Seminar on

EXPLOITATION OF SRI LANKAN INDUSTRIAL MINERAL RESOURCES

Organized by the

Research Committee on Geology & Mineral Resources

of the

National Science Foundation (NSF)

Date: 18th November 2004 Venue: NSF Auditorium

NA-296

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PROGRAMME

09.00 a.m.	Registration of Participants
	Inaugural Session
09.30 a.m.	**Welcome address** Chairperson/Director National Science Foundation
09.40 a.m.	**Introduction to the seminar** Mr Priyalal Dias Chairman/ Research Committee on Geology & Mineral Resources of the National Science Foundation
09.50 a.m.	**Overview of mineral resources and mineral based industries in Sri Lanka** Mr Dulip Jayawardena Former Director/ Geological Survey Department
10.10 a.m.	Discussion
10.20 a.m.	T E A
	Technical Session I
10.35 a.m.	**Mineral Exports** Mr Athula Mudunkotuwa Deputy Director- Geology Geological Survey & Mines Bureau
10.55 a.m.	Discussion
11.05 a.m.	**Sand resources** Mr C.H.E.R. Siriwardhana Senior Geologist Geological Survey & Mines Bureau
11.25 a.m.	Discussion

11.35 a.m.	**Offshore mineral resources** Mr S.U.P. Jinadasa Research Officer National Aquatic Resources Research & Development Agency
11.55 a.m.	Discussion
12.05 p.m.	**Gem mineral resources** Mr Sarath Weerawarnakula Director Geological Survey & Mines Bureau
12.25 p.m.	Discussion
12.35 p.m.	Lunch
	Technical Session II
01.20 p.m.	**Petroleum resources** Mr Titus Jayawardena Director General Petroleum Resources Development Secretariat
01.40 p.m.	Discussion
01.50 p.m.	**Existing problems faced by mineral developers** Dr Bandula Perera Managing Director Samson Rajarata Tiles Ltd. (Member of DSI Samson Group)
02.10 p.m.	Discussion
02.20 p.m.	**Environmental impacts of mineral exploitation** Mr U.R.B. Navaratne Deputy Director Central Environmental Authority
02.40 p.m.	**General discussion and summing up**
03.00 p.m.	Tea & close of seminar

Rapporteurs
Mr Asoka de Silva
Prof. P.G.R. Dharmaratne

Existing Problems Faced By the Mineral Developing Industries

More than eighty percent of the industries (large, medium and small) are in Colombo and Gampaha districts. Once the rulers realized the adverse effects of this situation there was a huge outcry to take industry to villege. With the exception of the apparel industry we have miserably failed to take industry to villege. There are many reasons for this failure. In this paper I shall deal with only one of those issues. Namely, the problems faced by industries engaged in the value added production of mineral based products, which opt to locate the industry in the rural areas where the raw materials are available.

This 'Marathon' starts with the hunt for land. There is no clear cut procedure to get Government land. Thus potential investors may start off from anyone from local land commissioner's office to powerful politicos. This 'Merry Go Round' (which perhaps is the most appropriate word as one has to go to the same place over and over) starts with the land commissioner's department and ends up eventually (If you are lucky enough to survive the number of years of agony) with the office of Her Excellency the President. This process involves Ministry of Land, Land Commissioner's Department, and Ministry of Industries, Local offices of the ministries of land and Industries, and an 'N' number of surveys.

Once the land is cleared, approval for mining of the minerals is the next hurdle. This may involve most of the following departments (depending on the type and location). Irrigation department, Forest department, CEA, Agriculture department, Agrarian services department, Farmers apex body, GSMBU, Survey General's office, Government valuer's department, Provincial Council, Ecological and environmental groups, and finally the Bank.

For a local investor, the above process takes at least four to five years. How can one expect a SME to survive this. For some of the 'Flash in the Pan' type foreign ventures who hardly add value has none of these problems.

Under these circumstances will there be any serious investors to add value to our valuable minerals?

Dr. Bandula Perera

OVERVIEW OF MINERAL RESOURCES AND MINERAL BASED INDUSTRIES IN SRI LANKA

Dulip Jayawardena
Former Director Geological Survey Department
and
Retired Economic Affairs Officer United Nations ESCAP

ABSTRACT

Although the mineral sector recorded rapid growth in the 1980s and in early 1990s significantly retarded since 1995.Some of the reasons attributed to such a decline are the lack of interest by the Government since privatization of mineral based industries in early 1990s and the absence of effective monitoring of the performance of this sector. The contribution to the GDP from the mining and quarrying sector including the export of gems is on the average 1.8 to 2 per cent for the last decade.

The development of mineral resources is governed by the Mines and Minerals Act No. 33 of 1992 and the Regulations framed under Section 64 cited as Mining (Licensing) Regulations No. 1 of 1993. However due to certain deficiencies in these legal enactments there is a major setback to such development. . The Gem and Jewellery Authority Act No 50 of 1993 governs the mining and development of the gem industry. However this Government institution needs restructuring so as to enhance the export of gems and earn valuable foreign exchange.

An attempt is made to review the present status of mineral surveys and critically analyze the ceramic, glass, cement, and steel industries as well as graphite and mineral sands industries which are entirely based on exports. The proposal by Regional Plantation Corporations to undertake gem mining is also discussed. The progress made on mineral discoveries since early 1970s such as the Eppawela Rock Phosphate deposit, the Seruwila copper magnetite deposit and the four mineral sand deposits along the north eastern coast is reviewed.

In conclusion the need for an effective National Mineral Policy for Sri Lanka and the finalization of the long overdue amendments to the Regulations framed under the Mines and Minerals Act No. 33 of 1992 are strongly advocated if the mineral based industries to achieve sustainable development The amendments to the Gem and Jewellery Authority Act No. 50 of 1993 to reflect a more competitive industry is also suggested.

"SAND RESOURCES"

BY

C.H.E.R. SIRIWARDANA

(SENIOR GEOLOGIST)

AT

THE SEMINAR ON

"EXPLORATION OF SRI LANKAN INDUSTRIAL MINERAL RESOURCES"

ORGANIZED BY

NATIONAL SCIENCE FOUNDATION

MEP AUDITORIUM 18 NOVEMBER 2004

INTRODUCTION

The mankind requires shelter and other infrastructure to improve quality of life.

While construction industry provides such facilities it consumes fair amount of natural resources.

SANDS, the most common fine aggregate material, is among those resources of prime importance.

Thus, it needs careful monitoring and control in use, due to depletion of resource and adverse environmental effects.

It is attempted to study the nature, problems and solutions/alternatives related to SAND RESOURCES in the use of construction industry in Sri Lanka.

