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A study on Land use change pattern of Meherpur rural area near Silchar City in Assam, India

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Abstract

Land-use and land-cover pattern change is one of the main important driving forces of global environmental change. Land-use and land-cover changes have impacts on a wide range of environmental and landscape attributes which includes the water, land, air quality, ecosystem processes and function, and the climatic condition of any region. Because of rapid population growth there is a very fast expansion of urbanisation in adjacent rural areas of any large town or city. Thus in order to check this change the present study is carried out to monitor and assess the present scenario of present land use change in the Meherpur area of Silchar mini city. It has been noticed that, there is a huge change in land use pattern over the last 9 years i.e. year 2005 and 2014 which is especially in respect of build up area growth in study area.

***Keywords**: Land use change; GIS application; Quantum GIS; Silchar*

Introduction

As urban-rural land use change is a very important process, which characterizes the urban and sub-urban areas surrounding the cities, due to urbanization activities, resulting from demographic, industrial development and also from immigration system. Urbanization is considered to be an important issue and its impact on the agricultural lands surrounding urban areas. In recent years, urban centers all over the world have experienced rapid growth because of the rapid increase in population and the irreversible flow of people from rural to urban areas. Specifically, in the larger towns and cities of the developing countries the rate of increase in population growth is very fast nowadays, most of such urban centers are facing unplanned and uncontrolled settlements at the densely populated in urban centers (Singh & Singh 2007). In India, unpredicted population growth coupled with unplanned developmental activities has resulted in urbanization, which is causing loss of the agricultural land. The urbanization takes place either in radial direction around a well-established city or linearly along the highways. Regular monitored of urban land cover/land use changes are necessary for sustainable development of any particular area. Land cover types and their distributions are fundamental data which is required for a wide range of studies in the physical and social science, as well as by municipalities for land planning purposes (Stefanov et al. 2001). The satellite images and aerial photographs provide the synoptic view of an area. Also, these are covered the area with a regular interval of time so that we can compare the area with the past years. These are consists of different types of digital data which are very useful in change detection analysis. The data are handled with the help of remote sensing, geographical information system (GIS) techniques. These types of analysis studies are very useful in land use change and urban expansion (Yang & Lo 2002). Land is becoming spontaneously a scarce resource due to immense agricultural and urban expansion. Hence, information on land use/land cover and possibilities for their optimal use is essential for the selection, planning and implementation of land use process to meet the tremendous demands for basic human needs and requirements. This information is also assists in to the monitoring process of the dynamics in respect of land use which resulting out of changing demands of increasing population (Tiwari & Saxena 2011). The developing countries presently facing a lack of natural resources and with the continuous increase in population rate it is becoming a critical factor to manage the increase in household needs, poverty, decreasing agricultural lands, direct or indirect impact on the global climate, illiteracy, water pollution and other factors. Thus, it is very important for comparative study of the behavior for urban change in a specified area over a given period of time. Urban Change is the conversion of the non-urban land to the urban land (Lefteris et al. 2008). It is also observed that many times urban change is such a rapid process that, the simple observation of the ground surveying method is not sufficient for analyzing such process. Hence, there is a need of such technique which provides data at regular time gap. Satellite remote sensing, in combination with geographic information systems (GIS), has been popularly applied and been approved as a powerful and effective tool in detecting land use and land cover change (Ehlers et al. 1990; Meaille & Wald 1990; Treitz et al. 1992; Westmoreland & Stow 1992; Harris & Ventura 1995). Satellite remote sensing provides cost-effective tools and turns data into valuable information form to understanding and monitoring of land development patterns and processes and for building land use and land cover data sets. Geospatial technology provides a useful environment for storing, analyzing, and displaying digital data necessary for change detection and database development process. Satellite imagery has been used to monitor the land cover types by different classification (Steininger 1996). Post-classification comparison and multi-date composite image change detection are the two most popular methods which used in the change detection analysis (Jensen 1996). In recent years, the techniques of remote sensing and Geospatial technology have been increasingly used to examine the spatial and temporal patterns of land use and land cover change in different nations, especially related to urban growth and its expansion (Dai et al. 1996; Chen et al. 2000). Remote sensing and GIS based change detection studies have predominantly focused on providing the knowledge of how much, where, what type of land use and land cover change has occurred in particular region or area. Current improvements in satellite data and its availability have made it possible to check the image analysis in vast scale compare to before. GIS has tremendous possibilities as an environment for the conception of dynamic models of physical environmental processes. Therefore, the application of Geospatial technology is the planning of the recognized and studied by many researchers so far. However, application of urban centre planning and rebuilding has less research compare to rural planning study. Because the rural economic status is mainly dominated by agriculture, the rural planning strictly protect arable land is placed in the core position, especially the accruing of cultivated land is prohibited. The significance of rural development and its study in the context is well reflected in the words of Mahatma Gandhi who once quoted that India lives in villages. Thus urban expansion in rural area is an important phenomenon for any such land use change study.

Materials and method

Study Area

Meherpur is a small village in the Silchar Tehsil at Cachar District of Assam, India. It is located 4 km towards South from District head quarters Silchar shown in Figure 1 Meherpur is more than 300 km from State Capital Guwahati. The place is located at the distance around 2.0 km away from the Municipal boundary of Silchar city. This area lies on main road called as Silchar-Hailakandi road which is also a connecting road link of some very important institutions as Silchar Medical College, Silchar Polytechnic, National Institute of Technology Silchar, Assam Central University and number of nursing homes as Nightingale Nursing home, Medinova Nursing home, Valley Hospital & Research Centre etc. There is also a municipal dumping ground which is also situated within the present study site, which situated around 300-400 meter from the main road i.e. from Silchar-Hailakandi road. The present study area is consists of new development road, Naga Punjji, Kuarpar road, Birbal Bazar, Sun City road, Migrant Camp and other organisational institutes as Silchar Polytechnic, LIC Regional head office, Suresh Goala LP School, United flour Mills, and the Sun City Building Project etc.

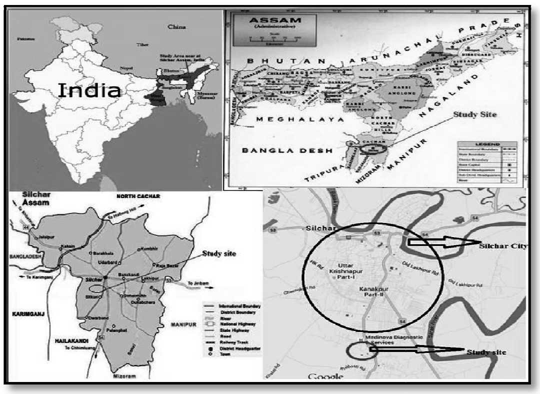

Figure 1. Study area

The objectives of study

The main intensions of this study are:

- To identification and
- Delineation of different land use/land cover categories using high-resolution remote sensing data by using the Google earth images.
- To generate the map of the changes occur in the area in respect of various land use/ land cover categories during the period of year 2005 to year 2014.

