*International Research Journal of Environment Sciences*_____ E-ISSN 2319–1414
Vol. **5(8),** 65-71, August **(2016)** *Int. Res. J. Environment Sci.*

Development Opportunities on Reclaimed Open Cast Mining Land: Dhanbad, Jharkhand

Sanjeev Kumar[1] and Suman Sourav[2*]
[1]Urban Planner, Society for Integrated Development of Habitat – Bhopal, India
[2]Urban Planner, Steaslit Systems Limited – Kolkata, India
sourav.archi@gmail.com

Available online at: www.isca.in, www.isca.me
Received 10th May 2016, revised 24th July 2016, accepted 19th August 2016

Abstract

Coal mining reclamation is a worldwide concern. As a result of the land reclamation development for opencast coal mine in India, the restoration and reclamation monitoring in Dhanbad has been noticed. Due to high urbanization rate in Dhanbad, per capita land availability is declining. There is a need to develop wasteland to cater the urban development demand of housing, agriculture, forestry, industries, transportation, recreational area etc. This paper presents a study where the land use aspects of reclamation are considered. The goal of the study is to transform the reclamation procedures into a physical process by integrating the use of land after reclamation and developing beneficial post operations. Study also proposes prospective development approach by assessing the current state of development of the reclaimed land in Jharia, Dhanbad coalfield region and to evaluate role of stakeholders for the proposed vision. In order to achieve this goal, a pilot survey was conducted to observe existing land use, and interviewed knowledgeable people and stakeholders in the case area. The study will able to: identify problems with the current state of urban development in Dhanbad, compare and contrast the needs and wants for redevelopment of the area and determine the perspective development vision that how the land could be redeveloped to appease as many of the interest group as possible.

Keywords: Approach, Development, Dhanbad, Opencast mining, Reclamation.

Introduction

This is the time when in the whole world, development policies have been the cause of much controversy because of different goals. The need of the hour is satisfying everyone's vision for growth[1]. The prominent motive of urban development is public welfare. Reliable information on the location, extent and land resources is the first requirement in planning for the sustainable management of land resources. Land resource mass is finite, but the competition among different kinds of uses in urban area for this land is increasing because of rapidly rising global population and urbanization. Due to high urbanization rate, the per capita availability of land in India decreased from 0.9 hectare (ha) in 1951 to 0.5 ha in 1980-81[1]. The situation of cultivated land is even more critical. This is likely to decrease further in same manner.

11th as well as 12th five year plans of India ask for sustainable development. Sustainability suggests for judicious use of resources. Landuse practices might be integrated to make it a renewable resource. Mining operations are usually for the sake of economic profit, which are usually relatively of short period. The long term environmental and social performance of a site is markable once mine closure and mine site operations have ceased or closed, however the social, economic and environmental, impacts are determined by the processes and procedures which occur during both the mining and mine closure phases[2]. All mine operations have certain life time, and it closes afterwards, due to resource exhaustion or because of economics of mining. Poor enforcement of mine reclamation policies and inadequate financial mechanisms can result have a great impact on the success of mine site closure and completion as it is dependent upon various external factors.

Usually the earlier practices in mine planning, mine closure and rehabilitation have seen negligence of basic concepts of post mine land use development and integrated mine closure planning. Countries have been burdened with a legacy of unplanned closured, hazardous mine sites and unclaimed lands, which have occurred as a result of poorly managed mining legislation which has failed to prevent or reduce the possible long term environmental impacts of mining operations and mine closure[3]. Countries that have developed and implemented good international mining practices, and despite significant progress in mine closure planning, various mining nations are yet to develop sophisticated corporate governance, regulatory frameworks, or financial insurance provisions to address mine closure planning and mine rehabilitation. In particular, it is apparent that few mining nations have developed and implemented specific mine closure and mine rehabilitation regulations and legislative controls[4]. In past, it was common practice to abandon mine sites, once mineral extraction was completed. The mining site was left poorly vegetated an exposed, and waste minerals remained untreated. There was

little concern for the environment and social impacts associated with mine closure, and a lack of recognition of post mine land uses. This legacy of abandoned mines, their associated environmental, social and economic problems and the post mine land use development has led to an increased emphasis on mine closure planning[5]. Mine closure and mine rehabilitation should commence within the initial mine planning process, with mine closure planning developed within the initial stages of mine operations and developed in a progressive manner as the mine site commences operation.