SANDS

Definition

Unconsolidated mixture of many constituents, minerals and rocks in usually rounded particles, with size ranges (petrological and technological).
0.05mm (dirt) < Sand <2mm (gravel)

Quality Requirements

-*Clean* (no dirt, micas, organic matter, inorganic gel)
-*Resistant to abrasion* (weak/crumbly rocks not suitable)
-*Resistant to freezing/thawing* (not be highly porus)
-*Resistant to wetting/Drying* (no fractures/porus)
-*Resistant to chemical reactions* (with alkalies, O_2)

Gradation

Each country has specific sizing limits (i.e., ASTM).

MINERALOGICAL COMPOSITION OF SANDS

Quartz	**> 80%**
Others	**<20%**
Ilmenite, rutile, sillimanite, zircon, monazite and other heavy minerals	**(found in variable amounts depending on the environment and proximity to source)**
Mica and feldspar, rock fragments(mainly in dry zone)	
Limonitic gravels and decaying organic matter (mainly in wet zone)	
Coral/shell fragments (mainly in marine environments)	

Main Available Sand Resources in Sri Lanka

- Main available Sand-resources of Sri Lanka are unconsolidated deposits of Quaternary to Recent age (generally <2 million years old) as follows:

  - Alluvial beds (river beds)
  - Paleo-alluvial beds (old river beds) & other land based deposits
  - Sand dunes
  - Beach sand horizons
  - Off-shore sand horizons

Main Alternative Sand Resources

Use of alternative sand resources depends mainly on production technology and its cost effectiveness and applicability of the products

Main Alternative Sand Resources are

- Crushed stones (manufactured sand)
- Quarry dust

ORIGIN

-The mineral *'quartz'*, the main component of sands, comprises in fair amounts in the high-grade metamorphic rocks (i.e., quartzites, chamockites, granites, gneisses and granulites) which underlie over 90% of Sri Lanka.

-Prolonged intense mechanical/chemical weathering under tropical climatic conditions alters rocks into series of weathering products

Weathered products:

- -Soluble salts
- -Clay minerals
- -Secondary minerals (hydrous Al and Fe oxides)
- -Weathering resistant
  - (a) Quartz
  - (b) Garnet, ilmenite, rutile, zircon, Corundum, Au etc.
  - (c) Feldspar, mica, ferro-mag. silicates (minor)

ORIGIN (conted..)

Weathering products are eroded and transported by agents such as water, wind and ice and are later deposited in lowlands and finally in sea forming sedimentary deposits including sand beds.

Environments of Formation

Fluvial Environment	*Marine Environment*
Alluvial/Paleo Alluvial deposits	**Off- shore Deposits**
-River floor sand beds	Terrigenous quartz sands
-Sandy islands and bars	**On-shore Deposits**
-Convex parts of meanders	Beach sands (reworked by sea waves)
-sandy overbank deposits	Dune sands (reworked by wind action)

Nature of Alluvial Sand Deposits

Location	*Conditions*	*Sand Deposits*
Upper Reaches	Narrow "V" valleys High gradient High flow velocity Low Sediment Influx	Ill-sorted coarse sands as isolated pockets within boulders and gravel beds
Middle Reaches	Broad "U"valleys Low gradient Low flow velocity High Sediment Influx	Sorted medium/ coarse sands as extensive islands, bars and floor beds with low clay intercalations,
Lower Reaches	Meanders/Oxbow lakes V. Low gradient V. Low flow velocity V. High Sediment Influx	Medium/fine sand beds in high clay intercalations "Paleo-alluvial beds"

ALLUVIAL SAND (AS) DISTRIBUTION

Generally, the larger sand deposits are found in drainage basins in the wet zone and are comparable with their discharges.

Drainage Basin	Catchment Area (sq. km)	Total Discharge (Cu.mx10^6)	Disch/Ppt %
Mahaweli Ganga	10327	11016	41
Kelani Ganga	2278	5474	62
Kalu Ganga	2688	7862	77
Walawe Ganga	2442	2165	22
Gin Ganga	922	1903	62
Nilwala Ganga	960	1104	40
Menik Ganga	1272	486	33
Aruvi Aru	3246	568	12
Kala Oya	2772	587	13
Deduru Oya	2616	1608	34
Maha Oya	1510	1608	29

(Source; MASL)

DUNE SANDS (DS)

- Sand dunes in Sri Lanka are low hillocks up to 1-5m heights, formed along coastal belts by wind-blown sands when they pile up against obstructions (shrubs /boulders).
- *Best developed around Jaffna peninsular, Mannar Poonaryn, Chilaw-Kalpitiya, Ambalantota-Batticoloa.*

- DS are Generally Fine grained, well-sorted , pure (without chemical impurities), subrounded to subangular sands
- Ideal for plastering, for concreting to be tested (i.e. cement mortar and concterte cube tests)

BEACH SANDS (BS)

Extensive beach sand deposits are located within littoral zone along almost entire coastal belts of Sri Lanka.

The sands, reworked by wave action, are generally coarse to medium grained and well-sorted but it may contain coral/shelly debris *(may cause negative effects on permeability in concrete)*and isolated heavy mineral sand pockets.

High in chemical impurities such as chlorides *(mainly cause corrosion and efflorescence)* , carbonates and sulphates when contaminated with sea water. Pure pockets with fresh water can be used as construction material.

OFF- SHORE SAND (OSS)

Major option that provides a large source of sand (practically inexhaustible?) is dredging of OSS

Used in many countries i.e. England, Netherlands, India, Seychelles and Singapore

Mandatory to conduct an EIA *(but studies show that* OSS can be won with minimal adverse environmental effects)

Gravity draining and action of rain can reduce the chloride levels in a stockfile to below acceptable levels of 0.075% and shell content (2%) did not impaire the engineering properties of concrete (Dias et al.,2002)

Large volume (over 7 million cu.m) has already been mined to supply for large scale projects, (CKE and SAGT port terminal)

MANUFACTURED SANDS (MS)

MS can be produced by crushing of rocks , specially silica stones such as quartzites.

Suitable for any purpose where river sand is used and cubicle/semi-cubicle shape facilitate dense matrix in concrete (Senaratne,2003)

Large number of quartzites are available in NCP, CP, WP and Uva P.

Steps in production: *Controlled crushing, grounding and abrasion,screening to remove clay size particles.*

QUARRY FINES (QF)

Could be used as partial replacement for sand for concreting, pre-cast concrete elements, cement blocks

Constitute particles of different shapes inherited from primary minerals including flaky micas

Smallest particle in QF is far smaller than of MS

SAND MINING INDUSTRY IN SRI LANKA

Sand mining activities has also shown an acceleration for past two decades. Main uses are for concrete aggregates, cement mortars and cement blocks, for macadamizing

Annual Sand Demand:

9.4 millions cu.m (National Sand Study for Sri Lanka, 1992).

