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Sand mining effects, causes and concerns: A case study from Bestari Jaya, Selangor, Peninsular Malaysia

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The mining of sand resources from rivers and ex-mining areas in Selangor state is a common practice and may lead to destruction of public assets as well as impacts or increase stress on commercial and noncommercial living resources that utilize these areas. Hydraulic and sediment transport modeling study were carried out to determine possible sand deposition and their flow towards Selangor river. The Hydrologic Engineering Centers River Analysis System (HEC-RAS) software were used to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels and to get input and output information in tabular and graphical formats.The resulting vertical and horizontal distributions of sediment show encouraging agreement with the field data, demonstrating markedly different dispersal patterns due largely to the differential settling of the various sand classes. The assessment of water quality shows that water has been highly polluted immediately downstream of station at Selangor River due to high concentrations of suspended particles. Transport modeling and water quality analyses performed have identified major physical environmental impacts. The issue poses a number of policy questions that are worth to be implemented by the government.

Key words: Selangor river, water quality, sediment, transport, modelling. environment, illegal mining.

INTRODUCTION

Sand mining is the removal of sand from their natural configuration. Sand is used for all kinds of projects like land reclamations, the construction of artificial islands and coastline stabilization. These projects have economical and social benefits, but sand mining can also have environmental problems. Environmental problems occur when the rate of extraction of sand, gravel and other materials exceeds the rate at which natural processes generate these materials. The morphologies of the mining areas have demonstrated the impact of mining with the prowess to destroy the cycle of ecosystems. Numerous publications have been written with respect to these effects, and the next step is what to do to minimize, prevent or correct these environmental effects, the so-called mitigating measures (Pielou, 1966).

Sand mining is of great importance to the Malaysian economy. It should however, be recognised that the processes of prospecting, extracting, concentrating, refining and transporting minerals have great potential for disrupting the natural environment (Rabie et al., 1994). Many Selangor streams, rivers and their floodplains have abundant quantities of sand and gravel that are mined conveniently and economically for a variety of uses. Often the conditions imposed on the approval for sand mining activities are expressed in administrative terms, without technical consideration of their potential impact on the ecosystem.

Physical impacts of sand mining include reduction of water quality and destabilization of the stream bed and banks. Mining can also disrupts sediment supply and channel form, which can result in a deepening of the channel (incision) as well as sedimentation of habitats downstream. Channel instability and sedimentation from instream mining also can damage public infrastructure

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(bridges, pipelines, and utility lines). Impacts to the biological resources include removal of infauna, epifauna, and some benthic fishes and alteration of the available substrate. This process can also destroy riverine vege-tation, cause erosion, pollute water sources and reduce the diversity of animals supported by these woodlands habitats (Byrnes and Hiland, 1995).

This study aims to investigate both the positive and negative impacts of sand mining. Positive in terms of financial gain and negative in terms of environmental impacts associated with potential sand mining operations and to outlines the best management practices in order to minimize the adverse impacts. The recommendations made in this paper are intended as guidance for decision-makers who are specifically involved in the review of sand mining and gravel extraction operations to make more informed decisions.

Bestari Jaya (Selangor) is geographically located at latitude (3.38 degrees) 3° 22' 47" North of the Equator and longitude (101.42 degrees) 101° 25' 12" East of the prime meridian on the map of the world. The Bestari Jaya is an old tin mining area for over 10 years and now is only sand mining area .The whole catchment covers an area of 3600 hectors which is located downstream at the embankment of Kampung Bestari Jaya and University Industry Selangor (UNISEL) main campus.

The Bestari Jaya catchment is drained by Selangor river whose length varies between 78 and 244 km and catchment area between 847 and 5,398 km^2. On an average, 11.73 million ty^{-1} of sand and gravel are being extracted from the active channels and 0.414 million ty^{-1} of sand from the river floodplains. The quantity of instream mining is about 40 times the higher than the sand input estimated in the gauging stations. As a result of indiscriminate sand mining, the riverbed in the storage zone is getting lowered at a rate of 7 to 15 cm y^{-1} over the past two decades. This, in turn, imposes severe damages to the physical and biological environments of these river systems.

MATERIALS AND METHODS

Sediment transport

Two independent sediment transport analyses were completed to evaluate physical environmental impacts of sand mining. First, numerical techniques were developed to evaluate changes in sediment transport patterns resulting from potential sand mining activities.

Sampling design

Field studies were conducted 8 March to July 2010 within the four sand resource areas and at three adjacent stations between sand resource area groups. Survey scheduling was designed to sample sand, suspended solids after dredging and water samples of the adjacent River Ayer Hitam where the water flows. A number of benthic grab samples was apportioned among surveys and resource areas. To determine sediment grain size, surface area and percentage of total surface area for each area were calculated. The percentage of the total surface area for each of the resource areas then was multiplied by the total number of stations available for the project minus three for the adjacent stations, resulting in the number of samples per resource area. The next step was the placement of sediment grain size stations within each area to characterize existing assemblages (Field et al., 1982). The goal in placement of the sediment grain size stations was to achieve broad spatial and depth coverage within the sand resource areas and, at the same time, ensure that the samples would be independent of one another to satisfy statistical assumptions. To accomplish this goal, a systematic sampling approach was used to provide broad spatial and depth coverage.

This approach can, in many cases, yield more accurate estimates of the mean than simple random sampling (Gilbert, 1987). Grids were placed over figures of each resource area. The number of grid cells was determined by the number of samples per area. One sampling station then was randomly placed within each grid cell of each sand resource area. Randomizing within grid cells eliminates biases that could be introduced by unknown spatial periodicities in the sampling area. During July, 9 stations were sampled for sediment grain size using a Smith-McIntyre grab. A differential global positioning system was used to navigate the survey vessel to all sampling locations. Temperature, conductivity, dissolved oxygen, and depth were measured near bottom with a portable Hydrolab to determine if anomalous temperature, salinity, or dissolved oxygen conditions existed during field surveys.

Sediment grain size

A sub-sample (about 250 g) of sediment for grain size analyses was removed from each grab sample with a 5 cm diameter acrylic core tube, placed in a labeled plastic bag, and stored on ice. In the laboratory, grain size analyses were conducted using combined sieve and hydrometer methods according to recommended American society for testing materials procedures (Kelley et al., 2004). Samples were washed in demineralized water, dried, and weighed. Coarse and fine fractions (sand/silt) were separated by sieving through standard sieve mesh No. 230 (62.5 µm). Sediment texture of the coarse fraction was determined at 0.5 phi intervals by passing sediment through nested sieves. Weight of materials collected in each particle size class was recorded. Boyocouse hydrometer analyses were used to analyze the fine fraction (<62.5 µm). A computer algorithm determined size distribution and provided interpolated size information for the fine fraction at 0.25 phi intervals. Percentages of gravel, sand, and fines (silt + clay) were recorded for each sample.

Water column

During May, bottom temperatures ranged from 8.2°C at Area F2 to 11.2°C in Area A1, salinity values ranged from 28.5 ppt in Area C1 to 33.8 ppt at Area F2, and dissolved oxygen measurements ranged from 6.41 mg/L in Area G2 to 9.60 mg/L at Area F2. During September, bottom temperatures ranged from 12.5°C for Area F2 to 22.2°C in Area G1, bottom salinity values ranged from 27.6 ppt in Areas G1 and G2 to 33.4 in Area A2, and bottom dissolved oxygen values ranged from 2.94 mg/L in Area G3 to 6.48 mg/L in Area G2. Hypoxic and anoxic conditions were not found during April or July.

RESULTS

Figure 1 shows current sand mining activity in the area.