Coal plays anprime role in development of the national economy of India. In terms of area India ranks seventh country in the world with 329 million hectare (mha) land mass, of which about 47 mha (14%) is degraded land. The reason behind land degradation is natural and human induced causes, wind erosion, water logging and mining. Coal mining area at present is only 0.06 percent of the total land area of the country. Per capita land availability in India is only 0.25ha mainly due to high population density, ranks it at 203rd position[6]. This will further reduced, if control measures for population growth are not taken up immediately. Out of total 329 mha land mass of the country, coal mining is functioning on 0.10% (0.36 mha) area. By the end of the year 2011 – 2012 for which about 40,000 ha of land would have to be acquired for coal mining projects, 85% from opencast mining[7]. Human activities are usually based on land, therefore, thus it reflects an urgent need to reclaim and restore the mined out land and other wasteland of the country to productive use for sustainable development.

Dhanbad district, is otherwise known as the 'Coal Capital of India'[8], is one of the most industrialized districts of the Jharkhand state[9]. The JCR comprises 450 km^2. Bharat Coking Coal Limited (BCCL) operates an area of 258 km^2. Coal mining has been conducted for more than 100 years[10]. The importance of JCR could be understood from the fact that it has one of the highest concentrations of thick coal seams in the world. Presentlythere are some 112 coal mines operating in the district. The BCCL, Eastern Coalfield Ltd (ECL), Indian Iron and Steel Company (IISCO) and Tata Steel are the major companies which have coal mines in the JCR[11]. This activity provides employment to nearly 1, 80,000 workers in the district, which is as much as 25 - 30% of the total workers in the district[12]. It was estimated that more than 20 sites that had reclamation potential were identified. Of these, five areas were identified to serve as examples and provide practical insight as to how reclamation could best be carried out[10].

In spite of its suitable physical characteristics, long run of unscientific mining and un-controlled growth of human settlements has brought us to a situation where ecological balance has been disturbed in the region[9]. The area is full of small inactive mines. Urbanization of a large scale over coal bearing areas had forced mine operators to stop activities related to mining. The past story of decadal urban population says that almost 80% population of Dhanbad is contributed by urban areas of JCR. Dhanbad has experience faster organic growth than different planned growth. The vision for future development of Dhanbad moves away from the JCR. Thus, there is a need to reclaim and restore the areas which are inactive on mining activities. The present scenario mitigated environmental degradation and it was estimated that it would also provide opportunities to coal companies to the restored lands which can be used provide accommodation to displaced families which would help in creating a healthier environment for land acquisition in future. A monitoring approach facilitating in taking remedial measures against degradation of environment as well as facilitate to make in use the reclaimed land for large public welfare activities as required.

Objective and Study Area: Land is one of the most important resources for the human beings as this is needed for all the activities. Land resource definition, identification, location, delineation, extent and land use plan is the prime requirement in planning for the suitable organization of land resources. Management plan for reclaimed or waste land seems to be a viable means and knowledge of coal mine reclaimed land become essential for sustainable land use plan. This scenario demands the rationalization and management of land and physical resources available with reclaimed land of Jharia coalfield region, Dhanbad. Based on land resource management the study aims "To propose an analytical approach for assessment of development opportunities and mobilization of opencast coal mine restored and reclaimed land". It requires the assessment of backfill area, settlements and water bodies, plantation, active mining area, distribution of wasteland, social forestry, forest land and agricultural land.

