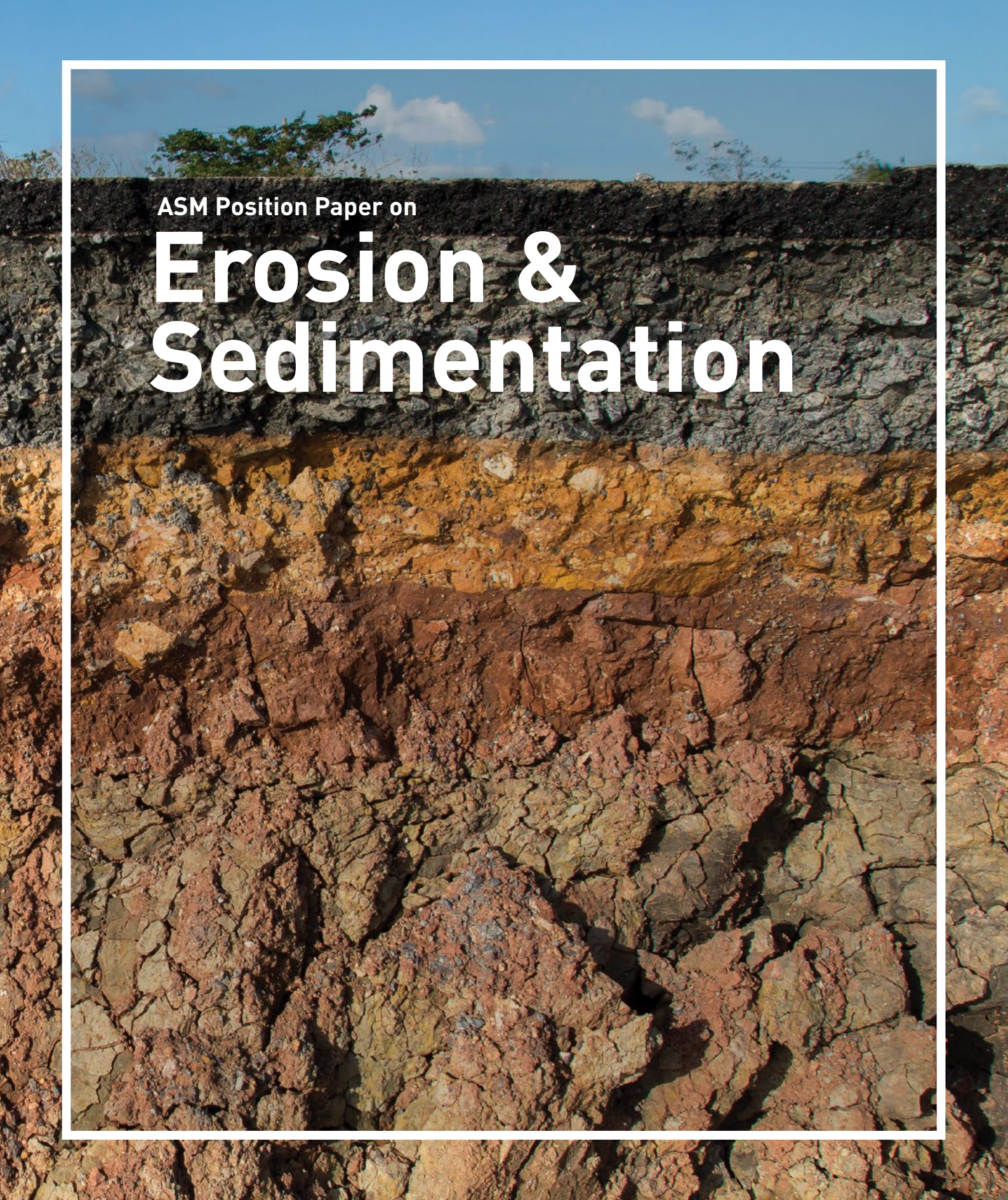




ASM Position Paper on

Erosion & Sedimentation

Erosion and Sedimentation



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Erosion and Sedimentation

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Academy of Sciences Malaysia
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Professor Datuk Dr Asma Ismail FASc
President
Academy of Sciences Malaysia

Uncontrolled development of land for urbanisation, timber extraction, mining, and agriculture has resulted in most of the rivers and coastal areas having heavy sediment loads throughout the year whilst soil erosion and sediment transport in rivers is the major cause of river water pollution in the world.

In Malaysia, one of the main causes of flash floods in urban areas is due erosion and sedimentation. The Department of Irrigation and Drainage (DID) in 2011 reported that around 29,000 sq. km of total land area are affected by flooding per annum and it was estimated that RM915 million worth of damages were caused by flood.

Hence, in carrying out its mandate as a “Thought Leader” in Malaysia for matters related to science, engineering, technology and innovation (STI), the Academy of Sciences Malaysia (ASM) has always endeavoured to analyse particular national problems and identify where science, engineering and technology (SET) can contribute to their solution and accordingly make recommendations to the Government.

ASM took note and aware of the seriousness of the sediment pollution and its detrimental effects towards the environment and its economic impact. As a result, the ASM Task Force on Erosion & Sedimentation was established to highlight the importance of ensuring erosion and sediment controls are designed, implemented, and regulated in order to curb environmental pollution.

I would like to take this opportunity to congratulate the Task Force for producing this Position Paper on Erosion and Sedimentation. The publication of this Position Paper by ASM provides independent, evidence-based input for policy making and promotes the innovative use of SET to solve national problems in the context of sustainable development. This effort would not have been possible without the strong support of all Task Force members through the leadership of Datuk Dr Abdul Razak Mohd Ali FASc.

I hope the highlighted issues, recommendations and proposed action by relevant authorities mentioned in this Position Paper would benefit policy makers, agencies, local authorities as well as industry players to harness science, technology and innovation towards a better erosion and sedimentation control.



Datuk Dr Abdul Razak Mohd Ali FASc

Chairman

ASM Task Force on Erosion and Sedimentation

Soil erosion and sediment transport in rivers is the major cause of river water pollution all over the world. It is also one of the main causes of flash floods in urban areas. In Malaysia, around 29,000 sq. km of the total land area are affected by flooding per annum (Department of Irrigation and Drainage, 2011).

This position paper seeks to address the needs of having technical officers in relevant government departments that are certified competent in erosion and sediment control. Having technically Certified Professional in Erosion and Sediment Control (CPESC) or its equivalent would ensure that Erosion and Sedimentation Control (ESCP) plans are properly designed and implemented on the ground for every major earthwork, in the sectors concerned.

Erosion and sedimentation have both environmental and economic impacts. Among others, they severely deplete aquatic life and reduce river flow carrying capacity. While it is known that natural processes do contribute to erosion, man-made activities centred around urban development are an aggravating factor. Uncontrolled development of land for urbanisation, timber extraction, mining, and agriculture has resulted in most of the rivers and coastal areas having heavy sediment loads throughout the year. It is for these reasons that the problem of erosion and sedimentation is given such serious attention.

Finally, I am grateful to all the Task Force members for providing their views and ideas, all of which helped to develop a deeper understanding of the challenges and the potential action plan expressed in this position paper. It is hoped that this report will serve as a useful reference for erosion and sedimentation issues in Malaysia.

