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SOME SOCIO-ECONOMIC ASPECTS OF CORAL MINING ACTIVITIES : A CASE STUDY FROM THE SOUTHWEST COAST OF SRI LANKA

U. WEERAKKODY

Introduction

Coral mining activities along the SW coast of Sri Lanka create environmental problems such as degradation of land, destruction of ecosystems, clearance of vegetation, etc. The annual production of corals from the area between Ambalangoda and Dickwella is about 9000 - 11000 tons (Lal de Alwis, 1981). Mining activities are specially concentrated on buried reefs in the hinterland as well as on living reefs in the offshore area. Hundreds of mined holes filled with brackish water which endanger human health and decrease land quality can be observed along the SW coast. Profits gained by the exploitation of coral resources are outweighed by the high cost of coastal conservation. The damages to the coastal environment include loss of land by sea erosion, decreasing land quality by surrounding mined holes, destruction of natural habitat and also air pollution. Several protective structures have been erected along the coast, including expensive engineering structures.

Steps are being taken, therefore, to overcome these problems mainly by attempting to find alternative employment opportunities for people engaged in coral mining (Amarasinghe & de Alwis, 1980). In the meantime, authorities as well as environmentalists who are engaged in the management of the coastal zone of Sri Lanka face difficulties on evaluation of the profits and gains of the coral mining industry, because very little is known of its socio-economics.

Considering the paucity of studies relevant to the coral mining activities, a research was undertaken to unravel selected socio-economic aspects of this sector by means of a field survey and other available information. The objective of this paper is to examine the nature of the work force, land tenancy, production and marketing of lime, income and profit gained by workers and miners with special emphasis on the SW coast of Sri Lanka.

Methodology

With reference to the above mentioned aspects, a reconnaissance survey covering the coast stretching from Ambalangoda to Matara was made so as to recognize general facts and densely concentrated areas of this coastal tract for a detailed study.

Since coral mining activities are widespread in many parts of the SW coast, two areas of densely concentrated mining activities were selected for detailed study (see also Figure 1). The longest stretch is along the Akurala coast where mining activities began some 165 years ago. The second one is the eastern part of Midigama which is situated far from the Akurala area. Mining activities of the Midigama area have begun some 200 years ago. These two areas exhibit differences both in mining and lime production. Due to the geographic initiative, the two areas are characterized by long established mining