Study explores development opportunities on coal mine restored and reclaimed land in Jharia and to find out redevelopment necessity of the reclaimed land. To achieve this research objective, relevant data and information collected using a variety of means. The method that is being used to achieve the objective was partial archival research, on-site visits, interviews of selected knowledgeable people, open-ended question and stakeholders, study of statics from secondary sources, data collection, data compilation, data synthesis, data analysis, finding and inferences, alternative proposals.

The district of Dhanbad is considered as one of the most resource regions in the whole country. The prime resource available here is coal, thus it is important in terms of fuel in maximum industries. Dhanbad district possess the largest coal reserves, which is about 13,000 million tons of metallurgical coal[12]. The region is commonly known as "Jharia Coal Field (JCF)" which has a spread of 480 sq.kms being a single depository of coal. As a result of which many associated industries have started in the vicinity like ceramic industry, washeries, coke plants, pottery works fertilizers, steel industries, zinc and leadsmelting and many other engineering industries.

Dhanbad District has total eight blocks, namely: Dhanbad, Sindri Block, Sadar, Jharia Block Baghmara Block, Gobindpur

Block, Topchanchi Block, Baliapur Block, and Tundi of which five blocks are forming the part of the Municipal Corporation Area such as Dhanbad Sadar, Baghbmara, Balaiapur, Jharia and Gobindpur part.

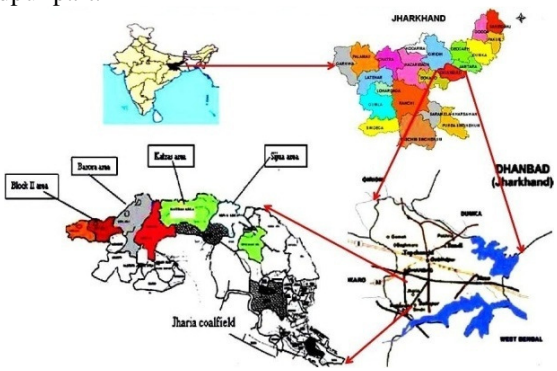

Figure-1
Location of Jharia Coalfield region

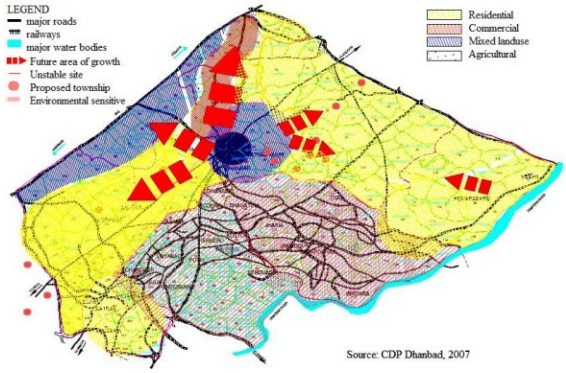

Figure-2
Development vision of Dhanbad

Now Dhanbad Municipal Corporation has its outgrowth to Dhanbad, Jharia, Sindri, Chattantand, Kataras etc. During different era, urban growth occurred in different directions.In case of physical barrier for development, the growth took its second best option. Few mining development occurred along major roads in the municipality area. Jharia, Pathardih, Jorapokhar, Tisra, Chasnala, Sindri, Bowra, Jamadoba and Bhagatdih have come up along Dhanbad-Jharia-Sindri road. Urban Settlements like, Angarpathar, Chaitudih, Sijua, Chandur have developed along Dhanbad –Karkend – Katras road. Thus, Dhanbad Urban Agglomeration is developed as one of the prime urbanized regions in the whole Country. Proposed plan suggests growth, in focus to the implementation of Jharia Rehabilitation Plan development will be directed towards the proposed townships. Growth potential areas assumed to be the area between railway track(Delhi-Kolkata) and NH-2 which leads to Gobindpur.

