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RIVER SAND AND SEA SAND MINING INDUSTRIES IN SRI LANKA

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Abstract
This report has been discussed sea sand and river sand mining in Sri Lanka. To find out the consequences of the present situation regarding sand market and problems arise due to high demand. Currently, Sri lanka is facing sever environmental problems due to sand mining such as river bank erosion, saline water intrusion, destroying of coastal, loss of land and loss of live hood due to flooding. Beside all there are production related problems and marketing problems also can be seen in this industry. This paper has suggested some long term and short-term solutions for these issues

Introduction
River sand is one of the main consumable items in the Construction Industry. Due to the upward trend in the Construction Industry during the past 3-4 years the volume of Construction Projects has increased. As a result, excessive extraction of sand from rivers caused adverse effects in various environmental problems mainly lowering of riverbeds, threats to the drinking water systems, drying up of irrigation canals and river banks erosion have resulted in flooding problems and losing land.

In Sri Lanka, sand extraction is reaching the break point where extraction exceeds sedimentation. Therefore, the traditional source cannot meet the demand at present and an immediate alternative for sand should be found to meet the high demand in the present Construction Industry.

Sand resources in Sri Lanka
There are four types of unconsolidated sand in Sri Lanka

- Beach Sand
- Dunes
- River Alluvium
- Offshore Sand

The principle sources of sand are Kalani river, Maha-Oya river, Deduru Oya river, Kalu river and other small rivers. The banning of sand mining in river beds has driven miners and those in the construction industry to exploit sand dunes in the Kalpitiya Peninsula. In recent years sea sand has also become an alternative for river sand [1].

A. Kalani River
Kelani river has been a major sand supplier for an extended period and there are many well-known mining places along the river. For an extended period, these places operated under a system of licenses, which were normally issued by the local authority of the area. However, with the construction boom, which started in the eighties, more and more people entered sand mining industry and permits were issued on ad hoc basis. Although there were periodical suspensions or limitation imposed over mining by the local authorities, they were not effective in maintaining the mining of sand at a sustainable level.

There are many sand mining places along the Kelani river (Wellampitiya, Halmulla, Kotuwila, Sedawatte, Ambatale, Kaduwela, Bomiriya, Hanwella, Pugoda, Tharala, Karawenella and Ruwanwella) and they confirm the fact that the Kelani river may not be able to sustain the current level of sand supply in the upcoming years. Miners have expressed the same idea and they themselves feel it is not possible to continue sand mining in Kelani Ganaga for an extended period.

B. Maha Oya River

Maha Oya river used to be a rich source of sand. With the construction boom and due to non-availability of substantial amounts of sand in the Kelani river, Maha Oya river became a major supplier of sand to the Western Province. With the availability of superior quality sand and large deposits at competitive prices, the demand for Maha Oya river sand further increased among house builders.

Easy access to deposits made sand mining in the Maha Oya river more profitable and, in many cases; sand was directly loaded from the river bed to the tractors. Miners now should dive 8 to 12 feet under water to bring up sand, which was earlier loaded directly on to the tractors. In addition, fiberglass
Boats have been introduced, making the sand mining operations along this river like those in the upstream of Kelani river.

C. Deduru Oya River

Deduru Oya river is more than 80km away from Colombo and is an economical source of sand to the Western Province. However, availability of large deposits and the low cost of extraction have made the Deduru Oya river a competitive source of sand to the Western Province. Eventually there will be a cost escalation as the resource starts depleting.

D. Kalpitiya Sand Dune

These sand dunes extend along the Kalpitiya Peninsula to an extent of about 2,670 ha, rising to 4.5-6 m. The dunes are important as carriers of fresh water aquifers and play a vital role in maintain the groundwater table. They also perform an important coastal protective function, since they represent

flexible barriers which absorb wave energy. Dune sand could be used for any type of concrete, plaster and mortar since its chloride content is very low. The quality of land based sand depended on the type of soil used and the method of washing.