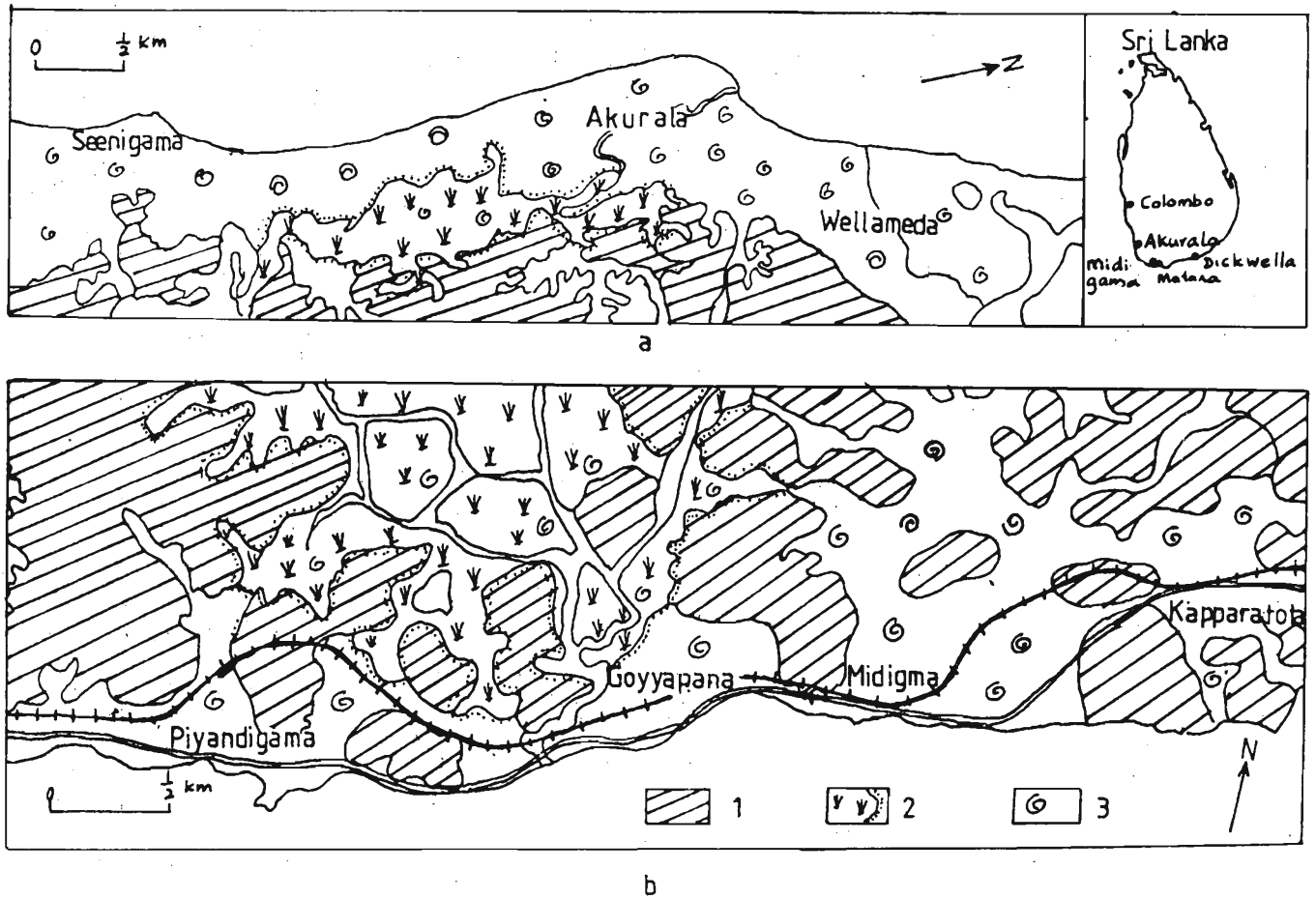

Figure 1: The study areas and their locations.

traditions. And a considerable percentage of the population living there is engaged in mining and lime production. In addition to the survey carried out in the two areas, data from previous work carried out by two students who studied in the Department of Geography, University of Ruhuna, under the supervision of the author were also utilized in this study. For the study of lime production, a 50 per cent sample out of 22 and 13 kilns of the two areas respectively was selected. However, for the evaluation of the rate of lime production, all the 35 kilns were considered. The methodology used for the study is shown in the flow chart of Figure 2.

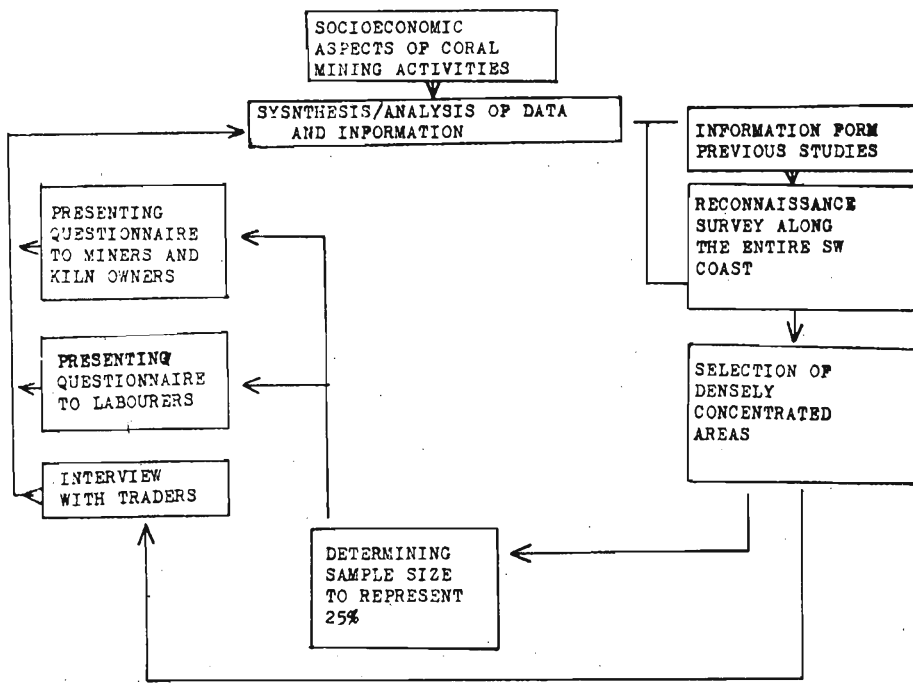

Figure 2: The flow diagram of the methodology used in the research.

Historical Development of Mining Activities

Historical evidence of the beginning of mining activities along the SW coast is scanty. However, since medieval times the colonization of Sinhalese had taken place in Gimhetiththa (Gintota), Walukagama (Weligama), Kammaragama (Kamburugamuwa), Neelawala (Matara) and Dewanagara (Devundara) (Gaiger, 1940). A road had existed in those early days running from Beematta (Bentota) to Mahanagahula (Ambalantota) via Gimhetiththa (Gintota), Galuganga (Galle) and Devanagara (Devundara) and crossing the Kalanadee (Kaluganga) by means of a bridge.

