available are from the internet and blogs written by scientists and researchers. There is a clear disagreement about the exact definition of Carbon Footprint. Scientists are yet to arrive on a common definition. But the term "carbon footprint" originates from the concept of Ecological Footprint, the term was first introduced by Wackernagel and Rees in the year 1996. As the concerns of climate change are getting realistic, Carbon Footprint is slowly emerging as an independent domain with extended applications in various fields, especially sustainability. Various definitions of Carbon footprint are there, a few of them are enlisted below.

The Carbon Trust (2007) defines Carbon footprint like "a technique for identifying and measuring the individual greenhouse gas emissions from each activity within a supply chain process step and the framework for attributing these to each output product". The definition subjects to include both direct and indirect process of carbon footprint generation into purview.

Wiedemann and Min (2008), defined Carbon footprint as "The carbon footprint is a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product."

Larsen and Hertwich (2009) defined carbon emission-based footprint on Green House Gas (GHG) emissions estimations based on the per capita consumption for an estimated number of inhabitants. The definition reads "Carbon footprint is the life-cycle GHG emissions caused by the production of goods and services consumed by a geographically-defined population or activity, independent of whether the GHG emissions occur inside or outside the geographical borders of the population or activity of interest." The carbon footprint is hence a global concept.

Peters (2010) defined carbon impression with a more extensive viewpoint for the definition, "The 'carbon impression' of a utilitarian unit is the environment sway under a predetermined metric that considers all important discharge sources, sinks, and capacity in both utilization and creation inside the predefined spatial and fleeting framework limit." This definition has greater adaptability on the two items with emanation classifications of interest. It likewise covers the fundamental concept of carbon cycle process.

Treptow (2010) explained fundamental standards of science are applicable to compute GHG outflows. He overall explained that science utilizes units, dimensional investigation, stoichiometry, thermochemistry, and related logical laws to play out the computations of various exercises that created Carbon di oxide. Every estimation begins with a fair compound condition for the discharge response identified with the individual movement. In this way, different logical and synthetic standards were utilized to communicate these emanation parameters. In the paper, he argued that estimation for CO_2 delivered in concrete creation, fuel ignitions, and petroleum gas burning. The mass of carbon dioxide delivered in every one of these responses depended on the mass of concrete created, the volume of fuel burned-through, and the warmth produced by the consuming of the gaseous petrol individually. Consequently, the fundamental target of his article was to exhibit the job of science in a worldwide temperature alteration.

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. 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 emissions".

The Carmichael Coal Mine and Rail Project SEIS: "Hydrogeology Report, arranged by GHD Pty Ltd for and for Adani Mining Pty Ltd measures the fossil fuel by-products by the mine inside Scope 1 and Scope 2 of the GHG Protocol containing the accompanying sources: Grid power, diesel for writing material use for energy purposes, explosives use for blasting and squander water taking care of, outlaw of methane just like underground mine and in result cause expulsion of ecology. The report finished up the all-out normal fossil fuel by-products to be roughly 2,290-kilo tons CO_2 for every annum with power utilization being the biggest benefactor followed by diesel utilization. These assessments are professed to be made utilizing the National Greenhouse Accounts (NGA) Factors. Following the assessment, different moderation and energy the executives' steps are proposed to lessen nursery discharges independently for the development stage and activity stage".

III. REPORTING OF CARBON FOOTPRINT

"As the requirement for computing Carbon impression developed, it cleared route for a global stage, the United Nations Framework Convention on Climate Change (UNFCCC), to report the GHG stock arranged by various nations. Under the program of UNFCCC, various nations marked the Kyoto Protocol, a settlement which expects to lessen the ozone depleting substance outflows. Till date, 195 nations have marked the arrangement and taken an interest to control their fossil fuel by-products and are alluded to as the "Gatherings to the show". As indicated by the convention, various nations have a fluctuating degree of duty towards restricting their outflows. The created nations have a legitimate restricting to report and find prompt ways to check their discharges inside as far as possible, though the agricultural countries are needed to report their all-out outflows yet are not

constrained to check these. Besides, it is suggested that the created countries should give the agricultural nations suitable mechanical help to diminish their outflows".