ASM	Academy of Sciences Malaysia
BMP	Best Management Practices
CIDB	Construction Industry Development Board
CPESC	Certified Professional in Erosion and Sediment Control
DID	Department of Irrigation and Drainage
DOA	Department of Agriculture
DOE	Department of Environment
ECM	Earth Control Measures
EIA	Environmental Impact Assessment
EQA	Environmental Quality Act
ESCP	Erosion and Sedimentation Control
FD	Forestry Department
GDP	Gross Domestic Product
IECA	International Erosion Control Association
JKPTG	Department of Director General of Land and Mines
JMG	Mineral and Geoscience Department Malaysia
KPTG	Department of Lands and Mines
KTM	Keretapi Tanah Melayu
LA	Local Authorities
MHA	Malaysian Highway Authority
MHW	MHW Group of Companies
MNKT	Majlis Negara Kerajaan Tempatan
MSMA	Urban Stormwater Management Manual for Malaysia
MSO	Malaysian Stormwater Organisation
NRE	Ministry of Natural Resources & Environment
NWRC	National Water Resource Council
PUB	Public Utilities Board
PWD	Public Works Department
RMA	Resource Management Act
SCAL	Singapore Contractors Association Limited
SDBA	Street, Drainage and Building Act 1974
SEPU	State Economic Planning Units
SET	Science, Engineering and Technology
STI	Science, Technology and Innovation
TNB	Tenaga Nasional Berhad

This paper explains the phenomena of erosion and sedimentation, and why it is receiving widespread attention all over the world. Soil erosion and deposition of the resulting sediment (defined as sedimentation) in waterways leads to sediment pollution. *Soil erosion and deposition of the sedimentation in waterways lead to sediment pollution.* It should be noted that coastal erosion is not included in the scope of this paper.

Sediment pollution is a major cause of waterway pollution in the world. Its detrimental effect on waterways include destruction of ecology and fish life, conveyance of toxic compounds (pesticides, weed-killers etc.) attached to the sediments and the reduction of the waterway capacity to carry storm run-off, leading to flooding. In addition, there are other economic losses due to maintenance requirements for hydropower lakes, recreation and aquaculture among others.

This paper addresses the anthropogenic causes of sediment pollution. With heavy rainfall, earthworks for any purpose will result in erosion and sedimentation. The longer the land is left unprotected, the more sediment is eroded out. All the primary sectors in the country's economy are involved in extensive earthworks: plantations, agriculture, housing development, infrastructure construction, mining and forestry. The history of the various sectors and present unsustainable practises are briefly covered together with proposed measures to remedy them. Some of the contributors of sediment pollution noted in this paper include deforestation, sand mining and land maintenance practises, all of which require urgent and immediate attention in order to remedy current impacts and circumvent future complications.

Fundamental to all sectors is the need to have competent regulators from the government side, who are trained in erosion and sediment control, and also the need to impose new requirements for ESCP to be designed and implemented on the ground for every major earthwork, in every sector concerned. Currently, all regulatory agencies involved in major earthworks (forestry, mining, construction, plantations and agriculture) have guidelines on erosion and sedimentation control. However, these are not effective mainly due to low competency and awareness on erosion and sedimentation control in agencies, consultants and also contractors. The implementation of ESCPs is also hindered by an ineffective framework in which parties involved lack accountability in their respective roles.

The above-mentioned issues need to be resolved so that the ESCPs can be implemented on the ground. The Department of Environment (DOE) has already made compulsory for consultants who address erosion and sediment potential and prepare ESCPs for projects subject to Environmental Impact Assessment (EIA) under the Environmental Quality Act (EQA) 1974, to be a competent person and certified in erosion and sedimentation control. Such moves should be complemented with proper monitoring and enforcement to ensure nationwide compliance.

It is also necessary to ensure that ESCPs and any future amendments to the ESCPs be adopted across all relevant sectors. Regulatory agencies can set up special funds paid for by every developer, so that ESCP consultants can be paid from this fund.

This position paper seeks to address the problem of erosion and sediment control in the country through the following recommended reforms:

- (i) Government regulatory agencies dealing with earthworks to have some technical staff that are certified competent in erosion and sediment control, e.g. CCPESC or its equivalent.
- (ii) ESCP to be made mandatory for all major sectors dealing with extensive earthworks: building construction, plantations, mining, agriculture, roads and highways, and forestry. The plans must be signed by a CPESC or its equivalent, and the consultant concerned must supervise the plans on-site. In addition, the consultant should be appointed and paid through a fund set up by the regulatory agency. Developers and contractors who have to do earthworks will have to pay to this fund to get their ESCPs done and supervised.
- (iii) The government to look into a mechanism to tackle the problem of illegal logging and land clearing so that they are quickly detected and the proponents swiftly dealt with before any large scale damage is done.
- (iv) EQA to be amended to enable intervention into any area where there is environmental or river damage due to extensive earthworks without ESC, regardless of whether the project is government owned or not.
- (v) Sand mining in the water catchment areas and forest reserves must be banned immediately. Application for sand mining in the rivers must be accompanied by submission of ESCP and its subsequent mining operation must be closely monitored by the authorities.
- (vi) Routine maintenance activities involving earthworks, especially by the local government, to comply with ESC requirements.

Soil erosion and sediment transport in rivers is the major cause of river water pollution all over the world [1] [2] [3] [4]. Uncontrolled development of land for urbanisation, timber extraction, mining, and agriculture has resulted in most of the rivers and coastal areas having heavy sediment loads throughout the year [5] [6] [7] [8].

Erosion and sedimentation have both environmental and economic impacts. Among others, they severely deplete aquatic life, reduce river flow carrying capacity and are the main cause of flash floods in urban areas of the country. Around 29,000 sq. km of the total land area are affected by flooding per annum (DID, 2011) [9]. It also affected more than 4.82 million people. Department of Irrigation and Drainage (DID) estimated that RM 915 million worth of damages were caused by flood [9]. Some notable examples of major flash floods aggravated by uncontrolled sedimentation in the country include the Kelantan flood in 2014 and the Cameron Highlands floods in 2013 and 2014. The Kelantan floods that occurred in December 2014 affected 503,302 people, claimed 25 lives and damaged public infrastructure amounting to an estimated RM2.9 billion [10]. Following the occurrence of these floods, few Keretapi Tanah Melayu (KTM) services along the East Coast route were cut off (The Malaysian Insider, 2014) [11].

The Cameron Highlands floods in 2013 and 2014 claimed four and five lives respectively, despite yearly investment of RM20 million in annual maintenance works and RM80 million every five years for dredging works in order to control sedimentation buildup at the upstream Sultan Abu Bakar hydroelectric dam [12] [13]. In 2014, the annual cost of damages to infrastructure, property and agriculture areas due to flash floods were calculated to be around RM1.06 billion [14].

It was only in 2005 that ESCP were made part of the requirements for earthwork applications on new developments. This was as a result of a paper pushed through by DID to the Majlis Negara Kerajaan Tempatan (MNKT). Although this was a significant move towards controlling the problem, they are still not effective in tackling the problem due to a host of reasons (as elaborated further in this report). It is timely that as the nation aspires to achieve developed nation status by 2020, measures be taken to stop further deterioration of the quality of our water environment.



Chapter 1

IMPACTS OF EROSION AND SEDIMENTATION

Erosion and sedimentation have both economic and environmental impacts.

Erosion severely diminishes the ability of the soil to support plant growth. Ironically, it is plant growth that has the strongest capacity to control erosion processes. Eroded soil contains nitrogen, phosphorus and other nutrients, which reduce water clarity, trigger algae blooms, deplete oxygen, and kill fish [1] [5] [7] [15].



Figure 1: Heavily sedimented stream in Kuala Lumpur

Sedimented rivers and beaches are also bad for recreation and tourism when the aesthetic quality of the waterways decline and activities like swimming are affected. Toxic pollutants like pesticides are also known to have chemical bonds with sediments, accumulating in dangerous quantities where the sediment settles, like river beds and beaches [7] [18] [19].

The loss of topsoil is another consequence of soil erosion. Topsoil is not only important for plant growth, its high organic content ensuring nutrient availability; it is also vital for the storage of moisture and aeration for the plants.

Sedimentation of rivers has serious economic consequences as river sections and structures like culverts get clogged up and the river floods adjacent areas during high flows. The large and frequent number of flash floods (Figure 2) in urban areas in the country can be mostly attributed to severe reductions in the capacity of the waterways due to sedimentation [5] [20] [4]. Excessive sedimentation

A particularly damaging ecological impact of erosion and sedimentation in waterways is the smothering of spawning habitat for fish [16] [17]. Freshwater fish require clear water with clean gravel and sandy beds for reproduction to be successful. Sedimentation of streams (Figure 1) can kill eggs and fry by depriving them of sufficient oxygen or by inhibiting the removal of waste products (carbon dioxide and ammonia). Sediment can also form a physical barrier to fry emergence by blocking the route of movement from the gravel.



