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www.aarf.asia,**Email** : editor@aarf.asia, editoraarf@gmail.com

"RELEVENT SOCIO ECONOMIC INDICATORS FOR SUSTAINABLE MINE CLOSURE"

[1]Rajni Pradhan
[2]Dr. Shatrajit Goswami
[1]Research scholar of SRM University Sikkim and
[2]Associate professor, Department of Economics, SRM University Sikkim.

Abstract

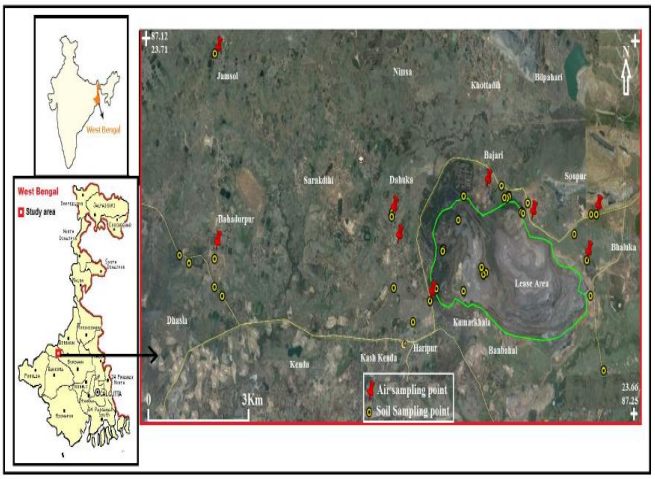
Mining have a finite life span as it is basically depends on exhaustible resources, and this kind of resources depleting day by day. On the other hand during period of mining operation people want to shift from traditional occupation to mineral extraction job for extra earning. On the Basic earning local area have been developed but after some duration of year mining process will be closed down without alternative livelihood strategy , again world bank identified spill over effect of mines is low ,so in that sense mining is unsustainable. Many researchers tried developed some socio economic indicators for sustainable Mine closure.United nation have also provided sets of socio economic indicators. But most work based on macro level and developed by experts opinion. So objective of this work find the indicators according to need priorities of local peoples surrounding mines areas. So to set the socio Economic indicators we selects two surface mines in Ranijanj and Asansole in West Bengal.

Key word: Sustainability, Mining, Need priority, Livelihood, PCA, Socio Economic, Chi square.

Study areas

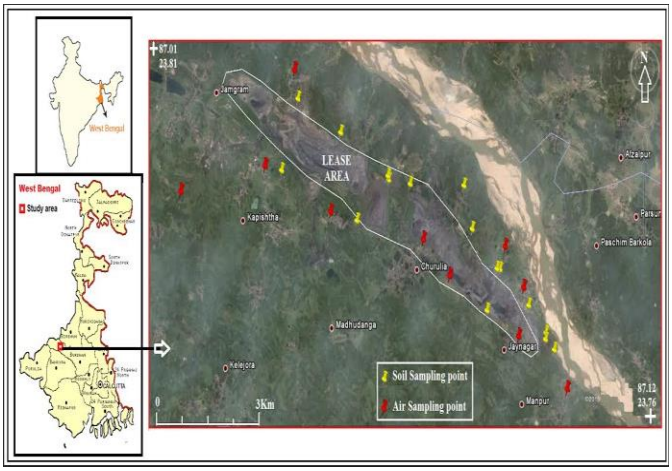
Each mine is having certain site specific sustainability issues. Hence, a case study approach is followed; the results of this study can be validated in other mining areas. After validation in several mining belt a broad framework of sustainability indicators can be developed.

Figure:1



Location map of study area:1

Figur:2



Location map of study area:2

Table: 1

Description of two case study areas

Features of the Study Areas	**Case Study Area 1**	**Case Study Area 2**
Location	Raniganj	Jamuria
Lease area	1525 ha	800ha
Geology and soil	Alluvial soil	Alluvial soil
Topography and climate	Flat & Maximum average temperature 37 degree centigrade	Flat & Maximum average temperature 40 degree centigrade
Land cover	Agricultural land & waste land	Agriculture land and waste land
Hydrology and drainage pattern	Drainage pattern of the area is controlled by a perennial water course.	Near to Ajay river
Primary sector	Cultivation	Cultivation
Local people Earning sources	Temporary jobs under mining contractor	Cultivation and Temporary jobs under mining contractor
farming and animal husbandry	Both have declined	Both have declined
Forest	Nil	Nil
Local institution	Panchayat	Panchayat
Geo-mining condition	Multi seam working using shovel, dumper and dragline	Multi seam working using shovel, dumper