5 million cu.m. obtained from major rivers (NERO, 2000)

Projected Sand Demand for the Construction Industry
(in million cu. meters per year)

Province	2004	2005	2006
Western	3.9	4.3	4.7
Southern	1.5	1.6	1.8
Central	1.2	1.3	1.4
North Western	1.0	1.1	1.2

Volume and Intensities of Sand Mining of Major Rivers

River System	Length (Km)	Sand mined (m^3)	Intensity (m^3/km)
Maha Oya -Lower Reaches	15	815,000	54,300
- Upper Reaches	60	1,084,000	18,000
- Total	75	1,899,000	
Kelani Ganga -Lower Reaches	60	750,000	12,500
- Upper Reaches	30	72,000	2,400
- Total	90	822,000	
Kalu Ganga -Lower Reaches	22	130,000	5,900
- Upper Reaches	45	191,000	4,200
- Total	67	321,000	
Total	232	3,042,000	

Source: National Sand Study for Sri Lanka – Report 1992 Netherlands Economic Institute

Divisional Secretariat	No of Identified Sand Deposits			Quantity available in cubes		
	1999	2001	2003	1999	2001	2003
Puttalam	11	08	12	46,740	7,100	26,100
Nilaweratiya	13	08	05	44,715	5,750	11,900
Anuradhapura	09	10	06	30,934	10,300	17,800
Kebelgane	20	12	11	74,490	10,500	44,000
Ibbagamuwa	08	05	-	2,903	1,800	-
Chilaw	09	03	04	35,212	1,100	2,100
Arachchikattuwa	11	02	03	34,510	1,100	2,400
Wariyapola	14	05	15	13,752	2,000	7,928
Ridigama	14	09	-	2,290	900	-
Ganewatta	08	06	04	4,465	2,150	1,800
Mahe	03	03	03	4,562	650	1,250
Kurunegala	01	01	01	220	50	700
Sigiriya	21	-	09	77,621.2	-	13,400

Comparison of Alternative Sand Sources

	Off-shore sand	Dune sand	Manufactured/crushed rock and sand
Particle size	Coarse to medium (but with few exceptions)	Fine and contained with in narrow grade envelope	Medium
Particle shape	Similar to river sand	Similar to river sand	Elongated and irregular
Content of fines (dust clay size particles)	unless calcareous mud is present 0.2% to 1.5% (with in permissible level of 4%)	0.2% to 0.4% well with in permissible limit of 4%	2% to 11% on material processed by washing/ sieving to remove excess fines (permissible limit : 16%)
Composition	May contain shells, shell fragments or some times calcareous mud	Small percentage of heavy metals	Same composition coarse aggregate

Comparison of Alternative Sand Sources Contd.

	Off-shore sand	Dune sand	Manufactured/crushed rock and sand
Properties of cement / sand or concrete mixes Workability and Strength gain	Similar to river sand	Good especially in plaster/mortar mixes. May need more cement or mixing with other type of sand	Poor workability due to particle shape, but both strength and workability improved by blending with fine sand such as dune sand
Deleterious material/ chemicals			
- Chlorides	0.01% to 0.2%(overall)	Less than 0.02%	Not applicable
-Sulphates	Less than 0.3% (with in acceptable limit)	Insignificant	-do-
-Organic matter	Insignificant	Very low	-do-

PRICES

Current prices of river sands are highly variable from about Rs. 3000/= to over Rs. 6000/- per cube

Prices depend s on (Sand survey GSMB,1998)

- Number of mine sites in an area
- Relative accessibility to the minesites in the area
- Relative distance between mine sites and the area of high demand
- Availability of labour

Prices of *River* Sand Alternatives with transport (as on September 2003)

Alternative	Price of Alternative Rs per cube	Comparative River Sand Price Rs per cube	Price increase of the alternative Rs.
Dune sand from Puttlam district	868	1200	-332
Off shore sand near Negombo	1100	1200	-100
Sand from washing soil Avissawella	900	1200	-300
Quarry dust	1400	1200	400

Source- Perera A -2003

Environmental Effects on Excessive Sand Mining on Rivers

-Changes in gradient and cross-sectional shape of river course disturb the natural dynamic equilibrium causing unexpected erosion and deposition within fluvial environment

(i.e collapse of banks with buildings/roads etc , sediment filling and changing river course)

- Closing of river mouth and collapsing of natural levees causing floods during rainy season

-Footing pillars of bridges immerge /destabilize

-Salt influx up to middle courses of the rivers during dry season (due to deepening river bed)

- Lowering ground water table in and around the area causing drying of wells/springs during dry season

-Acceleration of the erosion in watersheds

-Reduction of sediment flow to beaches leading coastal erosion

Summary

Alternative	Commence-ment	Availability	Environmental impact	Capital investment	Price wrt river sand	Applications
Off shore sand	Commenced	Long term	Low	High	Just below	Filling concreting
Dune sand	Commenced	Medium term	fairly low	Low	Just above	Plastering concreting
Land based sand	Commenced	Medium term	fairly low	Low	below to above	Filling concreting
Manufactured sand	Immediate future	Long term	Medium	High	much above	Plastering concreting
Quarry dust	Commenced	Long term	Medium	High	much above	concreting ct blocks

RECOMMENDATIONS

-It should be explored all the possibilities of alternative sand sources for alluvial sands

-Technical specifications should be updated to accommodate alternative sand sources and craftspersons should be trained

-Strict implementation of all laws and regulations of Environmental Protection Acts related to sand mining should be promoted and monitored.

-Necessary steps to be taken so that all sand miners should possess valid licences issued by the GSMB

-It should be reduced the demand for fine aggregate in construction by promoting the use of alternative partitioning, non-plastering of walls etc.

Marine Mineral Resources

- Sri Lanka's Potential

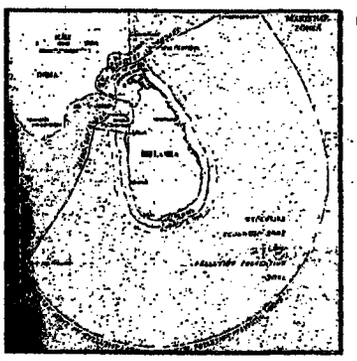
S.U.P. Jinadasa
Oceanography Division
National Aquatic Resources Research and Development Agency (NARA)
Crow Island
Colombo 15