Offshore Sand

Off-shore sand, which is now used world over, is the major direct substitute for river sand. The sand is to be pumped out from a 20 meter depth. Off-shore sand has proven the potential and when the stockpiled sand is exposed to one shower of rain; it will wash off the salt content in it. The deposits in North of Colombo to Kalpitiya as the best locations to exploit off-shore sand because the chloride and shell contents are low compared to deposits in the Southern area. It is cheap and we should pay less than Rs. 2,500 a cube. Offshore sand mining has been earned out during the last eight years in Sri Lanka on a large scale for different purposes. At present the construction of the Colombo Katunayake express way is supplied with offshore sand. According to the information there is no substantial adverse impact on environment from the existing project.

Sand base industries in Sri Lanka

- For all construction purposes
- Concrete aggregates
- Cement mortar
- Plaster for surface finishing of walls
- Cement bricks
- High way
- Sand papers
- Flower pots
- For water filters
- Glasses

Results And Discussion

A. Sand Usage Statistics

There are no records kept of the river sand mining operations and it is not feasible to determine directly the quantities of sand consumed in the construction industry. Many a survey have been carried out by number of authorities to assess the quantity of sand extracted and its impact on the river system. The trends established of usage of sand from the above studies.

Table 01- Average quantity of sand used in different sectors in 2013

Sector	**Qty of sand Mtr. Cubes**
Building	2.8 Million
Highway	1.8 Million
Bridges	0.3
Water Supply	0.07
Irrigation	0.003
Dredging & Reclamation	0.001
Other	0.02

Current Demand

The recent demand for sand for construction within the island appears to be in the region of 7.5 Million Meter Cubes per year.

Table 02- recent demand of sand within provinces

Province	**Sand Vol. Million Mtr. Cubes**
Western	2.8
Central	0.85
Southern	1.00
Northern	0.15
Eastern	0.30
North Western	0.70
North Central	0.50
Uva	0.20
Sabaragamuwa	0.50
Total	7.00

It is estimated that annual increase in demand will be about 10% and with influx of donor funding above increase is expected to rise further

Price Escalation

The scarcity of sand and the high demand for sand has increased the price by more than 100%, in the Western, Central & Uva Provinces. Demand in the Southern Province with the Tsunami re-construction program has increased in many foods where in the Matara District a cube of sand has increased from Rs, 2,500/- in 2003 to Rs. 6000/- in 2005. This has created an increase in the cost of Construction Projects beyond the manageable

limits and only a few clients agree to accommodate this price hike. Hence some of the ongoing projects are suspended, as there is no viable solution to overcome this issue of national importance. This has affected the projects, clients as well as the constructors and thereby the Industry. Due to the time overrun in projects the other consumables too have gone up in price and serious multiple affects have incurred in the Construction Industry where many small and medium constructors will go out of business

1 cube of sand price is varying from province to province and it is depending on,

- Number of sand mining locations in that province
- Quality of transport service and roads
- Demand
- No of employments

B. Environmental related problems

It is widely accepted and scientifically proved that the continuation of overexploitation will accelerate the process that damages the environment. Eventually it will cause permanent environment damage on several fronts. The intensive exploitation of resources in the Western province from the kelani river has already caused severe problems like river bank erosion [2]. Further damage has become manifested in beach erosion and saline water intrusion into rivers causing severe problems mainly in the drinking water supply system in the Colombo metropolitan area.

The following list includes the impacts of sand mining on the environment in varying degrees.

- river bank erosion resulting in the decline of land area and loss of vegetation and destruction of reverie ecology.
- Adverse impact on agriculture and community due to draining of water from the wells.
- coastal erosion, affecting the fish landing, tourism, livelihood and Landscape.
- Intrusion of saline water.
- damages to buildings and other infrastructures along the river bank

Fig01- River bank erosion in Oha oya River

Saline water intrusion prevention: The cost that was incurred during the last three-year period 2002 to 2005 to prevent saline water intrusion was more than one billion rupees. Although it is unfair to allocate this expenditure entirely to the above period and consider it as a cost of damage within this period it is still justifiable to do so because these prevention methods may have to be introduced to the other rivers within this decade if sand mining continues at this rate.

River bank erosion has led to loss of valuable land. It has been estimated that each year nearly 12 hectares of land along the river banks get lost due to the sand mining. Although the river bank land has not much commercial value everywhere, in certain areas it is highly productive.

