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Shamshuddin Jusop
Mohd Izuan Effendi Halmi
Syaharudin Zaibon

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Mitigation of Land Degradation in Malaysia

Ibrahim Abdullahi Ahmed [1] *and Christopher Teh Boon Sung* [2]

[1] **Faculty of Agriculture, Benadir University, Mogadishu, Somalia**

[2] **Department of Land Management, Faculty of Agriculture, Universiti Putra Malaysia**

Introduction

Malaysia, located in the Southeast Asia region, is geographically coordinated between the equator and 8° N and between 99° and 120° E. It receives a high intensity rainfall with an average of 2,500 mm annually, which sometimes causes severe degradation in areas where the protective cover of the land is removed. Harvesting of forests, agriculture development in hilly areas and exploitation of minerals and/or mining of ores greatly increases land degradation in Malaysia. Land degradation due to forest harvesting is referred to former forestland that had been cleared and being cultivated in unsustainable manner, or forestland that has been disturbed and abandoned. The degraded terrestrial ecosystems in the country include poorly stock logged-over forests, abandoned agriculture land, ex-mining land and ex-shifting cultivation areas (Table 1).

Table 1 Different degraded lands in Malaysia and area covered

Degraded Land	Area (ha)	Source
Poorly stock logged-over forests that had been converted to forest plantations in Peninsular Malaysia	56,260	Thai et al. (1995)
Shifting cultivated areas	4,800,000	FAO/UNEP (1981)
Degraded secondary forest i. Peninsular Malaysia ii. Sabah iii. Sarawak	(4,604,000) 174,000 1,100,000 3,330,000	Mat Isa (1992)
Ex-mining land	114,000	Chan (1990)
Abandoned Agricultural land Rice field Others	(700,000) 260,000 440,000	Berita Harian (1989)

The degradation of logged-over forestland in Malaysia are solely from the productive forests. This degradation is mainly caused by uncontrolled logging, followed by shifting cultivation. Although a sound system of selective management is practiced for managing the productive forests, there are still some unrestrained loggings that may result in poorly stock logged-over forests, which regenerates very gradually due to the damages caused on their growth by the logging activities. To improve the regeneration of the forests, some human interventions are needed. Additionally, there are also degraded secondary forests that may come from productive forests, state land forests, natural greenbelts in cities and are normally characterized in secondary forests and shifting cultivated area. However, the formation of secondary forest is the result of abandoned plantation projects, shifting cultivation, and illegal clearing of the forests that are under state ownership. Nevertheless, secondary forests at undeveloped slopes in the cities and river reserves are conserved as green belts and act as environmental buffer zones.

Abandoned agriculture land is mainly derived from the many conversion of state forestlands or degazetted permanent forest estate. Primarily, the success of industrialization process and the New Economic Policy that has changed the social economic status of the villagers are the main causes of the abandoned agriculture land. Of the villagers, mainly the younger generation would favor to work in air-conditioned factories with a stable income. Therefore, this creates a pattern of migration from villages to the city or industrial zones and this has been taking place since early 1990s. The migration has caused considerable setback in the nation's rice production and resulted in extensive area of abandoned rice fields.

Degraded and Problem Lands in Malaysia

Agriculture land use (LU) in Malaysia is classified into five classes, where only class 1 to class 3 land is only recommended for agriculture use. Agriculture land development in class 4 is allowed only after adequate land improvement and application of conservation work with high level of management because of the marginal soils that it consists. Class 5 land is not recommended for agriculture use due to its erosion risk and other degradation. In addition, class 5 and some class 4 lands are the fragile ecosystems (peat, BRIS, steep land, acid sulfate soil, etc.) in Malaysia. However, steep land and mountains, which occupy 15.7 million hectare (mha) of land (about 78% of the entire fragile land or 48% of the total land of the country), are the largest fragile ecosystem in Malaysia. Moreover, steep land is referred to land with slopes greater than 25 degree and are found in both the lowlands (<300 masl) and highlands (>300 masl), while mountains are only found in areas with elevations higher than 300 masl or the highlands. Generally, as elevation increases the slope also increases; nevertheless, there are some plateaus and inter-montane valleys, which are gently sloping and are potentially suitable for agriculture use. However, these topographies are very little in acreage, need high cost for development, and are critically vulnerable to erosion.

Meanwhile, peat, which covers up to 2.6 mha of land (13% of the fragile land and 8% of the total country's land), is a low potential, non-renewable resource and becomes weaken with use. It suffers a waterlogging and hyperacid conditions, acute major and minor nutrient deficiencies, poor trafficability, susceptible to fire hazards, diminishes irreversibly and disappears when drained. On the other hand, acid sulfate soils are found only the coastal areas of Malaysia. Under normal conditions, they are present in areas exposed to tidal influence and often inundated by seawater. Effective use of these soils for agricultural development require reclamation practices. Consequently, such reclamation is costly, tedious, time-consuming, and delicate and complex; hence, requires multidisciplinary expertise.

BRIS is the abbreviated form of Beach Ridges Interspersed with Swales and is referred to the alternating parallel sandy beach ridges with low depression areas that are usually occur in the shoreline of Peninsular Malaysia, Sabah and Sarawak. BRIS soils are infertile and predominantly composed of inert sand particles. The sandy nature of these soils results in a low characteristic soil condition, poor water holding and nutrient retention capacity, excessive drainage, high moisture stress, high surface temperatures and high evapotranspiration. In addition, during the monsoon the low-lying swales are prone to flooding. Though some of the BRIS lands have been cultivated effectively for tobacco, cashew nut, roselle and other annual crops, they are the most under-utilized land in the country. Land degradation in BRIS soil occur when the scarce natural vegetation is cleared for agriculture purposes. Farming system that does not care to the previously depleted sandy soil causes further deterioration of the fertility of these soils.