November 18, 2004

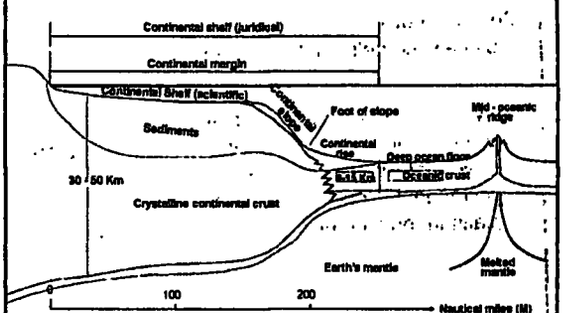
Introduction

- Oceans comprises over 70% of the earth's surface
- Prior to the Challenger expedition of 1943-46, little was known about sea floor, specially deep Oceans.
- Post world war generated vast amount of information on resource potential of the sea floor

Maritime zones



The continental shelf

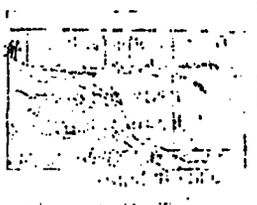


Origin of marine minerals

- Lithogenous (Detrital) Supply
- Hydrogenous
- Biogenous
- Cosmogenous

Lithogenous (Detrital) Supply

Lithogenous (detrital) fraction of marine sediments consists of material derived to the oceans as solids which undergo little alteration during their transport and final deposition (Windom, 1976).



- Lithogenous components of marine sediments may be of land erosion or submarine volcanic activity.
- Eg. Quartz sand, Heavy minerals (Black sand), Volcanic ash

Hydrogenous Supply

Chemical elements may enter into the seawater by

- dissolved material in rivers draining the continents
- hydrothermal solutions of submarine volcanoes.

Biogenous Supply

Biological elements may be supplied to the seafloor by

- Sinking of the marine organisms remnants
- Life processes of organisms.

e.g. Phosphorites are seafloor mineral deposits showing a major biogenic influence.

Cosmogenous Supply

Cosmogenous supply, originates by extra terrestrial planets, comets, meteorite, etc.

may not contribute substantially to the bulk composition of any marine mineral deposits. Nevertheless, it is possible that platinum of cosmogenic origin may be contributing to the platinum enrichments in some cobalt rich crusts

Marine Minerals potential

- Aggregates
- Placer minerals
- Phosphorites
- Manganese nodules
- Hydrothermal deposits

Aggregates

Near-shore deposits of non-metallic detrital minerals and calcium carbonate, principally used in the construction industry, Occur in both beach and offshore areas.

The economic value of aggregate deposits are mainly depends on

* grade and quality of the deposit
* distance from the potential markets
* environmental impact on aggregate mining (land and offshore)
* increase in land prices

Placer minerals,

- which are detrital metallic deposits generally found on beaches and in near shore areas.
- are metallic minerals or gems which have been transported to their site of deposition in the form of solid particles

Deep sea minerals

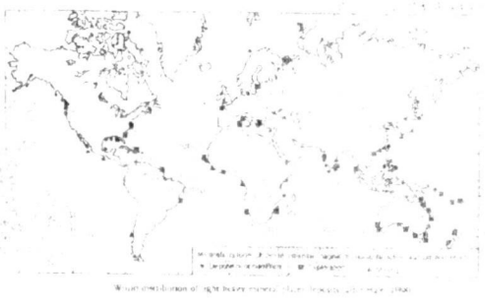
- Phosphorites - authigenic minerals formed in situ on the sea floor,
- Cobalt rich crust- Ferromanganese oxide crusts occur at seamount areas in and around island chains.
- Hydrothermal deposits, metalliferous muds including polymetallic sulphides, which are precipitates of principally iron, copper and zinc sulphides formed as a result of submarine volcanic activity.

but which can also contain enrichments of lead, silver and gold.

•Manganese nodules –

principally of manganese, nickel, cobalt and copper,

World Distribution of Placer Minerals



Placer deposits of Sri Lanka

Tools of identification.– composition & specific gravity

Placer minerals include * Gold

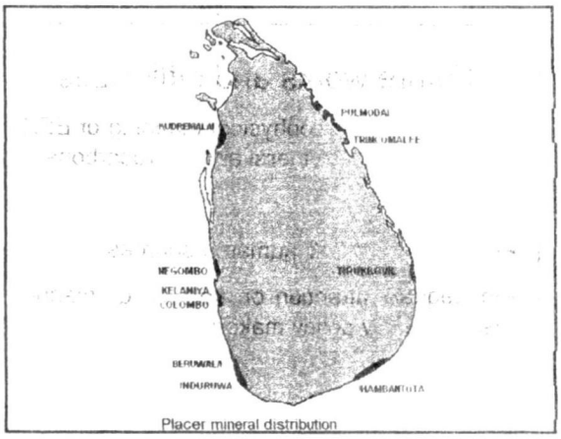
* Platinum

* Cassiterite (tin)

* **Ilmenite**

* **Rutile**

*

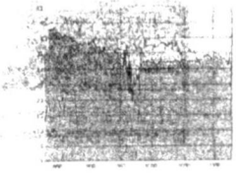


Placer mineral distribution

Offshore sand deposits

Mudun Ela sand deposit

This survey was conducted Sri Lanka Land Reclamation and corporation Under this project offshore geological and geophysical survey s were conducted The quality and quantity analyses were carried out by NARA and approximately 225 million cubic metres of sand deposit could be identified



Colombo to Galle survey

This program was conducted under CRMP project collaboratively with British geological Survey. Under this, It could be identified approximate volume of 250 million cm

Off Colombo (25 million cm);
Wadduwa(55 million cm);
Kalutara – Maggona (25 million cm)
Beruwala – Bentota (28 million cm);
Hikkaduwa(93 million cm)

Hambantota

NARA has already conducted some geological investigation at off Hambantota to off Kirinda. Under this investigation, we could identify the qualitatively suitable sand deposits at this area. However due to the limited resources NARA has unable to conduct the geophysical investigations. Therefore, geophysical investigations should be carried out for in this area to find out the potential of the deposit.

Pamunugama

Very recently, NARA has carried out geological and geophysical investigations at Pamunugama area jointly with Geological Survey of India. The sample analysis and data interpretations should be carried out jointly with NARA scientist at Geological Survey of India laboratory, Mangalore.

- East coast:

Location : Pulmoddai
Quantity: 4 million tons
Composition: ilmenite 70-72%,
zircon 8-10%
monazite 0.3%
sillimanite 1%

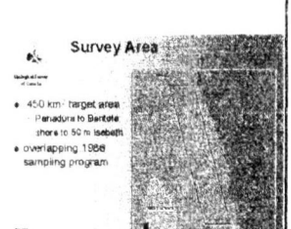
The offshore area in front of the Pulmoddai deposit has proven ilmenite, rutile and zircon reserves of 0.95 to 1.34 million tons.

