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Introduction:

Stock of natural resources and the pattern of their utilization for meeting the needs of the people determine the structure and level of development of any nation. In other words, differences in resource endowments have been perceived to be influencing income and prosperity differential between countries. The long-term prospects of an economy are thus constrained by the supply of natural resources, especially the exhaustible resources. To quote W. A. Lewis, "The extent of a country's resources is quite obviously a limit on the amount and type of development which it can undergo" (Lewis, W. A., 1955, p.52). Or following Fisher "Usually have to begin with and concentrate on the development of locally available natural resources as an initial condition for lifting local levels of living and purchasing power, for obtaining foreign exchange with which to purchase capital equipment, and setting in motion the development process" (Fisher, J. I. 1964, P. 32). It also determines to a certain extent, the composition of exports and imports by providing the comparative advantages to each and every aspiring nation. The significance of non-renewable resources in regards to quantity of wealth and growth of an economy is comparatively more than the renewable resources because there is the scope for correcting the mistakes of mismanagement in case of renewable resources (as those can be regenerated within a conceivable short span of time) and that chance is bleak in case of non-renewable resources. Only the generation of substitutes can mitigate the problems associated with the scarcity of such resources. Though over time changes in technology, development of human capital and man made capital resources enhances the utility and effectiveness of non-renewable natural resources substantially, full-scale substitution of such resources has never been possible. Moreover, the more the stock of such resources the greater will be the scope for development with every level of human knowledge and other forms of capital.

Plethora of studies are available that show how the choice of development coupled with the social, economic, cultural and demographic factor affects the exploitation of such resources and vice versa. Hence some sort of planning is essential for the judicious harvesting of such resources to make a balance between the present and future rate of growth of an economy. The path breaking works completed in 1960s and 1970s, where the economists systematically investigated the efficient and optimal depletion of resources, both renewable and non-renewable. The original works on optimal depletion of exhaustible resources dates back to Gray (1914) and the classic seminal paper by Hotelling (1931), which provided a foundation upon which the later resource economists like Dasgupta, Hill, Solow and Hartwick (1977, 1995) developed their more general and extended the structure of analysis.

Over three decades back Meadows in his *Limits to Growth* already raised doubt about the sustainable growth of the economies because of the exhaustibility of the natural resources, especially the critical exhaustible natural resources (Meadows, 1972). Continuous extraction of exhaustible resources like coal, petroleum etc, which are the main source of energy and other material resources will raise the scarcity of those resources and thereby it would halt growth process. Though the market economists gave their counter-argument against the principle of *Limits to Growth* that the rising cost or prices of existing exhaustible resources would lead to the development of the substitutes available at relatively cheaper rate and the growth process would not stop; there is no denying of the importance of some natural resources like coal, petroleum etc. However there have been continuous efforts across the countries for making the principle of weak sustainability a real one through the continuous improvement of technology and the human resources. But there is an uncertainty about how far the substitutability of those resources will be possible in reality. Moreover there is the time lag after which the substitutes become available and if that period is long enough one should not wait and continue to extract in an inefficient way so that the particular resource will exhaust before the arrival of its substitutes in the market. The future availability of any such resource depends on the current stock, rate of birth of new mines and rate of harvesting over time. Of course the rate of harvesting depends on the market demand across time depending upon the course of development activities and the expected price. The rate of new finds normally declines over time and the economically harvestable stock also changes with the level of technology that affects cost of extraction and the market price. The Hotelling rule for optimal extraction of an exhaustible resources says that $\frac{\dot{p}}{p} = s$. That is resources should be extracted in such a way that the rate of growth of price of the extracted resource should equal to the social rate of discount. If C is cost per unit of resource extraction then the optimal extraction is governed by $\frac{\dot{p}}{p-c} = s$, where P-C is the royalty of resource extraction. In other words, optimal price is equal to the marginal extraction cost plus marginal user cost.