Rated Capacity	8 million tonnes	2 million tonnes
Waste disposal	External dumps with limited backfilling	External dumps
Mining scheme	Opencast	Opencast
Number of converted villages	Three	One
Mine Life	30 years	17years

Socio economic survey

Two types of village surveys were conducted First, preliminary survey of all households to gather baseline socio economic information, which was followed by stratified random sample survey of households. Second, a participatory approach by calling the local villagers in a meeting and gathering information by discussion. A brief outline of the survey work is presented below:

i. In total twenty six villages, in two study areas, were covered.
ii. In twenty villages household survey was conducted in three thousand and four hundred and thirty five households .
iii. In twenty three villages meetings were conducted which were well represented by diverse village population.
iv. By means of stratified random household survey one hundred sixty seven detailed questionnaires were filled up covering eighteen villages. Village wise distribution of households covered under questionnaire survey is furnished.
v. Household survey blank format is furnished .
vi. Each questionnaire covered about fifty items highlighting socio economic and environmental aspects of mine closure. The basic purpose of this detailed questionnaire is to gather knowledge about villager's perception about the risks involved in mine closure.
vii. General information was collected about infrastructure and other facilities available in village for twenty three villages .
viii. During village meetings villages participatory data base were prepared by drawing maps by the villagers, for example, venn diagram, mobility map, village map, trend analysis maps.

Socio Economic data

Mines are located in remote areas that are mostly underdeveloped where majority of people are aboriginal who have lost their traditional means of livelihood. The shift in the means of livelihood, and also, irreversible changes in the local environment bring host of conflicting issues that needs to be resolved during the mine life cycle. Success of any company is dependent on how far it can maintain social and economic sustainability in the region. Social aspects of mine closure shall be dealt comprehensively, stating the specific data requirement, broad analytical framework with a brief reference about the type of tools used. Unless central social issues of mine closure are not adequately addressed environmental sustainability of the area cannot be maintained.

Needless to say, social issues cannot be identified without participation and consultation with the stakeholders. Prerequisite to socio economic analysis, with respect to a particular case study area, is generation of certain baseline information on demographic profile of the area. Based on household information available during stratified random household the following frequency distribution tables on various socio economic parameters are shown below.

Statistical analysis of socioeconomic data

The socio economic database is statistically analysed for several research outputs. First, major need perception of the villagers are elucidated. Second, statistical association between social groups and their need priorities are examined. Third, need for any policy intervention is examined Fourth socioeconomic indicators are designed, which is an integral part of the preparation of sustainability framework (amendment of MMDR Act 2015). Fifth, allocation of funds from District Mineral Foundation (amendment of MMDR Act 2015).

Need priority of villagers

Table 2

Need priority of respondents (Study Area 1)

Need Priority	Agriculture	Infrastructure	Environment	Job & Training	Total
Total	33	24	14	37	108
Percentage	(30.5)	(22.2)	(12.9)	(34.4)	100

Figures in parenthesis indicate percentage of distribution of the respondents by their need priorities.

Table 3
Need priority of the respondents (Study Area 2)

Need Priority	Agriculture	Infrastructure	Environment	Job & Training	Total
Total	11	9	3	7	30
Percentage	(36.67)	(30.00)	(10.00)	(23.33)	(100)

Figures in parenthesis indicate percentage of distribution of the respondents by their need priorities.

The above tables show distribution of respondents by their need priorities in two case study areas. Case study area 2 , being in remote area , larger percentage of the respondents have identified infrastructure development as their major need for maintaining sustainability of the local economy after mine closure. Also, in case study area 2, more respondents are in favour of restoration of agriculture activities after closure of the mine. Case study area 2, being close to Ajay river, more irrigation facilities is available in the paddy fields.

It is shown in the (Tables3) that, in study area 2, restoration of agriculture is the prime need of the villages of all age groups. On the contrary, in study area 1, large areas are degraded due to extensive mining activities in the area; therefore, restoration of agriculture is difficult. In this area, job and training requirement is prioritized as the major need. These observations bring forth the fact that problems of mining sustainability are largely site specific in nature.