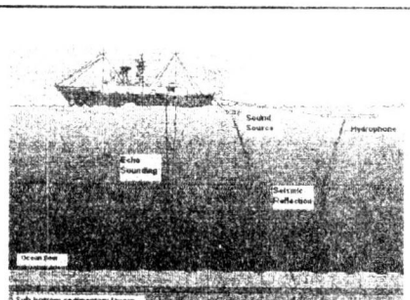
West coast:
Kudremalai (Monozite)
Chilaw, Negombo, Galle (Ilmenite)
Madampe, Marawila (Silica)
Beruwala, Kaikawela (Monozite)
Hambantota, Ussangoda (Garnet sand)

Beruwela Monazite deposit

Beruwala Placer deposit

~ 450 square kilometers of the continental shelf were explored for potential heavy mineral deposit at this area by Geological Survey of Canada under United Nations Revolving Fund For Natural Resources Exploration (UNRFNRE). Sixty eight surface sediment samples were collected for interpretation of the geophysical data. These investigations revealed that there was sediment deposit with approximately 400 million cubic metres. The thickness of the sediment cover varies from 1m to 14m's. After extraction of heavy minerals remaining can be used as sand for constructions.





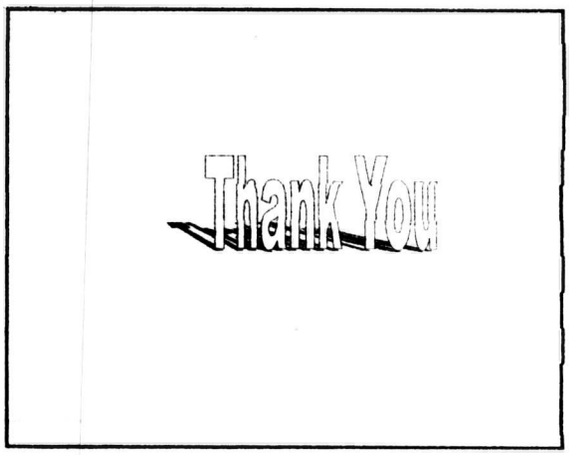
Offshore mineral exploration survey

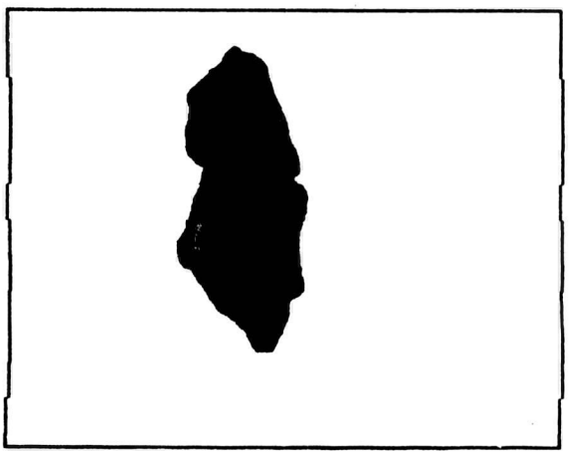
Future works and difficulties

- Geological & Geophysical mapping of EEZ of Sri Lanka for mineral and hydrocarbons

Difficulties

- Lack of physical & human resources
- Inadequate attention on non living marine resources by policy makers


Thank You



INTRODUCTION

The development of mineral resources was earlier considered as a vital engine of economic growth in Sri Lanka. However the importance of preserving the environment for future generations and the recent Earth Summit on Environment and Sustainable Development in 2001 has led to the Governments especially in developing countries to give low priority considerations for the development of this industry.

The mineral industries namely ceramics glass steel graphite and mineral sands were under Government control and operated by State Sector Corporations established under Industrial Corporation Act No. 49 of 1957. However since these state sector institutions were not efficiently managed and resulted in low productivity. This eventually led to serious losses and the Treasury had to heavily subsidize for the payment of salaries to workers and maintain the operations. Political interference was also a major cause for the downfall of these corporations that were earlier making profits.

The Government under the restructuring programme of the State Corporations converted the corporations to state companies under the provisions provided in the Conversions of Corporations and Government Owned Business Undertakings into Public Companies Act No. 23 of 1987. Accordingly the Corporations involved in mineral based industries such as the Ceramics, Graphite Steel Glass and Mineral Sands were converted to Public Companies and later the shares were divested to the Private Sector.

An attempt is made to review each industry from the days of state control and after privatization and identify the modalities that should be in place to effectively monitor the productivity and cut back on imports to improve the balance of payments as well as increase exports.

THE CERAMIC INDUSTRY

The major raw materials that are utilized for manufacture of ceramic products and brick and tiles are.

1- Clays- Three main clay provinces are known in the Island and these provinces closely follow the three distinct climatic areas. The exploitable clay deposits for the brick and tile industries are presently concentrated along the Maha Oya basin north of Negombo, Yatina and Uda-Walawe.The requirements of clay for the brick and tile industry have not been estimated .However it was reported that in 1983 the requirements were about 1500 acre feet in 1983. There are no reliable statistics on the present demand for brick and tiles and an attempt should be made by the GSMB to collect the information at the district level in close coordination with the District Secretaries

2- KAOLIN - The occurrence of kaolin in the low lying areas of Colombo has been known .The Boralesgamuwa Kaolin field is presently operated by

Lanka Ceramics Ltd. And the reserves were estimated at about 1 million tons in 1984. However the present reserve estimates are not known.The Meetiyagoda Kaolin field also operated by the same company but reserves are not known . The production of kaolin from these two mines and refineries was 8613 tons in 2002 valued at Rs 2.02 million .Further the two refineries in 1985 produced about 7000 tons of refined kaolin.

3- BALL CLAY- The best known ball clay deposit is located at Dediyaewla near Kalutara and the reserves in 1985 were estimated at 500 000 tons. The present reserves are not known. In 2002 , a quantity of 28, 431 tons valued at Rs. 28 .3 million was produced and the major consumers were the local Ceramic Companies and Lanka Wall Tiles Ltd.

4- FELDSPAR- mainly used in the ceramic and glass industries. And no reserve estimates are available. Feldspar occurrences in the form pegmatites are located at Rattota, Talagoda, Kaikawela Madampe and Koslanda areas. The major producer of feldspar is Lanka Ceramics Ltd. Apart from the other small producers. In 2002 a total of 28 866 tons of valued at Rs. 55.4 million was produced.

5- VEIN QUARTZ - High purity vein quartz deposits of 99.98 per cent SiO2 are found at Ekerella, Pelmadulla , Pusella, Matale Ratnapura Galaha and Mahagama.7857 tons of vein quartz valued at Rs. 108.4 million were Produced in 2002. No reliable reserve estimates are known but could Exceed 50 Million tons.