Figure 1. Ariel photograph of current sandmining activitiy showing high suspended solids at Bestari Jaya catchment.
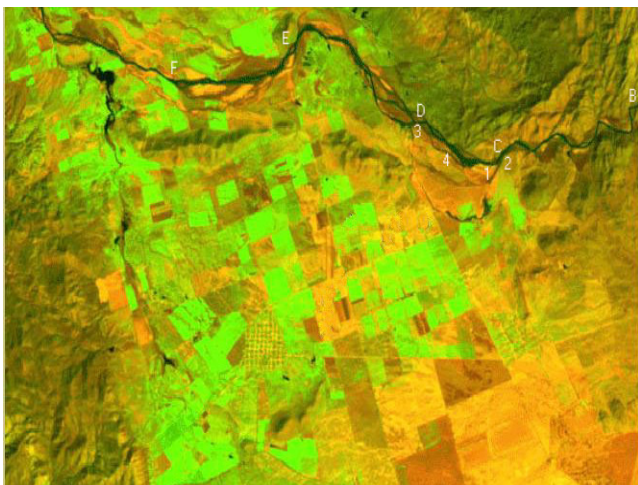
Figure 2. Sand mining in Bestari Jaya catchment, showing 2.3 m-depth of excavation (23 April, 2010).

Physical processes and biological data were collected and analyzed for mineral sand resources in order to address environmental concerns raised by the potential sand mining. Figure 2 shows the depth of ecxaction in the area.

Percentages of gravel, sand, and fines (silt + clay) were recorded for each sample. Table 1 shows grain siza analysis of the study area.Proportions of gravel, sand, and fines (silt + clay) varied within and among resource areas (Table 2). Areas A1 and A2 included sand stations and a few gravel stations. C1 stations generally had varied amounts of gravel and a few sand stations. F1 and F2 samples contained varied amounts of gravel. Samples from G1, G2, and G3 were mostly sand with only minor amounts of gravel at a few stations. There were little or no fines in the sediment samples. Tables 3 and 4 show

multidimensional scaling ordination and normal cluster analysis of the sediment samples while Figure 3 shows plot of variables on canonical discriminant analysis (CDA).

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DISCUSSION

Understanding the impact of sand mining operations in a complex environment requires a combined observational and modeling approach. Here, we use field measure-ments collected during mining operations in Bestari Jaya catchment to develop sediment parameters and source condition. The SS concentration in the surface plume of immediate vicinity to the dredging vessel is as high as 100 mg/L, and then the SS concentration decreases rapidly down to less than 5 mg/L within 1 to 2 km. The sediments introduced in the surface water undergo sinking and advection processes that differentiate sediment size classes (Mossa and Autin, 1998).

Predicted sediment infilling rates at borrow sites ranged from a minimum of 28 m^3/day (about 10,000 m^3/yr; Area F2) to a high of 450 m^3/day (164,000 m^3/yr; Area A1); infilling times varied from 54 (Area A1) to 303 years (Area C1). Sediment that replaces sand mined from a borrow site will fluctuate based on location, time of dredging, and storm characteristics following dredging episodes. How-ever, infilling rates and sediment types are expected to reflect natural variations that currently exist within sand resource areas. The range of infilling times was based on the volume of sand numerically dredged from a borrow site, as well as the estimated sediment transport rate. Predicted sediment infilling rates were slightly lower than net transport estimates derived from historical data sets, but the two estimates are within the same order of magnitude (10,000 to 160,000 m^3/yr versus 62,000 to 200,000 m^3/yr, respectively). Simulated infilling rates would be larger if the impact of storm events were incorporated in the analysis.

The loose boundary (consisting of movable material) of an alluvial channel deforms under the action of flowing water and the deformed bed with its changing roughness (bed forms) interacts with the flow. A dynamic equilibrium state of the boundary may be expected when a steady

Table 1. Sand resource characteristics (grain size analysis) at potential borrow sites in resource.

Resource area	Sutface area (x10^6 m^2)	Sand volume (x10^6 m^2)	Exacavation depth (m)	D10 (mm)	D50 (mm)	D90 (mm)
A1	2.21	8.8	4	0.60	0.35	0.21
A2	2.60	7.8	3	1.60	0.62	0.30
G1	1.12	4.5	4	0.85	0.41	0.19
G2	1.44	4.3	3	1.40	0.66	0.30
G3	1.09	3.3	3	0.90	0.51	0.26
C1	2.04	6.1	3	0.40	0.20	0.14
F1	Too small	Too shallow	-	-	-	-
F2	0.69	2.1	3	2.40	0.46	0.27

Table 2. Mean percentage (standard deviation) of sediment types in grab samples collected in the sand resource areas during March and July 2010.

Resource area (n)	Mean % gravel (SD)	Mean % sand (SD)	Mean % fines (SD)
A1 (22)	10.78 (20.11)	88.62(20.01)	0.19 (0.76)
A2 (26)	12.74 (14.71)	85.57 (15.70)	0.03 (0.10)
C1 (27)	19.97 (28.21)	78.09(28.09)	1.42 (7.25)
F1 (7)	15.95 (12.48)	83.68 (12.46)	0.00 (0.00)
F2 (11)	22.45(22.59)	77.15(22.52)	0.00 (0.00)
G1 (14)	6.62 (12.71)	90.71 (16.24)	1.44 (4.76)
G2 (20)	0.55 (0.86)	93.47(18.17)	4.20 (17.86)
G3 (16)	1.36 (3.61)	97.87 (3.58)	0.00 (0.00)

Table 3. Distribution by survey and resource area for station groups resolved from multidimensional scaling ordination and normal cluster analysis.

Station group	Resource area										
	A1	A2	C1	F1	F2	G1	G2	G3	Adj1	Adj2	Adj3
March											
A	1		2							1	
B											
C	1						2	2	1		
D	1	1	1			1	1				
E											
F	1	1	1	2	2	1	1				3
G											
X/Y		2	1			2					
July											
A			2							1	
B	6	3				5	4	3			
C	1					1			1		
D											
E		3					1				
F		1	6	3	5		2	3			1
G							1	1			
X/Y	2		3								

Table 4. Mean percentage (standard deviation) by sediment type for station groups resolved from multidimensional scaling ordination and normal cluster analysis.

Station group (n)	Mean % gravel (SD)	Mean % sand (SD)	Mean % fines (SD)
A (7)	47.75 (30.48)	51.30 (29.73)	0.50 (1.23)
B (21)	0.69 (3.02)	98.63 (2.98)	0.00
C (9)	8.99 (16.46)	81.35 (27.60)	5.78 (25.99)
D (5)	2.77 (4.20)	96.82 (4.29)	0.00
E (4)	8.33 (3.85)	84.54(15.08)	0.00
F (31)	12.13 (16.61)	87.22 (16.49)	0.04 (0.22)
G (2)	0.00 (0.00)	86.38 (12.41)	0.00
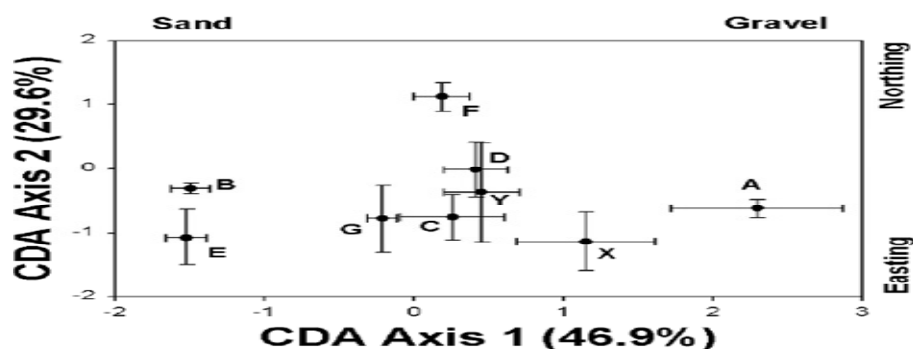
Figure 3. Means (6 standard errors) of canonical variables for station groups A through G plotted on CDA Axes 1 and 2.

and uniform flow has developed (Nalluri and Featherstone, 2001). The resulting movement of the bed material (sediment) in the direction of flow is called sediment transport and a critical bed shear stress (τc) must be exceeded to start the particle movement. Such a critical shear stress is referred as incipient (threshold) motion condition, below which the particles will be at rest and the flow is similar to that on a rigid boundary. Shield (Yang, 1996) introduced the concept of the dimensionless entrainment function, Frd 2 (=τo/ ρgΔd) as a function of shear Reynolds number, Re* (= U* d/v) where is ρ density of the fluid and Δ is the relative density of sediment in the fluid, d the diameter of sediment, g the acceleration due to gravity, U* is the shear velocity (√√τ o/ρ) and v the kinematic viscosity of the fluid, and published a curve defining the threshold or incipient motion condition as shown in Figure 4.