- Deduru Oya is increasingly overexploited. It is a good example that demonstrates the level of economic and environmental destruction due to uncontrolled sand mining. Divisional Secretaries in the area

(especially those in Chilaw and Arachchikattuwa) realizing the magnitude of the destruction caused by sand mining, have taken strict measures to control sand mining in Deduru oya river due to public pressure. Despite these interventions, sand extraction continues at an alarming rate.

- Simultaneously dramatic changes have occurred upstream of Hanwella along Kelani river. Some years ago, there were considerably large sand deposits upstream Hanwella. Unlike in the Maha oya river these deposits were under water and the high demand for sand drew many small operators into sand mining in this area. The local licensing system was not enforced firmly and political patronage too played a role in opening exploitation without restriction. In the meantime, sand miners started using sea worthy fiberglass boats of 17-20 feet, which were sold at a salvage value of Rs 6000 by fishermen. The number of fiberglass boats (17-20 footers) in operation upstream from Hanwella is estimated to be more than one thousand five hundred. This is a complete change in the industry and this type of operator could be found up to Awissavella, a town more than 60km away from Colombo.
- Due to intensive mining, upstream of Hanwella, the depth of the river is more than four meters in the sand mining areas during the dry seasons. The rock bottom is exposed in many places and the riverbanks have been eroded or became susceptible to erosion. Miners are experiencing a gradual decline in both output and quality of sand.

Coastal protection: The coast conservation department(CCD) has spent several million rupees on coastal protection over the last fifteen years and the amount of funds allocated for the next ten-year period is approximately Rs 400 million per annum. Due to the tsunami effects, this value may increase. During the last 15 years CCD has spent approximately Rs 336 million per annum for coastal protection. It is assumed that cost of coastal protection is the cost incurred beforehand to protect the areas which are likely to be eroded because of extensive extraction of sand from the rivers.

Loss of land: It is estimated that in areas where coastal protection has not taken place around 5 hectares per annum is eroded.

The loss of livelihood, extra cost incurred by the fishermen due to relocation, loss of safe landing sites, damages to boats and decline of time involved in fishing are the major reasons for the loss of livelihood for the fishermen.

Fishing community loses around ten to twenty permanent and semi-permanent houses per annum in addition to several hundred temporary structures. It is prudent to assign a value of Rs 150,000 per unit of these permanent and semi-permanent houses based on the discussion with the affected families. This includes some churches and other nonresidential buildings.

The loss of income to the tourist industry has a large effect on the organized leisure industry as well as the many other small timers in the industry who are directly and indirectly involved. Other than these economic losses the disappearance of beaches (loss of scenic beauty), and archeological sites, (loss of heritage), are also should be taken into consideration.

The major damage to environment quality is the loss of scenic beauty, appreciated and valued by visitors and residents of the area. At Wennappuwa and beyond, there is severe beach erosion. Otherwise it could have been an area of major tourist attraction. In order to value the beaches in this area, a decision was made to derive the value for Wennapuwa beach using the estimated value of the Hikkaduwa coral reef. A study carried out under a UNDP project has estimated, Rs 6135 million as the value of the Coral reef of Hikkaduwa. Assume out of the total value of coral reef, 10% can be attributed to solely to the beach.

Since the beauty of the beach at Wennappuwa and beyond is not yet known to many people it is very safe to assume that its value is as 10% percent of the value of Hikkaduwa beach. The total loss of environment quality in the area is therefore around Rs 61.35 mn (1% of the total value of Hikkaduwa beach and the coral reef). This is an extremely conservative figure.

Similarly, due to time constraints it is difficult to value the loss to the tourism industry. If there is a downturn in tourist arrivals in the area higher than the decline in the total tourist industry, the difference is the loss of tourism income due to destruction caused to the beach in the area.

The cost of health caused by pollution is very large in cities and less in other areas. However, the increase of vehicle movement to and from the Deduru Oya river carrying sand to Colombo will aggravate the situation in the adjacent areas. Officials in the health sector very often come out with the severity of the problem. However, it is logical to admit that even off shore sand mining and processing will not reduce the health cost of pollution because operation of dredgers and transporting of sand will cause the same threat but in a slightly reduced way. Therefore, we must keep in mind that offshore sand mining will not contribute in a large way to reduce the health cost of pollution.