Coal and limestone are the two major nonrenewable natural and economic resources of Meghalaya. These have been playing a significant role in the generation of income and employment in Meghalaya. Though the extraction has started long before (more than 100 years before as is clear from different evidences), primarily for the domestic use, the commercial extraction has started only a few decades back and records indicate that since 1978-79, the rate of extraction has been increasing in case of coal and since 1965-66 in case of limestone. Though these resources mostly owned by the private individuals, over time the rate of extraction have been increasing noticeably and it is not certain whether the revenue generated fro these resources have been properly invested to generate alternative resources so as to attain future prospect of the local economy. The present paper is a small attempt to analyse the comparative nature of the current trend of extraction of these two resources, examine the sustainability and look into the possible consequences of such extractions. It also seeks to explain the implications of coal and limestone extraction on the economy of Meghalaya.

The plan of this paper is as follows: in the next section a brief description of availability of coal and limestone in Meghalaya is given. Then the methodology of the study is described. In the following section, observations from the analysis of data is given and we tried to analyse the over time rate of extraction of the two resources and if the current trend of extraction continues, how long the present estimated stock would last i.e., the life of the resources. Thereafter possible consequences of such extractions on the economy of Meghalaya are highlighted in that section. Moreover, we would like to address the optimal rate of extraction considering the behaviour of coal and limestone prices over time. The final section includes conclusion of the whole study.

Coal in Meghalaya:

Coal is one of the important exhaustible resources of the state of Meghalaya. The coal extraction and its related activities have been contributing a considerable portion (around 10 per cent) of net state domestic product. It may be noted that around 23 per cent of gross state domestic product of Meghalaya comes from mining. Geological Survey has been in progress in the area since 1825 for the exploration of total mineral position of the region. Though many areas of North-East India are yet to be explored, mineral reserves of Meghalaya has been extensively explored. Here coal is available all over the state (in all three viz. Khasi, Jaintia and Garo Hills) and estimated to be within 300 metres of depth under the soil. The total proved stock of the state's coal reserves is around 118 million tones. Total reserves including indicated and the inferred quantity is about 460 million tones. But it is yet ascertain whether the indicated and inferred amount would be economically exploited or not.

The extraction of coal in Meghalaya has been started more than hundred years back. The available record however shows that the extraction was going on a very minor scale since 1960s, which had been very small in quantity and through surface mining process (popularly known as the rat hole method) with the help of manual labour. Production was primarily for meeting the internal domestic needs of the people. Large-scale commercial extraction has been started on an increasing scale since 1970s and now gradually mechanical devices have been employed and we observe slight reduction in the unit cost of extraction. It is natural that with the increase in extraction, availability declines and also the difficulty of exploitation rises with the unchanged technology and thus cost of extraction rises. But in Meghalaya we observe rather reduction in cost of extraction due to the mechanization though it has been going on a very slow pace. This is also due to the economies of large-scale operation. Though the quality of coal is not of very high standard, due to increase in scarcity in other regions of the country and improvement of communication, coal of Meghalaya is being exported to other regions where it is mixed with the good varieties for industrial use. It is the most export earner of the state of Meghalaya. It is used in fertiliser manufacturing, smokeless coke, cement, textile, paper, rubber, brick and pottery industries and partly for power generation. Most of the mines in Meghalaya are owned by the private individuals, where it is normal that they will be guided by the profit maximizing principle and hence utilize the resource judiciously. Whereas, we observe over-exploitation of coal, as is happened in case of open access common property resources.

Limestone in Meghalaya:

Limestone is the second most important mineral of Meghalaya after coal. In terms of export it brings second most export earning at present. Around one-third of export income of Meghalaya comes from limestone. Every year the quantity of export and earning from limestone has been increasing. Though the exact contribution to state domestic product is very difficult to calculate (as it not only contributes in the form of sales proceeds, it creates employment opportunities in the allied industries, export and value enhanced due to addition in the industries) we can say that it contributes around five per cent of gross state domestic product of Meghalaya through its production value (De and Kharlukhi, 2005).