IMPORTS OF CERAMIC RAW MATERIALS

According to the 2002 Sri Lanka Minerals Year Book published by the GSMB the following ceramic raw materials were imported to Sri Lanka:

Mineral	Quantity	Value
Kaolin and Kaolinitic clays	10334 tons	Rs. 284 M
Feldspar	1842 tons	Rs. 8.64 M
Quartz	147 tons	Rs.14.82 M
Clay	4848 tons	Rs 168.33
Dolomite	43.3 tons	Rs .96 M
Total	17214 tons	Rs. 519 M

It is not known as to how the above minerals which are found in abundance in Sri Lanka were imported draining Rs. 519 million as foreign exchange .The govt. should investigate as to why these minerals were imported and encourage the ceramic and other factories including those in the FTZ to use the local raw materials.

PRESENT STATUS OF THE CERAMIC INDUSTRY

At present 40 companies are involved in manufacture of ceramic products.. The products range from table ware, sanitary ware, wall tiles, floor tiles insulators, refractory bricks, and ornamental ware. Some of these items specially table ware and wall tiles have found good export markets. If the year 2002 such exports earned over Rs. 3.94 Billion.However it has been reported that in 2002 the value of ceramic ware imported to Sri Lanka was 1.43 Billion. The sanitary ware produced in 2002 was valued at Rs. 59 Million as compared to import of such products for the same year at Rs 310 Million.

THE CEMENT INDUSTRY

The main raw materials are Miocene limestone and clay. Gypsum is imported. Limestones are found in commercial quantities along the north western coastal belt and in the Jaffna Peninsula. The Ceylon Cement Corporation operated the Puttalam and Kankesenturai cement factories and the clinker grinding and bagging plant at Galle unto the early 1990s when these facilities were privatized. The Kankesenthurai Cement factory ceased operations in mid 1980s with the eruption of hostilities and civil unrest in the region. The total use of cement in 2002 was in the region of 2.32 million tonnes as compared to about 600 000 tonnes in 1984.

The total reserve estimates of Miocene limestone at Aruwakalu and Kankesenthurai were in the region of 100 million tones in 1985.according to the surveys carried out by the Geological Survey Department. The Department in the 1970s conducted further surveys in the Parippukandanthan area close to Mannar and proved a reserve of 38 million tons.. Further the Dept. also proved a reserve of 40 million tons on the Dutch Bay.

PRESENT STATUS OF THE CEMENT INDUSTRY

In the year 2002 the cement producing facilities located at Puttalam, Trincomalee and Galle were in operartion. However the Puttalam cement factory owned by Holcim (Lanka)Ltd subsidiary of Holderbank Ltd from Switzerland produces cement using local limestone and clay. The Tokyo Cement Co at Trincomalee and at Galle to grind clinker and gypsum which are imported and and the cement is distributed bagged or in bulk.

848, 093 tonnes of limestone were mined from Aruwakalu by Holcim Ltd in 2002. The production of Portland cement from the operating facilities in Sri Lanka for 2002 was 1.08 million tonnes valued at Rs.5484 Million. However the imports of Portland cement alone apart from other cement based products for 2002 were 1. 207 Million tonnes valued at Rs. 4.310 Million.

It must be stressed that the present status of proven reserves of Miocene limestone and clay is not known to any degree of certainty as the GSMB has not actively monitored the use of such non renewable mineral resources and carried out extension during the recent past. Accordingly it is uncertain as to how long these raw material will last and eventually the company will have to import clinker or limestone and clay in addition to gypsum to maintain production even at the present levels.

THE GRAPHITE INDUYSTRY

This industry is the oldest mining industry in Sri Lanka dating back to about 160 years. The boom periods were during the two World Wars where there were nearly 6000 open pits and shallow underground mines in all parts of the Island. These mines produced over 35 000 tonnes of high-grade graphite. However after the Second World War only 4 mines were in operation in 1951.and from 1965 only 2 mines namely Bogala and Kahatagaha/ Kolongaha were producing graphite for export.

In 1971 the graphite industry was nationalized and operated by the State Graphite Corporation. Subsequently with the policy of privatization of State Corporations and Government Owned Business Undertakings into Public Companies Act No 23 of 1987 two public companies were established and later ownership was divested to the private sector. At present Bogala Graphite Ltd. operates the Bogala mine .The Kahatagaha Graphite Lanka Ltd. had severe labour problems since privatization and was renationalized in 1996. The mine operated until about 2002 and was closed due to severe cash flow problems. At present urgent maintenance work such as dewatering is carried out and the new management hopes to start operations soon. However the Government has still to decide whether to privatize the mine again or not.

The total quantity of graphite produced in the year 2002 was 3 619 tonnes as compared to 5910 tonnes in 1998.A total of 4053 tonnes valued at US$ 1,515 159 was exported in 2002. However it is reported that in the year 2001 a total of 3387 tonnes of graphite valued at US $ 1 152 550 were exported only to Japan. In 1985 the State Graphite Corporation had been exporting on the average of 7500 to 8000 tonnes of graphite from the two operational mines.

Since the GSMB has no effective supervision of the graphite industry it is not possible to monitor the operations and the exports specially the prices of the various grades depending on the carbon content and the particle size vis a vis the International market prices.

THE MINERAL SANDS INDUSTRY

The Ceylon Mineral Sands Corporation was established in 1957 primarily for exploitation of the Pulmoddai heavy sand deposit .The Corporation operated an integrated mining and mineral separation plant for ilmenite zircon and rutile. It is estimated that the deposit contains 6 million tons of heavy sands but this tonnage is

replenished every year during the north east monsoon. The composition of the sands is 70 –75 per cent ilmenite 8-10 per cent zircon and 10 percent rutile.

The Geological Survey Department in collaboration with Intersite BV a company from the Netherlands carried out a detailed exploration programme to locate new heavy sand deposits along the coastal stretch from Nilaveli to Mulaitivu in 1981.This programme was successful to confirm the findings of the Department on the occurrence 4 promising deposits. The heavy sand deposit at Poduwakattumalai which extends into the land area for about a mile along a stream course proved a tonnsage of over 8 million tones of heavy sands. The other deposit was at Nai- aru where the sands are concentrated in the form of a hard black reef along the coast and further work was not possible due to unsettled conditions.

Lanka Mineral Sands suspended all operations at the Plant in 1992 after the LTTE blasted the conveyor belt and the loading jetty at Pulmoddai. A vessel that was anchored at the jetty for loading of ilmenite was also sunk. However the exports of mineral sands from the stock piles continued from the Port of Colombo.

In 2002 a total of 5 tons of ilmenite (valued at US $ 7850) , 1662.1 tons of rutile (valued at US $ 361415) and 19854 tons of zircon (valued at US $ 1, 750, 704 were exported or sold to local buyers.