When flow characteristics (velocity, average shear stress etc.) in an alluvial channel exceed the threshold condition for the bed material, the particles move in different modes along the flow direction. The mode of transport of the material depends on the sediment characteristics such as its size and shape, density ρs and movability parameter U where W is the fall velocity of the sediment particle. Figure 5 has been used to establish fall velocities of sediment particles of different shape factors.

Some sediment particles roll or slide along the bed intermittently and some others saltate (hopping or bouncing along the bed). The material transported in one or both of these modes is called 'bed load'. Finer particles (with low fall velocities) are entrained in suspension by the fluid turbulence and transported along the channel in suspension. This mode of transport is called 'suspended load'. Sometimes finer particles from upland catchment (sizes which are not present in the bed material), called 'wash load', are also transported in suspension. The combined bed material and wash load is called 'total load'. A summary of mode of sediment transport is given in Figure 6 (Nalluri and Featherstone, 2001).

Bed load ranges from a few percent of total load in lowland rivers to perhaps 15% in mountain rivers to over 60% in some arid catchments. Although a relatively small part of the total sediment load, the arrangement of bed load sediment constitutes the architecture of sand- and gravel-bed channels. The rate of sediment transport typically increases as a power function of flow; that is, a doubling of flow typically produces more than a doubling in sediment transport and most sediment transport occurs during floods (Kondolf, 1997). Two existing sediment transport equations have been identified to be suitable for use in the prediction of the replenishment rate of rivers in Malaysia that is Yang and Engelund-Hansen equations.

In second approach sediment transport patterns were modeled for existing and post-dredging conditions.The depth and volume of deposition will in return determine the viability of sand extraction taking into account the

Table 5. Over-spill sediment volume released during sand mining operation in Bestari Jaya.

Items	Values	Units	Remarks
Loading volume	1000	m^3/h	2000 m^3 capacity dredger
Overflow water	10,000	m^3/h	10 times of loading
Sediment in overflow	0.0736	t/s	10% of loading
	73,611,111	mg/s	
	7950	mg/l	Size 0.5 mm (30%)
	7950	mg/l	Size 0.25 mm (30%)
99%-sand; overflowing size fraction: 3:3:2:1:1	5300	mg/l	Size 0.125 mm (20%)
	2650	mg/l	Size 0.0625 mm (10%)
	2650	mg/l	Size 0.0312 mm (10%)
	5300	mg/l	Size 0.5 mm (20%)
	5300	mg/l	Size 0.25 mm (20%)
98%-sand, overflowing size fraction: 2:2:2:2:2	5300	mg/l	Size 0.125 mm (20%)
	5300	mg/l	Size 0.0625 mm (20%)
	5300	mg/l	Size 0.0312 mm (20%)
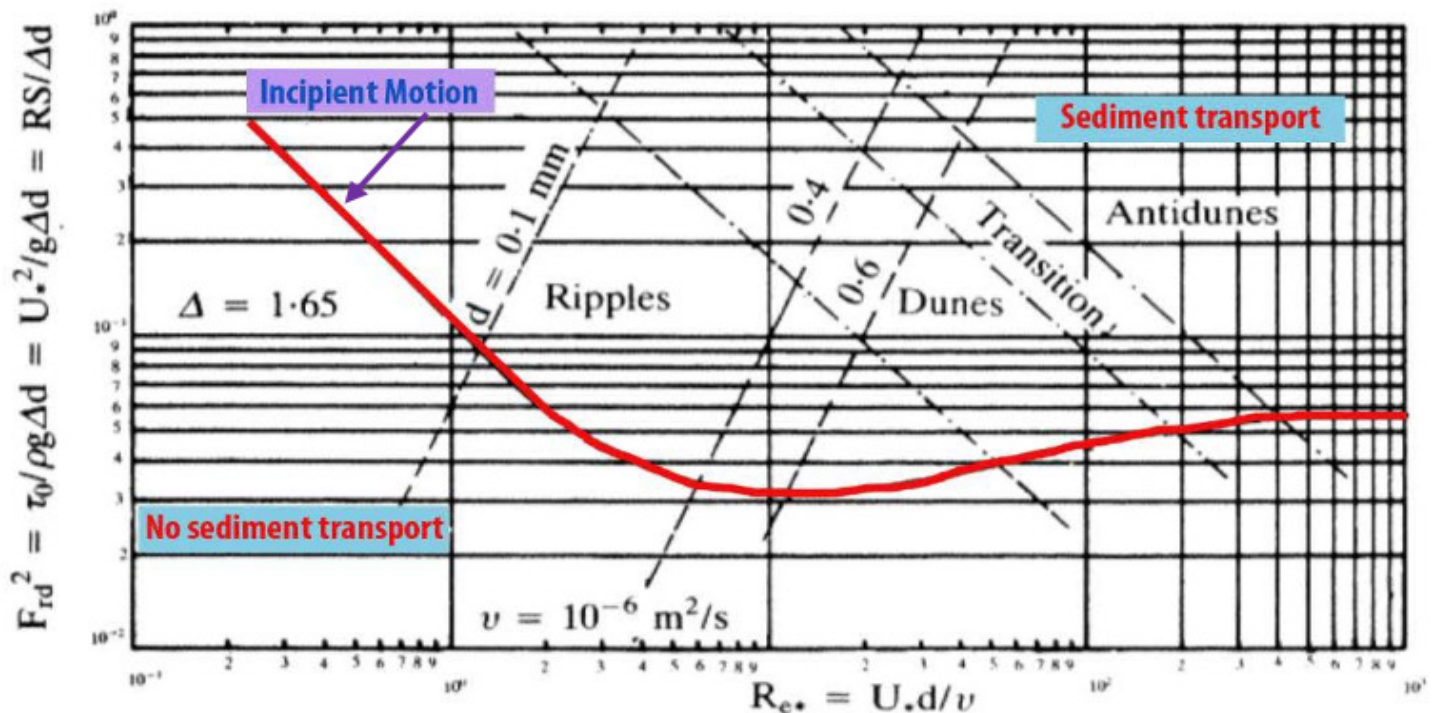
Figure 4. Shields diagram of Bestari Jaya Catchment (Nalluri and Featherstone, 2001).