Limestone occurs in an extensive belt (approximately 200 Km long) along the southern border of Meghalaya. The quality of limestone found here varies from cement grade to chemical grade. Therefore the limestone of Meghalaya can be extensively used in different industries like steel, fertiliser, cement, lime and hydrated lime, precipitated and activated calcium carbonate, calcium carbide, bleaching powder, acetylene black and other chemical industries. It is most suitable for the manufacturing of cement, lime, precipitated calcium carbonate, etc. Though Geological Survey of India estimates the total reserve so far as 4147 Mn tonnes, according to directorate of mineral resources inference it would be around 12000 Mn tonnes (DMR, Information 2005). Meghalaya has more than 91 per cent of total possible reserves of limestone in North-East India. Thus there is the potential of investment in and development of limestone based industries in Meghalaya and the export of related products. Though it is available all over the state, the distribution of deposit is skewed towards Khasi and Jaintia Hills (De and Kharlukhi, 2005).

Data and Methodology:

The data on extraction of coal and limestone in Meghalaya, which have been presented in Appendix-1 and 2, have been collected from the Directorate of Mineral Resources, Government of Meghalaya. It was available for the period 1961-62 to 2003-

04. For the sake of analysis, we have first considered the extraction of coal in Meghalaya from 1978, since when we observe a systematic pattern of extraction over time and extraction started commercially. Though in case of limestone also we observe gradual decline in extraction during first 5-6 years since 1960, we considered the whole period from 1960-61 to 2003-04. Actually, commercial production of limestone started much before coal to supply raw material to the cement factory in Bangladesh where limestone was not available and the supply disturbed in the initial years of post-independence and harvesting of both coal and limestone affected for few years up to 1977-78 due to ethnic problem when labourers most of whom come from outside were not available.

After careful examination of the scatter diagram of the extraction figures in Meghalaya (presented in Appendix-1 and 2), an equation of the form $\text{Ln } Y_t = a + b.t$ ..(1) is fitted by regression method to estimate the growth of cumulative extraction. Where Y_t is the cumulative total extraction up to time t i.e., $\sum_{k=0}^{t} Y_k$ and a, b are the two parameters. Here b represents the annual exponential rate of growth of cumulative extraction.

After estimating a and b and putting Y_t equals to total possible reserves, the equation $Y_t = Y_0 e^{\beta t}$ ….(2) is solved for t which gives the estimated number of years after which the total extractable stock is expected to exhaust unless new reserves are found i.e., no further new discoveries that would be economically exploited and assuming that all future extractions will follow the existing trend and there will be sufficient demand for the resource till it exhaust.

We have also considered the growth of export price of coal and limestone over the years and compared it with the existing interest rate presuming it to be the representative of the rate of time preference. This is done to know whether the respective mine owners give much importance the future or in what way they value the future stock. Though the data on price was not available directly, here we have calculated the price after dividing the total sales proceeds by the quantity of extraction of a few years from 1994 to 2002 that were available from different sources and compound growth rate has been calculated. Here due to scarcity of sufficient data, time series regression has not been possible.

Results and Discussion:

Data presented in graph-1 shows that the rate of extraction of coal in Meghalaya was at much lower scale before 1978-79. Moreover, the extraction was declining over the years and in 1977-78 it was only 10 thousand tones due to the social disturbances and non-availability of mine workers. Since 1978-79 there is increasing rate of growth of coal extraction in the state. Graph-2 shows the increasing rate of growth of extraction of coal. After using OLS method we observe that the annual exponential rate of growth of cumulative extraction is 21.1357 per cent, which is highly significant. The estimated equation is $LnY = 6.30519 + 0.211357\,t$. ……(3)

$$(0.015049)\ ,\quad R^2 = 0.89153$$

The term in the bracket indicates the standard error of the β. Putting estimated Y equals to 118000 thousand tones, and solving the equation we get the value of t as 32.53 that is around 33 years. Even if we assume that some amount had already been extracted before 1978 and we deduct it from the estimated 118000 thousand tones available stock and equate with the cumulative stock, we get the result as t equals to 32.47. There is not much difference in the result, because the cumulative total extraction up to 1978 was very small in quantity with respect to the available resources. If the total inferred reserve of 460 million tonnes of coal can be economically extracted then the life would extend to around 40 years.