Data on the use of coral in medieval times do not exist, but utilization of these coastal resoures may be assumed considering the building materials then used. Sudha (motar) made by mixing lime (chunna) and sand (pansu), has been used in Sri Lanka since the medieval era (Gaiger, 1940). The sources of the extracted lime are not known but it can be assumed that it was derived from crystalline limestone outcropping upcountry or from coastal areas. In the coastal zone, particularly coral mining was practised and so inland sources of lime were not used. However, the utilization of corals showed a sharp increase in the 16th century and there after due to the modernization of architecture in the SW coastal belt under foreign influences.

Severe adverse influences of mining activities began to be felt in the early 16th century when building activities became widespread. The utilization of corals along the coastal area was intensified during Purtuguese and Dutch periods with the beginning of the construction of ports and forts along the SW coast. Some structures such as major fortresses and other large buildings appear on maps and charts compiled by the Dutch and dated 1682 and 1722 (Brohier & Paulauz, 1958). These maps give a good general idea of the numerous constructions along some of the coastal segments. Field observations confirm that most of these historical buildings and fortresses were constructed using corals.

The use of coral resources was intensified during the war times when the fortresses had to be strengthened. According to the administrative report of the Governor covering the period 1656 - 1665, the highest population of the coastal area at that time was in the Galle Administrative Division, between the Walawe River and Aluthgama (Pieters, 1908). Most of the construction materials were probably obtained from the coastal resources. This is confirmed by government orders given to collect corals and sea sand and send them for baking in kilns (Pieters, 1908).

Nature of Coral Mining

Coral mining activities of SW Sri Lanka is threefold: mining buried coral reefs in the hinterland; collecting of coral debris on the shore zone, and breaking of living reefs to collect coral debris. In the areas of Midigama (east and west) Madihe and Talaramba, collecting of corals destroying living reefs takes a value of 36.78 per cent of the mining of buried reefs in the hinterland. Some 19.64 per cent of the total employment is engaged with the production of lime. The other 9.16 and 6.87 per cents are the workers attached to subsidiary activities such as supplying fire-wood, driving of vehicles, etc, in the coral mining and lime production sections.

Coral reefs preserved as buried reefs on the adjacent land of the sea shore extend as a narrow belt with varying widths along the coast (Deraniyagala, 1958; Cooray, 1967). Figure 4 shows the area of coral mining with some other details relevant to lime production. A Holocene marine transgression maximized during 5000 - 4000 years BP gave a favourable conditions to form coral reefs and subsequent fall of the sea level there after preserved them on the present land areas (Weerakkody, 1988). The preserved reefs are now buried in 2 to 3 m thick soil layers or water bodies especially during wet seasons (Weerakkody, 1990). This geomorphologic nature of the buried reefs deter-

mines the type of expenditure of coral mining such as wages for excavation, cost of water pumps, fuel, transportation, etc.

Debris washed off by storm waves rest on the present shore area especially along the coralline coast. Collection of these coral debris on the shore is mostly done by women and children. Productions made out of them are sold to wholesale dealers who ultimately transport corals in bulk to kilns.

The most destructive activity of coral production is the collection of debris from living reefs. Here, a diver works 4 to 5 hours during early hours of the day. Such workers have to be careful so as not to get caught to the police or the Gramasevakas who can charge them for engaging in such activity. Usually some person is employed on payment by the diver to watch out for them.

Even though these activities are common throughout the entire coast between Ambalangoda and Matara, three zones of highly concentrated mining activities can be recognized as follows;

a) The Ambalangoda - Wekaragoda tract covering th e villages of Madampe, Werallana, Wellameda, Galduwa, Akurala, Wekaragoda;

b) The Galle - Kataluwa tract which extends through Mihiripenna, Talpe, Malalagamaduwa; and

c) The Weligama-Matara tract which consists of villages such as Midigama, Kambugamuwa, Walgama, Madihe, Matara, etc. (see Figure 3).

General Facts on Employment

There are 60 and 48 families in the population of 600 and 343 in Akurala and Midigama respectively. Nearly, 397 and 340 people are living in the two selected areas of this detailed study. In these areas, 138 and 104 workers responded to the questionnaire submitted to them. These amounts represent 23 and 30 per cent of the entire population of the two areas respectively. Accordingly the composition of employment in the two selected areas is shown in Table 1.

This table reveals that coral mining and lime production are the most common occupations in the two areas. However, the type of employment in the mining sector is varied and wages depend on the type of labour, skill and sex.. Six types of workers employed in the mining activities can be recognized as follows;

(a) shovellors (mullugasanno), (b) takers of corals from the mined holes (godadamanno), (c) operators of water pumps (pompakarayo), (d) people who load corals to bullock-carts and lorries (patawanno) and (e) washers of corals (hodanno). Table 2 shows the differences in wages according to performance, sex and period of time.