To understand the actual cost to the economy, the Economic Cost Benefit analysis has been conducted. It has been further extended by incorporating environmental degradation in estimating the resource damage the replacement cost or the damage preventive costs were used. Health cost and income lost are straight forward if the assumptions made are reasonable. The large-scale removal of sand from dunes in the Kalpitiya peninsula and the sea belt from Udappuwa to Palavi in the Puttalam district of the North-Western Province has caused considerable damage to the eco-system as well as to the livelihood of the villagers, who mainly depend on agriculture. Due to this, the villagers of Kalpitiya Peninsula now fear that they may lose their lands Excessive mining of the dunes has already damaged the age-old sand formation that acts as a wind barrier in the area.

C. Production related problems

Fig2- River sand mining in Kelani River

Sand is one of the key materials used in the construction industry. The demand for sand for building construction within the country is approximately 7-7.5 million cubic meters per year and the demand for sand rises by10 percent annually. The recent tsunami destruction has caused a rapid increase for the demand of sand. According to industry insiders, over 22,000 million cubic meters of sand would be needed for immediate construction work, not counting any mega projects that may be drawn up in the long term. But the current supply is not sufficient to fulfill this requirement [3].

Due to the weather patterns in Sri Lanka sand can only be harvested in six months of the year. Miners generally do not keep a large stockpile of sand and therefore the requirement cannot be fulfilled.

Banning river sand mining in some areas has seriously affected on the production. River sand mining in Maha Oya river, Deduru Oya river and Kalu Oya river has been completely stopped recently. Before the ban was imposed, around eight million cubic meters of sand was harvested from these rivers. Therefore, authorities have imposed restrictions and have banned extraction of sand from rivers, oyas and streams that have been the traditional sources of supply.

Another severe problem is the lack of workers. This problem arises mainly due to the risk involved with the industry. It is widely experienced that prolonged staying under water causes serious problems in the eardrums and many other ailments. Also, the payments are quite low. A sand miner earns around Rs 300-500 per day. And there is a period of six months where there is no work.

The current construction material suppliers were small scale operators. However, the alternatives for river sand must be used by large scale investors and such investors must bear many extra costs such as taxes, license fees etc. This is one of the reasons materials such as off shore sand cannot get off the ground easily. Off-shore sand in the Southern province is not ideal due to high chloride and shell content and it reduces the resources.

The offshore sand mining should supply only the sand that has been washed, either mechanically or naturally to reduce the chloride content. The cost of a washing plant referred above is estimated at 1994 prices (sand study) [4]. The price of the plant is USD 40,000 at 1994 prices.

D. Marketing problems

The supply of sand was dramatically gone down due to the restrictions in production and transportation. In handling, large construction projects such as dams, highways etc. the concern is the availability of sand at the correct time and with the required standards.

The restrictions on extraction and transport of river sand has effected on the market. Costs have increased sharply, making it difficult for constructions to be completed in time, and within the estimated cost. Another problem is scarcity of sand in the market.

E. Suggestions to develop the industry

Due to the environmental impacts of the sand mining it is being restricted by the government. Since there is no way to avoid using sand for construction purposes it should be prevented or control the harmful effects and develop the industry. Also, there will not be sand in rivers in future to mine. Therefore, the necessary administrative and monitoring mechanisms must be set up to ensure environmental sustainability of river sand mining, the necessary regulatory and quality control measures should be in place, and development and implementation of standards and operating procedures for alternative processes for sand production must be carried out.

Finding alternatives for river sand is one way. Sand from dunes, crushed rock and quarry dust along with off-shore sand is viable alternative to river sand. When using offshore sand for construction purposes appropriate adjustments should be made. In concrete work, the amount of chloride that should be allowed in offshore sand depends on the amount of cement used, and the sand/cement ratio. If offshore sand is drained and exposed to rain for a short while, the chlorides come down to a lower level, making it acceptable.

The sand manufactured from rocks must be considered as a suitable alternative to river sand to cope with the increasing demand. We can find that manufactured sand resembled river sand in the composition of grain size and can be manufactured to serve the specifications and requirements of a range of common sand based products.

Dune sand could be used for any type of concrete, plaster and mortar since its chloride content is very low. The quality of land based sand depended on the type of soil used and the method of washing. The compressive strength results have shown that concrete made with all these alternatives were as good as the strength of concrete made with river sand. With a mixture of dune sand and crushed rock sand in the ratio of 1:1, a strength value higher than for river sand and offshore sand could be obtained.