The respondents who are either illiterate, drop outs from schools want restoration of agriculture in the mining areas. By means of analysis done, so far, the following prime need priorities have been broadly identified.

a) Job and Training

b) Enhancement of agriculture activities

c) Restoration of environmental quality to pre mining status

d) Improvement of infrastructural facility of the area

Further, statistical analysis is done to examine, by means of Chi square statistics, whether any specific need of the different vulnerable sections of the local people can be elucidated. It is revealed in Following table

Table 4

Statistical analysis of need perception of villagers

Variable		Age 50	**Age 60**	Caste General	Below Secondary	Illiterate	Above Secondary
Need Agriculture	Chi	0.906	**7.7335**	0.577	1.8752	1.1799	0.458
	Probability value	0.327	**0.005**	0.447	0.171	0.277	0.499
		Insignificant	**significant**	Insignificant	Insignificant	Insignificant	Insignificant
Need Infrastructure	Chi	0.5474	0.4757	0.8414	1.2525	0.2442	0.2157
	Probability value	0.459	0.49	0.359	0.263	0.621	0.642
		Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Need Environment	Chi	1.1121	1.2746	0.0598	0.0924	3.0823	0.8914
	Probability value	0.292	0.259	0.807	0.761	0.079	0.345
		Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Need Environment + Agriculture	Chi	0.0379	3.3217	0.7654	1.1431	0.0339	0.0002
	Probability value	0.846	0.068	0.382	0.285	0.854	0.99
		Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Need job + Training	Chi	0.1934	1.7202	2.9456	0.0217	0.0562	0.1527
	Probability value	0.66	0.19	0.086	0.883	0.813	0.696
		Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant

Continued

Variable	Strata					Sex	
		Strata Mining	Strata Agriculture	Strata Business	Strata Other	Female	Male
Need Agriculture	Chi	0.0067	0.081	0.0147	1.187	0.9601	9601
	Probability value	0.935	0.893	0.903	0.276	0.327	0.327
		Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Need Infrastructure	Chi	0	1.0581	**4.0456**	0.608	1.5537	15537
	Probability value	0.996	0.304	**0.044**	0.436	0.213	0.213
		Insignificant	Insignificant	**Significant**	Insignificant	Insignificant	Insignificant
Need Environment	Chi	2.0114	0.0386	2.9905	0.0006	0.1814	0.1814
	Probability value	0.156	0.844	0.084	0.981	0.67	0.67
		Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Need Environment+ Agriculture	Chi	1.0871	0.0673	1.1351	0.9982	1.4486	1.4486
	Probability value	0.297	0.795	0.287	0.318	0.229	0.229
		Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Need Job + Training	Chi	1.186	1.3626	0.4007	0.1364	0.0316	0.0316
	Probability value	0.276	0.243	0.527	0.712	0.859	0.859
		Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant

Analysis of needs of different village social groups in study area 2

Variable	Caste		Education			Sex	
	SC & ST	General	Below Secondary	Illiterate	**Above Secondary**	Male	Female
Need Environment	1.2919	1.2919	2.9167	0	**4.537**	0.2381	0.2381
	0.25	0.25	0.088	1	**0.033**	0.62	0.62
	Insignificant	Insignificant	Insignificant	Insignificant	**Significant**	Insignificant	Insignificant
Need Infrastructure	**3.4737**	**3.4737**	0.1071	0.12	0	1.7143	1.7143
	0.062	**0.062**	0.74	0.72	1	0.19	0.19
	Significant	**Significant**	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Need Job & Training	0.1435	0.1435	2.14	2.4	0	2.14	2.14
	0.705	0.705	0.143	0.12	1	0.143	0.143
	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Need Agriculture & Environment	0.1435	0.1435	2.14	2.4	0	2.14	2.14
	0.705	0.705	0.143	0.12	1	0.143	0.143
	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant

Continued

		Age			Strata		
Variable		00-20	20-50	above 50	Strata mining	**Strata agriculture**	Strata others
	Chi	0.3704	0.8333	0.0176	8.2	**3.8**	3.8
	Probability value	0.45	0.36	0.89	0.004	**0.05**	0.05
Need Agriculture		Insignificant	Insignificant	Insignificant	Insignificant	**Significant**	Insignificant
	Chi	0.5556	3125	0.1058	0.1923	7.2321	1.4286
	Probability value	0.456	0.567	0.745	0.661	0.007	0.232
Need Infrastructure		Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
	Chi	0.24	1.5	2.57714	0.92	.1-71	1.71
	Probability value	0.624	0.221	0.109	0.337	0.743	0.19
Need Environment		Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
	Chi	0.1333	0	0.1587	**4.61**	2.14	2.1429
	Probability value	0.715	1	0.69	**0.03**	0.143	0.143
Need Environment+ Agriculture		Insignificant	Insignificant	Insignificant	**Significant**	Insignificant	Insignificant
	Chi	0.1333	0	0.1507	**4.61**	2.14	0
	Pr	0.715	1	0.69	**0.032**	0.143	1
Need Job + Training		Insignificant	Insignificant	Insignificant	**Significant**	Insignificant	Insignificant