Even though the wages have increased during the period between 1971 and 1991, labourers complain that they are still under-paid and exploited. Owners of mines often seem to pretend that they make only marginal profits due to high expenditure.

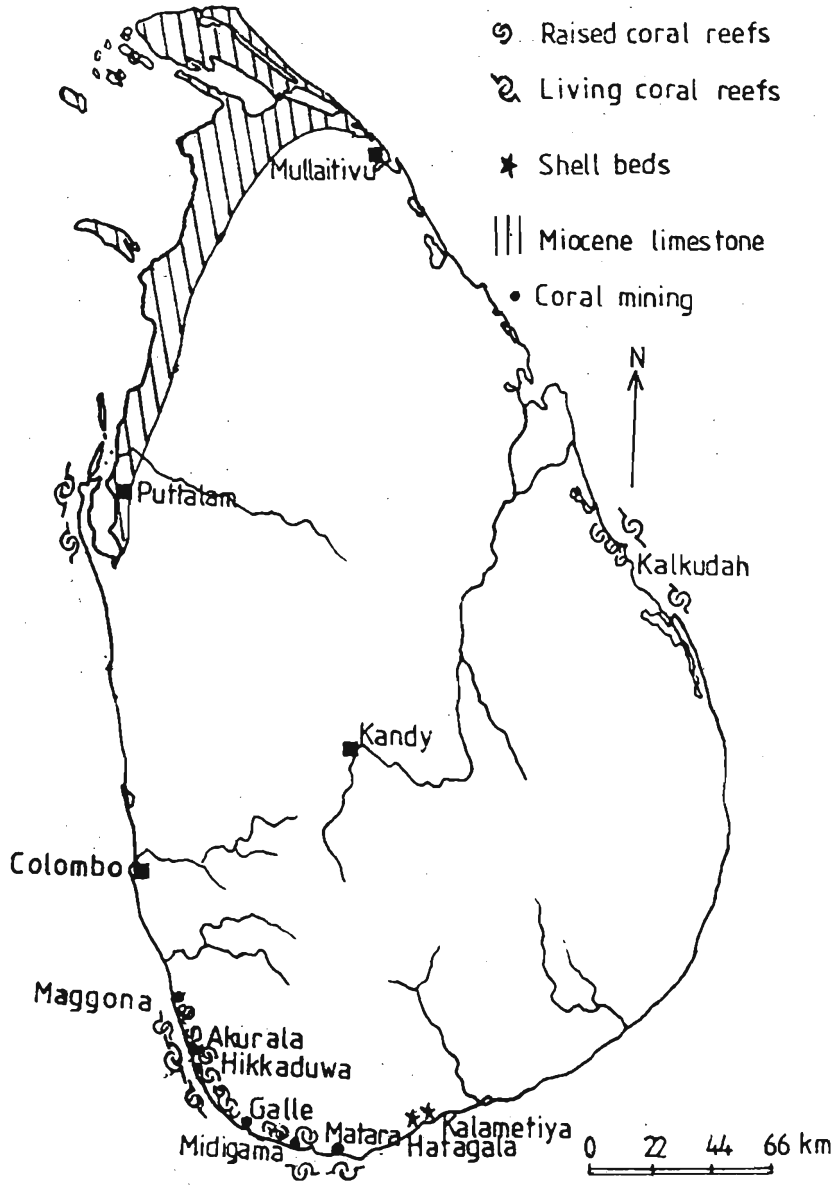

Figure 3: Coral mining areas of Sri Lanka. Distribution of living reefs, shell beds, Miocene limestone and crystalline limestone is shown for comparison.

Table 1: Composition of employment in the selected areas of Akurala and Midigama.

Type of employment	Akurala		Midigama East	
	Total number	Percentage	Total number	Percentage
Government employment	16	11.66	11	10.57
Mining & lime production	63	45.65	30	28.85
Traders	12	8.70	6	5.76
Employed in private sector	18	13.05	23	22.12
Fishing	10	7.24	8	7.70
Coir industry	15	2.90	6	5.77
Total	138	100.00	104	100.00

Source: Field survey, 1991.

Table 2: The average wages of coral miners in the Midigama (east) area.

Type of labour	Average daily wage in Rs.	
	1971	1991
Skilled labourer	67.50	112.50
Unskilled labourer		
male	37.50	70.00
female	27.50	50.00
Child	20.00	32.50
Water pump operator	55.00	117.50

Based on information given by labourers.
Source: Field survey, 1991.