Annual average compound growth of that price is calculated to be around six per cent from 1994 to 2002. This was much lower than the long-term interest rate (though declining) in the commercial banks existing during that period. That is growth of price of coal is lower than the rate on interest. This was an indication of lower time preference of the coalmine owners for the future than what it would have been. The owners can earn more by extracting and investing in bank than if they preserve and extract in future. That means they are not much concerned about the preservation for the future and they value their present welfare more than the future.

In case of limestone, the cumulative extraction follows almost an exponential trend i.e., its log values follow a linear trend. The estimated equation is

$$Ln\ Y_t = 5.568 + 0.089\,t, \quad \text{…….(4)}$$

$$(.0028) \qquad R^2 = 0.959$$

where Y_t is the cumulative extraction as defined earlier. Considering 4147 Mn Tonnes of total reserve in Meghalaya, the total stock is expected to exhaust in around 110 years. This is minimum years estimated and as there is a small upward bias, it would linger a few years. If the 12000 Mn tonnes can be harvested economically, it would last some more years (120-130 years as the growth may decelerate after reaching some peak level, when population will stabilize). As already more than 40 years have already been elapsed we can expect the sector to grow by another 80-90 years and thereafter unless the alternatives to limestone arrives the situation may be critical.

In case of price of limestone we find ups and downs every year and there is no trend. Either it increases at over 25 - 30 per cent or declines by 20-30 per cent every year.

Conclusion:

From the overall analysis it becomes clear that if the current trend of exploitation of coal in Meghalaya is continued then it will not for a long period. Even if we assume that a considerable portion of indicated and inferred stock will be available it will not take much time to exhaust the deposit of coal under Earth surface of Meghalaya, unless judicious approach is adopted to utilize the same. Though in many countries technologies have been changing to find alternatives of coal (for rising cost and fear of exhaustibility as well as to avoid the rising pollution problem due to huge combustion coal), in India coal is still being extensively used for domestic purposes (for cooking, in fireplaces of hilly areas etc), in iron and steel, cement and other industries and also in thermal power projects. India will have to go a long way to obtain economically full-scale substitutes of coal either on its own or from the advanced countries. Therefore a judicious approach is well warranted in the utilization of coal.

Secondly, 33 years is not long enough. Even though we assume that it would not be possible to maintain this rising trend of extraction after some years and it would last a few more years, that will not long enough which can allow the next generation of those mine owners to survive only on the naturally supplied stock of coal without searching for and investing in alternative opportunities. It is also not a healthy symptom for the economy of the region.

Thirdly, it is apparent that there are a few owners of the total coal reserves of Meghalaya and they must be operating like a cartel. But here the situation is not like so. Because the experience says that these few owners are enmeshed in competition among themselves to exploit as much as possible quickly and becoming rich over night and also to maintain a luxurious lifestyle. So they give more importance on their present consumption needs than the future. So it is a case of competition among the few who are moving along the conflict locus of Stackleberg's oligopolistic model. All of them are trying to produce more and making more revenue whatever be its implication on price and per unit royalty. Which may be one of the reasons of slow rise in price of coal compared to the social discount rate.

Fourthly, a few of them may be interested in investing money in the bank for earning interest income or invest in real estate around Shillong or other places to raise rental later and sustain on that. But these efforts would not help in the development alternatives to coal that would help continuous progress of industries and thus economies. Moreover, there is the possibility of loss job opportunities in such mining and related activities.

Finally, though we could not say much about what would be the optimal rate of extraction for which we need the concrete data on prices for a considerable period of coal and its substitutes and the development in the substitutes of coal and its related industries, transfer rate of alternative technologies from the other countries, trend of new finds in the other region of the country etc, one can safely argue for the need of deceleration in the extraction rate and investment for the development of employment generating resources in the region. However there is much scope for the development research in this line.

References:

De, U. K. and R. D. H. Kharlukhi (2005), "Status and Prospect of Limestone Quarrying in Meghalaya and its Trade with Bangladesh", paper presented in the International Seminar on Indo Bangladesh Border Trade: Status and Prospect on 12-13 July, 2005 organised by ICSSR-NERC and North-Eastern Hill University, Shillong.