ability of the catchment to replenish the sediment Hydrologic Engineering Centers River Analysis System (HEC-RAS) model was used for this purpose (National Research Council, 1983). The HEC-RAS is an integrated system of software designed to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels and provide input and output information in tabular and graphical formats. This system is capable of performing steady and unsteady Flow water surface profile calculations. Proposals on the minimum level or "redline" and maximum level for sand extraction are given based on the HEC-RAS modelling results. Figure 7 shows the sediment discharge rate in the study area while Figure 8 shows the comparison of replenishment at the studied locations. It is proposed that the minimum depth of the excavation or redline must be at 1 m deposition above natural channel thalweg eleva-tion while the maximum allowable mining depth is 1.5 m.
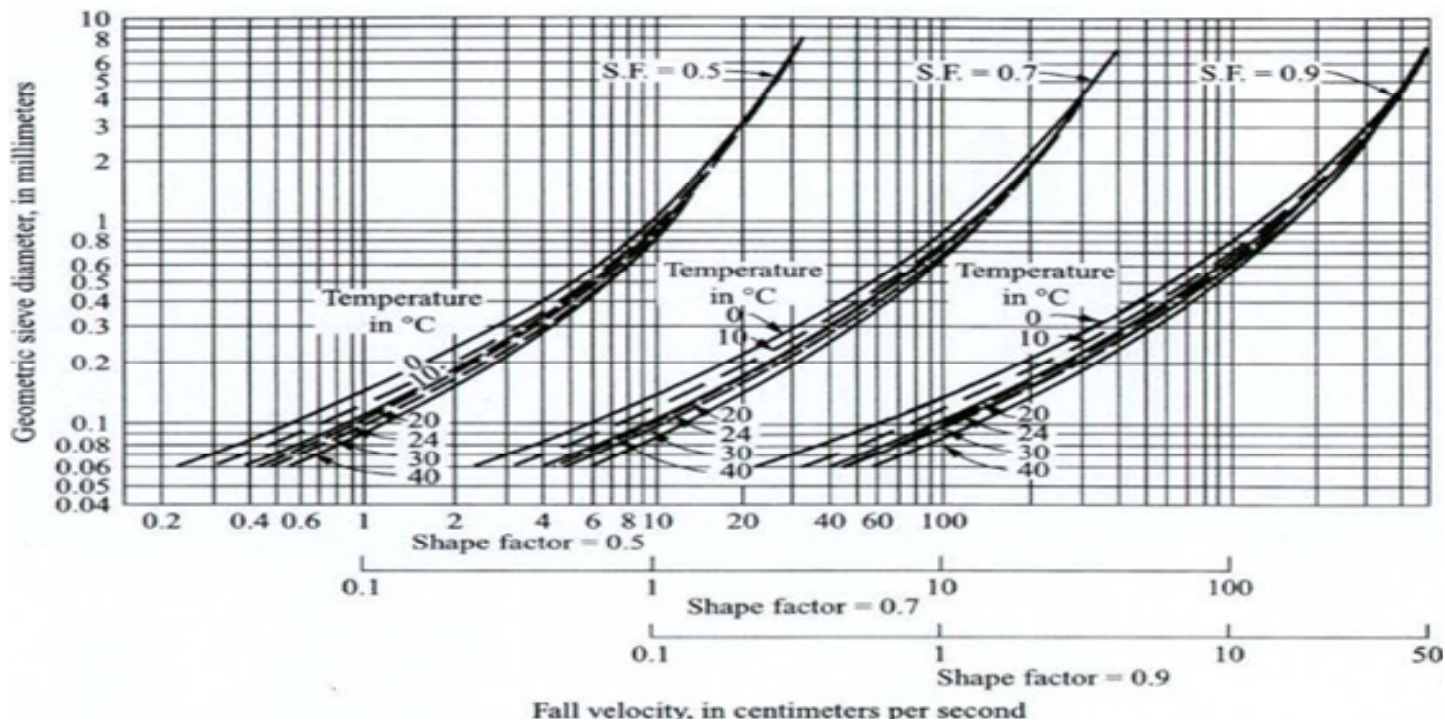
Figure 5. Fall velocities of sediment particles (Vanoni, 1975).
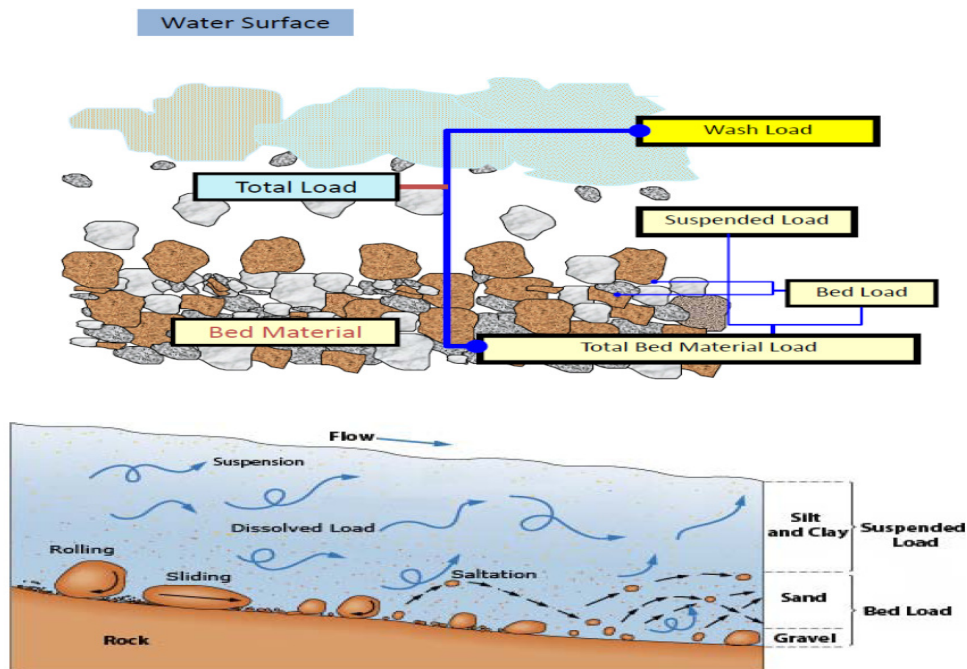

Figure 6. Modes of sediment transport in River Selangor.

The extraction is allowed for the whole active channel width after taking into consideration of the required set back to avoid bank erosion, and buffer zone encroach-ment. Allowing the channel wide extraction will increase the volume of the extraction for a particular site (Madsen and Grant, 1976). Hence, few mining sites are allocated for catchment which will minimize the disturbance to river equilibrium and environment. Based on the sedimentation
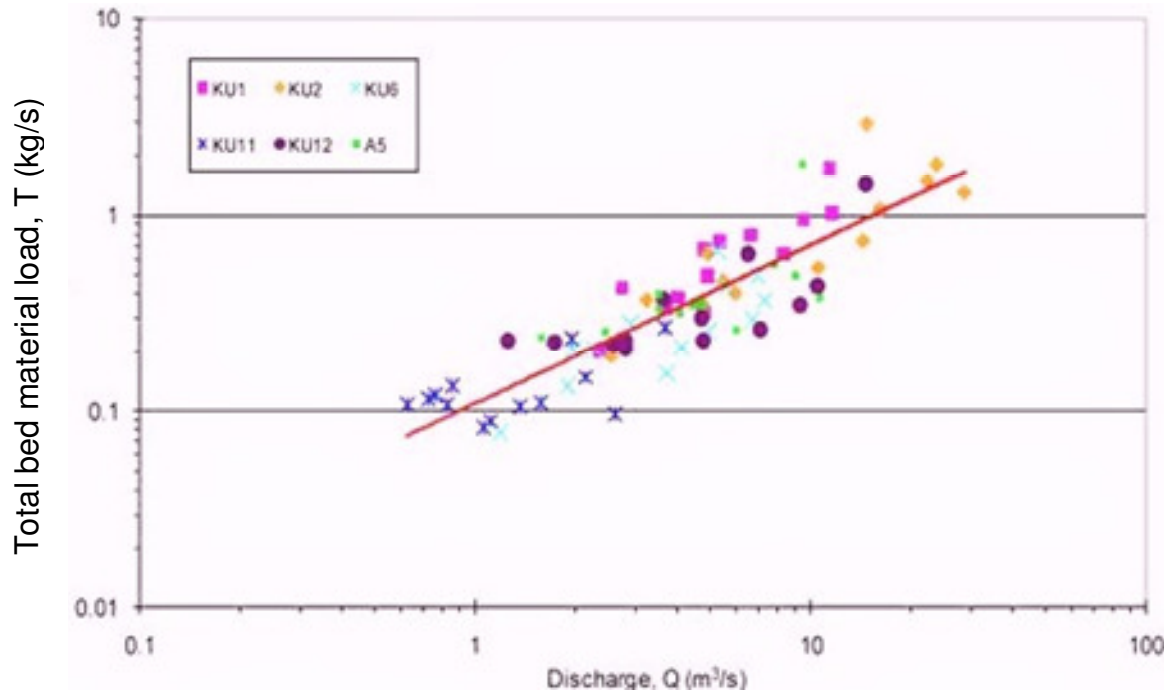
Figure 7. Sediment curve for Bestari Jaya catchment.
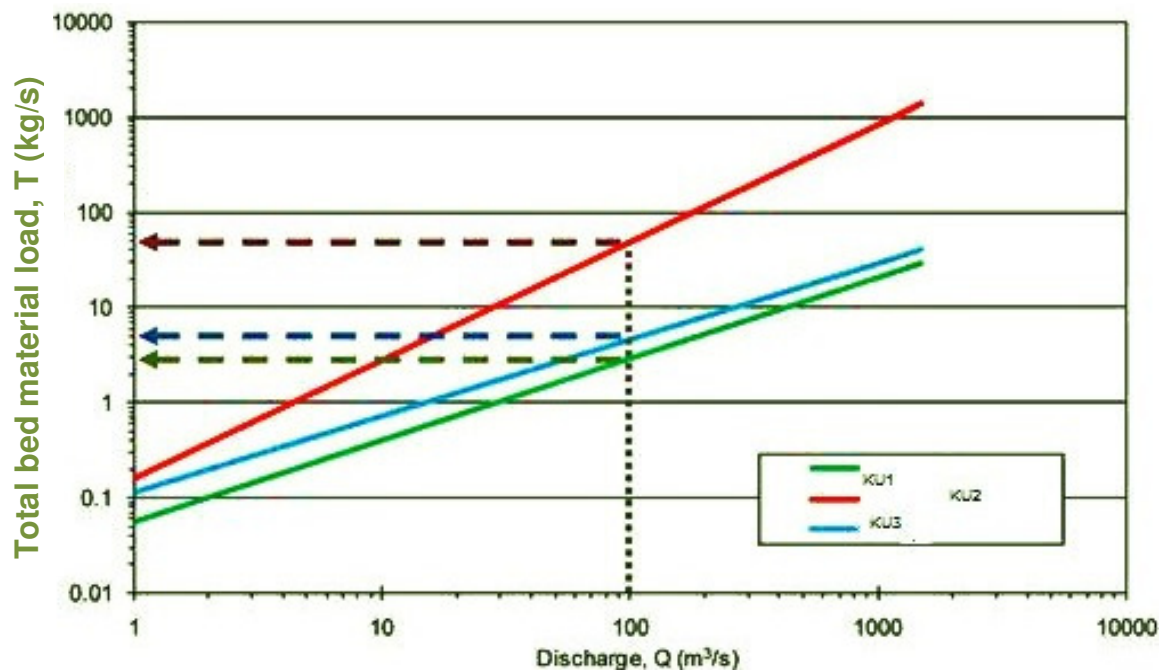
Figure 8. Comparison of replenishment rate at three different locations in the catchment.