Methodologies

The methodology adopted in the present study to carry out the details of the land use / land cover mapping is given in the flow chart. Study is carried out in the stages which are as follows:

- Pre Field work
- Field work
- Post Field work

Pre field work

- Land use / Land Cover classification.
- Designing land use/land cover classification scheme based on the available data source.
- Defining the different land use / land cover classes.
- Preparation of base maps for all the natural and manmade features like roads, drainage and landmarks were incorporated on the base map for easy transfer of details from interpreted overlays.
- Interpretation.
- Setting the minimum delineation for classifying the different land use/ land cover.
- Visual interpretation of the Remote sensing data by using the usual clues such as shape, size, pattern, texture, tone and associated features as well as local knowledge.
- Transfer of interpreted information onto the base map.
- Marking of the doubtful cases on the map for field checking in order to ascertain the actual use.
- Interpretation results of two databases (2005 and 2014) are recorded in the digital form by doing in Google Earth. These maps are digitised by doing on screen digitisation to form a digital data base for computer based analysis, which will serve the base for all the information regarding the land use/ land covers statistics and as well as land use / land cover change analysis.

Field work

- Reconnaissance survey to get a general idea of the area features environment and accessibility.
- Checking of the ground sample points.
- Checking of unresolved cases. After checking the polygons they were assigned in appropriate classification codes with field verification.

Post field work

- Finalization of land use map is done after incorporating necessary corrections and modifications after field check.
- Land use / land cover change analysis.
- Preparation of Final maps Tables and Charts.

Methodology for data operation

For of assessment such dynamic phenomenon the input source should provide the data at

sufficient intervals of time (Jat et al. 2007). Thus for this study the data source used is Google Earth which has been an excellent data source of high resolution satellite images and which provides a fast and efficient way of analyzing land use change study. Google Earth provides the geo-referenced images which are within the acceptable limit of error. The data used is high resolution satellite image of study area of two different years. The first image used is of year 2005 and the second image used is of year 2014. Hence there is a sufficient amount of time interval of 9 years to detect the change in an area. The digital image is first digitized in the Google Earth defining the buildings or settlement points by point, vacant lands or plots by polygons and road network by path. Then the digitized image is transferred to Quantum GIS by converting the kml file to shp file. The Quantum GIS utilizes the shp file of the digitized image and the database is created with the help of the QGIS. The attributed can be added as per requirements such as area for polygons and length for road. Finally comparing the attributes such as area of a defined polygon of two different years we can detect the urban change in a particular area. For detecting the change in area manually we can overlay the map of the study area of 2005 on the map of study area of 2011. Hence we can observe the change in land use area.
The methodology for carrying out this complete work has been explained below with the help of a flowchart. The area shown above in Figure 2 in color is the study area which includes all the regions mentioned above. The change has been detected in this given area which includes built up area, vacant land and road network.

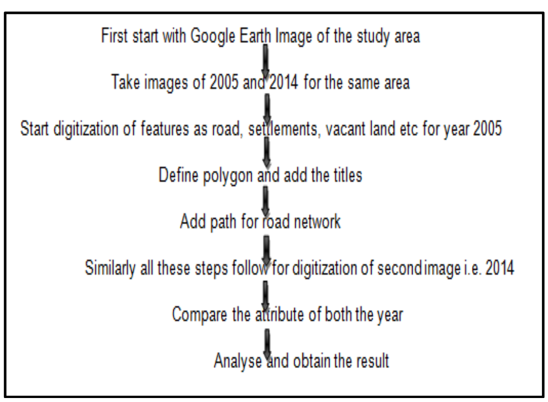

Figure 2. Flow chart of methodology

Results and Discussion

Geo-spatial technology has developed at a remarkable pace over the past two decades and plays a key role in the development of nations in the 21st century. A geographic information system (GIS) is a computer based information system that has the capability of handling all kinds of spatial data for decision making system. It enables the input, management, manipulation, analysis, modelling, output and dissemination of spatially referenced land relative data. In Panchayat Raj or decentralized administration, empowering various tiers of governance with decision making power needs a complex data and information on many issues. Analyzing these data parameters and taking decisions based on this database often is not easy. Geo-spatial tools like GIS integrate both spatial and attribute parameters and reflect the free representation of field situation. Analyses of these data base help to identify and solve the problems of an area. The present study Meherpur village emphasizes the power of GIS technology which will help the authorities to better understand and evaluate spatial data for identifying and solving the problems by creating graphic displays using information stand in the data base.

Settlement or Build up Area: Settlement area that has been estimated digitized on Google Earth images for the year 2005 and 2014 as kml file which being converted to shapefile in QGIS and map has prepared in QGIS which shown in Figure 4 the settlement points which is highlighted by blue color dots. Light pink polygons are area indicates the vacant lands in the year 2005 Figure 3. Here the 2005 image has been overlapped with 2014 image and extra portion i.e. points shown here with square red color indicates settlement change that increased over the passage of time i.e. in year 2005 and 2014 shown in Figure 6. There is significant increase in settlement area for every locality but major changes can be seen easily in the Figure 5 comparison with Figure 3 where vacant land area is converted to build up area especially with high rise multi story buildings shown in Photo 1 and 2 respectively. Project like as Sun City Township that started in the Meherpur area for that there is a significant change in land use in this area particular area. As there were 250 settlement points in the study area in 2005 which increased up to 385 till 2014 i.e. net increase of 135 settlement points shown in Table 1. It has been observed that, after the year 2005 in Kuarpar Road Medinova Nursing home has established and in the entry side at the road of municipal dumping site one large Jain temple has also established after the end of year 2010 probably.

Vacant Land: There were 17 vacant lands/plots in the year 2005 but all are converted either to settlement points or build up area category which are shown in Figure 2 out of these vacant lands the Sun City project is largest one with the area of 91392.087 square meter which is shown in the Photo 2 below, followed by area near the entry of Sun City gate side which is now occupied by one huge multi story building and several houses shown in Photo 1 and having area of 41569.32 square meter and rest are small plots mostly in Sun City road, Kuarpar road and.

Road Network: There is no such major change in road network in the study area over the time period but only change is noticed for Sun City project road which developed after 2005.