The monthly income distribution relevant to various types of coral production is shown in Table 3 and is based on a survey carried out in 1986 under the supervision of the author.

Table 3: Income distribution of various types of coral mining activities along the coast between Midigama and Polhena.

Monthly income in Rs. Type of coral mining	less than 500	501 1000	1001 1500	1501 2000	2001 2500	more than 2500	Total
Collection of debris from living reefs	--	19	15	12	--	--	46
Mining of buried corals	5	5	4	7	1		22
Collection of debris on the shore zone	4	8	2	--	--	--	16
Owners of kilns	--	--	--	7	5	10	22
Others	4	5	5	--	--	--	14
Total	13	37	26	26	6	10	120

Source: Field survey, 1986.

As explained in a later part of this paper, the owners of kilns receive the highest income than workers and miners. However most of people who are in the lowest level of income (between Rs. 500 - 2000) are the reef destroyers.

The amount of profit in the mining sector, however, depends on the size of the mine. Three sizes of mines can be recognized on the basis of the work force employed in mines of the two study areas as follows; large-scale mines employing more than 16 persons; medium-scale mines with 16 - 7 persons; and small-scale mines employing less than 7 persons. This classification was based on a 50 per cent sample of 44 and 30 mines operated at present in the Akurala and Midigama areas respectively. Of the three types, medium-scale mines are the commonest in the areas. In general, one third of the work force of the three types of mines consists of female labourers. Also child labourers make up nearly one-fifth of the work force while 50 per cent of the labour force of the medium-scale mines is made up of child labourers whose age is less than 15 years.

The total work force engaged in lime production in the 50 per cent sample derived from 22 and 13 kilns is 89 and 58 in the Akurala and Midigama areas respectively. This shows that the average number of workers of a kiln is eight and therefore, the total number of employees in 233 kilns situated between Ambalangoda and Matara does not exceed 1900 workers. According to the sample, 89 per cent of the work force is engaged in the kilns scattered in the Akurala area. Absence of child labourers is the other prominent features of the composition of the labour force in the kilns. However, the majority of the labour force is engaged in the mining sector.

Land Tenurial System in Mining

The availability of lands for mining depends on the type of land tenancy. An entrepreneur can either use his own land or can rent a land at a reasonable price. However, the price promised is paid in instalments through the entire period of mining

process. There were no difficulties in the selection of suitable land during the 1960's and 1970's. At the beginning of 1970's the demand for land increased rapidly due to the increasing demand for lime. Many entrepreneurs actively participated in the mining industry in those former periods. But today, there are some difficulties in the selection of suitable land for a mine. If a land is not available under rent or lease, a miner can co-operate with a land owner on the basis of share-holding system. The tenancy functioning in the two study areas is shown in Table 4.

Table 4 : Land tenurial system in coral mining in the Akurala and Midigama areas.

Type of tenancy	Akurala (in per cent)	Midigama (in per cent)
Own land (Sinnakkara)	40	42
Leased land (Badu)	27	36
Share-holding (Hauvl)	14	07
Rented land (Kulee)	09	14
Other (encroached land, land belonging to the Government, temples, etc.)	09	02
	100	100

Source: Field survey, 1991.

Under the share-holding system, the miner should pay nearly one-third of the total income to the owner of the land in the Akurala area while in the Midigama area the relevant share is only one-fourth. The difference in shares between the two areas is due to the following factors;

a) Most lands in the Midigama area are not rich in large bulk of corals and, therefore, the degree of risk of the entrepreneurship is somewhat greater than that in the Akurala area,

b) The supply of land in the Akurala area is very limited as compared to the Midigama area. In addition, most of the available land in the Akurala area has already been utilized.

Not only land, but tools and equipment such as water pumps used for mining are also available under hire-purchasing or share-holding basis. Tools and equipment used for the mining process are the steel rods (alawangu), steel-wired baskets (kambikuda), mining rods (illamkura), shovels, spades, water pumps, etc. Expenditure for such tools and equipment is somewhat high because each worker should be supplied a tool or equipment. Cost of fuel too has to be met in addition to the rent of water pumps. Four and a half liters of kerosene and half a liter of petrol are consumed by a 2" water pump per working day. If a mine hole is attached to the nearest water body, it needs a 4" water pump which consumes 11 liters of kerosene and 2 liters of petrol per working day. The

fuel cost is Rs. 190/= and Rs. 285/= for 2" and 4" water pumps respectively per working day at the current price of fuel.