THE STEEL INDUSTRY

The Ceylon Steel Corporation was established in 1961 for the purpose of implementing the steel project, which included the setting up of rolling and wire mills under Stage 1. These two mills were commissioned in 1967 and had a capacity of 80 000 metric tons per annum. Under Stage 2 of the expansion programme a continuous casting electro-smelting plant was commissioned in 1982 and was capable of using local scrap iron. Stage 3 of the expansion programme envisaged the use of local iron ore.

The Geological Survey Department had proved 2.2 million tons of limonitic iron ore in the Dela, Noragolla, Opata and Poranuwa areas of the Ratnapura District .The iron content varied from 53-54 per cent. These occurrences are highly scattered and are in the form of boulders but the main drawback in utilizing this ore is the high phosphorous content.

The department also discovered 3 magnetite deposits at Wilagedera(1959) Panirendawa(1962) and Seruwila(1971).The Panirendawa deposit contains 5.6 million tons of magnetite but cannot be mined as one unit as it is broken into 4 structural blocks underground. The Seruwila magnetite deposit is on the surface and is the most promising deposit in Sri lanka. An advanced exploration programme carried out in early 1980s by the French BRGM proved a reserve of 4 million at 40 per cent soluble iron up to a depth of 100 meters.

At present the major requirements of iron and steel are imported. However some products as required by the construction industry such as rolled products, drawn wire etc. are manufactured in the local steel plant by Ceylon Heavy Industry and Construction Company (CHICO) a subsidiary of DOOSAN of the Republic of Korea.

In 2002 a total of 9207.63 tonnes of iron and steel products were manufactured by CHICO.

The imports of iron and steel in 2002 were 333,571 tonnes valued at Rs. 8450 Million. Further a total of 9208 tonnes of stainless steel valued at Rs 750 Million were also imported in 2002.

THE GEM INDUSTRY

The precious and semi precious stones in Sri Lanka with the exception of moonstones are won from gravels in river beds, buried river valleys and swamps. At present extensive gemming activities sometimes of an illicit nature are carried out in the Ratnapura, Elehera ,Okkampitiya Embilipitiya, Madampe, Kahawatta , Balangoda and Rakwana areas.

The State Gem Corporation was established under the State Gem Corporation Act No. 13 of 1971 with the main functions of issuance of licenses for gemming, cutting and polishing trading as well as auctioning crown lands for gemming.

In order to further widen the scope of the Gem Corporation the national Gem and Jewellery Authority (NGJA) was established in 1993.The main objectives of the NGJA at present are development, regulation and promotion of the gem industry and the jewellery industry and provide for institutions to promote such development. It is widely known that the NGJA is unable to fulfill its objectives for lack of staff. Moreover the functions assigned to this Agency are highly diversified and infringe into the legitimate functions of other state sector institutions. There is also conflict of interests in issuance of licenses specially for trading.

The Annual Report of the NGJA for 2002 state that major activities included providing lands for gemming (state lands) issuances of licenses implementing the Act supervision of gemming, facilitate the export of gems and rehabilitation of gemmed out land.

In the year 2002 the total income of the Authority in performing the above functions was Rs 104.7 Million, which also included income from, fixed deposits and Treasury bills amounting to Rs. 25 Million. Therefore the operating income was only Rs 76.7 Million against an expenditure of Rs. 80 .3 Million resulting in an operating loss of Rs. 3.5 Million for 2002.

It is proposed that the Government may consider the restructuring the NGJA to reflect the following.

The issuance of licenses for gemming to be handed over to the GSMB and such licenses issued under the Mines and Minerals Act No. 33 of 1992 and the Regulations framed under this Act.

The supervision of gemming and related environmental management to be assigned to the GSMB in collaboration with the CEA.

The Regional Plantation Companies be permitted to carry out gemming within their estates.

To achieve the above objectives it is mandatory that the two main legal regimes for these activities namely the NGJA and MM acts should be amended.

EMERGING ISSUES RELATED TO THE MINERAL INDUSTRIES IN SRI LANKA

An attempt has been made in this paper to review the present status of the mineral industries in Sri Lanka. With the adoption of the open economic policies in 1977 the entire industry was restructured and with the exception of the mineral sands industry the rest were privatized.

However during this transformation there was hardly any consideration given to the effective supervision and regularization these industries resulting in the inability of the Government to closely monitor the performance of these private companies in the national interest.

The use of mineral raw materials for the various industries is also not properly monitored. Moreover the most serious issue is the non-availability of proven reserve estimations of such minerals and the projected use of such minerals in comparison with the long-term Corporate Plans of such companies.

It would have been more effective if the privatization process took into consideration the Mines and Minerals Act No 33 of 1992 and specially Section 10 (!) and (2) of the Regulations where there is provision for negotiating a Mineral Investment Agreement by the proponent with the relevant Secretary of the Ministry administering the Geological Survey and Mines Bureau.

Although the mining and export of graphite and mineral sands have gone on for decades no meaningful steps have been taken to establish production lines for value addition. Sri Lanka graphite is the most pure form of carbon and ideal for manufacture of refractories, carbon brushes and crucibles. This form of graphite is also used in atomic reactors as a radiation shield.

The upgrading of ilmenite to synthetic rutile for manufacture of white pigment was actively pursued by the Government in the late 1980s but was not successful.

The Eppawela Phosphate deposit was discovered by the Geological Survey Department in 1971. In spite of research work done by local scientists and international research institutions such as the International Fertilizer Development Center (IFDC) in Alabama USA during the past 33 years no processing facility has been established for conversion of this rock to water soluble phosphate fertilizer. It must be pointed out that the Supreme Court has issued an injunction and a restraining order that no development of this deposit should be even considered until such time that all reserves of apatite in Sri Lanka are moved from inferred to proven category and a comprehensive EIA carried out by the CEA Moreover the CEA was designated as the project approving authority.

The GSMB and the CEA should take note of this restraining order if any project to manufacture phosphate fertilizer is to be seriously considered.

The Seruwila copper magnetite deposit was discovered in 1971 by the Geological Survey Department. This mineralized belt runs in a northeast - southwest direction and indications are that it could be mineralized. The GSMB should give priority and initiate a detailed exploration programme without delay.

The ceramic industry is well established in Sri Lanka mainly due to the availability of high quality raw materials. As indicated there over 40 companies engaged in such manufacture including Noritake. However there is a grave danger that the local raw materials will be exhausted if urgent corrective measures are not taken.

The GSMB should take the pivotal role in getting the Ceramic Council to look into this matter and see how the facilities at Lanka Ceramics Ltd could be improved. It is known that the production lines of this company are now obsolete. It is suggested that the leading ceramic manufacturers should inject capital by forming an effective JV with Lanka Ceramics Ltd. on the basis of having buy back guarantees for the mineral raw materials.