"India being a non-industrial country, does not have a legitimate restricting to control its outflows, yet since it's anything but a member in the convention, it's anything but a recipient to the innovative help from the created nations. As of now, India is expressed as the third-biggest producer with 5.2% of complete worldwide discharges. The other driving supporters are China (emanating about 21.1%) and the United States of America (producing about 14.1%). India marked the UNFCCC in the year 1992 and reports it discharges to it by means of the National Communication to the UNFCCC (NATCOM). India has arranged two reports of National Communications, which contained the point-by-point assessment of outflows from significant areas, for the year 1994 (Initial National Communication) and 2000 (Second National Communication). Aside from submitting for the UNFCCC, India fostered its very own GHG stock for the year 2007 which was brought out by the Indian Network of Climate Change Assessment (INCCA). The pattern in the GHG outflows for the years 1994, 2000 and 2007 are introduced in Figure below".

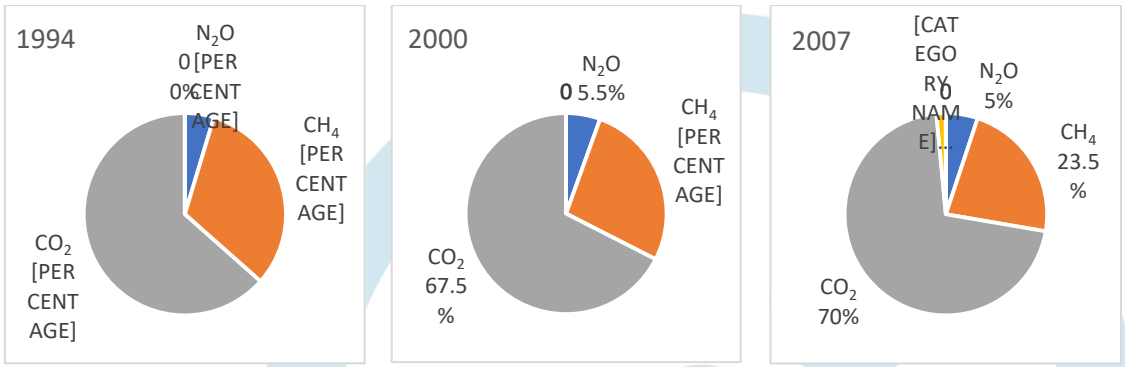

Figure 3: Green House Gas emission of 1994, 2000 & 2007

IV. CARBON FOOTPRINT IN MINING vis-à-vis INDIAN SCENERIO

"The mining area is perhaps the most basic areas. It includes the extraction of minerals that consider the need of crude materials for some essential ventures and a secret weapon during the time spent turn of events. India, having bountiful stores of minerals, has a huge potential to create through the mining area. The reasonable and arranged misuse of these stores can make the country independent in fulfilling its energy needs, crude material necessities for modern turn of events, and unfamiliar exchange type of mineral fares. In this way, mining is an extremely vital industry for an agricultural country like India".

"The mining area in India has developed amazingly since 1952 with the worth of mineral creation arriving at the degree of Rs. 282726 crores in 2013-14 from Rs. 85 crores in 1952. Besides, the complete number of detailing mines in 2013-14 (barring those of oil (unrefined), petroleum gas (used), nuclear and minor minerals) were discovered to be 3699. Of these, 552 mines had a place with coal and lignite, 663 to metallic minerals, and 2484 to non-metallic minerals. The revealed creation of coal and other significant minerals has likewise shown an astounding ascent. The coal delivered in 2013-14 was accounted for to be in 566 million tons which were almost multiple times that created in 1952. Likewise, the creation of iron metal, bauxite, and chromite has expanded essentially since 1952, with the new sums being 152 million tons, 21.7 million tons and 2.85 million tons individually for the year 2013-14. To enhance this uncommon ascent underway, mining has developed innovatively over the course of the years into a massive industry with an always expanding number of hardware including Dumpers, Shovels, Excavators, Drills, Crushers, Surface Miners, and so on".

"One of the significant employments of mining is the extraction of coal and other traditional fills to meet the energy necessities of the country. Energy is alluded to as a 'essential product' and any vulnerability in its inventory can be inconvenient to the development of creating economies like India. As the energy necessity is expanding at a quick rate, keeping a decent and consistent stock is of prime significance. Also, it is discovered that Coal and Lignite are the essential wellsprings of energy creation in our nation representing practically 74% of the absolute creation for the year 2013-14. Power age is the greatest shopper of coal with nuclear energy stations representing an astounding 70.25% of the all-out introduced limit in the nation, trailed by steel enterprises.

V. 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. **Organisational 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.

VI. 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
			TOTAL	**1983069.17**

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**

VII. 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 include 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.

VIII. 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.

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