Variable		**above age 50**	**age 20-40**	**Illiterate**	**Below sec**	**Above Sec**
Need Environment	Chi	CHI(10.6935)	CHI(.1552)	CHI(.8826)	CHI(3.2903)	CHI(2.4569)
	Probability value	Pr(.001	Pr(.694)	Pr(.347)	Pr(.07)	Pr(.117)
		Significant	Insignificant	Insignificant	Insignificant	Insignificant
Need Agriculture	Chi	**CHI(5.68)**	CHI(.0974)	CHI(2.072)	CHI(2.266)	CHI(.0244)
	Probability value	**Pr(0.019)**	pr(.7555)	Pr(.150)	Pr(.134)	Pr(.876)
		Significant	Insignificant	Insignificant	Insignificant	Insignificant
Need Agri&Env	Chi	CHI(16.89)	CHI(.2731)	**CHI(3.6028)**	CHI(1.1026)	CHI(1.1262)
	Probability value Probability value	Pr(0.000)	Pr(.610)	**Pr(.058)**	Pr(.013)	Pr(.289)
		Significant	Insignificant	**Significant**	Significant	Insignificant

that there is lack of statistical association between different social groups and their need priorities. It is mentioned earlier that different social groups are identified on the basis of their primary occupation, literacy level and age. Lack of statistical association indicates that the vulnerable section of the village community lack skill and empowerment to face the livelihood security challenges arising out of mine closure. Chi square statistics is calculated and compared with Chi square distribution table to assess the association between the social groups and their need priorities. . Also, *p* value is checked to find out whether it is below 0.05 that is 95% confidence level. Results reveal that there is lack of statistical association between different social groups within a village and their need priorities. Different social groups within the village community have not developed any alternate skill by which they can shift their jobs after mine closure. Hence, in their present improvised state the villagers also lack any future vision on how they will shift to alternate jobs after the mine closes down.

Discussion and Results

It is found that the villagers in the mining belt are mostly engaged in casual jobs under mining contractors. After opening of the mines in the area earning of the villagers from agriculture and other traditional sources has declined significantly. Being in temporary unskilled jobs under mining contractors their livelihood and social securities are not maintained. Few vulnerable groups in villages, both in native and rehabilitated villages have expressed that restoration of agriculture is their prime need priority. It is already shown, by means of mining footprints, that there are significant changes in the soil quality in the impact zones of the study area 1 and 2. Therefore, large scale restoration of agriculture is not feasible. It is worth mentioning again that after losing their traditional means of earning from agriculture they could not yet acquire any alternate skill by which they can sustain their livelihood after closure of the mine. Hence, they lack self empowerment and resilience to face the challenges that will be posed by loss of jobs when the mine will close down. With the above findings in the background, it is essential to relook at the present policy on sustainable development of the mine and suggest necessary policy reforms.

Policy suggestion

It is worthwhile to refer here the broad tenets of National Mineral Policy (2008) where emphasis is laid on contribution of mineral development to regional and more specifically peripheral development. The policy clearly envisages building assets to boost the rural economy and empower the local people so that they can face the challenges of mine closure. ICMM (2016) has designed a community skill development program to empower the vulnerable section of the society . As already discussed, in the recent amendment of MMDR (Mines and Mineral Development and Regulation Act, 2015) it is stipulated that a District Mineral Foundation shall be established in any district affected by mining related operations. It is a subject of research how this fund will be distributed for investment in building rural assets that can sustain the livelihood of the local people after closure of the mine. The core to livelihood analysis is to create rural assets so that empowerment and strength of the villagers can be built. Policies and development initiatives shall aim at transferring some profit earned by the mining companies to livelihood assets. The villagers shall be made aware of these assets, which are their strengths Livelihood assets are human capital, natural capital, social capital, financial and physical capital. Investments on these livelihood assets are based on the need perception of the villagers that are available through village level surveys. A detailed discussion on investment strategy suggested by British Department for International Development (DFID) .

Livelihood assets

In this paper the following steps are adopted to assess the livelihood assets of a village.