The mineral sands industry is in doldrums at present. The Pulmoddai factory has not functioned for years. However the stockpiles were sold and it is reliably learnt that plans are under way to commence production soon. A private company has also established facilities for production of premium grade zircon from the crude zircon purchased at the factory gate price from Lanka Mineral Sands Ltd. Close monitoring of this operation has to be carried out by the Govt. if maximum benefits should accrue to the country.

There is a great interest in mining and processing of garnet sands .A Canadian company had carried out a detailed techno- economic feasibility study on the best garnet sand deposit in the country at Hambantota. However this project was not implemented due to the interference by politicians at the central and local Govt. levels.

There is a keen interest shown by entrepreneurs for mining and value addition to silica quartz. It is most interesting that there are 3 Cabinet decisions on this subject, which, contradict each other. It is now believed that the export of raw quartz is banned except for

the specific provisions provided in a Mineral Investment Agreement signed with the Govt and if the FOB price is over US 4300 per metric ton.
I strongly feel that there is no level playing field on this matter and urge the Ministry of Environment and Natural Resources to look into this as a matter of priority.

The issues related to sand mining were highlighted in the local press recently. This activity is highly politicized and I am aware of the conflicts between the District authorities. It is surprising that the relavent Government authorities who have to only recommend issuance of permits are ignorant of the Mines and Minerals Act No. 33 of 1992 which specifically state that the issuance of permits can be done only by the Director of the GSMB or a official designated by him.

The decision of the Supreme Court to ban mechanized sand mining covering all parts of the Island is good and the GSMB together with the CEA should take action to carry out a comprehensive study of the damage caused by such indiscriminate mining activities along all river beds in Sri Lanka. It is further suggested that the culprits should be identified and disciplinary action taken to claim damages.

CONCLUSIONS

The majority of mineral industries in Sri Lanka are now operated by the private sector and the continuous use of local raw materials for such industries will lead to accelerated depletion without knowing the reserve estimates. To this end the GSMB and is subsidiary GSMB Technical Services Ltd. should take immediate action to embark on such surveys with the main objective of proving the reserves in close coordination with the private sector.

Immediate action should be taken by the Government to formulate a comprehensive National Mineral Policy for Sri Lanka taking into consideration the concerns of the private sector. It is suggested that the Government consider studying the two legislative enactments related to mining of minerals and gemstones and assign functions so as to avoid duplication and even conflict of interests.

Early action should be taken to legislate the proposed amendments to the Mines and Minerals Act and the related regulations so as to avoid any loopholes in these enactments and prevent any unlawful activity.

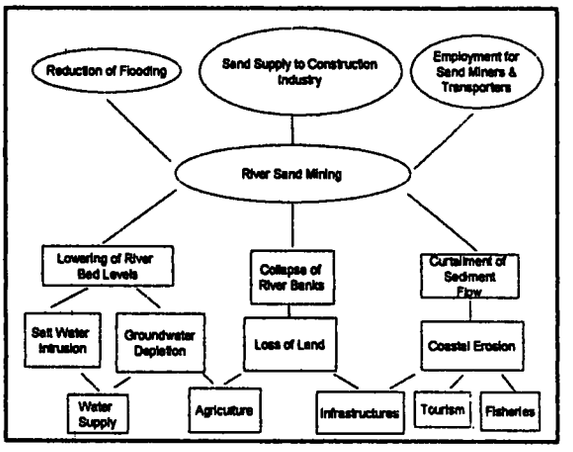
Environmental Impacts of Mineral Exploitation

- River Sand Mining
- Offshore Sand Mining
- Metal Quarries
- Extraction of Quartz, Mica and Feldspar

Environmental Impacts of River Sand Mining

Present Situation

River Sand Formation : Extraction = 1:2.7



Mitigatory Measures (Recommended to the Ministry of E&NR)

- **Impose restrictions on sand mining (up & down stream) to selected water intakes**
- **Impose ban on sand mining in places close to roads and bridges**
- **Suitable places for sand mining through a study such as the one done for Deduru Oya**
- **Tender sand deposits under strict conditions imposed by relevant agencies**
- **Protect an extent of 10m from the river that takes a circular route**
- **Promote planting of trees such as Kumbuk on the river banks**
- **Proposed alternatives for river sand such as offshore sand**

OFFSHORE SAND MINING

ANTICIPATED ENVIRONMENTAL IMPACTS

Mining Site and Pipeline

Physical Impacts

- Damage to coastal resources and possible threats to coastal stability
- Damage to the Coral / Sandstone reeves in the sea
- Enhancement of turbidity

Biological Impacts

- Impact on the bio-diversity

Social Impacts

- Disturbance to the fisheries activities

Suitable Mitigatory Measures

- Control of mining to ensure that there won't be any significant changes in wave current pattern and energy
- Control of mining to ensure that the underneath strata are not exposed so that the disturbed sea-bed ecosystem is given the best chance of re-establishing itself in the shortest possible time
- Establishment of a warning system at mining site and along the trace of the pipeline for the safety of the fishermen
- Compensation for the fishermen who loss the income in consultation with the Dept. of Fisheries

Stockpiling Site

Physical Impacts

- Saltwater intrusion
- Drainage problems

Biological Impacts

- Impact of the bio-diversity (especially due to the increase of the salinity of surface water)

Social Impacts

- Increase of salinity in drinking water
- Impact on agriculture
- Damages to the temporary structures (shanties)

Suitable Mitigatory Measures

- Proper drainage system/path for storm water in the temporary storage area
- Installation of a separate pipeline to pump back the seawater
- Continuous monitoring of the groundwater quality of the area

Environmental Impacts due to Metal Quarry Operations

- Inconvenience to the residents / damages to the houses of the area due to ground vibration and air blast overpressure
- Inconvenience to the residents due to increase of noise level
- Accidental hazards due to fly rocks
- Inconvenience due to dust emission
- Soil erosion and siltation
- Increase of landslide risk

Suitable Mitigatory Measures

- Control of ground vibration and air blast overpressure – Restrictions on blasting parameters (number of boreholes, diameter of boreholes, borehole depth, quantity of explosives)
- Fly rocks – Employing Suitable engineering measures
- Noise – Planting Tree Belts
- Dust – Tree belts, Spraying water
- Soil erosion and Siltation – Silt traps, Proper Drainage management system
- Landslide risk – Avoid quarrying at the places where the risk is high

Environmental Impacts due to Quartz, Mica and Feldspar Extraction

- Soil erosion and Siltation
- Pollution of surface water and paddy fields and lands
- Impact on wildlife due to abandoned pits
- Mosquito breeding
- Siltation due to processing activities (e.g. Ambanganga)

Mitigatory Measures

- Erection of silt traps
- Proper drainage management system
- Impose a ban on mineral extraction in declared forest reserves, national reserves and riverbank reservations
- Rehabilitation of the mining site
- Impose a ban on mineral processing at public water bodies