Figure 2: Flash flood in Taman TTDI Jaya due to Sg Damansara overflow

reduces reservoir storage capacity, which requires frequent and costly dredging and removal.

Besides the cost of maintenance, there are the capital costs of flood mitigation projects which the government and hence the public, has to pay for. The average cost borne by the Government to mitigate floods over the past 40 years has risen from about RM3 million per year during the Second Plan period, 1971-1975 to RM1.3 billion per year during the Tenth Plan period, 2011-2015 [10], an unacceptably high cost which continues to climb unless erosion and sediment control measures, and stormwater quantity control measures become more effective.

While it is known that natural processes do contribute to erosion, man-made activities centred around urban development are an aggravating factor. It is for these reasons that the problem of erosion and sedimentation is given such serious attention.





Chapter 2

HISTORY OF EROSION AND SEDIMENTATION PROBLEMS IN MALAYSIA

In Malaysia, convectional rainstorms have been shown to exceed 200 mm/hr [21]. Such intense rainfall is highly erosive on exposed soils. As a result, most rivers on the west coast of the Peninsular show heavy sediment loads, especially those that pass through rapidly developing areas like the Klang Valley. There is however, a long history of development activities, which are responsible for the current state of the rivers.

2.1 Logging

Forests in Peninsular Malaysia are managed by the National Forestry Policy of 1984, which designates Malaysia's forests into three categories: permanent reserve forests (13.43 mil ha), national parks, wildlife and bird sanctuaries (1.53 mil ha), and state land/alienated land (3.39 mil ha). Logging is strictly prohibited in national parks, and wildlife and bird sanctuaries as well as in protected areas of permanent reserve forests (2.62 mil ha) [22]. Logging activities in permitted areas are subject to practises as prescribed by the Selective Management System (ISO: MS 9004), which is a guideline made to ensure that cutting regimes allow for reasonable regrowth of target species, maintenance of forest composition and reduction of cost of forest rehabilitation. Other policies related to the maintenance of forest land include Forest Harvesting Guidelines, Forest Engineering Plan and Forest Road Specifications. EIA 1985 was also updated to include control measures for forest land use [23] [24] [25] [26] [27] [28]. Hence, officially-sanctioned logging is fairly well regulated although there will still be sedimentation when pristine upstream rivers in the upper catchments are involved.

In Malaysia, deforestation is reported to occur at a rate of 0.7%, which translates to about 140,000 ha per year since 2000 - almost double the rate of deforestation in the 1990s [29]. Some major drivers of deforestation are discussed below.

Forest Plantation

Forest plantations in Malaysia started with the rapid conversion of jungle land to rubber plantations in the early 1900s. The rubber tree was brought into the country from Brazil. Finding the climate and soil especially suitable for the trees, large areas were cleared and planted with them, to cater to the rising demand for rubber latex. Over the next 30 years however, the advent of artificial rubber made rubber prices less attractive and many of the plantations converted to oil palm [30] [31].

Today, the country is covered with tree crop plantations on 21% of its land area, a huge 6.9 million hectares of previously thick jungle [32]. In 2015, the main tree crops are: oil palm (82%), rubber (16%), coconut (1%) sago (0.9%) and cocoa (0.3%) [32]. Undisturbed forests typically have very mature soils which date back to 2.6-66 million years ago. The soils have a stable structure with high infiltration capacity which reduces run-off and erosion, allowing for good root growth and water and nutrient uptake [33]. Deforestation for agricultural activities, such as tree crop planting, has led to degradation of soil structure and quality [33] [34] [35]. The average economic life of these tree crops is 20 to 25 years, after which the trees are cut down and the area cleared for replanting. On the average therefore, 4 to 5% of the 6.2 million ha is always in the process of replanting every year; which works out to about 310,000 ha of land laid bare, devoid of plant cover and exposed to the erosive power of tropical rains.

As the saplings normally take at least 2 years before establishing sufficient foliage, ground creepers are usually planted to cover the bare earth. These however, also take a few months to establish themselves. As a result, during the replanting period, erosion rates increase substantially; from the normal 10 tonnes/sq.km/year up to 400 tonnes/sq.km/year [36]. Hence, there is a substantial amount of sediment being eroded out to receiving waters from plantations.

In a study on the Pahang River basin [37], it was pointed out that about 30% of the sediment load in the river came from the plantations, despite the fact that they only occupy about 8% (240,000 hectares) of the total basin area (29,300 sq.km). The Pahang River, the largest in Peninsular Malaysia, was estimated to carry down 4.5 million tonnes of sediment a year to the sea.

Replanting for plantations to replace unproductive old trees with new trees, inevitably involve large-scale land clearing and massive sedimentation of rivers. Without ESCPs prepared by certified professionals in ESC responsible for the plan implementation, this status quo looks set to perpetuate. Even with ESCP consultants, implementation will be a problem as they are obligated to their paymasters, i.e. the plantation owners. That is, unless the consultants are paid out from a fund operated by a regulatory agency.

Agriculture in The Highlands

At about the same time as the real estate housing boom, demand for vegetables and flowers started to pick up. Cameron Highlands with its cool hill climate and thick fertile soils became the perfect place to cultivate vegetables and flowers. Unfortunately however, the mostly steep terrains have very fragile soils, which when exposed, are easily washed away by heavy tropical rains. Massive amounts of soil have been washed away from hill slopes, as evidenced by the amount pouring into National Power Corporation's Ringlet Reservoir [38] [39] [40] [41]. Rehabilitation efforts in the Ringlet reservoir and its associated tributaries as well as maintenance of the Sultan Abu Bakar hydro-electric dam has cost Tenaga Nasional Berhad (TNB) and the government millions of ringgit [42] [43] [44].

The problem has now spread to the neighbouring hills of Lojing, in Kelantan (see Figures 3 & 4), where over 25,000 ha of land has been cleared since 1990 [45]. Despite assurances from the state government that logging concessions had been frozen since 2006, 41 logging concession license were approved by the state Forestry Department in 2014, most of which were for the purpose of large-scale conversion to forest plantations [46]. Deforestation activities in this area have been cited as the cause of heavily sedimented rivers, such as Sungai Belatok and Sungai Legis [47]. Sg Belatok is a tributary of Nenggiri River, which flows into Sg Kelantan, while Sungai Legis is a river which runs through the Perias Forest Reserve in Gua Musang.



Figure 3: Vegetable farming in Lojing Highlands, Kelantan



Figure 4: Slope failure, Lojing Highlands, Kelantan

Cameron Highlands was only recently put under control with the enforcement of the Land Conservation Act [48] by Pahang; after more than 40 years of environmental degradation in the highlands. This Act was enacted in all the States in the Peninsular back in 1960 to "consolidate the law relating to the conservation of hill land, the protection of soil from erosion and the inroad of silt". Short term crops on hill land are the specific targets for regulation under this Act.

Illegal logging and land clearing

Sometimes, a permanent forest is de-gazetted for certain purposes, e.g. agriculture, road construction, etc. These areas are then termed as state-land forests. Since there are still timbers in these areas, the state gives out permission to log these areas. So logging activity is carried out with permission of the state but the Forestry Department has no control over how the logging is being done. It does not follow normal logging regulations, hence, there is a need to look into this aspect of logging so that the amount of erosion and sedimentation can be controlled and monitored.

‘Illegal logging’ also exists and this activity covers illegal jungle clearings for agriculture and unlicensed logging in remote areas to steal timber. These activities are carried out with no regard for anything other than quick gains and as a result. This leaves massive damage to the soil and streams.

Some major obstacles in the implementation of policies established for the purpose of managing national forests include corruption, lack of transparency, and lack of enforcement and skilled manpower [49] [50] [51]. Additionally, there is a need for federal to leverage on state powers in managing forest land. Currently, forestry legislations provide wide-ranging discretionary powers to high-ranking officials, which allows them to exempt any licensee from adhering to local rules (Sarawak), or issue concession licenses (Sabah), and revoke or change conditions of a license at any time (Sabah and Peninsular Malaysia). Furthermore, there is no formal oversight by any parliamentary committee over the country’s various forest agencies, which limits actions that can be taken to ensure compliance to a federal standard of environment protection [49].