Step 1 Identification of stakeholders

A) Primary stakeholder

a) Aboriginal people (local villagers)
b) Local contractors
c) People employed in service sectors e.g. shops, restaurant etc
d) Panchyat representatives from a village
e) Mine owners / Mine officials
f) Resettled villagers
g) Land losers

B). Secondary stakeholder

a) Local and national government
b) NGO
c) Policy makers

Step 2 Building database on village level livelihood assets

a) Household survey

following socioeconomic scenario of the study areas emerge.

i. Education level is extremely low as the percentage of graduates varies from two percent to six percent.

ii. Percentage of illiterate varies from twenty two to thirty seven percent. As per census 2011 literacy rate of Burdwan district is 76.21% as against 78 percent to sixty three percent in the study areas.

iii. Mining labour is thirteen to twenty three percent. The percentage of villagers who are either cultivator or agriculture labourer is twelve percent in one study area and thirty three percent in another study area. The reason for higher percentage of villagers in agriculture in one study area is because of more water availability due to proximity to a river.

iv. About fifty percent of the villagers live in concrete houses. And twenty to thirty percent of the villagers live in mud houses.

v. Drop out rate is twenty one percent of total school going children.

b) Collection of general information about the village

Salient features of the villages are summarized below

i. Majority of the villages is having a primary school and secondary schools are located far away from the villages.

ii. Majority of the villages is not having primary health Centre and in case of emergency they have to rush to hospitals that are far away from these villages.

iii. All most all the villages are enjoying electricity.

iv. Market places are within 5 km.

v. Water supply is either by tube wells, ponds or wells. It is reported that these get dried during summer.

vi. No significant help is being received either by the mining company or local government bodies.

The data analysis done so far reveal that infrastructure and other facilities like water supply , roads , schools are similar to villages located far away from the mines , therefore , benefits of mining is not perceptible in the adjacent villages. . Only difference is shift in livelihood pattern from traditional agriculture to mostly jobs under mining contractors and service sectors. It is amply demonstrated from the discussion on village data that no significant effort has been made by the mining companies to invest in the livelihood assets

Step 3 Interpretation of survey data on investment on livelihood assets

Village survey results discussed, so far, amply demonstrate that investment by the mining companies in the adjacent areas is highly inadequate and in no way commensurate with the high level of investment done at the mines. No significant investment has been done on natural capital by enhancing land quality and establishing irrigation in the areas. As stated before natural capital is a major rural livelihood asset in the study area 2. Education infrastructure and health facility are highly inadequate as a result of low investment on human capital, in both the study areas. Needless to say that both human capital and natural capital are vital livelihood assets that can build a strong resilient and self-empowered mining community who can overcome challenges of mine closure. The data analysis and discussions made here create definite ground for introducing policy reform so that investment in livelihood assets in the surrounding areas becomes mandatory. Tabular data on need perception of the villagers is presented in (Tables 10-15)

The need priorities, shown in these tables, are broadly reclassified under the following forms of capital.

Natural capital ----- Investment on restoration agriculture land, investment on air , water , drinking water and ground water quality control and common property resources , that is , community resources like ponds , forest and grazing lands.

Physical capital -----Investment on infrastructure, medical centers, roads, transport, local government facility, water availability, water treatment plants.

Human capital ------- Investment on human resource development by means of training, education, job creation and self empowerment

Table 4

Need priority on different types of capital (Study Area 1)

Need Priority	Natural Capital	Physical Capital	Human Capital	Total
Total	47 (43.4)	24 (22.2)	37 (34.4)	108 (100)

Table 5

Need priority on different types of capital (Study Area 2)

Need Priority	Natural Capital	Physical Capital	Human Capital	Total
Total	14 (46.67)	9 (30.00)	7 (23.33)	30 (100)

Step 4 Allocation of funds for building livelihood assets.

Research output is analysesto allocate funds from District Mineral Foundation to different forms of capitals. PCA is used to derive weights of each capitals using the perception of the villagers. These weights will be used to allocate funds in different capitals under the .newly introduced District Mineral Foundation.