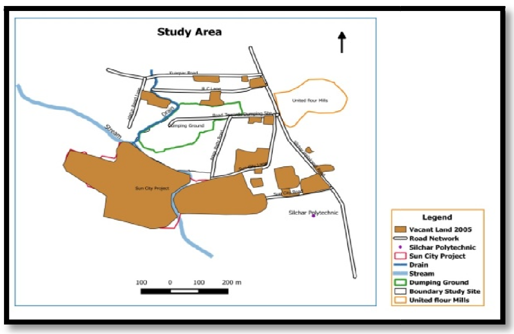

Figure 3. Vacant land area in year 2005

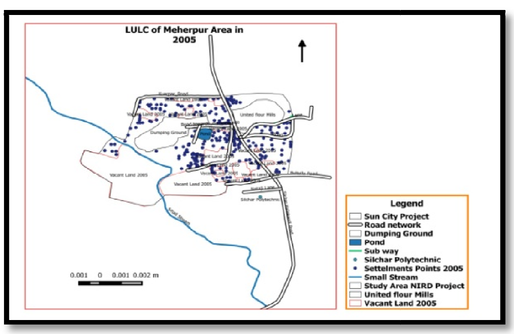

Figure 4. Settlement points in year 2005

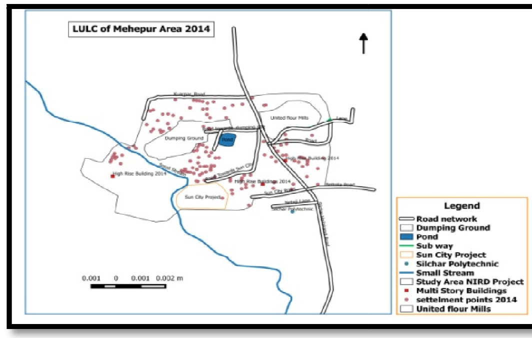

Figure 5. Settlement points in year 2014

Table 1. Settlement point details for year 2005 and 2014

Year	2005	2014
Number of settlement points	250	385
Vacant Lands/plots	17	0

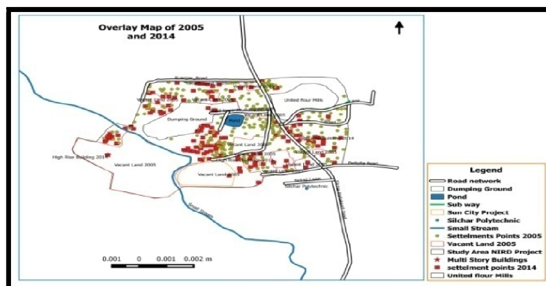

Figure 6. Overlay map showing data for year 2005 and 2014

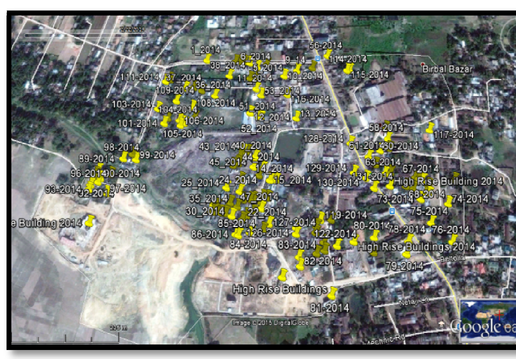

Figure 7. Settlement points in the year 2014 marked in Google Earth

Figure 8. High rise multi storey buildings in 2014

Conclusion

The total area under defined boundary is 503496.74 sq meter. Where the built up area or settlement points are calculated using Quntum GIS for the year 2005 has been estimated as 250 numbers and for the year 2011 it has been estimated as 385 numbers. Where it also been noticed that, vacant land area is decrease significantly as, there were 17 numbers of vacant lands or plots in study area in year 2005 but in 2014 all these vacant land or plots converted either to build up area or settlement points. Hence, it is found that, the Meherpur area is growing very fast towards the urban expansion from the rural status. The built up area or settlement area of the study site for a period of 9 years (2005-2011) has increased tremendously. With the change maps, now it is possible to identify, those areas which are undergoing expansion. This study gave a glimpse of land use change in the area over the passage of time and also gave the up to date scenario of the area in contest of rural and urban point of view.

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A Critical Review On Applications of Vermifiltration for Treatment of Wastewater

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Abstract

This paper presents the review of the treatment efficiency of vermifiltration in treating wastewater coming from rural and urban areas. It has been found that vermifiltration is the best technology for the treatment of wastewater than other conventional treatment system. It is low cost, non-labour intensive method of waste water treatment, which removes heavy metals and organic solids present in wastewater streams through earthworms. The average removal efficiencies of vermifilter bed for COD, BOD, TDS and TSS are 84.5%, 91.8%, 97%, and 97.4% respectively.

Keywords: *Earthworms; low cost; organic solids; vermifiltration; wastewater*

Introduction

Vermifiltration is a cheap technology which was widely used to treat the wastewater, and appeared to have high treatment efficiencies, including synchronous stabilization of wastewater and sludge (Damodhar et al. 2014). Vermifilter (Lumbrifiltration) was first advocated by the late Professor Jose Toha at the University of Chile in 1992 which was a low-cost sustainable technology over conventional systems with immense potential for decentralization in rural areas (Meiyan et al. 2010).It has a great potential which adapts the traditional vermin composting to a passive wastewater treatment (Lakshmi et al. 2014). Vermifiltration is a low cost, odorless and non-labour intensive method of wastewater treatment. The resulting vermi-filtered water is clean and disinfected enough to be reused for farms & irrigation, parks and gardens except drinking purposes.

The earthworms body works as a bio-filter and various earthworm species have been used in vermifiltration of municipal wastewater (Damodhar et al. 2014). In the vermi-biofiltration system, suspended solids are trapped on top of the vermifilter and, after getting processed by the earthworms, are fed to the soil microbes immobilized in the vermifilter. Dissolved and suspended solids (organic and inorganic get trapped by adsorption and stabilization through complex biodegradation processes which occur in the "living soil" inhabited by earthworm and the aerobic microbes.

In developing countries like India there is scarcity of water due to rapid growing population and pollution of 70% of freshwater river bodies (MoEF 2009). Total of 38000 millions of sewage generated treatment capacity is only about 12000 millions litre per day. Sewage consist of high loading of organic matter refer as biochemical oxygen demand (BOD) and COD (chemical oxygen demand), total dissolved solids, total suspended solids (Sinha et al. 2008). Due to their negative impact on environment, many environment regulations and laws come to exists. Conventional treatment techniques of wastewater are expensive, since they have large requirements of land, high maintenance cost and creates significant negative effect on environment. So there is a need of alternative technique which is low cost, high treatment efficiency and lowered operating cost.(Ghatnekar et al. 2012).

Vermifiltration process

Vermi-bio-filtration technology involves use of synergistic activity of the selected microorganisms, enzymes and earthworms for the degradation of toxins from the waste water converting it into "bio-clean" and "bio-safe" crystal clear water. This technology has proved to be the best environment friendly and cost-effective solution for wastewater treatment. (Ghatnekar et al. 2012) Earthworms' body works as a 'biofilter' and they have been found to remove the 5 days' BOD (BOD_5) by over 90%, COD by 80–90%, total dissolved solids (TDS) by 90–92%, and the total suspended solids (TSS) by 90–95% from wastewater by the general mechanism of 'ingestion' and biodegradation of organic wastes, heavy metals, and solids from wastewater and also by their 'absorption' through body wall (Pathania et al. 2013).

Factors affecting Vermifiltration

i. Hydraulic Retention Time

It is the time taken by the wastewater to flow through the soil profile (vermifilter bed) in which earthworms in habits. The longer the wastewater remains in the system in contact with earthworms, the greater will be the efficiency of vermi-processing and retention of nutrients. Maximum HRT can results from 'slower rate of wastewater discharge' on the soil profile (vermifilter bed) and hence slower percolation into the bed. Increasing the volume of soil profile can also increase the HRT. (Sinha et al. 2008)

ii. Hydraulic Loading Rate

It is the volume of wastewater applied, per unit area of soil profile (vermifilter bed) per unit time. It critically depends upon the number of live adult earthworms functioning per unit area in the vermifilter bed. High hydraulic loading rate leads to reduced hydraulic retention time (HRT) in soil and could reduce the treatment efficiency. (Sinha et al. 2008)

iii. Presence of Sodium Chloride in Waste Water

The presence of high salt concentrations inhibits the growth of worms, which in turn significantly reduces the efficiency of the filter. It has been observed that high levels of Sodium Chloride (NaCl) are more toxic to the worm species than similar levels of Sodium Sulphate (Na_2SO_4), perhaps indicating the inhibition of filter performance in the presence of chloride ions.(Pathania et al. 2013)

iv. Earthworms Selection-

Two worm species, *Eisenia Fetida* (Red Wriggler Worms) and *P. Excavatus* are widely used earthworms for vermifiltration unit. *E. Fetida* is widely used and is particularly used for smaller home based units, *P. Excavatusis* believed to reproduce at a faster rate, ensuring earlier stabilization, while producing more worm castings, which is vermin compost, a commercially valuable product. (Pathania et al. 2013)

Earthworms

Earthworm body works as bio-filter which widens the microbial metabolism by increasing their population. Effluent resulted will be extremely rich in nutrition and can be reused as earthworms are versatile waste eaters and decomposers. It also grinds, aerate, crush, degrade the chemicals and act as biological stimulator. Microbial and vermi processes will simultaneously work by treating the wastewater using earthworms (Lakshmi et al. 2014).