2.2 Mining

Mineral mining is currently not a major industry in Malaysia although the sector has the potential to develop in response to rising demand for iron ore, gold, coal and tin concentrate, which are valued at RM2 billion, RM700 million, RM442 million and RM237 million respectively [52]. In total, the minerals industry contributes about 7% to the country’s GDP [53]. Recent mining ventures are done through collaborations between local companies and foreign investors. To date, there are 98 iron ore mines, 15 gold mines, 14 tine mines and seven coal mines in operation in the country [52]. While there are a variety of mines in operation in Malaysia, several specific industries can be especially associated with sediment pollution in waterways.

Tin mining

Tin mining developed in the 1820s rapidly grew to become the biggest contributor to the Malaysian economy in the 1970s. At its peak in 1979, Malaysia was producing about 40% of world’s tin output, with about 40,000 people employed in the industry [54] [55]. In contrast with major tin deposits elsewhere, where the tin is located deep underground, tin deposits in Malaysia, Indonesia, and Thailand (together producing 80% of the world’s tin) are located in the gravel along streambeds. Dredges or pumps are used to create large artificial ponds, as the process involves the washing of the soil to separate out the heavier tin ore. Based on several separate studies on the conditions of rivers adjacent to mining areas, not enough was done to control the soil laden waters from flowing out to the rivers [56] [57] [58].

It was only in 1985 when tin prices crashed that tin mines started closing down in Peninsular Malaysia and now, 25 years later, tin is no longer a significant factor in the economy. Next to jungle clearing for estate cultivation, tin mines were among the biggest contributors to sedimentation of rivers, leading to large sediment plumes at the river mouths on the west coast of the Peninsular [58].

Bauxite mining

Bauxite mining has been going on in Johor for many years. The recent wide-scale mining of bauxite in Kuantan however, is the one that has captured nation-wide public and media attention due the extent of environmental damage in nearby populated areas. Over a period of only two years, bauxite production multiplied from just 208,770 tonnes in 2013 to 963,000 tonnes in 2014, and then to 20 million tonnes in 2015 [59] [60] [61]. Now there are hectares of exposed soil left all over the district (mostly in the Felda Bukit Goh area), all eroding massive amounts of sediment to the rivers every time it rains heavily.

Regardless of whether only few mines were registered with the Mineral and Geoscience Department Malaysia (JMG), while all the rest were not even licensed to mine, there is very little awareness and competency in ESC being exercised both by regulatory agencies and contractors alike. There was also no condition for the mines to produce a certified ESCP which can at least be used to guide the excessive amount of sediment being released to the rivers and the environment as a whole. The problem looks set to continue with regulatory agencies and local authorities are lacking staff with competency in ESC and poor awareness in ESC among contractors.

Without the additional requirement of an ESCP plan be submitted with the other mining requirements (e.g. rehabilitation plan, rehabilitation deposit, notice of closure etc), control of earthworks in mining activities will continue to be difficult. Leaving the plan to be just a small part of the mining plan by mining consultants as it is will not show improvements in this sector. This plan needs certified professionals for the plan implementation.

Sand mining

Sand mining was not technically regulated, there being no guidelines as to which stretches of the river are suitable to be mined; especially given the general view that any activity which deepens the river will help in controlling floods. Many rivers were severely over mined, for example, the Muda River which in the 1990s had well over 100 mines registered, had sand mined in the region of 1 million cubic metres a year, when the river only produces about 10,000 cubic metres a year of sand from its upstream areas; an over- extraction of 100 times [62] [63] [64] [65]. As a result, there were severe drops in the river bed levels, dangerously exposing bridge piles to logs and other hazards during high flow. Large stretches of banks were also severely eroded threatening houses and properties [65]. Excavated sand contains a lot of finer sediment like silt and clay which needs to be washed out before it can be used for the concrete in such high demand in the housing industry; the washing of sand mined from rivers is the main culprit for sediment pollution.

The problem is expected to be better controlled with the adoption of gravel mining guidelines for the Bay of Plenty in New Zealand; where hydraulic studies are conducted for the river concerned to determine the stable bed profile envelope. In places where the bed is above the upper envelope, gravel is allowed to be mined. This way, only designated stretches of any river will be determined as suitable for sand mining in advance. All other stretches will be deemed unsuitable for any mining, unlike the present case, where miners determine where they want to apply for mining, which usually happens to be near construction sites [66].

The present lack of a State Water Resource agency responsible for overall water resources management in most states (with the exception of Selangor and Kedah), specifically the rivers, is a severe handicap for the states to manage rivers on a day-to-day basis. Effectively this means that there is no regulatory agency for rivers in these states.

Hill Sand mining

A new development to river sand mining is hill sand mining, which refers to the mining of sand at the foothills of previously pristine headwaters of catchments. A few of these have been discovered in Melaka and Johor [67]. Large ponds are created from water needed to wash the sand. These ponds have a permanent brown colour characteristic of lateritic clay. Invariably, they will overflow during

heavy rain, releasing sediment into the clear streams. Even during low flow conditions, the water retains the brown appearance all the way to the main river. Figure 5 shows the conditions and operation at one of the sites visited. Several large excavators pile up small hills of muddy sand which are washed using high powered hydraulic jets pumping water pooled up from an excavated pond nearby.



Figure 5: Hill sand mining in the foothills of Melaka; with ponding of extremely sedimented water from sand washing

2.3 Eroding River Banks

Urbanisation and land development has seriously altered the hydrological regime of most rivers in Malaysia, resulting in spiky high flows after rainstorms and shallow low flows for the periods in-between [68]. Such abnormal high flows destabilise river banks which have evolved over millennia, resulting in many stretches of scoured and failed slopes, so characteristic of urban rivers in Malaysia (photo 6). Scoured banks expose bare slopes of loose soil, devoid of vegetative protection, which are easily attacked by high flows, carrying away

large chunks of earth with each event. With the high frequency of tropical thunderstorms typical of Malaysia, this means that leaving these areas to stabilise by themselves will take an extremely long time, while sediment keeps on pouring into the river depositing along the beds and finally at the river mouth – all resulting in high costs of maintenance to dredge every year. Research in the United States have shown that as much as 75% of the sediment load in rivers can come from the mass movement of soil from eroded and scoured river banks [69].



Figure 3: Vegetable farming in Lojing Highlands, Kelantan



Figure 4: Slope failure, Lojing Highlands, Kelantan

Rivers need stable stream banks with thick greenery covering it right from the water's edge up to the flood plains. Greenery protects the soil from being exposed to the highly erosive tropical rainstorms. Trees are a vital part of this greenery, their roots anchoring the soil acting as natural revetments. With vegetative cover, the erosive forces of high flow waters will also be dampened, and the banks will not suffer the scouring so common to rivers devoid of vegetation.

Best practise guidelines for watershed management from all over the world [70] [71] [72] [73] [74] note the importance of the establishment and maintenance of a buffer zone along both banks of the river in order that river ecology can be allowed to prosper and rehabilitate the river [75] [76]. In line with this therefore, it is essential that present DID practise of using bank-based excavators to do river desilting works be discarded due to the extensive damage they incur to the buffer zones on both banks of rivers when doing such work. Instead these should be replaced with mini dredges (photo 7) which operate from the water. This way, trees and other greenery along the banks will not be cleared to make way for the machinery as is the case at present, hence enabling the bank greenery to fully mature and stabilise the banks, in the process also protecting them during high flows.