Table 6

Principal components (eigenvectors)

Component	Eigen value	Difference	Proportion	Proportion
Comp1	1.49808	.291628	0.4994	0.4994
Comp2	1.20645	.910973	0.4021	0.9015
Comp3	.295476		0.0985	1.0000

Table 7

Principal components

Variable	Comp1	Comp2	Comp3	Unexplained
Need _ Social Capital	-0.7550	-0.1445	0.6396	0
Need_ Natural Capital	0.5999	-0.5462	0.5846	0
Need_ Human Capital	0.2649	0.8251	0.4991	0

It can be seen from the above tables that the first two components explain about 90% of the variance within the villager's response data. The factors with eigenvalues greater than 1are considered practically significant, that is, as explaining an important amount of the variability in the data, while eigenvalues less than 1are considered practically insignificant, as explaining only a negligible portion of the data variability. In this case, two components should be retained. The first Eigen value is 1.498 and first extracted column, irrespective of sign, is (0.755, 0.5999, 0.2649) Second Eigen value is 1.20645 and second extracted column is (0.1445, 0.5462, 0.8251). Weight age of the capitals are calculated as follows

Need _ Social Capital = 1.498 x 0.755 + 1.20645 x 0.1445 = 1.305
Need_ Natural Capital = 1.498 x 0.5999 + 1.20645 x 0.5462 = 1.558
Need_ Human Capital = 1.498 x 0.2649 + 1.20645 x 0.8251 = 1.392

Relative weights are calculated as follows

Sum of 1.305 + 1.558+ 1.392 =4.255 (reciprocal = 0.235)
Relative Weight Physical Capital = 1.305 x 0.235 = 0.3066
Relative Weight Natural Capital = 1.558 x 0.235 = 0.366
Relative Weight Human Capital = 1.392 x 0.235 = 0.32712
Funds can be distributed with this ratio. 0.3066:0.3666:0.32712, that is, Physical: Natural: Human Capital

A methodology is demonstrated above to allocate funds to different rural assets that will strengthen and empower the local people residing around the case study areas.

Socio Economic Indicators

Mines are mostly located in remote areas where mostly underprivileged indigenous people reside. One mine differs from another mine on several counts as environmental, socioeconomic and geo-mining settings are unique for a particular mine .In this case , top down approach of merely involving expert opinion in design of sustainability indicators will fail as it will not be able to capture unique diversities existing in each mine scenarios. Hence, at each mine site it is essential, as stated before, to follow a bottom up approach, which is primarily based on perception of the villages about their need to empower them for shifting to alternate jobs. Keeping UN frame work of indicators the background it is essential to devise a mechanism to monitor the implications of implementation of policies centered on investment on livelihood assets. Ultimately, the newly created livelihood assets will strengthen and empower the village community so that long term environmental and social sustainability is maintained that will continue even after mine closure. Social and livelihood security of the local people is the bed rock of local level sustainability. To demonstrate the results of investment in livelihood assets for maintaining non declining welfare to the local people it is essential to design appropriate tools. A set of indicators are the tools that can

serve some useful purpose. They will have policy objectives to monitor sustainable mine closure by imparting strength to the local villagers through investment in livelihood assets. Based on the analysis done so far some socio economic indicators are suggested in Table 21**.** Since these indicators are suggested based on analysis of village data collected from two case study areas, therefore, bottom up approach is followed in design of socio economic indicators. Capital

Table 8
Relevant Indicators in Research Areas

Natural capital	i. Ecological footprint / active mining zone ii. Dump area rehabilitated naturally/ Dump area rehabilitated by scientific technical and biological reclamation techniques iii. Excavation area / area backfilled iv. Excavation area / area backfilled and agriculture established v. Backfilled area brought to some land use in consultation with stakeholders / Total backfilled area vi. Area used for water storage / Excavation area vii. Ratio of number of native species used for afforestation / Number of exotic species used for plantation viii. Overall survival rate of planted trees ix. Total budget for building natural capital / Total budget allocated for mine rehabilitation x. 95 percentile value of environmental parameters / Standard values either stipulated by government or expert knowledge xi. Mean value of environmental parameters / Standard values either stipulated by government or expert knowledge xii. Ratio of water flow in the surface nallahs / (mine water pumped + surface flow due to rainfall) xiii. Ratio of air quality at the working zone and outside the green belt area. xiv. Quantity of surface runoff stored/ Total surface runoff from mined watershed xv. Total agriculture land covered by irrigation / Total agricultural land xvi. Mean value of environmental parameters / Standard values either stipulated by government or expert knowledge
Social Capital	i. Total villagers trained/ Number of adults in the village ii. Number of SHG functioning in the area
Financial capital	i. Number of loans provided by bank for SHG and entrepreneurship development

Human Capital	i. Mortality rate below 5 years ii. Life expectancy at birth iii. Primary school enrollment rate iv. Percentage of tax collected from the mining companies spent on primary , secondary education with breakup
Physical capital	i. Infrastructure expense per capita ii. Total villagers trained/ Number of adults in the village iii. Number of SHG functioning in the are

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