trend as predicted by HEC-RAS model and after applying the 1 m redline, it can be concluded that sand mining could be done in Bestari Jaya catchment but in specific areas as shown in Figure 9 while Figure 10 shows sediment discharge delivery in five months.

ENVIRONMENTAL IMPACTS OF SAND MINING

The authors base the following report on fieldwork conducted in May 2010 and on interviews with local, coastal residents. Sand deposits are linked to one another such
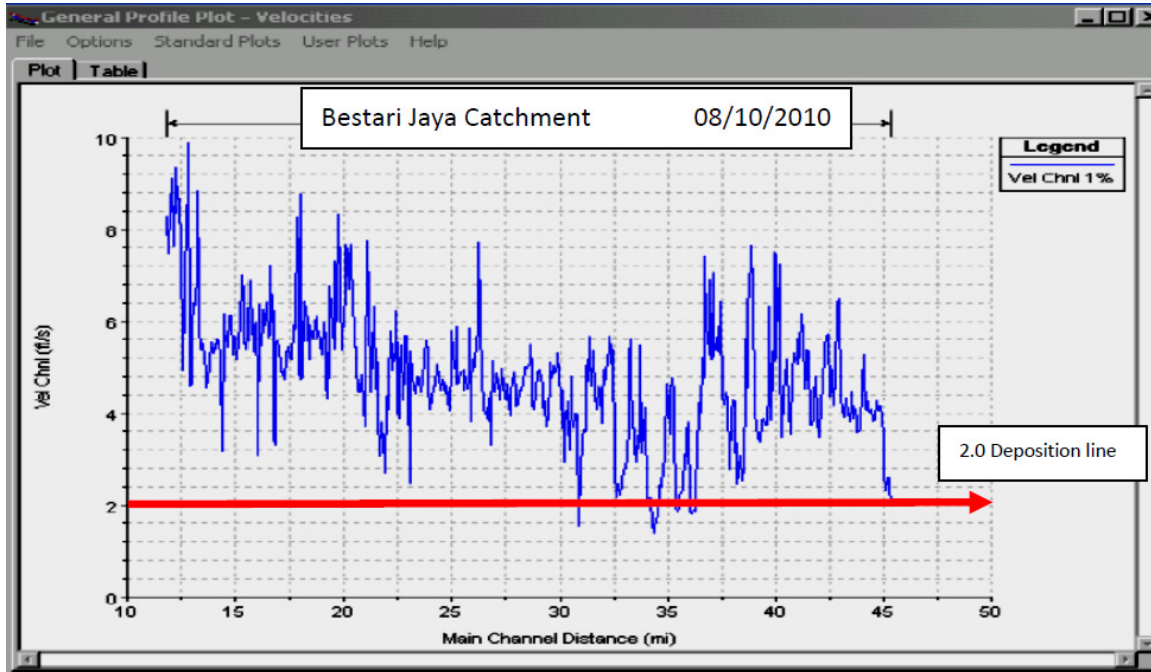
Figure 9. HEC-RAS modelling results for Bestari Jaya.
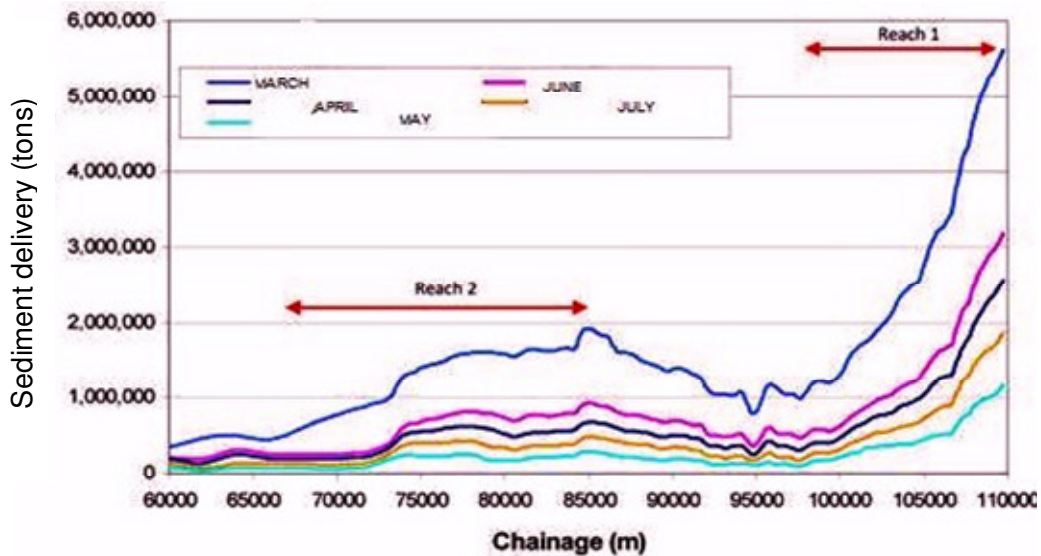
Figure 10. Sediment delivery in tons in the studied five months.

that addition or removal of sand from one area affects all of the other environments. The problems created by sand mining are numerous. Below is a brief summary focusing on the problems recently documented in Malaysia.

Turbidity

Wash-water discharge, storm runoff, and dredging activities from improper sand and gravel operations can increase the turbidity of streams. Turbidity is generally greatest at dredging sites or wash-water discharge points. Turbidity decreases with distance downstream, and can be controlled by containing runoff and by filtering or containing wash water. Water temperature and dissolved oxygen of streams can be changed if in-stream mining reduces water velocity or spreads out the flow over shallow areas. Changes in some situations are local

in nature and subtle.

Bird habitat

Physical disturbance of the habitat caused by dredging activities includes generation of noise, which can interruptnesting/breeding activities. Other effects include destruction of habitat for foraging and nesting, increased exposure to re-suspended toxicants, human disturbance from mining operations and increased predator use of recently dredged areas.