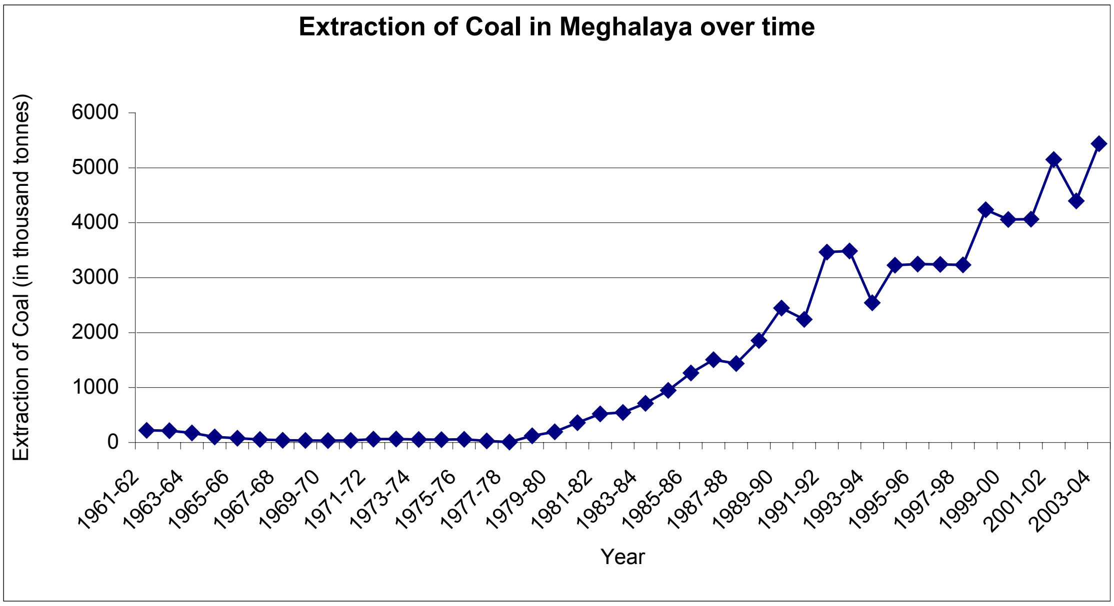
Fisher, J. I. (1964), *The Role of Natural Resources in Economic Development: Principles and Patterns,* Williamson and Buttrick.

Geological Survey of India NER NEWS, Vol. 13, March 2001, Shillong, P. 6.

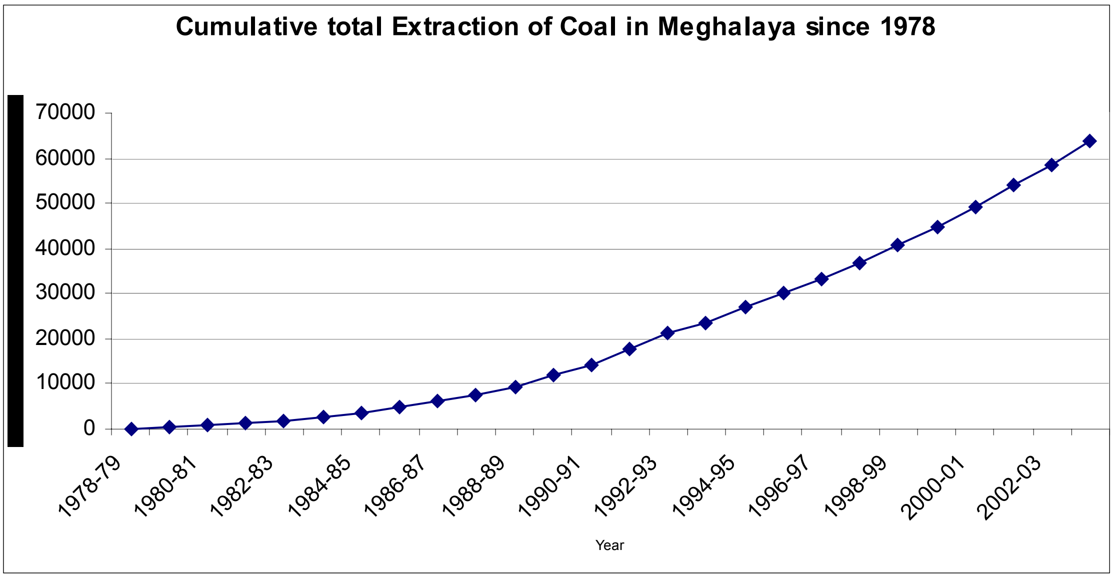
Hartwick, J. M. (1977) "Intergenerational Equity and the Investing of rent from