Methodology

Study is designed to achieve the ultimate objective. Study is initiated with literature review which covers the study of reclamation trend, physical planning of reclaimed mines, current reclamation standards, case studies, environmental impact of mines, reclamation consideration and reclamation projects.

Later study reviews city development plan of Dhanbad and environmental reports to explore urban growth pattern of the study area. CMPDI publishes the annual reclamation report for Indian coal mines. Land use distribution of reclaimed mine for last three concurrent years (2008 - 2010) were collected and their comparative study were done base on percentage breakup of different land use. All 50 reclaimed mines of India were brought on the same platform and were graded based on their developable potential success. All reclaimed mines of India were graded for development as per its progress. Specific recommendation was made for the case of mines in Dhanbad.

A 3X3 matrix was generated to give the grade to the mines. This matrix was prepared to give the weight to the reclaimed mine for development priority with their identified development models. Some other static and logical concepts were adopted and a matrix was prepared to classify and grade mines. The analysis result of matrix gave perspective development vision which will be helpful to make any physical plan on reclaimed mines. Physical, social and environmental aspects with reclamation objectives were also suggested.

Proposed analytical approach for assessment: The study prepares an analytical approach for the assessment of area of plantation, OB dumps, backfilled, active mining area, settlements, social forestry, distribution of wasteland, water bodies, agriculture land in the leasehold land of OC project and finding the methodology to analyze data for the selection of best mines in terms of their reclamation practice in India by the study of past reclamation progress. A matrix was designed based on some theoretical concept and static rules. It arranges all the assessed mine in a way by which reclaimed mines could be prioritized and selected for development as well as a tentative prospective vision could be made for development. This arrangement would supplement authorities to provide weighted interventions in reclaimed mines for improving the observed land use and practices.

The matrix was developed with following assumptions and statistical concept: i. past success trend might be a standard for future, ii. Land use mix may be development parameters, iii. Percentage break-up as a tool of comparative analysis of parameters, iv. Property of equal class size, v. Finding score by greatest integer function, vi. Law of directly proportional (Proportional scoring and grading) – higher score is proportional to maximum coverage and higher grade is proportional to greater scorer, vii. Vegetation cover, resources and built development have been used as indicators of reclamation success, viii. Pair grading extend the range of characteristic, ix. Periodic behaviour of rows and column, x. Periodic increase in rows from left to right, xi. Periodic increase in column from bottom to top, xii. Periodic increase and decrease in diagonal way, xiii. Top down approach of analysis technique.

Data of Scrubs, Open forest, Dense forest, Plantation on OB dump, Social Forestry and Plantation on backfill and plantation of backfill were collected and categorized into 'Vegetation Cover' parameter. Similarly data of water bodies, crop land, fallow land, urban settlements, rural settlements, industrial settlements and sandy body/fly ash pond were also collected under 'Resource & Built Development' parameter category. The methodology for distribution of the 50 reclaimed mines in a 3X3 matrix using data on these two categories is briefly documented.

There is no unique tool for measuring vegetation and resource &built development parameter on reclaimed mines except land cover. Considering this, six indicators have been taken for the assessment of vegetation cover and seven indicators were selected for resource and built development. Land cover data of all these indicators of both the parameters were collected from CMPDI annual reclamation reports. Score to each indicator was given based on the percentile coverage of an indicator. The aggregate score total of indicators within a parameter was converted into grade (A, B, C) separately. Thus each mine gets a grade for vegetation cover parameter and a grade for resource & built development. The pair grade was helpful to place a mine into 3X3 matrix.