Earthworms are long, narrow, cylindrical, bilaterally symmetrical, segmented animals without bones. The body is dark brown, glistening, and covered with delicate cuticle. They weigh over 1400–1500 mg after 8–10 weeks. . Usually the life span of an earthworm is about 3–7 years depending upon the type of species and the ecological situation. Earthworms harbor millions of 'nitrogen-fixing' and 'decomposer microbes' in their gut. They have 'chemoreceptor's which aid in search of food. Their body contains 65% protein (70–80% high quality 'lysine rich protein' on a dry weight basis), 14% fats, 14%carbohydrates, and 3% ashs. Earthworms can also tolerate toxic chemicals in environment. As worms breathe through their skin proper ventilation of air in soil medium is necessary. They can tolerate a temperature range between 5 and 29 C. A temperature of 20–25C and moisture of 60–75% are optimum for good worm function. Generally earthworms can also tolerate extensive water loss by dehydration. Earthworms are bisexual animals and multiply very rap-idly. After copulation each worm ejects lemon-shaped 'cocoon' where sperms enter to fertilize the eggs. Studies indicate that they double their number at least every 60–70 days. Given the optimal conditions of moisture, temperature, and feeding materials earthworms can multiply by 2^8, i.e. 256 worms every 6 months from a single individual. The total life cycle of the worms is about 220 days. Red worms takes only 4–6 weeks to become sexually mature (Sinha et al. 2008). They have been reported to bio-accumulate them in their tissues and either biodegrade or bio transform them to harmless products with the aid often enzymes.

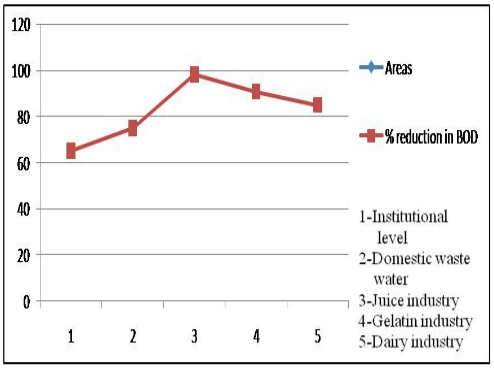
Earthworms have proved to be master bio-processing agents for the management of organic effluents from diverse sources ranging from domestic sewage to industrial refuse startlingly; they convert effluents that are an undesirable nuisance into coveted plant probiotics in the form of soil-conditioners. The use of microorganisms is also considered as an integral part of the wastewater treatment process. Higher concentration of microorganisms is able to remove the organic matter from the water at a faster rate, particularly in the case of lagoon systems lagoon systems where it can take several months for the complete degradation process where it can take several months for the complete degradation process (Ghatnekar et al. 2010)

BOD and COD removal

Various Researches had been done for the treatment of wastewater from rural and urban areas including dairy, fruits and gelatin industries. It had been found that this method is very effective for residential quarters with more than 90% removal efficiency. The removal parameters review in different areas given in Table 1.

Table 1. Potential Application of Vermifiltration-

S. No.	Area	Parameter Removed	Comments	References
1	Institutional level	COD=65%,BOD=92% TDS=90%,TSS=88% Turbidity= 93%	No sludge formation Odour	Lakshmi et al. 2014
2	Domestic grey water (Nagpur city)	BOD=8593%,COD=74-80%, S.S =70-80%	pH change from acidic to neutral	Kharwade et al. 2011
3	Dairy industry	BOD=98%, COD=80-90% TDS=90-92%,TSS=90- 95%	No sludge formation Odour free, used for irrigation	Sinha et al. 2007
4	Gelatine industry	COD=90.8%, BOD=89.2%	Effluent used as irrigation Bedding material convert to humified vermicompost.	Ghatnekar et al. 2010
5	Domestic Waste water(Shanghai, China)	COD=47.3-64.7%, BOD_5=54.78-77.9%, SS=55.18-77.9 %, TN=7.6-14.90%, NH_4-N =21.01-62.31%	Activity is more when larger earthworms are used.	Longmian Wang et al. 2011
6	Palm oil mill effluent	COD=71-90%, TSS=76-96% QQ		Tengku et al. 2013
7	Rural domestic sewage	COD=81.3%, NH_4=98%, TN=60.2%, TP=98.4%	Efficiency more low hydraulic loading rate and high worm density.	Meiyan et al. 2010
8	Urban waste water	TSS=88.6%, TDS=99.8%, COD=90%, NO_3^-=92.7%, PO_4^{-3}=98.3%		Arora et al. 2014
9	Residential quarter waste water	COD=84.4%, BOD=91.8%, TDS=97%, TSS=97.4% Turbidity=97%		Damodhar et al. 2014
10.	Juice industry	COD= 98.3%, BOD=85.3%	Effluent can be used as Washing floor and other purpose except drinking.	Ghatnekar et al. 2012



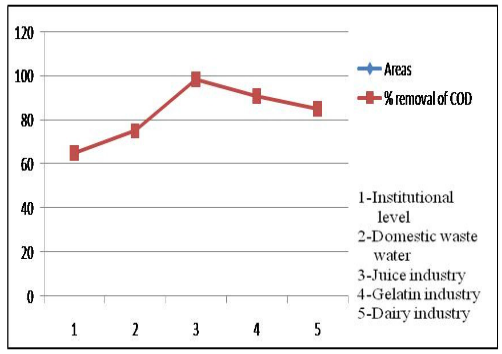


Figure 1. % Removal of BOD Vs Areas under consideration **Figure 2.** % Removal of COD Vs Areas under consideration

This review paper studies application of vermin filtration in different areas. The graphs for different areas plotted along with the removal efficiencies of BOD and COD in Fig 1 and Fig 2. It has been found that this treatment system is very effective for Juice industry with more than 98% of COD removal and 85% of BOD removal.

Conclusion

Vermifiltration is found to be suitable for decentralized treatment of wastewater. It is highly efficient in removing chemical oxygen demand (COD), biochemical oxygen demand (BOD) and suspended solid (SS) and Total suspended solids(TSS) than other convectional treatment process. The reduction of wastewater characteristic was greatly facilitated by addition of sawdust to the soil, which enhances the porosity of soil. Vermi compost thus produced is used as fertilizer.

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Assessment of Carbon Footprint at an opencast coal mine – An approach

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Abstract

The emission of CO2 the principal greenhouse gases (GHG), is strongly related to the use of fossil fuel, especially coal, for energy production. Direct use of coal leads to environmental pollution. Coal will continue to remain as the prime energy source in foreseeable future.