Income and Profit from Mining

The miners of the two areas use neither a national measuring unit nor an international measuring unit to measure their production. The common measuring units are 'kambikuda' (Steel-wired basket load) and 'karaththaya' (bullock-cart load). These measuring units have been used for centuries in the areas. Such traditional measuring units give them special benefits, i.e. even though a unit of different types of corals is the same in mass, its weight may vary due to water content, materials, sand content, etc. These traditional units are used to measure different types of corals without considering their weight. On the basis of these traditional units, production of corals and the income derived in the two study areas are shown in Table 5.

Table 5 : Production of corals and incomes derived in the Akurala area.

Level of production	Large mines			Medium mines			Small mines		
	Actual production	Total capacity	Total income in Rs	Actual production	Total capacity	Total income in Rs	Actual production	Total capacity	Total income in Rs
High	13	75	46875	9	31	19375	6	23	14375
Low	10	69	43125	8	41	25625	4	17	10625
Average	11.5	72	4500	8.5	36	22500	5	20	12500

in 'karaththa' (bullock-cart loads).
Source: Field survey, 1991.

The difficulty of calculating the cost-and-profit from coral mining arises from the varying prices paid for different types of corals. Some types are characterized by a high content of calcium carbonate, and they are sold at higher prices. The prices paid for different types of corals are shown in Table 6.

Table 6: The prices of different types of corals

Types of corals	Price in Rs.	Average price in Rs
Andugal (finger-like corals)	650-700	670
Magal (broad corals)	600-650	600
Pathurugal (flaky corals)	500-550	520
Other types	500	500

Price of a bullock-cart load of corals (karaththa)
Source: Field survey, 1991.

A collector of debris (destroying living reefs) produces 8 to 10 'kambikuda' of corals per day. It has been reported that the work force engaged in this activity along the coast between Midigama and Polhena is about 30 per cent of the total mining force.

A seasonal variation in the collection of debris destroying living reefs is observed along the coastal stretches of Midigama, Madihe and Polhena. Rough seas induced by the SW monsoon during the period between May and August decreases the rate of mining on living reefs (Figure 4). Calm conditions of the sea experienced between September and April help to accelerate the activities of mining on living reefs. Some 7782 metric tons of corals per annum are removed from the living reefs of the SW coast of Sri Lanka (People's Bank, 1985).

A survey carried out during the year 1986 shows that the amount of debris collection on the shore area is about 15,20,08 and 12 'kambikuda' (steel-wired basket load per day) in Midigama east, Midigama west, Talaraba, Madihe and Polhena respectively. Collecting debris on the shore is mostly done by women and school children. The collected debris is sold to owners of kilns at a price between Rs. 8/= and Rs. 15/= per basket load.

Production and Marketing of Lime

Corals are baked in kilns to produce quicklime and slaked lime. A kiln is a furnace or a circular shaped oven in which are stored several tons of corals for baking. The lower portion of the oven is built to store fire-wood which is sufficient to give a uniform heat for two or three days. In 1984, there were only 26 kilns in the Matara district. This number increased to 49 kilns in 1986. Most of kilns were operated at that time without legal permission. There are 233 kilns along the area between Ambalangoda and Matara. Out of this, 22 and 13 kilns are situated in Akurala and Midigama respectively. Since the operational process of lime production is very simple, a large sample representing 50 per cent of the 35 kilns was taken into consideration in collecting data.

The rate of production of quicklime (calcium oxide) depends on the amount of corals supplied to kilns. Many kilns work more than one shift. Table 7 shows the number of shifts of baking of corals relevant to kilns in the two sample areas. In each shift, a kiln bakes 10-12 karaththas (bullock-cart load) of corals for four days continuously.

In the case of Midigama, prices are influenced by the transport costs because of the differences in mileage between Colombo and Akurala and, Midigama. A lorry of quicklime (4 metric tons) is sold at a price of Rs. 4000 in Akurala while in Midigama it is about 3500. A metric ton of quicklime (calcium oxide) is sold at a price of 1700 or 1800 in Colombo.