Riparian habitat, flora and fauna

Instream mining can have other costly effects beyond the immediate mine sites. Many hectares of fertile land are lost , as well as valuable timber resources and wildlife habitats in the riparian areas. Degraded stream habitats result in lost of fisheries productivity, biodiversity, and recreational potential. Severely degraded channels may lower land and aesthetic values. All species require specific habitat conditions to ensure long-term survival. Factors that increase or decrease sediment supply often destabilize bed and banks and result in dramatic channel readjustments.

For example, human activities that accelerate stream bank erosion, such as riparian forest clearing or instream mining, cause stream banks to become net sources of sediment that often have severe consequences for aquatic species (Newell et al., 1999). Mining-induced changes in sediment supply and channel form disrupt channel and habitat development processes. Furthermore, movement of unstable substrates results in downstream sedimentation of habitats. The affected distance depends on the intensity of mining, particles sizes, stream flows, and channel morphology. The complete removal of vegetation and destruction of the soil profile destroys habitat both above and below the ground as well as within the aquatic ecosystem, resulting in the reduction in faunal popultions. Channel widening condition continues until the equilibrium between input and output of sediments at the site is reestablished.

Groundwater

Apart from threatening bridges, sand mining transforms the riverbeds into large and deep pits; as a result, the groundwater table drops leaving the drinking water wells on the embankments of these rivers dry. Bed degradation from instream mining lowers the elevation of streamflow and the floodplain water table which in turn can eliminate flow depth and a barskimming operation increases flow width. Both conditions produce slower streamflow velocities and lower flow energies, causing sediments

arriving from upstream to deposit at the mining site. As streamflow moves beyond the site and flow energies increase in response to the "normal" channel form downstream, the amount of transported sediment leaving the site is now less than the sediment carrying capacity of the flow. This sediment-deficient flow or "hungry" water picks up more sediment from the stream reach below the mining site, furthering the bed degradation process. This causes shallowing of the streambed, producing braided flow or subsurface intergravel flow in riffle areas, hindering movement of fishes between pools. Channel reaches become more uniformly shallow as deep pools fill with gravel and other sediments, reducing habitat complexity, riffle-pool structure, and numbers of large predatory fishes.

Stability of structures

Sand-and-gravel mining in stream channels can damage public and private property. Channel incision caused by gravel mining can undermine bridge piers and expose buried pipelines and other infrastructure. Bed degradation, also known as channel incision, occurs through two primary processes: (1) headcutting, and (2)"hungry" water. In headcutting, excavation of a mining pit in the active channel lowers the stream bed, creating a nick point that locally steepens channel slope and increases flow energy. A second form of bed degradation occurs when mineral extraction increases the flow capacity of the channel. A pit excavation locally increases water table-dependent woody vegetation in riparian areas, and decrease wetted periods in riparian wetlands. For locations close to the sea, saline water may intrude into the fresh waterbody.

Water quality

Instream sand mining activities will have an impact upon the river's water quality. Impacts include increased short-term turbidity at the mining site due to resuspension of sediment, sedimentation due to stockpiling and dumping of excess mining materials and organic particulate matter, and oil spills or leakage from excavation machinery and transportation vehicles. Increased riverbed and bank erosion increases suspended solids in the water at the excavation site and downstream. Suspended solids may adversely affect water users and aquatic ecosystems. The impact is particularly significant if water users downstream of the site are abstracting water for domestic use. Suspended solids can significantly increase water treatment costs.

Biological environment

The environmental impact due to dredging stem from the

suspension of sediment themselves and the release of pollutants from the disturbed sediment. Thus, dredging-induced suspensions can perturb water quality and affect local biota (Dubois and Towle, 1985). Dubois and Towle cite operational design, scale and duration of activity as significant factors since each material handling phase--extraction, transport and emplacement--can generate undesirable effects. While the direct environmental impacts associated with offshore dredging are due to the massive displacement of the substrate and the subsequent destruction of nonmotile benthic communities, the resulting indirect impacts are more subtle and can escape recognition by an untrained person. They include (Borges et al., 2002):

(a) Restriction of feeding and respiratory efficiencies and induced mortalities in hottom- dwelling biota, such as bivalve mollusks, as a result of the smothering effect of sedimentation;
(b) Reduction of the primary productivity (photosynthesis) due to turbidity in the water column;
(c) introduction of abnormal volumes of organic material and nutrients, thus increasing the biological oxygen demand (BOD), which in turn reduces oxygen levels and productivity;
(d) Reintroduction of toxic substances uncovered by mining activities;
(e) Inadvertent destruction of the adjacent habitat critical to the life cycles of certain organisms.
(f) Disruption of migratory routes of motile marine organisms.

A concentration of resuspended sediments and their subsequent distribution and deposition are the primary agents causing the biological stresses mentioned above. Survival under these stressful conditions depends largely on the specific requirements of the aquatic communities affected and a host of extraneous factors such as depth of sediment, length of time under burial, time of year, sediment grain size and sediment quality. Another consequence of concern is the physical reduction in habitat area, which is a function of the rate of repopulation of the dredged area. If the sediments are organic-laden, the subsequent decomposition can lead to anaerobic conditions and the deterioration of the quality of the ambient water. Hence, the reestablishment of marine habitats at the dredged area is again dependent on the magnitude of the dredging operation, new sediment interface and water quality.

Health hazards

Health hazards of the mining activity are of least concern for the authorities, as it seems from their deeds. The proposed mining is for extracting ilmenite, which is about 70% of the sand. The residue of the extraction process is the radioactive mineral such as monazite and zircon. The maximum recommended absorbed dose of radiation is 5.0 mSv a-1* (less for children and expectant moms) which implies that people in the radioactive area Bestari Jaya are at risk even when the ilmenite - silica blanket and the process of thermodynamic processes reduce the natural radiation from the radioactive minerals (Van Dolah et al., 1984). Somatic, genetic, teratogenic, stochastic and non - stochastic effects of the natural radiation are well studied and documented by researchers. The researchers aptly refer to the areas of high incidence of mutations as "evolutionary hot spots". From the fact that rate of background radiation in the area tends to increase with mining and that mutations of human DNA increase with increase in background radiation, mining in the proposed site will only help to spread the resultant ailments and ill health from the Bestari Jayas and adjoining areas to a new area, affecting thousands more. The changes that increased radiation rates will cause to the flora and fauna of the area is unknown to even the scientific community as studies are lacking in this regard.

Climate

In natural conditions, thermo dynamic processes neutral-lize emissions from radioactive minerals in the coast, thereby reducing effective radiation felt in the surroundings, considerably. Moreover, ilmenite and silica act as a blanket, playing their role in reducing the natural radiation. When the sand is passed through sulphuric acid in a stage of ilmenite extraction process, the emissions from the radioactive monazite is revitalized. This will increase the local atmospheric temperature, altering the micro climatic conditions. This would affect the energy budget of earth and also contribute to the phenomena of global warming in its own way.

Destruction of riparian vegetation

Caused by heavy equipment, processing plants and gravel stockpiles at or near the extraction site. Heavy equipment also causes soil compaction, thereby increasing erosion by reducing soil infiltration and causing overland flow (NMFS, 1998). Disturbing the natural hydraulics of the riparian zone during infrequent elevated flow levels (1 in 3 or 5 year events) . Caused by temporary bridges and mounds of soil overburden and sand. In such cases water, with important nutrient and silt loads, may be prevented from being deposited on riparian terraces downstream of the disturbance. This can significantly impact on the recruitment of certain species which are reliant on these events for their long-term persistence on these terraces. In other words a gene-ration of recruitment may be lost causing a gap in the population structure which can be exploited by other species, commonly exotics (Warren and Pardew, 1998).

MATIGATION MEASURES FOR SAND MINING

Instream mineral mining is prohibited in many countries including England, Germany, France, the Netherlands, and Switzerland, and is strongly regulated in selected rivers in Italy, Portugal, and New Zealand (Kondolf, 1997, 1998). In the Malaysia, instream mining may be the least regulated of all mining activities and regulations vary by state.