A study was made with an objective to measure Carbon Footprint at an Opencast coal mining Project in accordance with GHG Protocol's Lifecycle Accounting and Reporting Standard, identify the hot spots and to explore how coal mines management through relevant planning activities, can reduce their Carbon Footprint. The study has been made at one of the opencast of Coal India limited. In this study the physical boundary as part of Greenhouse gas has inventory boundary which included: Disturbed area where tree cutting , felling and removal of top soil is in progress, Area where Overburden are being removed, OB dump site, Current mining faces, De-coaled area where extraction of coal has been completed but no reclamation is done, De-coaled area where extraction completed and concurrent reclamation done, Backfilled area where afforestation activity has been undertaken and the area has been restored, Workshop, Washery, Coal Stock Yard. Emissions from low oxidation of waste coal, overburden removal and fugitive emission is not being accounted because there is no accounting of quantity and huge uncertainty associated with it.

Calculation were based on different activities broadly divided into Overburden removal, Extraction of coal (i.e. breaking and Removal), Monitoring & maintenance, Coal Stocking, Coal Cleaning & Recycling, Afforestation. These activities (i) were further subdivided into sub-activities (j) and sub-activities into activities level (k).

The study were conducted for 22 emission sources of which 12 emission sources were from Scope-1, three sources of Scope-2 and 4 sources of scope -3. The various activity Level included were: Forest bio-mass loss, Forest carbon stock change, Mineral Soil Carbon loss, Soil disturbance and degradation, Fuel use, Electricity (Purchased) use, Electrical AT & Losses, Explosive use, Lubricant use, Fugitive Emission, Carbon Stock Gain.

The results reveals that there were increasing trend of GHG emission ranging from 278 million tes CO2e to 340 million tes CO2e. The emissions attributed by different sources shows that GHG emission for Source no. 6 i.e. contribution by fugitive emission is maximum. Scope – 1 emission is the leading contributor to about 80-81% followed by Scope-2 (16-17 %) and Scope-3 (4%) . The emission load in last five years 1.56 Million tes of CO2e has been contributed by the study area with an average value of 0.31 million tes of CO2e per year.

Coal production process contributes maximum in the life cycle stages of the coal mining process. The values ranges from 0.20 to 0.26 Million tes of CO2e emission. Coal stocking, clearing and recycling process in the LC stage are the next contributor ranging from 0.05 to 0.06 Million tes of CO2e emission. The OB removal and the transportation process of LC states have almost equal contribution i.e. 0.014 to 0.025Million tes of CO2e emission. Though there are some carbon stock gain gains in the tune of 2435 to 2947 tes of CO2e emission during afforestation done by the study area. This will increase in the times to come.

The total GHG Emissions revolves round the diesel consumption as the mining process is energy intensive and rely upon diesel powered machines or processes. The performance of GHG emissions per ton of coal production of the study area has improved year on year.

***Keywords**: GHG, Footprint, opencast, lifecycle*

Introduction

Our world is in the grip of a dangerous carbon habit. Coal and oil paved the way for developed countries' industrial progress. Our dependence on carbon based energy has caused a significant build-up of greenhouse gases in the atmosphere. We do not just burn carbon in the form of fossil fuels but also valuable plants are being felled .This further manifestation of our carbon habits also destroys a valuable resource for absorbing carbon. However, direct use of coal leads to environmental pollution. Coal will continue to remain as the prime energy source in foreseeable future. The emission of CO2 the principal greenhouse gases (GHG), is strongly related to the use of fossil fuel, especially coal, for energy production. Escalating population and increasing energy demand warrant development of strategies to assess greenhouse gas emission level with minimum uncertainty and also to ensure stabilizing emission to desired level. So it is essential to do research to find out engineering solutions like carbon footprint measurement. Carbon footprint as per UK Carbon Trust 2008 is the total set of GHG (greenhouse gas) emissions caused directly and indirectly by an individual, organization, event or product. Once the size of a carbon footprint is known, a strategy can be devised to reduce it.

Materials and methods

Objective

The aim of the study is to measure Carbon Footprint at an opencast coal mining Project in accordance with GHG Protocol's Lifecycle Accounting and Reporting Standard and identify the hot spots.

Rationale

Carbon Footprints, as an indicator of climate performance, help identify major GHG emission sources and potential areas of improvement. Greenhouse gases (GHG) as per Kyoto Protocol includes Carbon Dioxide (CO2) , Methane (CH4), Nitrous Oxide (N2O), Hydroflourocarbons (HFCs), Perfluorocarbons (PFCs) , Sulphur Hexafluoride (SF6) . As per International panel of Climate Change – 2007: CO2 contributes to about 77%, CH4 – 14%, N2O – 8%, F-gases – 1% of the global GHGs.

Companies are increasingly interested in quantifying, reducing and offsetting the greenhouse gas(GHG) emissions associated with the lifecycle of products that they manufacture or supply. As demand accelerates, there is greater need for consistency in practice across the board.

Scope of Study

The geographical scope of the study area is the leasehold area of one of the opencast project of Central Coalfields Limited. The project is located Tandwa Block, District- Chatra of Jharkhand state. The project is located at a distance of 75 km from Ranchi and 60 km from Hazaribagh. It is well connected to Khalari railway station and Ray railway station, which are at distance of about 10 km. The Khalari railway station is linked to Ranchi by a black topped road road (S.H-47) via Bijupara (about 26 km from Khalari) on Ranchi-Daltonganj highway (S.H-48). it is an operating coal mine of Central Coalfields Limited, a subsidiary of Coal India Limited – a Maharatna company. This coal mine is presently contributing more than 1/5th of the coal production of CCL.

Design, development and operation of the study area was done by White Industries Australia Limited, Australia in conjunction with Central Coalfields Limited. This project originally had an operating capacity of 6.5 MTPA of ROM coal production. This project is the most productive coal mine in India and is the first coal mine in the country to incorporate a large-scale washery for the thermal coal beneficiation and mining by in-pit crushing & conveying. The project was expanded to 10.0 MTPA in 2007. The peak capacity of 11.5 MTPA was introduced in 2012. It was further expanded to 12.5/13.375 MTPA and 14.875 MTPA in 2014.