Table-1
List of indicators within Parameters

Indicators within Vegetation Cover Parameter	Indicators within Resource & Built Development
Scrubs, Open forest, Dense forest, Plantation on OB dump, Social Forestry, Plantation on backfill	Water bodies, crop land, fallow land, urban settlement, rural settlement, industrial settlements, sandy body / fly ash pond

The percentage distribution of each of the above indicators was calculated and scored as per its percentage class. Five equal class of class size 20 was prepared. Based on the percentage coverage for an indicator, a score from 1 to 5 is given. In other words percentage coverage between 80-100% was given a score of 5 while percentage coverage between 0 – 20% was given a score of 1. The intermediate ranges have been given the scores of 2, 3 and 4. An example of the scoring pattern of a parameter is as below:

Table-2
Standard score table for an indicator

Percentage of an indicator within the range	Score
0 – 20	1
20 – 40	2
40 – 60	3
60 – 80	4
80 – 100	5

These indicators are assigned with scores in the same way and the composite score is arrived by summation of the scores of each indicator within a parameter. Composite parameters' score is divided into three categories by taking the difference between the lower and the higher composite score and defining three parts with same range. Every part has been assigned with final score ranging from A to C. An example of the final scoring pattern of vegetation cover and resource & built development parameter is given below.

Table-3
Grading system of

Composite score of a mine for 'Vegetation Cover'	Vegetation Grade	Composite score of a mine for 'Resource and Built Development'	Vegetation Grade
7 – 10	C	7 – 10	C'
10 – 13	B	10 – 13	B'
13 and above	A	13 and above	A'

Following the above method and applying on the land cover data of mines, every mine got some score for its respective land use (13 indicators). These indicators were aggregated into two groups under their respective parameters of 'vegetation cover' and 'resource & built development'. Finally the aggregate figure turned into grades namely A, B, C for vegetation cover and A', B', C' for resource and built development. Thus each mine was tagged with a pair grading and placed into its respective pair grade box of the 3X3 matrix.

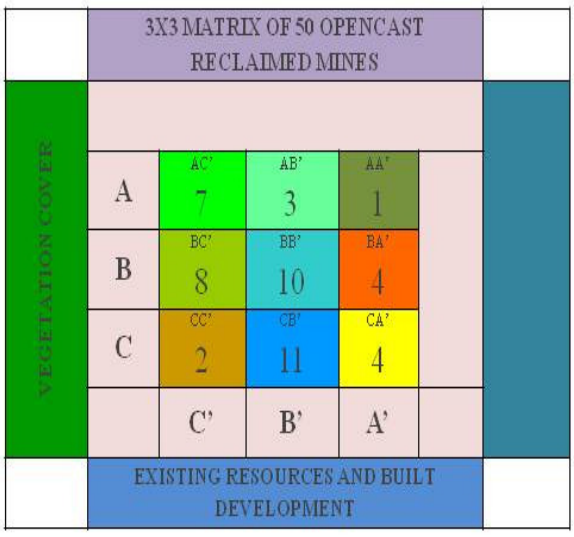

Figure-3
Proposed conceptual matrix model for presentation of mines development progress

Characteristics of proposed matrix model: The proposed matrix model has been validated for universal data of mines in Indian context and based on the behavior of the data following characteristics of the matrix has been identified: i. The success of reclamation on mines increase by moving from left bottom to right top. ii. The land use mix proportion increases by moving left to right in any row. iii. The vegetation cover proportion increases form bottom to top in any column. iv. Row C has minimum vegetation cover and column C' has minimum resource and built development. Thus CC' includes least progressive OC mine projects. v. Row A has maximum vegetation cover and column A' has maximum resource and built development. Thus AA' includes highest progressive and successful OC mine projects. vi. Box CA' lies in right bottom box of the matrix, thus mines under this box have good proportion of resource and built area but bad vegetation cover. These mines may be developed with some unique and specified purpose with respect of existing individual land use. vii. Box AC' lies at the left top box of the matrix, thus these mines are good with vegetation including plantation and forest cover. These mines may be developed for recreational purpose with natural beauty of plant species.