Mitigation must occur concurrently with sand and gravel extraction activities. Restoration is therefore a part of mitigation and the aim of restoration should be to restore the biotic integrity of a riverine ecosystem, not just to repair the damaged abiotic components. Following mitigating measures can be applied before, during and after the sand mining works and are briefly described below.

BEFORE

During the preparations and planning of sand mining projects various mitigating measures can be applied to prevent or minimize potential damage to the environment.

Selection of the best sand mining areas

A well-known mitigating measure applied at various locations around the world is selecting sand mining areas, which will cause the least environmental damage because at a trailing suction hopper dredger the overflow will by about 10%. This will reduce the turbidity and will protect the fishes and the benthic communities. In case the sand will be from fine sand to silt the TSHD will have an overflow of about 40 to 60%. This will cause a lot of turbidity and will damage fishes and benthic communities.

Efficient surface mining

This is a very important mitigating measure for surface mining, sand mining (outside the navigational channels) is allowed up to a maximum depth of 2 m. However, due to the land reclamation for the Selangor state development, therefore pits will be created at 5 to 20 m depth. By mining sand in long stretches with a depth of 2 m or pits, the damage to the benthic communities can be reduced by more than 80%.

Potential toxic sediment contaminants

Prior to sand or gravel removal, a thorough review should be undertaken of potentially toxic sediment contaminants in or near the streambed where these types of operations are proposed or where bed sediments may be disturbed (upstream and downstream) by the operation. Extracted aggregates and sediments should not be washed directly in the stream or river or within the riparian zone. Turbidity levels should be monitored.

Mathematical model simulations

During the study phase of the project mathematical simulation studies can be applied to investigate the dispersion and settlement of the resuspended sediments during the sand mining process. These simulation models can be used to test various execution methods and strategies in order to minimize ecological effects. As this can be a rather costly exercise this measure is usually only applied in case of large scale sand mining projects or in case of sand mining projects in or near very sensitive areas.

Bar skimming only

Operators would extract minerals from in-channel bars and only above the water table. This alternative would lessen the risk of mining-induced headcuts, but could nevertheless cause hungry water and associated channel incision downstream of mine sites. Bar skimming also could cause other problems such as elimination of side channels, abrupt relocation of the low-flow channel, and higher mobility of loosened sediments (Kondolf, 1998). Gravel-rich streams would be less susceptible to disturbance from this form of mining than would gravel-poor streams, because replenishment by excess gravel from upstream sources would partially mitigate channel disruption; mining of bars in gravel-rich streams should be emphasized over mining in gravel-poor streams. Furthermore, specific reaches in individual streams may be better locations for mining, because these reaches may receive high deposits of sediment while other reaches do not (Jacobson and Pugh, 1997). Special guidelines would be needed for mining in so-called "losing" streams, which do not have perennial flow.

DURING

The generation of suspended sediments and the subsequent dispersion of these sediments are the most important aspects to be managed and controlled during the execution of the works. Therefore the mitigating measures during the sand mining works are oriented at: minimizing the concentrations of suspended sediments, limiting the dispersion of the suspended sediments, and minimizing the resettling of suspended sediments in sedimentation sensitive areas.

Riparian habitat

Riparian vegetation performs several functions essential

to the proper maintenance of geomorphic and biological processes in rivers. It shields river banks and bars from erosion. Additionally, riparian vegetation, including roots and downed trees, serves as cover for fish, provides food source, works as a filter against sediment inputs, and aids in nutrient cycling. More broadly, the riparian zone is necessary to the integrity of the ecosystem providing habitat for invertebrates, birds and other wildlife. Minimise or avoid damage to stream/river banks and riparian habitats. Sand/gravel extraction operations should be managed to avoid or minimise damage to stream/river banks and riparian habitats. Sand/gravel extraction in vegetated riparian areas should be avoided. Undercut and incised vegetated banks should not be altered. Large woody debris in the riparian zone should be left undisturbed or replaced when moved and not be burnt. All support operations (e.g. gravel washing) should be done outside the riparian zone. Sand/gravel stockpiles, overburden and/or vegetative debris should not be stored within the riparian zone.

Limiting the overflow losses

Selecting a modern trailing suction hopper dredger, which has a central overflow system and releases the overflow mixture underneath the bottom of the dredger, can minimize overflow losses. A more technical mitigating measure, which is to be carried out by the dredging contractor, is to adjust the loading process. By reducing the pumping flow during the final stages of the loading process or by reducing the total loading time (stopping earlier) the overflow losses can be reduced significantly. This will result in reduced suspended sediment levels.

Application of production limits and water quality criteria

During sand mining the increase in concentrations of suspended sediments determine to a large extent the effects on sensitive ecosystems. One of the mitigating measures, which can be used, is to put limits on the daily production levels of the dredging process. Another method is to put limits on specific water quality criteria, like a maximum level of suspended sediment in front of sensitive areas, which need protection. It is to be noted that these mitigating measures require sufficient knowledge with respect to the local environmental characteristics and the relation between the production levels and the resuspension of sediments.

Usage of silt screens

A method to limit the dispersion of suspended sediments is the placement of silt screens. Silt screens are made of flexible geotextiles and form vertical barriers in the water column. Silt screens can form excellent barriers for many kilometers, but cannot always be applied. Minimise activities that release fine sediment to the river. No washing, crushing, screening, stockpiling, or plant operations should occur at or below the streams "average high water elevation," or the dominant discharge. These and similar activities have the potential to release fine sediments into the stream, providing habitat conditions harmful to local fish.

Minimum enveloped level or redline

The absolute elevation below which no mining could occur or "redline" would be surveyed on a site-specific basis in order to avoid impacts to structures such as bridges and to avoid vegetation impacts associated with downcutting due to excessive removal of sediment. An extraction site can be determined after setting the deposition level at 1 m above natural channel thalweg elevation, as determined by the survey approved by DID.

Monitoring relevant ecosystems

Field monitoring of sensitive habitats before and during the dredging works can be done by means of temporary or permanent measuring systems and sensors, sampling, visual observations and surveys. The advantage of regular field monitoring is that the predicted effects can be verified. In addition it will provide information with respect to the results of the applied mitigating measures and whether or not the level of the mitigating measures is too high or too low. In case the level is too high, certain mitigating measures can be eliminated (cost-savings), whereas in case the applied mitigating measures are not sufficient for the planned protection, additional measures can quickly be incorporated into the project.

AFTER

Once the sand mining works have been completed, options are available to restore or accelerate the restoration of the original habitats. A sound mitigating measure after completion of the dredging works is to speed up the recovery process by human interventions. Deep dredged pits can be filled up again with other sediments originating from maintenance dredging or the removal of unsuitable overburdens from other areas.

Restoration and reclamation

Allowing the natural restoration of the impacts of in-stream mining may require reduction or cessation of sand

and gravel extraction. The time required for a stream to naturally recover from impacts caused by sand and gravel mining is highly dependent on the local geologic conditions. Recovery in some streams can be quite fast. Human reclamation of river or stream environments requires a design plan and product that responds to a site's physiography, ecology, function, artistic form, and public perception (Arbogast et al., 2000). Under-standing design approachcan turn features perceived by the public as being undesirable (mines and pits) into something desirable. Forward-looking mining operators who employ modern technology and work within natural restrictions can create a second use of mined-out sand and gravel operations that often equals or exceeds the value of the pre-mined land use.