Exhaustible Resources”, *American Economic Review,* vol. 67. pp 972 – 974.
Hotelling, H. (1931), “The Economics of Exhaustible Resources”, *Journal of Political Economy*, Vol. 39, Pp. 137–75.
Lewis, W. A. (1955), *The Theory of Economic Growth*, Allen and Unwin.
Meadow, D. H., et al. (1972), *The limits to Growth,* Universe Books, New York.

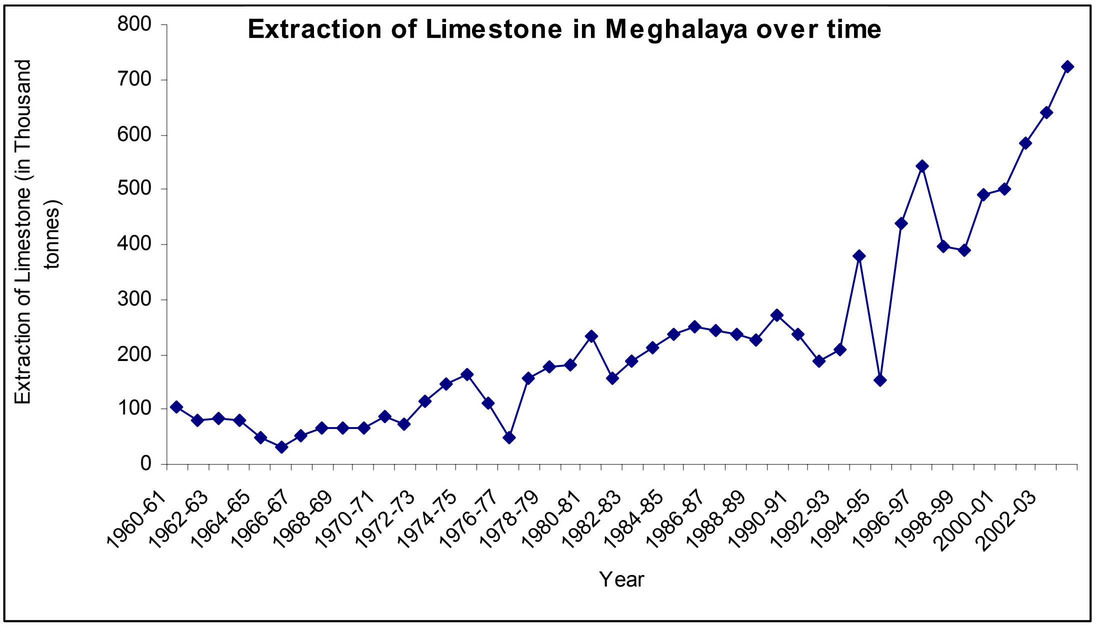
Graph -1



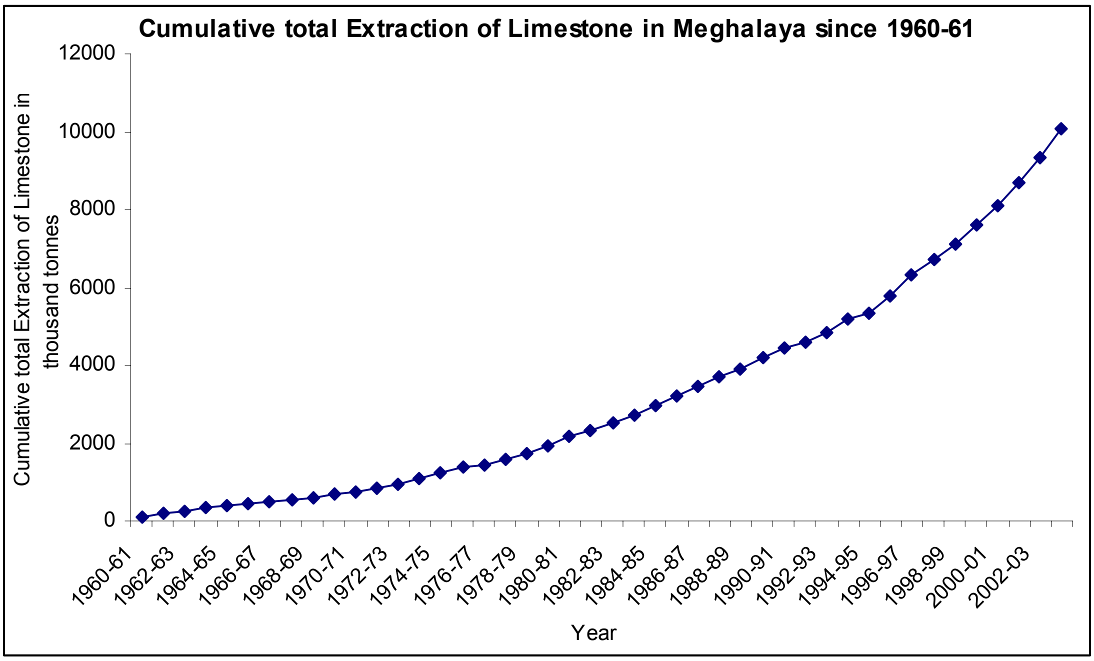
Graph-2



Graph-1



Graph-2



Appendix-1

Quantity of Extraction of Coal in Meghalaya during 1961-61 to 1993-94 (Thousand tones)

1961-62	220
1962-63	215

1963-64	176
1964-65	102
1965-66	79
1966-67	54
1967-68	40
1968-69	37
1969-70	34
1970-71	39
1971-72	61
1972-73	63
1973-74	56
1974-75	53
1975-76	59
1976-77	29.8
1977-78	10
1978-79	122
1979-80	196
1980-81	362
1981-82	521
1982-83	548
1983-84	713
1984-85	949
1985-86	1265
1986-87	1507
1987-88	1436.2
1988-89	1855.5
1989-90	2446.8
1990-91	2241.3
1991-92	3464.3