The proposed matrix model approach is useful to grade a mine for its potential of development. All reclaimed mines of India indentified from CMPDI annual report were graded for its development opportunity. Mines of Dhanbad were also graded. Detail recommendation for the case of Dhanbad mines has been made for its suitable development scope.

Results and Discussion

In light of the population growth and urban agglomeration, CDP Dhanbad has emphasized on Urban Development and Growth Management: "Guided Urban Development with open spaces and recreational facilities for the City". The 2nd edition of INDO-US coal working meeting held on Washington, November 2005 has discussed on mine closure requirements and reclamation to revert back mined out areas for sustainable use.

Government of India's "National Mineral Policy 1993" is focused on rehabilitation and mine closure. Mining communities are settled as a result of which it leads to loss of jobs but also disruption of social life. In case of mandatory mine closure, the process can be systematically planned to overcome the said issues. Development of water body, Community Park, gardens, orchards on opencast mines reclaimed land maybe a step to cover the vision of city development.

50 opencast projects in India are being selected from different coal company to access the development opportunity potential. The selections of projects are based on the latest published report on reclamation and restoration of coal mines by CMPDI. All open cast projects as on 2010 satellite image are given below:

Table-4
50 OC projects under their respective CIL subsidiary

Subsidiary (No. of Projects)	Opencast Projects
WCL	Sasti, Ukni, Niljai, New Majri (IIA), Pimpalgaon, Padmapura, Ghugus, Durgapur, Mugoli, and Umrer
SECL	Dipka, Gevra, Dugga, Jamuna, Rajnagar, Dhanpuri, Chirimiri, Kusmunda, Manikpur, and Bishrampur
NCL	Amlohri, Jayant, Bina, Kakri, Dudhichua, Khadia, Krishnashila, Jhingurdah, Block-B and Nigahi,
MCL	Ananta, Balram, Jagannath, Hingula, Belpahar, Lakhanpur, Samleswari, Lajkura, Lingraj, Bharatpur and Bhubaneswari
CCL	Ashoka, Piparwar, Rajrappa, K.D. Hesalong and Parej
BCCL	Muraidih and Block-II
ECL	Rajmahal, Sonpur- Bazari

Following the approach of matrix method, each of the 50 mines has been graded for vegetation cover and resource & built development. For instance, if a mine has a final grade of 'A' for vegetation cover and 'C'' in existing resource and built development; it was given a rank of AC' (row A and column C') in the 3X3 matrix. The matrix is presented in 3 rows and 3 columns where left to right rows represent existing resource and built development grade increase and columns represent increase in vegetation cover grade from bottom to top of mines. However, for the sake of convenience the mines have been arranged in a 3X3 matrix on the basis of their pair grading.

The matrix assessment result was prepared based on the success of different practices of OC projects. The success of reclamation on mines increase by moving from left bottom to right top. The higher grade matrix boxes (AA', AB', BA') have 8 mines. These mines have good combination of plantation, forestry, agriculture, water body and settlements. This is being followed by medium (diagonal boxes- AC', BB', CA') grade and lower grade boxes (BC', CB', CC').

The dominant activity of Dhanbad district is coal mining. A total of 112 coal mines are active as on present day in this district. Coal mines are operated by four companies such asTISCO, ECL, BCCL and HSCO. From above table, Block- II and Muraidih are two OC projects where reclamation is going on. These mines cover 14.06 sq. km. area which can be used for development purpose as per its environmental and physical suitability.

Block – II of Jharia, Dhanbad comes under matrix box of BC'. Development proposal should be recommended with the scale

and property of box BC'. BC' box is moderate suitable for vegetation and least suitable for mix use development. The development proposals should tend towards dense vegetation for Block - II. It has 8.68 sq. km. leasehold area in which 4.03 sq. km. area has been mined out and 3.36 sq. km. has been reclaimed. It doesn't have forest cover but it has 3.38 sq. km. total vegetation cover in plantation on backfill, OB dump, open forest and scrubs. It covers 0.08 sq. km. area for water body which is only 0.92% of total leasehold area of mine. It has 0.98 sq. km. area in agriculture and whole area is fallow from last 3 years.