Illegal sand mining in Slengor

The Selangor state of Malysia, likewise, is experiencing the effects of the veritable loot. Everyday Malaysian local newspaper are full of illegal sand mining reports. Despite numerous prohibitions and regulations, illegal sand mining continues rapidly in the state. Selangor loses over RM100 mil in revenue every year due to illegal sand mining activities in the state. Illegal sand mining areas include Bestari Jaya, Rawang and Kuala Langat, where illegal sand minding is widely carryout .In some places, this has been going on for more than 20 years. The state government had issued a total of 46 sand mining permits in private lands, but the number of illegal activities detected was double that.The Selangor government has identified 30 small illegal sand mining sites with an output of up to 600 lorry loads a day in various districts in the state since it shut down five major illegal mining spots recently. Illegal mining activities were a great concern as the damage to the environment was extensive and there was one site along Sungai Sembah in Kuala Selangor that now looked like a lake. There is a great concerned over the activities along Sungai Sembah as it flows into Sungai Selangor which is tapped for drinking water and it is now facing serious erosion and the water is also turning murky. A site in Kuala Selangor where 10 pontoons were seen carrying out the illegal sand mining activities. Large number of the affected areas identified were in the Hulu Selangor District while the other Districts affected were Klang, Kuala Langat and Kuala Selangor.There are eight operators in the state with permits to mine sand in Selangor but the activity is in full swing in at least 30 illegal sites. Sand siphoned from illegal mines in the Sepang, Kuala Selangor, Hulu Langat and Kuala Langat Districts and sold at RM18 to RM20 per tonne have built a multi-million ringgit industry.Eager to tap into this industry by channelling profits back to the rakyat, the state government is confident illegal sand mining will cease once state-owned mines dominate the scene. Sand mining is not only carried out in secluded rural areas but also in urban areas. One such place is near Taman Ladang Jaya in Shah Alam, opposite TTDI Jaya where sand mining is carried out along Sungai Damansara.

The instances cited above are only illustrative. The malaise is pretty widespread as many other states, like Johor, Terengganu, etc. are also victims of unchecked illegal sand-mining the consequences of which, needless to say, are very serious. Rivers of Malaysia are already seriously sick. Polluted by industrial and urban effluents, they are also victims of deforestation in their catchments, sequential damming and degradation because of unchecked sand-mining on their banks and beds. Many in Malaysia, perhaps, are not able to foresee how lack of governance, virtually, in every sphere is going to hit them in not too distant future. Take for instance mining. Illegal mining of mineral resources, with generous help of political and bureaucratic big wigs, is so rampant that not only are the country's precious natural resources being purloined in a big way, its forests are being clean-felled, land degraded and its rivers threatened with extinction.

What is to be done

(i) The degeneration of Indian environment is detrimental to the global environment also and so, it warrants serious attention from the environmentalists across the globe. Since environment remains the livelihood resource for the people at grassroots level and downtrodden masses, the national agencies, with the assistance of the international agencies, must undertake a study on the impact of mining on the social life of Malaysian people.
(ii) Therefore, a big level, socio-scientific research on the adverse effect of illegal mining in Selangor must be made and the inferences must be brought to the knowledge of the world. Certainly, scientists and environmentalist from UN bodies must be a part of this research team.
(iii) The persons responsible for the irreversible damage caused to the environment must be made to pay for retrieving the loss of natural resources.
(iv) A high level lobbying committee must be formed with the participation of the affected people and certainly, AREDS that tied the bell to the cat against illegal mining in Selangor.
(v) It is evident that the sand mafias and their cliques form a league to swindle the miner minerals all over the nation. The rulers connive over this, as they get the lion's share of benefit from illegal sand mining and the government plays spoilsport. Therefore, purging of the Malaysian legislation and the administration is needed.

SUMMARY AND CONCLUSIONS

1. During the year 2010, Malaysia consumed 2.76 billion metric tons of natural aggregate worth $14.4 billion. Of

this amount 1.17 billion metric tons, or 42.4%, was sand and gravel, with a value of $5.7 billion. The percentage of total aggregate production that is sand and gravel varies widely from state to state. Melacca consumes 7.7% sand and gravel, which is lower that any other state. Selangor, Johor, Terengganu and Federal territory (Kuala Lumpur and Putrajay) all consume 100% sand and gravel. About half of the aggregate (including crushed stone as well as sand and gravel) is used in government-funded projects.

2. Most sand and gravel produced in Malaysia is of alluvial, glaciofluvial, or marine origin. Stream-channel or terrace deposits of sand and gravel are widely distributed throughout Malaysia, and in some areas these are the only sources of any type of natural aggregate. In some areas, sand and gravel does not meet the physical or chemical requirements for certain uses. The resource may not be accessible because of conflicting land use, environmental restrictions, zoning and regulations, or citizen opposition. There are large regions, and even entire counties, where the places to obtain sand and gravel are extremely limited. In these areas, importing sand and gravel from outside the area or substituting another material for sand and gravel may be necessary.

3. The two most widely used substitutes for sand and gravel are crushed stone and recycled concrete or asphalt. Potential sources of crushed stone are widely distributed throughout the Malaysia, but some large areas contain no potential sources; sand and gravel is the only source of aggregate. Aggregate companies recycled a total of 14.5 Mt of asphalt or cement concrete in 2010, which constitutes less than 1% of total national aggregate demand. Furthermore, it is the user, not the producer, who commonly specifies the type of aggregate, and in some applications the user will not accept a substitute for naturally occurring sand and gravel.

4. Rivers are complex, dynamic geomorphic systems whose major function is to transport water and sediment. The climatic, geologic, topographic, vegetative, and land-use character of the drainage basin determines the discharge and sediment load it must handle under a variety of flow rates, as well as the location, type, and amount of sand, gravel, and other sediments present along various stretches of the river.

5. The normal variations of discharge and load commonly can be accommo-dated by a river without major changes to the channel. If a river is exposed to major long-term changes in climate or basin tectonics, or is exposed to certain types of human activities, such as agriculture, urbanization, bridge construction, channeliza-tion, and in-stream mining, the river may adjust its channel geometry if one or more variables are altered beyond certain limits.

6. There are numerous methods to extract sand and gravel from stream channels including excavation with conventional earth moving equipment, channel dredging, channel diversion, and mining from ephemeral channels. The method chosen commonly depends on the nature of the deposit and on operator preference.

7. Instream mining can be conducted without creating adverse environmental impacts provided that the mining activities are kept within the hydraulic limits set by the natural system. Many rivers and streams can accom-modate the removal of some portion of their bedload without serious effects. However, if instream aggregate mining creates too large a change in specific hydraulic variables, those changes may produce environmental impacts. The nature and severity of the impacts are highly dependent on the geologic setting and characteristics of the stream.

8. The principal cause of impacts from in-stream mining is the removal of more bedload than the system can replenish, or shortening of the stream channel. A decrease in bedload or channel shortening can cause headcutting and downstream erosion. The stream may change its course, thus causing bank erosion and the undercutting of structures. In-stream mining can also result in creation of deep pools, loss of riffles, channel shortening, overwidening channels, increased turbidity, and changes in aesthetics. All these impacts can result in major changes to aquatic and riparian habitat, and associated impacts to the biota occupying those habitat.

9. Environmental impacts from in-stream mining may be avoided if the annual bedload is calculated and aggregate extraction is restricted to that value or some portion of it. Defining a minimum elevation for the deepest part of the channel and restricting mining to the volume above this elevation may allow gravel extraction without adverse impacts. Some sections of a river are more conducive to aggregate extraction than others, and removal of gravel from some aggrading sections of a river may be preferable to removing it from eroding sections. Even if a section of river is eroding, aggregate mining may take place without causing environmental damage if the channel floor is, or becomes, armored by particles that are too large to be picked up by the moving water. Risk analysis is an alternate method for identifying poten-tial impacts by in-stream mining.

10. Restoring streams or mitigating the impacts of in-stream mining requires reduction or cessation of sand and gravel extraction. The time required for a stream to recover from impacts caused by sand and gravel mining is highly dependent on the local geologic conditions, and mad-made impacts upstream and downstream. Some streams can recover from in-stream mining in a few years, while other streams may take decades to recover. Wisely restoring our environment requires a design plan and product that responds to a site's physiography, ecology, function, artistic form, and public perception.

11. The necessity to clearly understand the far-reaching effects of such projects is the responsibility of every conscious and sensible individual of this country. Capi-talism nearing its doom is cunning and brutal; it will seek all possible means to continue in control. As crisis in the manufacturing industry is casting long shadows on the global market, capitalists are in a desperate spree to

claim their stake on the natural resources of earth.

12. Illegal sand mining is rampant all over the state. Supporting the illegal activities against public interest is the basic trait of all political parties and that is why, any government headed by any political party is behind illegal sand mining. The act of government that allows illegal mining at the cost of natural environment and livelihood resources of the nation is definitely anti-people.

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