1992-93	3486.7
1993-94	2543.5
1994-95	3226.2
1995-96	3247.5
1996-97	3240.9
1997-98	3233.5
1998-99	4237.6
1999-00	4060.1
2000-01	4064.9
2001-02	5149.3
2002-03	4396.2
2003-04	5439.1

Source: Directorate of mineral Resources, Government of Meghalaya.

Appendix-2

Extraction of Limestone in Meghalaya during 1961-62 to 2003-04

Year	Quantity (Thousand tonnes)
1960-61	105
1961-62	79
1962-63	84

1963-64	79
1964-65	49
1965-66	30
1966-67	51
1967-68	66
1968-69	66
1969-70	65
1970-71	87
1971-72	74
1972-73	115
1973-74	145
1974-75	164
1975-76	113
1976-77	49
1977-78	156
1978-79	176
1979-80	181
1980-81	234
1981-82	156
1982-83	188
1983-84	211
1984-85	236
1985-86	249
1986-87	244
1987-88	237
1988-89	227
1989-90	273
1990-91	235
1991-92	188
1992-93	209
1993-94	380
1994-95	152
1995-96	439.8
1996-97	540.9
1997-98	396
1998-99	389
1999-00	489
2000-01	500
2001-02	585
2002-03	641
2003-04	721.8

Source: Directorate of Mineral Resources, Government of Meghalaya.