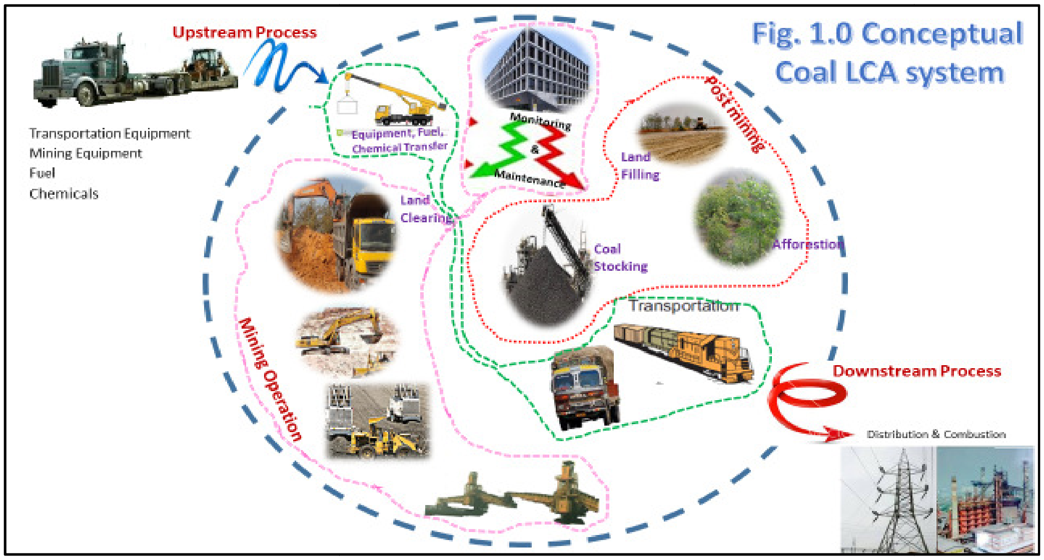


Figure 1. Conceptual Coal LCA System

The physical boundary as part of Greenhouse gas has inventory boundary which included: Disturbed area where tree cutting , felling and removal of top soil is in progress, Area where Overburden are being removed, OB dump site, Current mining faces, Decoaled area where extraction of coal has been completed but no reclamation is done, Decoaled area where extraction completed and concurrent reclamation done, Backfilled area where afforestation activity has been undertaken and the area has been restored, Workshop, Washery, Coal Stock Yard. Emissions from low oxidation of waste coal, overburden removal and fugitive emission is not being accounted because there is no accounting of quantity and huge uncertainty associated with it. Fig. 1.0
shows the conceptual coal LCA system covering typical view of organizational and operational boundary of study area. The study has been concentrated on this model.

Location & Communication

The project is located in Tandwa Block, District-Chatra of Jharkhand state. The project is located at a distance of 75 km from Ranchi and 60 km from Hazaribagh. It is well connected to Khalari railway station and Ray railway station, which are at distance of about 10 km. The Khalari railway station is linked to Ranchi by a black topped road road (S.H-47) via Bijupara (about 26 km from Khalari) on Ranchi-Daltonganj highway (S.H-48). Study area is mined by open-cut methods. It is characterised by the presence of up to six opencastable seams with dip angles of 2°-5°. Seam thickness ranges from2.4m to 29m. The thickest seam is lower Dakra seam. Original mineable reserve was 197.58 Mt within a 244 Mt in-situ resourceat average strip ratio of 0.75cum/te.

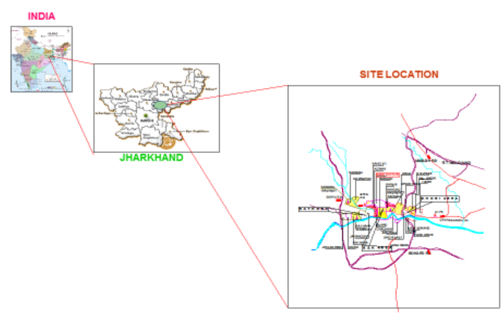


Figure 2. Location of the site studied

Methodology

The science of carbon footprint analysis is young and evolving. No specific international standards currently exist on how to create a carbon footprint for coalmining projects, though some s. This study will in accordance with GHG Protocol's. Measurement of GHG emissions included : Identification of emission sources, Calculation approach, Collecting data, Applying suitable emission factors, Deriving total carbon footprint.
Calculation were based on different activities broadly divided into Overburden removal, Extraction of coal (ie breaking and Removal), Monitoring & maintenance, Coal Stocking, Coal Cleaning & Recycling , Afforestation. These activities (i) were further subdivided into sub-activities (j) and sub-activities into activities level (k).
Calculation of Carbon footprint will be based on following empirical formula :

$$TE = \sum_i \sum_j \sum_k ES \quad \text{---------------------------------} \text{(i)}$$

Where,

TE = Total emission in kg CO_{2e}, ES = Emission due to va

$$ES = activitylevel \times emmissioncoefficient$$

The study were conducted for 22 emission sources of which 12 emission sources were from Scope-1, three sources of Scope-2 and 4 sources of scope -3. The various activity Level included were: Forest bio-mass loss, Forest carbon stock change, Mineral Soil Carbon loss, Soil disturbance and degradation, Fuel use, Electricity (Purchased) use, Electrical AT & Losses, Explosive use, Lubricant use, Fugitive Emission, Carbon Stock Gain.

Results and Discussions

There were increasing trend of GHG emission ranging from 278 million tes CO_2e to 340 million tes CO_2e of which Scope-1 sources are the major contributor.

Table 1. GHG Emission Scope Wise-yearwise

Year	Scope-1	Scope-2	Scope-3	Total
2009-10	219152	48186	11050	278389
2010-11	240684	47968	11002	299654
2011-12	254268	50161	11483	315912
2012-13	266508	51597	11798	329903
2013-14	274668	53342	12181	340190

As shown in fig. 3 & 4 the emissions attributed by different sources shows that GHG emission for Source no. 6 i.e. contribution by fugitive emission is maximum. The hot spots shown in table confirms the stand. Other hot spot area is near source no. 16 to source no. 19.

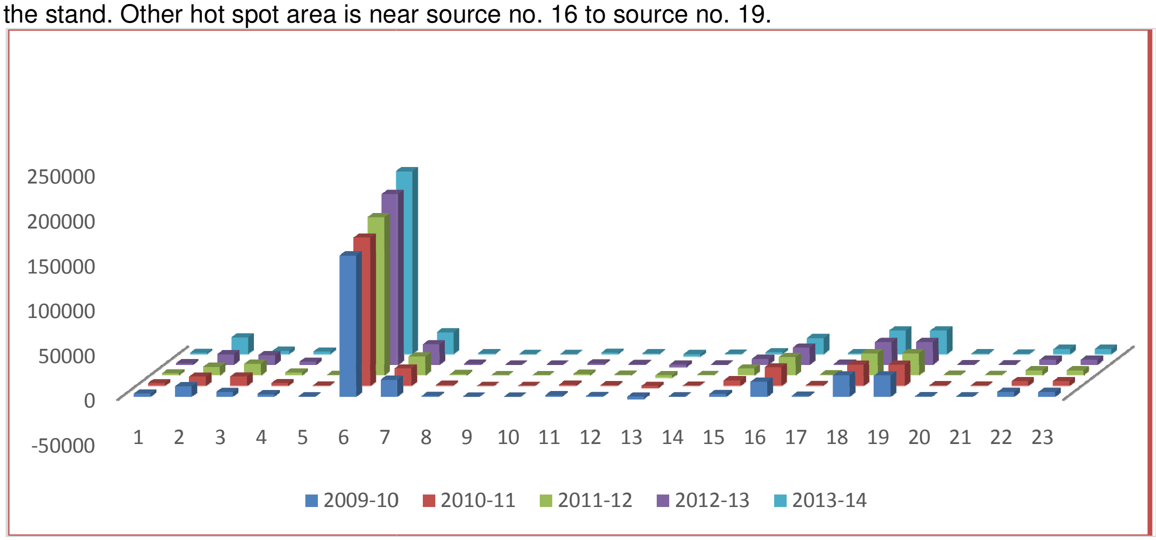
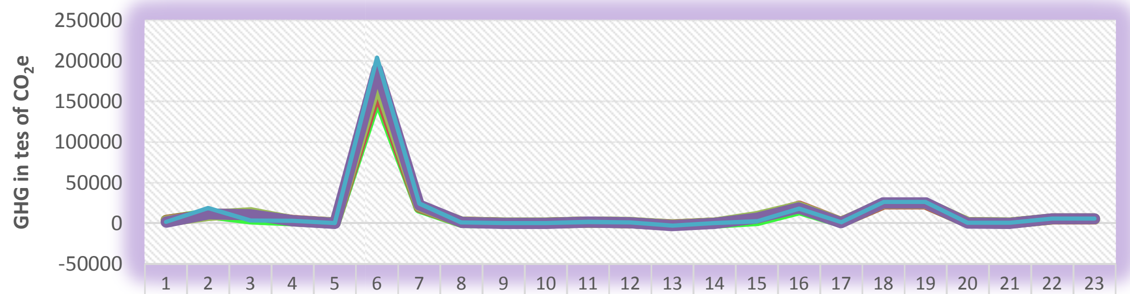