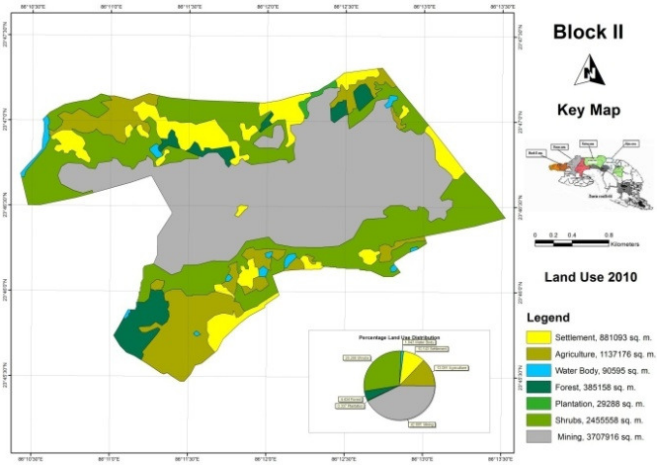

Figure-4
Developable land in Block - II

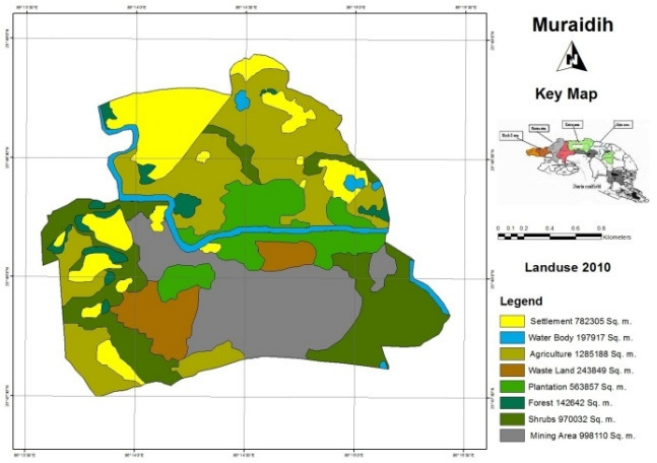

Figure-5
Developable land in Muraidih

OC Project - Muraidih of Jharia, Dhanbad comes under matrix box of CB'. Proposal should be recommended with the scale and property of box CB'. CB' box is least suitable for vegetation and moderate suitable for mix use development. The development proposals should tend towards mixed use for Muraidih. It has 5.38 sq. km. leasehold area in which 2.05 sq. km. area has been mined out and 1.59 sq. km. has been reclaimed. It doesn't have forest cover but it has 2.05 sq. km. total vegetation cover in plantation on backfill, OB dump, open forest and scrubs. It covers 0.13 sq. km. area for water body which is 2.42% of leasehold area and 8.18% of total reclaimed area of mine. It has 1.34 sq. km. area in agriculture and whole area is fallow from last 3 years. It has settlements in 0.35 sq. km. area which is less than the area covered in Block – II for settlements but equal percentage contribution.

As per respective matrix box properties the proposal should tend toward vegetation for Block – II but it is moderately suitable thus the site may be developed for open forest or social forestry. The site area also has rural, urban and industrial settlements in total area of 0.57 sq. km. which is only 6.57% of total leasehold area still if there is local demand of open space, it may have some recreational area like gardens with less disturbance. Muraidih site is moderately suitable thus the site may be developed as open space for recreational purpose. Some playground or small establishment with light construction may be proposed here. The site area also has 2.05 sq. km. vegetation cover thus site development proposals should have landscape plan. If there is local demand of commercial or public purpose, it may be proposed with special environmental concern and geological and structural study for construction.