2.4 Housing Development

Massive land development for housing in the 1970s carried on this trend of heavy sedimentation when plantation land, especially those no longer productive and close to urban centres, began to be converted to 'real estate' for housing. Developers 'cut and fill' huge areas, up to hundreds of hectares, levelling out mostly natural, undulating and hilly land (photo 8). Despite the existence of earthworks regulations in all local authorities who are responsible for managing such developments, there have been many accounts of river bank or hill slope erosion cases [77] [78] [79] [80]. As of 2011, about 24,800 units of housing started construction in the Klang Valley, three times less the amount of housing that began construction in 2003 (76,400 units) [81]. Across the country, the total number of newly launched units in 2014 was 68,351, most of which were located in Selangor (18%), Kuala Lumpur (17%), Johor (16.8%), and Perak (8.4%) [82].

It was found that in urbanising areas, some 90% of sediment load to rivers come from land cleared for construction [83] [84]. Figure 8 is typical of a large housing development in the Klang Valley with extensive land clearing and massive earthworks. As a result of such heavy development, it has been estimated that erosion rates average 2950 tonnes/sq km/yr for the whole catchment [84]. In small upstream areas of the Batu River (a tributary of Klang River) catchment, extreme erosion rates of up to 50,000 tonnes/sq km/yr have been calculated [83] [84]. All these compare with rates for undisturbed forest catchments of around 100 tonnes/sq km/yr [84].

The worst flooding event in Malaysia occurred in 2014, which resulted in the evacuation of a total of around 3390 people in Kelantan and 4209 people in Terengganu. A combination of factors were attributed to the event, including hillslope runoff and consequent shallowing of rivers due to high sediment loading, collapse of temporary dams due to debris accumulation, and extremely heavy rainfall. Evidence of high degree of soil erosion is seen from thick layers of clay that remained after the flood waters receded [85] [38] [86].

Presently, the 2005 requirement for ESCPs in all land developments for housing and industry is ineffective for the simple reason that ESCPs are being prepared by inefficient professionals. The plans are also not supervised and implemented on the ground. This must be rectified in accordance with DOE requirements, as stated in 2.2.1 above. Consultants who prepare ESCPs must be certified competent in ESC and they must supervise these plans on the ground. In addition, the consultants must be paid from a fund operated by the regulatory agency concerned, in this case, the Local Authorities (or the water resource agency).

The existing Schedule of Payments for earthworks has yet to be aligned to the ala-EIA-recommended Schedule of Works for buildings and other types of construction, i.e. crusher-run road surfacing, drainage, and turfing have to be carried out, first, and be paid as per the recommended Revised Schedule of Payments, prior to putting up any or piling works of building structure.

The land owners of borrow pits for extractions for earthwork or accepting earth as a dumping site should be responsible to ensure stability of the borrow pits or dumping sites and protection against

erosion, silt contamination of adjacent properties, drains and rivers. It should include greening the borrow pit and dumping upon completion or partial completion.



Figure 8: Large-scale housing development in the Klang Valley

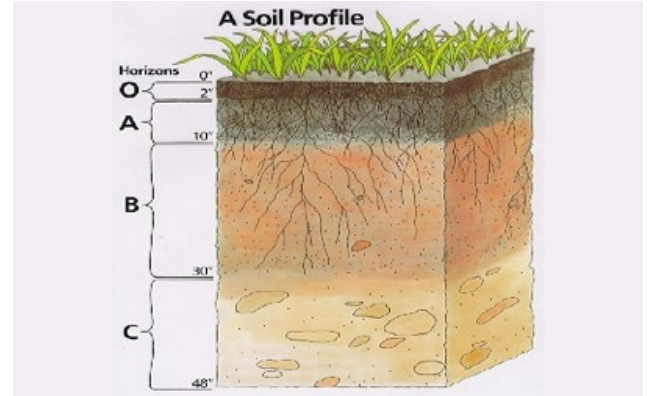


Figure 9: Topsoil, the organic layer of the soil with constituents vital for plant growth and storage of water

2.5 Poor Landscape Maintenance Practises

Poor awareness in erosion and sediment control is evident everywhere, especially in urban areas. This is despite the fact that the specifications of construction contracts are mostly derived from originals in the British days, namely, the Silt Control

Enactment of 1922 for the Federated Malay States. These originals correctly specify the practise actually needed to protect against erosion and sedimentation [87].

Turfing Practises

Almost all housing developments and public sector construction contracts are allowing the wrong practise of 'close turfing' or 'spot turfing' when putting in grass cover on to bare soil, without the addition of topsoil (Figure 9). Turfing contractors contend that the '2-inch topsoil' requirement in the contract specifications is met by the small amount of soil already attached to the clump of grass to be spot or close turfed. Hence, they do not need to actually cover the whole ground with a 2 inch layer of topsoil.

As a result, most turfing especially on the slopes, in urban areas all show the consequences of such malpractice – eroding slopes, and poor grass

growth (Figure 10). Without the topsoil (Figure 9), the grass is deprived of organic nutrients and the typically lateritic mineral soils left in most cut slopes do not have the capacity to retain the moisture (from rainfall) for long.

Manuals nowadays recommend that the organic content of the soil be restored for such cut slopes; by mulching in a layer of compost into the top 100 mm of the soil [69]. This practise should be the norm, in cases where existing topsoil is too little to be retained and restored back to the cut slope.



Figure 10: Eroding slope along a highway



Figure 11: Spot turfing onto bare soil on a slope

Exposure of Bare Soil

Bare soil is always exposed, not only in 'spot turfing' practises but more so when planting flowers to landscape urban areas. 'Mulching' is the practise of covering bare soil, usually with organic material like wood chips. Mulching is commonly used to maintain or improve soil quality, prevent erosion and establish vegetation [88] [89] [90]. As evidenced by the incidence of soil being washed out from landscaped areas during heavy rains, it is possible that mulching might not be commonly or correctly practised.

Most Landscape Departments of Local Authorities are equipped with mechanical 'mulchers' which grind out branches, and wood cuttings which are the byproducts of their trimming routines for trees in urban areas (Figure 11). Unfortunately however, these valuable wood chips are not reutilised as they were meant to be. Instead they are usually thrown away as waste, to add to the already huge pile from urban areas.



Figure 12: Local Authority mulching machine with valuable ground 'wood waste' being collected for disposal at dumping site

Maintenance Grass Cutting

A common practise by contractors in all our Local Authority areas is to practise grass cutting right down to soil level. This is meant to economise and lengthen the period in between cuttings. In maintaining grass turf, care should be taken to consider the combined effects of slope, percentage

of cover and blade grass length on soil erosion [91] [92] [93] [94]. Already most grass slopes in urban areas, especially those on highway embankments, show the ravages of erosion and depleting grass cover (Figure 10).



Chapter 3

EXISTING LEGISLATIVE AND REGULATORY FRAMEWORKS

3.1 National Legislative and Regulatory Frameworks

The control of erosion and sedimentation in Malaysia is primarily governed through sector-specific regulations. Several manuals and guidelines by different federal, state and local authority entities have been published in order to address erosion and sedimentation issues (listed below). Malaysia's first comprehensive environmental legislation was the EQA 1974, which provided the basis for the coordination of all activities related to pollution control [95]. The first formal document published specifically drawn to assist planners and developers in controlling erosion was the 1978 document Guidelines for Prevention and Control of Erosion and Siltation (Annex I), which was subsequently amended and reviewed in 1978, 1992 and 1996 [96]. An amendment to the EQA in 1985 brought on the mandatory implementation of environmental impact assessments. The law, designated under the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987, came into effect on 1st April, 1988 [97]. In 2000, DID released the Urban Stormwater Management Manual for Malaysia (MSMA) which provides guidance for planning, designing and implementing appropriate erosion control practises for construction and land development activities. This guideline was followed by the Guidelines for Erosion and Sediment Control in Malaysia, published by the DID in 2010, which provided a more accurate soil loss estimation calculation and more specific and stringent design requirements for ESC

facilities, among other additions. The document aims to improve information provided to planners, developers, engineers and contractors on the proper selection, installation and maintenance of Best Management Practices, as well as to support ESCP preparations [98]. Other legislation which addresses erosion and sedimentation include:

- Land Conservation Act, 1960 (Laws of Malaysia Act 395);
- National Forestry Act, 1984 (Laws of Malaysia Act 313);
- National Forestry (Amendment) Act, 1993 (Act A864);
- State Mining Enactments;
- State Water Enactments;
- The street, Drainage and Building Act, 1974 (Laws of Malaysia Act 133) and Uniform Building By-Laws, 1984;
- Town and Country Planning Act, 1976 (Laws of Malaysia Act 172); (Amendment) 1995, Act A933;
- Local Government Act, 1976 (Laws of Malaysia Act 171);
- Fisheries Act 1985 (Laws of Malaysia Act 317);
- Geological Survey Act, 1974 (Laws of Malaysia Act 129);
- Federal Territory of Kuala Lumpur, Earthworks By-Laws, 1988;
- Selangor Waters Management Act, 1999.