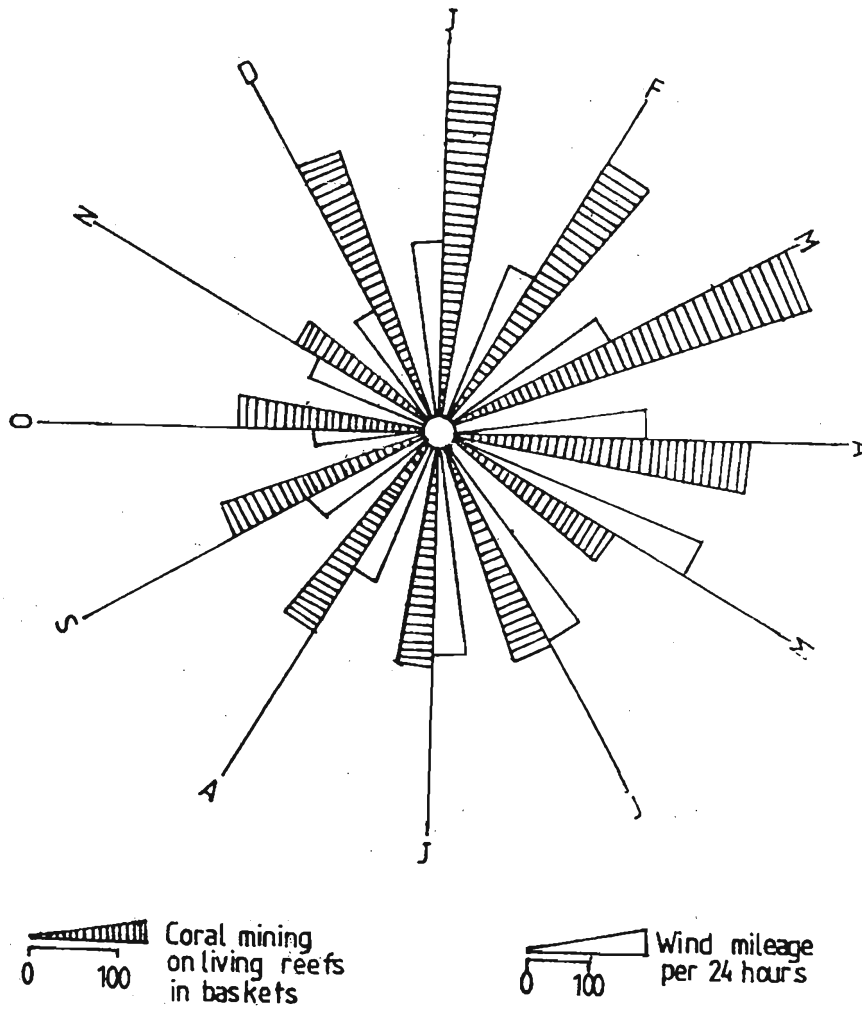

Figure 4: Annual distribution of coral mining on living reefs in the Midigama area. Intensity of the mining activities depends on the less wind mileage induced by the intermonsoonal periods.

The financial risk of operating kilns is somewhat less than that of mining, because the latter incurs a considerable expenditure for the clearance of vegetation and the excavation of top soil layers. Even a well-experienced miner cannot assess accurately the quantity of corals contained in a mine.

Quicklime is presented to the market in units of sacks. The weight of a sack is never measured and the producer marks the price per sack. Another way is the selling of slaked lime in sacks of 50 kgs each. Many waste materials such as sand, dust of dolomite, etc, are deliberately added to slaked lime and customers are often cheated.

Table 7: Monthly rate of production of quick lime in Akurala and Midigama

No. of shifts	Number of kilns operated in Akurala	Number of kilns operated in Midigama
1	2	1
2	2	2
3	3	1
4	3	1
5	6	4
6	4	2
More than 6	2	2
Total	22	13

based on the total number of kilns in the two areas.

Source: Field survey, 1991.

A kiln bakes four tons of corals on average at one shift and a kiln works 5 to 6 shift per month. If an owner uses the full capacity of the kiln, the maximum gross income received is around Rs. 48,000/= per month. After deducing the prices paid for corals, fire-wood, transportation, etc, and wages, a kiln owner gets profit between Rs. 2500/= - Rs. 5000/= per month. However, the real figures of profit are difficult to obtain other than by calculating them.

Both quicklime and slaked lime are sold mostly in Colombo and in the suburbs such as Moratuwa, Panadura, Maharagama, Homagama, Kotte, Kelaniya, etc. A small part of the production is distributed among the nearby villages of Southern Sri Lanka. Dolomite ($CaCo_3$. $MgCo_3$) and Miocene limestone ($CaCo_3$) are the other alternative materials for lime in the market. However, more than 50 per cent of the entire lime production is derived from the coastal zone (Lal de Alwis, 1981).

As the quality of quicklime produced by baking of corals is superior to that of dolomite, the demand for corals is stable throughout the year. Purchasing of lime, however, is carried out by middlemen who participate at various levels of marketing. If middlemen do not participate, the selling of lime in bulk is somewhat difficult. Accordingly, a considerable portion of profit goes to middlemen. The production of lime along the sea coast is purchased only by individuals and large firms. No Government Department participates directly in selling or buying of lime, because the destruction of coral reefs is prohibited by the coastal laws (Coastal Conservation Act No. 57, Government of Sri Lanka, 1981; 1988) and condemned by various environmental authorities of Sri Lanka.