Figure 3. GHG Emmision source - year wise



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Series1	334	114	511	271	203	157	187	751	0	0	141	675	-24	143	299	165	901	236	236	483	198	518	518
Series2	306	104	106	319	203	165	197	111	0	0	141	706	-24	129	621	208	897	235	235	483	197	516	516
Series3	224	951	129	314	203	176	210	124	0	0	141	736	-28	125	788	202	938	246	246	483	206	539	539
Series4	174	117	105	322	203	190	227	108	0	0	141	767	-28	117	644	190	964	253	253	483	211	555	555
Series5	138	184	350	284	203	203	243	686	0	0	141	798	-29	195	213	178	997	261	261	483	219	574	574

Figure 4. Hot spots

The fig. 5 shows the year-wise and scope wise GHG emission. Scope – 1 emission is the leading contributor to about 80-81% followed by Scope-2 emissions with about 16-17 % and to Scope-3 emission ranging up to 4%.Fig. 6 shows the trend of GHG emission. There is increasing trend of emission. The emission load in last five years 1.56 Million tes of CO2e has been contributed by the study area with an average value of 0.31 million tes of CO2e per year.

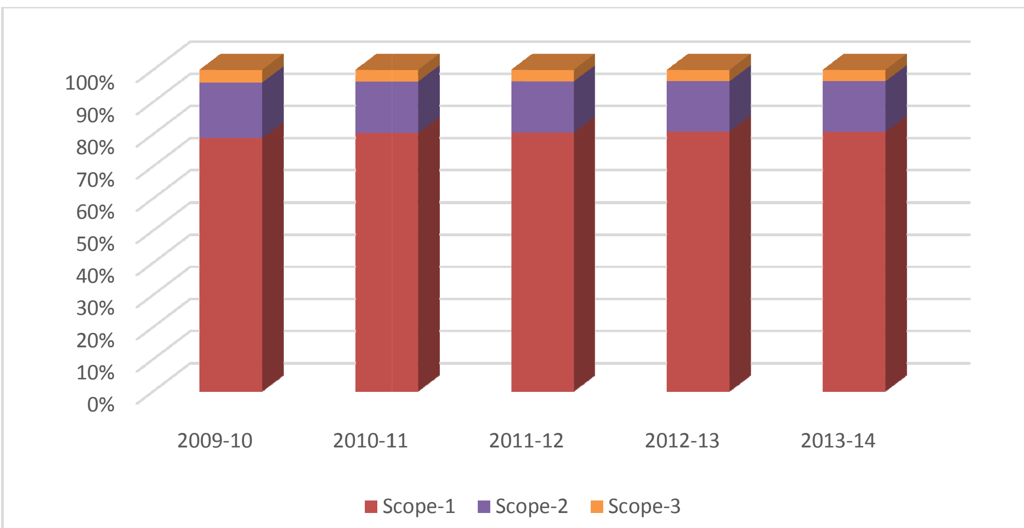


Figure 5. The year-wise and scope wise GHG emission

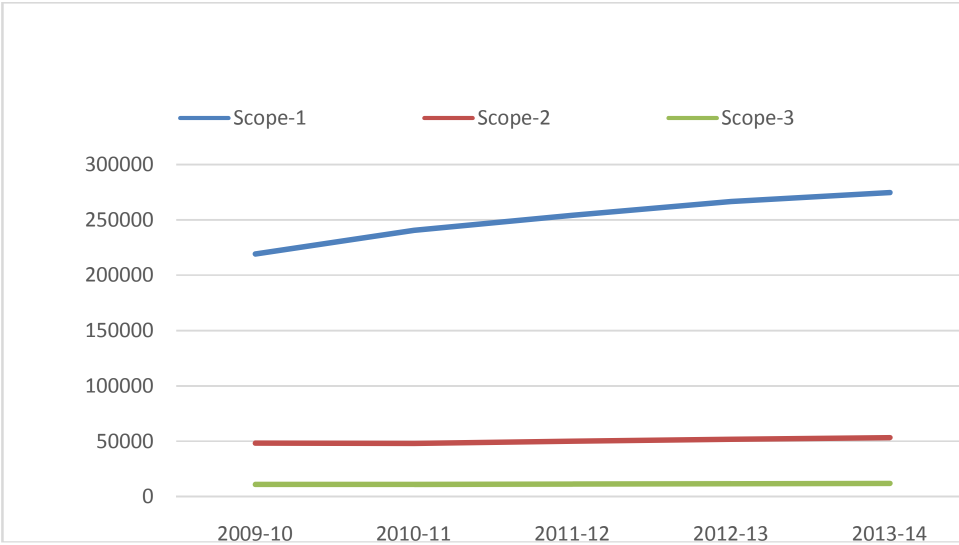


Figure 6. The year-wise and scope wise GHG emission

This is a consequence of fact that the mining process is energy intensive. As shown in Fig. 8 coal production process contributes maximum in the life cycle stages of the coal mining process. The values ranges from 0.20 to 0.26 Million tes of CO2e emission. Coal stocking, clearing and recycling process in the LC stage are the next contributor ranging from 0.05 to 0.06 Million tes of CO2e emission. The OB removal and the transportation process of LC stages have almost equal contribution i.e. 0.014 To 0.025 Million tes of CO2e emission. Though there are some carbon stock gain gains in the tune of 2435 to 2947 tes of CO2e emission during afforestation done by the study area. This will increase in the times to come.