3.2 International Legislative and Regulatory Frameworks

United States

In 1973, adopting the model prepared by a task force after the March 1972 meeting of the Workshop on Soil Erosion sponsored by the National Association of Conservation Districts, the Council of State Governments issued a model state act for soil erosion and sediment control (hereinafter, Model Act). The Model Act was designed to set down the basic requirements for an effective state soil erosion and sediment control law and amend state soil and water conservation district laws to strengthen and extend their existing programs.

All states, as well as the U.S. Virgin Islands and the District of Columbia, have enacted laws that use district-type erosion control plans in statewide

programs of erosion and sediment control for water quality management purposes.

The state erosion and sediment control laws are generally amendments to the conservation district law or new sections added to the code following the conservation district law. Moreover, they usually require the state programs to identify critical sedimentation areas and to provide guidelines for local programs on district erosion control standards. They also require local authorities to confirm erosion and sediment control methods before granting permits for urban development activities.

The table below shows several examples of erosion and sediment control in several states:

State	Regulation
• Virginia [99]	In accordance with the Virginia Erosion and Sediment Control Law, Regulations, and Certification Regulations, Department of Environmental Quality implements the state Erosion and Sediment Control program (effective July 1, 2013) to help prevent destruction of property and natural resources caused by soil erosion, sedimentation and nonagricultural runoff from regulated land-disturbing activities.
• Maryland [100]	Maryland's Erosion Control Law and regulations specify the general provisions for program implementation; procedures for delegation of enforcement authority; requirements for erosion and sediment control ordinances; exemptions from plan approval requirements; requirements for training and certification programs; criteria for plan submittal, review, and approval; and procedures for inspection and enforcement. Proper design, installation, and maintenance of erosion and sediment control practises are essential to having an effective program. Maryland Department of the Environment (MDE) has established minimum criteria for effective erosion and sediment control practises. The 2011 Standards and Specifications for Soil Erosion and Sediment Control are incorporated by reference into State regulations and serve as the official guide for erosion and sediment control principles, methods, and practises.
• Florida [101]	Florida's stormwater regulatory program requires the use of best management practices (BMPs) during and after construction to minimise erosion and sedimentation and to properly manage run-off for both stormwater quantity and quality. BMPs are control practises that are used for a given set of conditions to achieve satisfactory water quality and quantity enhancement at a minimal cost. Accepted engineering methods must be used in the design of these control measures, such as those established by the Florida Department of Environmental Protection (FDEP), Florida Department of Transportation (FDOT), U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS), International Erosion Control Association (IECA), American Society of Civil Engineers (ASCE), U.S. Army Corps of Engineers (USACOE), or other recognised organisations.

Singapore

Singapore has two separate systems to collect rainwater and used water. Rainwater is collected through a comprehensive network of drains, canals, rivers, storm-water collection ponds and reservoirs before it is treated for drinking water supply. Thus, it is of paramount importance to keep waterways and reservoirs clean.

After a heavy downpour, the waterways often turn brown. This is because silt gets washed down from exposed earth surfaces and construction sites. To tackle the problem of silty discharge, Public Utilities Board (PUB) has been working with the construction industry on concerted efforts in public education and engagement, technology upgrading, and enforcing good earth control measures.

To provide guidelines on earth control, PUB revised its Code of Practice on Surface Water Drainage in 2007 to provide best practises on earth control measures (ECM) at worksites. Along with the revision, building contractors have been required to register an ECM plan with PUB, designed and endorsed by a Qualified Erosion Control Professionals, and implement the ECM plan before the start of any construction work.

The 4th edition of the Singapore Contractors Association Limited (SCAL)-PUB ECM guidebook was published in October 2014.

European Union



Legislations on erosion and sediment control at the level of the European Union are mainly focused on sediment dredging in coastal zones, due to the shared impacts of sediment contamination at these locations. At the same time, several legislations aimed at maintaining water quality in inland water bodies can be used to address sediment pollution. Due to the inextricable link between upstream land activities, water quality in inland water bodies and water quality in coastal and marine environments, there is a 'catchment-coast continuum' of regulations and policies which make up the protective framework which collectively works to preserve water quality [102](Figure 12).

Legislations governing the quality of inland water bodies are subject to the specific regulations of member countries. One EU-wide policy is the Water Framework Directive (WFD) (2000/60/EC) [103], which aims to manage land-water interactions through policies at the catchment-level. However, implementation of the directive is highly dependent on individual member states. While the document does not specifically refer to sediment, Article 16(1) of the WFD, - which requires the adoption of measures to progressively reduce discharges, emissions, and losses of priority hazardous substance - can be cited to address soil erosion and sedimentation problems in inland water bodies. The role of the WFD in monitoring sediment pollution is reviewed in [19].

Sediment pollution is also controlled by the regulation of land activities, for example, through soil protection and waste management legislations. Especially for dredged sediment, the European Waste Catalogue 2001 refers to the management of dredged sediment by the avoidance of waste, beneficial use and safe disposal of wastes - including excess sediment - resulting from dredging activities [104]. This provision is enforced through the European Waste Directive (75/442/EEC) which calls for the proper disposal of waste [105].

Soil protection guidelines and regulations in the European Union and its member states are not as established or uniform as the regulations governing sediment dredging in rivers and coastal zones. For example, the Dutch Soil Protection Act [106] specifically refers to sediments, while the Soil Protection Law in Germany [107] excludes sediments in its soil management plan [108]. Recognising the necessity for a targetted and comprehensive protection plan for soils in order to prevent further degradation, the Thematic Strategy for Soil Protection proposal was adopted in 2006. Under the strategy, a Soil Framework Directive was proposed to address soil degradation in the region. However, the proposal was blocked on the grounds of subsidiarity, excessive cost and administrative burden [109]. That aside, the protection and sustainable use of soil is continuously upheld through several EU policies, including the Common Agricultural Policy (CAP) [110] and Industrial Emissions Directive (IED) [111], among others (for a review, see [109]).

New Zealand

In New Zealand, sediment pollution in waterways is controlled at the federal level through the Resource Management Act (RMA) 1991. Sections 9, 12, 13, 14, and 15 of the RMA stipulate the regulations on activities relating to land use; works in the coastal marine area; streams, rivers and lakes; and the diversion of water and discharge of sediment to the environment [112]. Authorisation to undertake land-disturbing activities and the associated discharges is provided express permission by a district or regional authority, or through resource consent [112] [113].

The RMA places the management of land use and discharges for the maintenance of water quality and in-stream habitat and biodiversity under regional and district councils (Section 30 of RMA) [113]. Therefore, there are also various policies at these different levels which support the implementation of sediment control measures.

For example, under the Environment Canterbury's Regional Policy Statement, there are specific and directly enforceable regional plans which aim to control earthwork-associated activities [113]:

- The Land and Vegetation Management Regional Plans for Kaikoura East Coast (Part I) and the Port Hills (Part II), addressing the management of earthworks and vegetation clearance.
- The Proposed Natural Resources Regional Plan (NRRP) – Chapters 4: Water Quality and 8: Soil Conservation.
- The Transitional Regional Plan for Canterbury.
- The Transitional Regional Plan for the Nelson-Marlborough Region as it applies within the Kaikoura District – incorporating Plan Changes 1 & 2.