Conclusion

Land is emerging as a resource for living habitat. It is the place where animal and plant born, get their food and living. People use it for different purposes. They leave it when their purposes are completed. The era has come when plants and land are not counted as renewal resource. The concept of sustainable planning is the call for the era. Environmentally sustainable uses of land for different purposes require attention at pre project, active project and post project level. Industrial land use has norms and standard for its activity to conserved and preserve environment. Due to ignorance of these rule and regulation environment is getting polluted. Mining and specially coal mining needs to keep attention in this direction. Mining is a finite period activity for some specific project. It needs to shut down after the excavation of all resources or when it gets lose financially. Proper reclamation can give reuse opportunity and may return the mined out land to the society.

Dhanbad has urban agglomeration problem due to high urbanization rate. It will require land for development in near future. Jharia is most dense area of the district. It also has maximum number of coal mines. To supply land to the resident of Jharia is the challenge for local development authorities. Eco-friendly reclamation of coal mine may be the solution of this challenge. Muraidih and Block – II mines may be use for social benefits. Some action plan needs to prepare after detail environmental and socio-economic study of household in the catchment area. EIA report may be prepared to minimize the future disaster. A frame of development authority may be made and their role and responsibility may be defined earlier.

The proposed approach is useful for the assessment of potential development of all reclaimed open cast mines. It also suggests prospective development information. Assessment of Block – II and Muraidih mines finds that the reclaimed mines might be used for social and environmental benefits. The study might be more elaborated by integration the study scope. More reliable socio-economic proposal might be made for with the support of primary data collected through HH survey. Thus there is tremendous opportunity for research in this direction.

Acknowledgement

We are very much thankful to Mr. Ashfaque Alam, Assistant Professor, SPA Bhopal and all professor of the Planning Department for their valuable guidance for this paper.

References

1. Singh R.B. (1992). 7 Land use change, Diversification of agriculture and agroforestry in Northwest India. Department of Geography, University of Delhi, Delhi.

2. Peck P. (2005). Mining for Closure; Policies and Guidelines for Sustainable Mining Practice and Closure of Mines. The Environment Security (ENVSEC).

3. Remy Felix and Mac Mahon G. (2002). Large mines and local communities: Forging partnerships, building sustainability. Mining Department, Washington, DC.

4. Dalupan CG (2001). Mining and Sustainable Development: Insights from international law. Claredon.

5. Smith B. (2007). Sustainable Mine Practices, Rehabilitation and Integrated Mine Closure Planning; Mining for Closure. Thesis, Australia.

6. Singh N.P., Gupta V.K. and Singh A.K. (2010). Geospatial Technology for Land Reclamation Monitoring of Opencast Coal Mines in India. Central Mine Planning & Desgn Institute, Ranchi, India.

7. CMPDI (2008). Land Restoration / Reclamation Monitoring of Open Cast Coal Mines of South Eastern Coalfields Limited Based on Satellite Data for the Year. Ranchi.

8. National Information Centre (2012). Welcome to coal capilat of India, Dhanbad. N. I. Centre, Producer & Department of Infromation Technology, Retrieved January 7, 2012, from Dhanbad District of Jharkhand: http://dhanbad.nic.in/links/dhanbad.html.

9. Singh P.G. (2006). Environmental Problem of Mining Areas. Newsletter of the ENVIS, Indian School of Mines, Centre of Mining Environment, Dhanbad.

10. Schori A., Scrymgeour A.H. and Munshi P.L. (1997). Environmental Management Plan for The Jharia Coalfield - India. Bharat Coking Coal Ltd., Dhanbad.

11. GOI-UNDP. (2009). Draft 1.0 - City Disaster Management Plan Dhanbad. GOI-UNDP Urban Eartquake Vulnerability Project, Dhanbad.

12. IL & FS. (2007). City Development Plan for Dhanbad. JNNURM Project Report, Dhanbad Municipal Corporation, Jawaharlal Nehru National Urban Renewal Mission, Dhanbad.