Some Socio-economic Problems of Coral Mining Communities

Several thousands of people earn their living by mining corals and producing lime (Lal de Alwis, 1981). However, destructive social unrest and social crises are abundant among them. The removal of corals from the area between Ambalangoda and Dickwella reaches to some 9000 - 11000 metric tons (Lal de Alwis, 1981). So the resources will be rapidly depreciated. Some 60 per cent of land in Akurala area has been consumed for mining and the rest is covered either by settlements or homestead gardens. Tourist resorts have been erected on some land and they remain as permanent business areas. Keen competition exists between mining and construction of houses, so the mining industry is limited to lands which are not suitable for housing. In contrast, alternative materials such as dolomite and lime produced by the Cement Corporation using Miocene limestone gain no result in the case of meeting the demand for lime. Accordingly, miners face real problems regarding the availability of lands.

In addition, the Akurala and Midigama societies face crisis originated from the unavailability of land for construction of houses for the young generation. Some 36 and 19 hectares of land in the Akurala and Midigama areas respectively have been destroyed and a very limited amount of land for construction is available. Some 1295 m^2 and 885 m^2 of land in the Akurala and Midigama areas are covered by kilns. Their surrounding areas are also not suitable for housing since they are continuously polluted by smoke and lime dust induced by kilns.

Corals are mined by unorganized enterpreneurships, and therefore, a considerable part of the contamination is lost in the mined hole itself. After having spent their wealth on mining, many land owners are frustrated because they cannot use the land again for any other purpose. The work force engaged in mining activities is unemployed at a certain time every year. Many persons try to find day to day work and therefore, competition among labourers is widespread. Every person who is engaged in mining activities suffers the risk of unemployment. In addition, they also face the external pressure by the Government due to the possibility of passing a law in the future which may ban coral mining and production of lime. Criticism of coral mining activities induced by the mass-media in Sri Lanka is rapidly increasing and some miners carry out their day to day work with a feeling of guilt.

In addition, unrest among residents of the two areas is created by the effects of mining activities on their residential environment. Many damages to houses have been reported and they are summarized in Table 8.

Table 8: Monthly rate of production of quick lime in Akurala and Midigama

Nature of damage	Number of affected houses in Akurala	Number of affected houses in Midigama
Cracking of floor and walls of house	40	33
Slumping of house	18	08
Land degradation	10	12
Land submergence	04	02

Source: Field survey, 1991.

Much of cracking and subsidence of houses is due to the formation of pores in the subsoil induced by absorption of sand grains by pumped water under mining process.

The other problem that people face is the engagement of child labour in mining activities. Collecting coral debris, washing mined corals, working as labourers at mines are the common jobs of these children who are below 15 years of age. There were 21 children who served as labourers in the two sample areas. They are either school children or children who should be attending school.

Conclusions

Absorption of the coral mining work force by other economic sectors has been suggested by some researchers as a long-term remedy for the protection of coastal environment. Since an assessment of the coral mining activities is difficult without knowing their socio-economic aspects, this research examines the general facts of employment, land tenurial system, income and profit levels, production and marketing of lime and also distinctive socio-economic problems of the community.

Facts discussed as an introduction suggest that there were certain periods of intensified activities of coral mining during historical times. At present, three types of these activities can be recognized: the mining of buried corals, mining living reefs and collection of debris accumulated on the shore.

The labour force engaged with the mining of corals works in specified jobs but they are paid according to skill and sex. The workers in kilns do not have to perform any specified task and hence do not need skill. However, daily wages received by all the workers are very low and most of them only earn their day-to-day living. People engaged in the mining of living reefs earn the lowest income.

In general, the profit gained by the owners of kilns and mines are higher than the other income groups. However, they are fewer in number and are able to control the whole of the wage levels. Both groups, the owners as well as labourers, suffer through enforcement of laws and propaganda against the industry.

The distinctive problem of mining in the two areas is the shortage of land and miners find land, under complex tenurial system. This problem is severe in the Akurala area because most of the land has already been used for mining. In addition, unrest arising due to environmental pollution, adverse effects on houses of the area, participation of child labour, etc, is experienced by the community.

The supply of alternative employment for the miners of living reefs is most essential and urgent as far as conservation of coral habitat is concerned. This situation leads us to deduce that none of the economic reasons can be found to keep them in the mining sector. The prohibition of activities of kilns along the SW coast as suggested by some authorities can lead to immediate unemployment of some 1900 people. Some workers have been asked to settle down in Mahaweli areas. The work force employed in the mining sector does not have any knowledge of agricultural practices. The workers of the kilns also do not have any knowledge of agricultural practices, so they should all be absorbed into other possible sectors of the economy. It is apparent that coral mining activities are characterized by complex socio-economic factors. Therefore, a suitable and well-formulated policy is essential to overcome the problem.

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