In the region of Auckland, several statutory documents support the RMA in the management of land-disturbing activities [112]:

- Hauraki Gulf Marine Park Act 2000 (HGMPA) (applies to the catchments and coastal waters of Auckland's east coast)
- Auckland Council Regional Policy Statement (1999) (ARPS) Ÿ
- Auckland Council Regional Plan: Sediment Control (2001) (ACRP:SC)
- Auckland Council District Plan (operative district plans of the seven pre-2010 city and district councils of the region) (ACDP) Ÿ
- Proposed Auckland Unitary Plan (2013) (PAUP)

All projects involving land-disturbing activities in the Auckland region must submit and incorporate an ESC plan, which is subject to reviews by the Auckland Council. Small projects which do not require land use consent must also adhere to the relevant conditions as stipulated in the provisions of ACDP, CRP:SC and PAUP.

Canada

Control of erosion and sediment pollution in Canada is divided over a framework of federal, provincial, and municipal policies. Regulatory agencies also publish standards, codes of best practise and guidelines with specific reference to certain types of activities, e.g. urban construction, transportation infrastructure, etc. Most of these legislations make explicit requirements on the control of the release of harmful substances, including silt and sediment, into the environment. An inexhaustive list of these regulations including highlights relevant to erosion and sediment control is provided below [reviewed in [114] [115]]:

Federal

- Fisheries Act, 1985 (sections 32, 35(1), 36(3))
- Navigable Waters Protection Act, 1985 (sections 21, 22)
- Migratory Birds Convention Act, 1994 (section 35)
- Canadian Environmental Assessment Act, 2012, (section 14)
- Canadian Environmental Protection Act (CEPA), 1999

Provincial

- Environmental Protection and Enhancement Act, 2000 (sections 108, 109)
- Soil Conservation Act, 2000 (sections 3, 4, 6)
- Public Lands Act, 2000 (section 54)

Municipal

- City of Edmonton
 - Sewers Use Bylaw No. 9675
 - Surface Drainage Bylaw No. 11501
- City of Calgary
 - Drainage Bylaw 37M2005
 - Street Bylaw 20M88

Implementation on the ground is supported by the provincial legislations such as Ontario's Conservation Authorities Act (CAA) 1990 [116] and the Edmonton Municipal Government Act (MGA) 2000 [117], which confer authority to conservation authorities and municipalities respectively to publish and enforce standards and guidelines for the management of water bodies and natural habitats.



Chapter 4

SOLUTION THROUGH ESCP

In 2000, the DID released a manual called Urban Storm Water Management Manual (MSMA) primarily aimed at controlling flash floods which are the direct results of the drainage plans of new housing developments. The improved version of MSMA, MSMA 2nd edition was launched in 2012. Traditional drainage planning uses the approach of 'rapid disposal' of stormwater discharge; that is, stormwater is designed to be conveyed away to the nearest river as rapidly as possible. This results in damaging peak discharges which are too high and too rapid for the river. This approach is in line with developments all over the world, where stormwater is 'managed' in a way that mimics the natural drainage process when the land was in its natural state; releasing slower and lower peak discharges to the river. The approach results in a more natural flow regime and less riverbank collapse from erosion.

The manual also contains comprehensive guidelines on 'Best Management Practices' (BMP) for erosion and sediment control during construction. However, despite a few years of awareness and technical training, on-the-ground practises remain largely unchanged. Decades of entrenched practises in the industry and the lack of technical know-how among supervising engineers contribute to the problems mentioned above.

In August 2004, the government made it compulsory to have ESCP as a prerequisite for all new earthworks non-agricultural in nature i.e. covering all housing and industrial developments.

In June 2006, a delegation from Malaysia attended the International Erosion Control Association (IECA) convention in Denver, USA and came back with an approval to conduct certification examinations from a certification body of IECA called 'Certified Professional in Erosion and Sediment Control' (CPESC). Malaysia is the first country where the examinations are held outside of the USA.

CPESC has been in operation in the USA under the sponsorship of the Soil and Water Conservation Society since 1982. It became an independent entity in 2001 under the umbrella of EnviroCert International, and entered into a memorandum of

understanding with the United States Department of Agriculture Natural Resources Conservation Service in 2011 [118] [119]. Similar to the concept of certifying Professional Engineers (PE) as being suitable to prepare engineering designs in their respective fields, CPESC signatories to ESCPs take professional responsibility for their plans. This in itself is a huge burden off the shoulders of regulatory engineers who previously had to scrutinise hundreds of ESCPs a year to ensure effective implementation.

From 2007 to 2014, CPESC held an average of two to three examinations a year, resulting in more than 300 professionals from regulatory agencies and private sector consultants being certified with CPESC.

A Malaysian NGO, the "Malaysian Stormwater Organisation" (MSO) was registered in 2011 and in 2012 signed an agreement with the parent body of CPESC, EnviroCert international, to be a "region" of the US body in Malaysia (at present there are other "international regions" of EnviroCert like Australia and Canada, and "national regions" which comprise the various regions of the United States). MSO will in the future conduct the examinations (in the process of being Malaysianised) and regulate members in the future.

It is envisioned that ESCPs will be extended to the agricultural and forestry sector to further strengthen control measures and CPESC or its equivalent will be a requirement for those preparing ESCPs.

Many proven bioengineering designs are available to repair scoured and damaged river banks [120] [121] [122]. Unfortunately, these are not well known or practised in Malaysia although products like 'coir logs' or 'fibre rolls' using coconut fibre have been available for some time locally. The most commonly used product locally to repair river banks is the 'gabion'. Yet they are never used in a bioengineering manner – with soil and vegetation added into the gabions to add long-term stability, besides making them more environmental. Native vegetation should be the priority, as these are the proven vegetation through the thousands of years of existence at the location. Alien vegetation, e.g. Vetiver grasses, which at present are convenient as they are available in spray-seeded form, can still be used as temporary cover instead of leaving the soil bare. With time however, native vegetation will usually prevail, crowding out the aliens with their rapid growth once they establish a foothold.





Chapter 5

RECOMMENDATION

There has been no effective regulation of earthworks to control the heavy and destructive sedimentation of rivers which affects not only the whole stretch of rivers, but also the whole coastline along which the river discharges.

Even developed countries are still grappling with the problem of erosion and sedimentation, and it is on their experience that we basing the concerted action to regulate and control this highly destructive phenomenon.

It is recommended that the following policy actions be taken in an effort to contain the problem and regulate earthworks that are the source of the problem:

1. ESCP to be made compulsory for all land development involving earthworks in all sectors: plantations, agriculture, mining, forestry, and the construction and housing industry. Regulators will require that these ESCP plans be prepared by certified consultants who will also be responsible for implementation of the plan on the ground. They will paid out of a fund established by the regulatory agency, to be collected from proponents involved in the industry concerned. This way, there will no longer be the “paymaster syndrome” whereby the consultant is obligated to the developer who pays for his services.
2. To be sustainable, all sectors will have to move towards “self-regulation” whereby industry players manage their own land development through ESCPs prepared by the appointed certified consultants, with monthly compliance reports. All earthworks will need approvals (through Notice of Intent) to begin and need to register completion of earthworks with stabilisation of all areas (through Notice of Termination). Regulatory agencies will no longer need to “approve” ESCP plans beforehand (as presently the case). They will only need to do inspections on compliance and act on complaints, prosecuting when necessary.