As previously stated the alternatives for river sand must be used by large scale investors and such investors must bear many extra costs such as taxes, license fees etc. If the government can facilitate them with reduction of taxes and some other requirements the industry will rise again.

F. Suggestions to mitigate environmental problems

It is essential to consider the sand scarcity as an issue of national importance. The Construction Industry should grow hence it has become a major contributor to the GDP and GDCF of Sri Lanka [5]. The employment share of the Construction Industry is more than 350,000 and the indirect employment opportunities provided by the industry is about 350,000. Taking into consideration the importance of the Construction industry, it is essential to have short, medium and long-term solutions for this issue.

Short Term

- Allow sand mining in non-sensitive areas of rivers such as in Daduru oya river, Kelani river and Mahaweli river until such time alternative sources are found. Stipulating certain replenishments (such as rehabilitation of the land) when licenses are issued.
- As non-sensitive areas of rivers are mainly in the periphery remove all transport restrictions imposed on sand so that constructors themselves will be able to transport sand to their project sites without having a middleman.
- The limitation of sand mining up to a quantity of 35 cubes per month under license to be increased to a reasonable amount and allow constructors who have projects in hand to transport the amount necessary for the project without having an upper limit of 10 cubes per month.
- Import sand from India or Myanmar
- Locate dune sand deposits and allow sand mining in those deposits
- Encourage importation of ready mix mortar

Medium & Long Term

- Study the feasibility of pumping sea sand to rivers
- Encourage cement manufacturing companies to manufacture mortar for plastering and brick laying
- We can use the sand manufactured from rocks and sea sand must be considered as an appropriate alternative to river sand to cope with the increasing demand. Sand alternative manufactured from rocks resembles river sand in the composition of grain size and can be manufactured to serve the specifications and requirements of a range of common sand based products
- Do a feasibility study on natural sand reserves
- Research to be done to reduce usage of sand in construction or methods for construction without sand.
- Encourage prefabricated housing
- Encourage manufactured sand by granting 801 statuses for investors

Conclusion

River and sand mining has been the traditional source of sand for construction industry for generations. Since there is no price, tag on the resource, sand mining is profitable economic activity, and access to the resource is loosely restricted. This situation and the continuous increase in the construction industry have driven many investors to sand mining legally as well as illegally and exerted a large pressure on the resources. The rivers Kelani river, Maha Oya river, and Deduru oya river are major and direct victims of this process and river banks, water table, physical structure and the vegetation and riverine ecology has been badly damaged. Further the cumulative impact of the previous long term sand mining and the accelerated mining. This includes the costs of erosion of beaches, prevention of saline water intrusion to water supply systems, loss of agriculture outputs, tourism. Fishing and living hood of the people of the coastal areas. The loss of scenic beauty in coastal areas and the reverie ecology are damages, which is difficult even to quantify. Consequently, the average value of damage incurred to society by supplying sand from river mining to satisfy the demand in the Western Province, in financial terms, went up more than one billion rupees per annum.

The average cost of production of one cube of sand, including labor material and other indirect costs, is approximately Rs 5000/=. The government cannot afford to bear this cost and if it is continuous to do so the result will be more disastrous and many other economic sectors will face worse consequences.

The feasible option therefore is the offshore mining of sand, (which already is being done for another purpose). The technical report confirms if the sand is washed mechanically or naturally it can be used for all types of construction.

The offshore sand mining option has been studied and the financial analysis has shown that cost of washing one cubic meter, is very low, if the investor starts with a plant capable of washing at a high rate of sand.

It can be concluded that the investor has many options to run his business profitably. Separating of seashells will make the project financially viable even if the processed sand is sold at the existing prices. Moreover, it will readily solve another larger problem, the mining of corals for lime.

Production and which is the major contributory factor coastal erosion, mainly in the south of the country. The environment benefit of offshore sand mining is the elimination of damage caused by the river sand mining.

The government, should study the sustainable level of river sand mining and impose an environment tax on river sand mining to represent the full cost of the resource. At the same time investors can request government to impose lower VAT rates on off shore sand mining. The same rate should be applicable to river sand mining also.

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