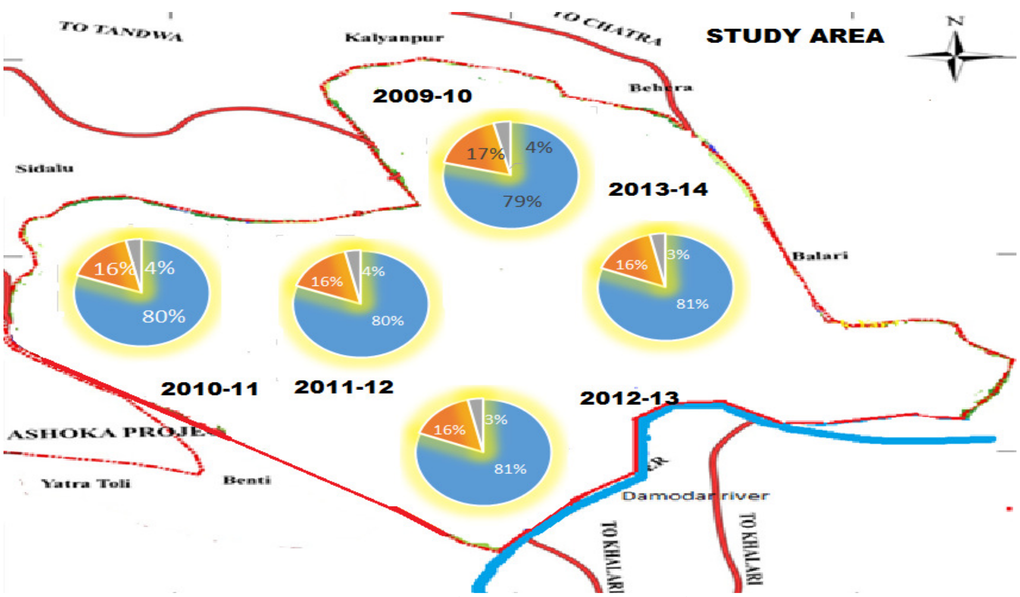


Figure 7. Scope-wise chart at Study Area

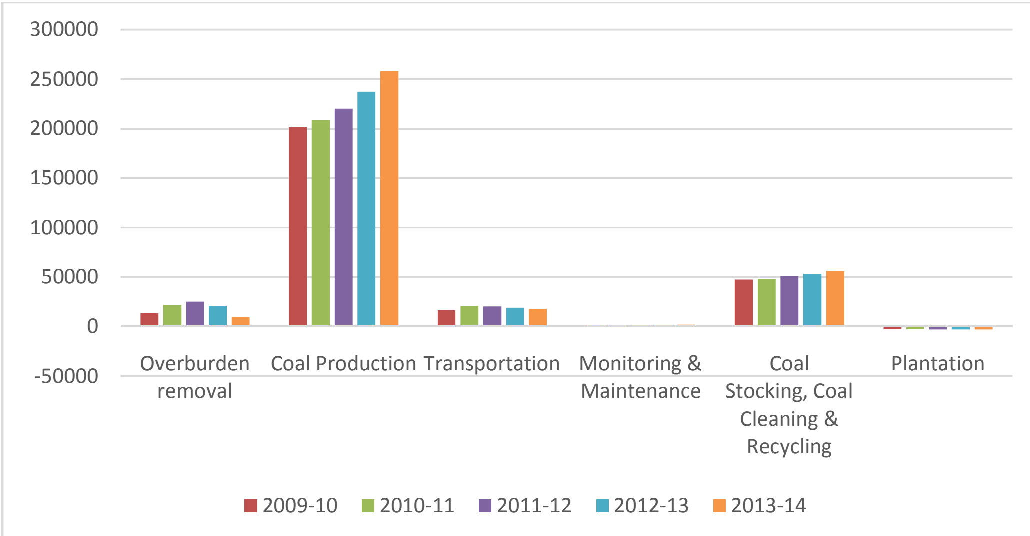


Figure 8. GHG Emission in Life Cycle Stages

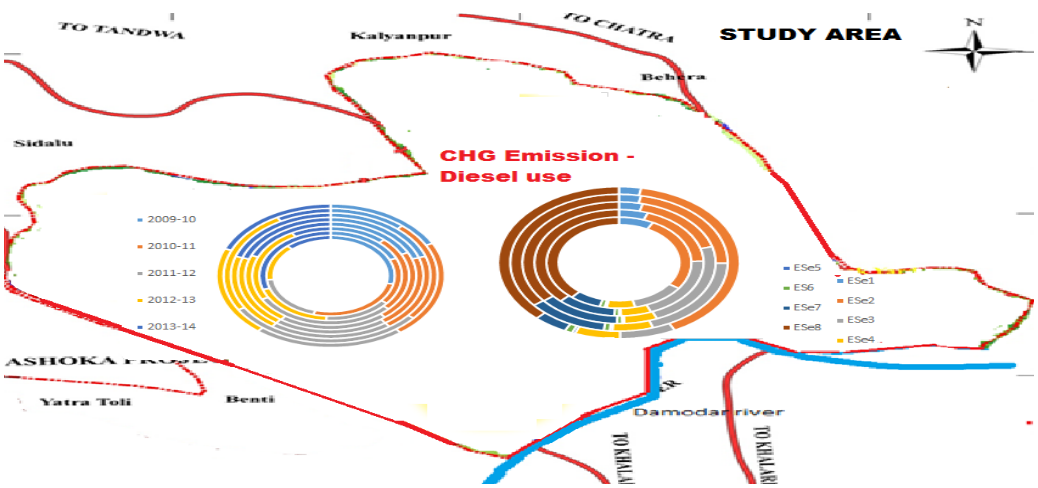


Figure 9. GHG Emission – Fuel use

The total GHG Emissions revolves round the diesel consumption as the mining process is energy intensive and rely upon diesel powered machines or processes. Fig. 9 shows the GHG emission for diesel use i.e. the main fuel being used in the LC stage of coal production. The main contributor amongst them is coal evacuation process [ES8] in scope-3 emission source contributing 38-39 %. The other contributor during coal production is ES2 & ES3 in Scope-1 emission source. (38-39% in combination) i.e. 76-78 % are contributed by ES8, ES2 & ES3.

As shown in Fig. 10 the performance of GHG emissions per ton of coal production of the study area has improved year on year. In the year 2009-10, 2010-11, 2011-12, 2012-13 & 2013-14 the GHG emission were 29.3, 29.9, 29.6, 28.7, 27.6 kg CO2e per ton of coal production respectively.

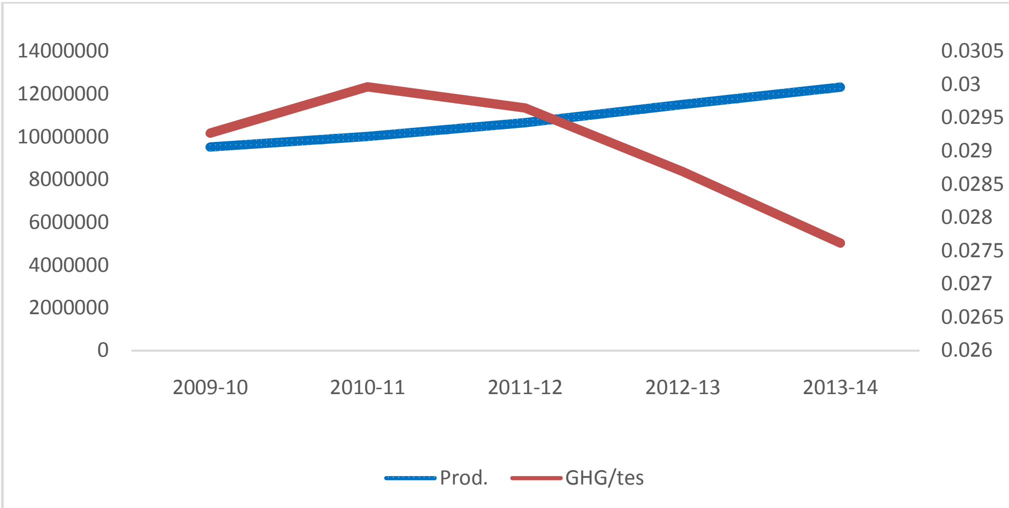


Figure 10. GHG Emission per te vis a vis Coal production

Though the rate increases in 2009-10 to 2010-11 from 29.3 to 29.9 kg CO2e per ton of coal production. But after that there is continual performance improvement of about 1%, 3% & 4% in subsequent year and a total of 8% from the 2010-11 level.

Conclusion

Under certain assumed conditions and with the help of derived equations Carbon Footprint of a relatively small opencast coal mine with available data can be calculated and GHG emission can be derived. Though in the final analysis the mining complex under study are found to have provided a fair GHG emission. The GHG emission per unit of coal production has been in decreasing trend but the overall GHG emission has increased.

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