Proposed Action by Relevant Authorities

Action	Organisations in charge
ESCPs to be prepared by Certified Professionals - The present requirement for Erosion and Sediment Control Plans (ESCP) to precede earthworks activities should be further consolidated to be more effective. As the gap has been identified to be the lack of competency among professional engineers assigned to prepare these plans, this area has to be addressed. Professional engineers should demonstrate competency through certification by the Certified Professional in Erosion and Sedimentation Control (CPESC) or equivalent based in the USA. At the time of writing, there are already over 300 CPESC registered in Malaysia. ESC Plans prepared by CPESCs relieve the regulatory body of the burden of having to scrutinise hundreds of such plans a year (as is the case at present), which is a typical workload in a district. - It should be a requirement that only certified engineers in ESC with PE are allowed to prepare and submit ESCPs for earthworks. This is already a requirement by DOE for all ESCPs prepared for EIA projects. This requirement should be extended to all earthworks in Local Authority areas.	1. DID To propose i) amendments to earthworks bylaws of SDBA; and ii) adoption by all Local Authorities for CPESC or equivalent to be additional requirement for signatory to ESC plans, as already implemented in EIA requirements by DOE.
Regulatory agencies to also get Certified Professionals - At the same time, regulatory bodies like DID should strive to ensure that engineers who approve the plans are competent enough and also certified to do so. The same goes for large engineering departments like the Lembaga Lebuhraya Malaysia (LLM), Jabatan Pertanian, Jabatan Perhutanan and the JKR, implementing large projects involving massive earthworks. A core of certified engineers will enable their guidelines to be updated and be more effective. - Agencies which have enforcement powers should have their inspectors who ensure implementation on site to be suitably certified with CESSWI (Certified Erosion, Sediment and Stormwater Inspector) or equivalent.	1. DID 2. PWD 3. DOE 4. MHA 5. FD 1. DOE 2. FD 3. LA
ESCPs to be required for Agriculture, Sand Mining and Logging sectors ESCPs should also be required to be submitted for all earthworks and mining activities, other than the present one for building development alone. In particular, those for agriculture in the highlands, sand mining and logging, which do not fall into the 'scheduled list' of EIA projects, should also be required to submit proper ESC plans. These sectors are now major problem areas due to the cumulative effect of their sheer numbers, similar to that of the construction industry.	1. DOA 2. FD

Action	Organisations in charge
Land Conservation Act to be activated in all States - The Land Conservation Act should be activated in all states through the gazetting of high areas to be designated as 'hill land'. This is the vital step missing in all states (with the recent exception of Pahang and Penang, the first states to do so) since the adoption of the Act by all peninsular States way back in 1960. This Act has been enacted specially to control the type of agriculture activity (i.e. short term crop cultivation) which is devastating the highlands of Lojing, adjacent to Cameron Highlands, but lying in the state of Kelantan. The present exercise to review the Act by the Department of KPTG should take into account the problem of the lack of technical staff in the Land Office at District level to monitor and prosecute for non-compliance. - From past experience (Cameron Highlands, Sg Muda, Lojing), the Land Office is not the suitable agency to regulate technical matters like erosion and sedimentation because of this. It should be assigned to a suitable technical agency as made out in the Kedah Water Resources Enactment, to monitor and prosecute.	1. NWRC – through NRE 2. SEPU 3. Office of State Secretaries 4. JKPTG 1. KPTG 1. SEPU 2. Office of State Secretaries 3. DID
Institutions in all States to look after Rivers and Water Resources There is a dire need for the setting up of an institution to look after river water resources, water quality, fishery and the vital functions that the river brings. This is in view of the fact that the present state of affairs has left the river without 'ownership' as it meanders through the various local authority areas, while all the pollution and sedimentation comes from urban areas in the various local authorities. The Kedah Water Resources Enactment is an example of such an enactment which also sets up an institution specifically to manage rivers and water resources in the State.	1. SEPU 2. Office of State Secretaries 3. DID
Sand Mining to be properly regulated Sand Mining needs to be properly regulated. The present arrangement is too loose and leaves a gap in the vital area of monitoring. DID is only consulted to give the technical approval and conditions for the mining operation. Once approval is given by the Land Office, there is virtually no monitoring of the operation. In most cases, they do not comply with the conditions, mining right up to the banks. Sedimentation of the river is inevitable as a result of the cleaning process for the sand.	1. SEPU 2. Office of State Secretaries 3. DID

Action	Organisations in charge
- There needs to be a competent technical agency regulating the activity, as provided for in the Kedah Water Resources Enactment. - Hill sand mining should be stringently monitored and any damaging release heavily penalised as it affects the entire river. Sediment control facilities should be designed by certified professionals (as submitted above) and submitted to the regulatory body to comply with competent ESC design.	1. DID 1. Office of State Secretaries 2. DOE 3. DID
Best Management Practices (BMP) to be costed for in BQs of all contracts. The latest standard contract documents from PWD (as amended by their Arahan Teknik 2010) which itemises BMPs to control Erosion and Sedimentation in their Bill of Quantities, should be the only one used by all technical agencies in their tender documents. This will ensure that contractors will construct and deploy such BMP controls during the course of their earthworks, as they will be paid for it; in contrast with present conditions where contractors do everything to avoid implementing such BMPs as they represent additional costs to them.	1. PWD 2. DID 3. MHW 4. LA 5. CIDB
ESC courses to be made mandatory for earthworks contractors CIDB should incorporate ESC courses as part of their compulsory course for the registration of earthworks contractors. In the long term, by 2017 say, it would be advisable for such contractors to show a CPESC as a staff member on their payroll to enable them to renew registration with CIDB.	1. CIDB
DID to abandon the practise of River Berm clearing DID should abandon the present practise of leaving river berms clear of trees and permanent vegetation. The rationale of leaving space for maintenance machines to operate to go about their river excavation routines at regular intervals, is not only irrelevant, it is also very damaging to river ecology which needs the trees and vegetation. This is because bare berms are easily eroded by heavy rain, and when coupled with the 'trimmed slopes' typical of such activities, will rapidly redeposit sediment back into the river. The bare banks are also easily scoured during high flows, making the whole maintenance exercise futile.	1. DID

Action	Organisations in charge
Maintenance should, instead be carried out using floating 'mini dredges' which can navigate shallow rivers and also travel overland.	
River banks to be rehabilitated with greenery Rivers with scoured riverbanks should be rehabilitated through restoration of river bank vegetation to reduce sediment load to the rivers. In the long run, it should be more economic than regular dredging besides the ecological benefits. Similarly, river berms should be revegetated and restored with suitable native trees.	1. SEPU 2. DID
Mulching to be widely promoted Mulching', the practise of covering bare soil, usually with organic material like wood chips, to protect the soil against erosion, should be widely adopted by all proponents involved in the sectors mentioned above, especially by the Landscape Departments of Local Governments.	1. SEPU 2. LA 3. DID
Maintenance grass cutting to be reformed The present practise of grass cutting down to ground levels to lengthen the period in- between cuttings should be immediately stopped. Grass should not be cut shorter than 50 mm. Slopes should not be trimmed as they require thick vegetative cover. Bare slopes should be hydroseeded to restore greenery. The damaging practise of spraying with herbicides to kill off grass lining drains should be stopped. The exposed soil is usually rapidly eroded by heavy rainfall.	1. SEPU 2. LA 1. LA
Turfing to revert to standard practise The standard in almost all the 'Specifications' of Building Contracts, that 2 inches ie 50 mm of 'Topsoil' should be put in place before grass can be planted, should be strictly enforced. It is also advisable that 'spot turfing' practises be stopped.	1. DID 2. PWD 3. MHA 4. LA



Conclusion

Erosion and the consequent sedimentation of waterways is a very damaging problem long neglected in our country. The ESCP is a vital step towards control of erosion and sedimentation which can be extremely high in our heavy tropical rainfall. A history of extensive land development, converting jungle to plantations and other land-uses like housing, greatly compounds the problem.

Entrenched practises in the construction industry which are not sustainable from the point of view of ESC will need to be eliminated, and proponents educated on the need to reform their practises. The same holds for maintenance practises especially those by local authorities.

Awareness on available Best Management Practices (BMP) and competency training is necessary in addition to legislation to tackle the problem.

To this end, certification of professionals is a necessary tool to ensure competency. Research will also need to be done on curative measures to remove suspended sediments or colloidal suspension, in streams and rivers.

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Academy of Sciences Malaysia

Level 20, West Wing, MATRADE Tower,
Jalan Sultan Haji Ahmad Shah,
off Jalan Tuanku Abdul Halim,
50480 Kuala Lumpur, Malaysia

Phone : +6 (03) 6203 0633

Fax : +6 (03) 6203 0634