There are other potential sources of land degradation in Malaysia; for example, shifting cultivation is a potential source of land degradation in Sarawak, Malaysia. About 2.7 mha of land or 22% of the total land in Sarawak is under shifting cultivation. Several years ago, the shifting cultivation, mainly areas of hilly paddy fields, was not considered as a risk to land degradation because of the long fallow periods (over 10 year period). However, as the population of hill growers increased, the fallow period is shortened in order to produce more food that would meet the demands of the increasing population. This matter has been a great concern with regard to land degradation particularly soil erosion, which can become a serious problem since the hill land farmers do not use soil conservation measures.

Types of Land Degradation in Malaysia

Soil erosion is recognized as one of the major forms of land degradation in Malaysia. Soil erosion is the detachment and transportation or carrying of soil particles from the original place by erosion agents (water, wind, and gravity, etc.). Soil erosion can occur geologically or accelerated. The latter is promoted by anthropogenic activities that makes the soil surface uncovered, thereby creating the topsoil to be easy washed by the erosive agents. Besides soil erosion, salinization, fertility depletion, waterlogging and lowering of water table are also recognised as important degradation processes in a comprehensive study of land degradation in Malaysia (Aminuddin, 1994). Soil erosion in agriculture land and land with logging activities is the main process that causes fertility depletion. Fertility decline also occurs in gently sloping alluvial land used for growing wetland rice due to the gradual loss of clay particles. The lowering of water table is the result of excessive drainage.

In coastal areas where there are potential acid sulfate soil, the lowering of water table may result in the development of strong acid soils. Moreover, huge areas of soil in the riverine flood plain is affected by waterlogging. If control measures is not implemented, such as enhancing drainage systems to prevent the problem, a soft soil may result in areas of rice-growing fields, which in turn hampering farming operations that are carried with heavy machineries. On the other hand, salinization is also recognised as an important land degradation in the country, especially in the coastal land. However, some of the saline coastal soils have been reclaimed through drainage and other means to produce coconut, oil palm, cocoa, rice and coffee. In the marine alluvial soils of the Muda or Kedah-Perlis coastal Plains, which is the main rice-producing region in Malaysia, saline water affected about 20% of the region (Joseph and Samy, 1980).

Causes of Land Degradation in Malaysia

Land degradation in Malaysia is caused by the extreme amounts of seasonal rainfall, which severely affects the non-vegetated areas (particularly hilly sloping land), resulting in severe soil erosion. Usually, land cleared for plantation or other purposes is left uncovered for extended periods before establishing conservation measures. Failure to implement control measures that are appropriate to the existing condition in timely manner may aggravate the problems of soil erosion. Fortunately, oil palm and rubber holdings try to minimise soil erosion during the period of land clearing process. They use the practice of 'zero burning', where (after land clearing) all biomass are left between the rows of oil palm or rubber plantations to decompose. In some cases, the highland areas used for the production of high-value sub-tropical crops are applied with high amounts of fertilizers and manure that can offset the effects of erosion. Although the application of high rates of fertilizer and manure can help maintain equitable levels of crop production, the unchecked losses of soil, nutrients and chemicals by erosion process will play a key role to downstream pollution and sedimentation. Sedimentation is the build-up of sediments in channels or the bed of a watercourse. Sedimentation in water streams or rivers raise up bed levels, which in turn results in the increase of flash floods, especially during heavy rainstorms.

Land Degradation Mitigations in Malaysia

Generally, national programs for forestry, water and agriculture resources conservation and legislations have been implemented in Malaysia for the control of land degradation threats. Furthermore, the individual sectors involved in the development of land employ strict mitigation measures for their development projects to minimize the land degradation. Currently, to increase farm productivity the Ministry of Agriculture and agro-based industry through its various agencies is vigorously promoting good practice certification schemes for agriculture involving crop production, veterinary and aquaculture. The Department of Agriculture, Peninsular is now using these practices as the foundation in extension program. There are several mitigation measures in Malaysia that include legislation, policies, guidelines and awareness campaigns, covering sustainable forest management, water resource management, environmental impact assessment (EIA) and soil and water conservation and erosion control measures.

Legislations to control land degradation

To control the degradation of land resources, the Malaysian government has introduced many legislations including such laws as Environmental Quality Act (1974), Land Conservation Act (1960), and National Forestry

Act (1984). The Environmental Quality Act (1974) has various regulations including regulations on restrictions of soil pollution, restrictions of noise pollution, restrictions imposed on pollution of the atmosphere, restrictions of pollution of inland waters, etc. and all of these restrictions have contributed to the mitigation of the land degradation process. Regarding this Act and the many regulations that it contain, 19 land-based developments, such as agriculture, forestry, residential and infrastructure, require an EIA report on impacts of development on the environment. The Land Conservation Act (1960) is currently being reviewed to provide more effective control of soil erosion and to protect river silting, which are more common in agricultural land. The Lands and mines Department has recently initiated a review of the national policy on sustainable LU.

Policies and Guidelines Introduced

Various policies have been introduced in Malaysia to ensure sustainable use of land resources for development. The main policies put into place are the National Agriculture Policy (NAP), National Forestry Policy and National Urbanization Policy. These policies together with the other mitigation procedures have significantly contributed to the control of land degradation. The NAP gives emphasis on increasing productivity by providing policies on the efficient use of land resources. Under this policy, the opening of new land is discouraged and rigorous efforts are made to enhance the efficient use of underutilized land, idle land, and even marginal land such as ex-mining land, acid sulfate land, and BRIS soils. To use optimally the agricultural land, mixed farming comprising cropping, livestock farming and aquaculture are encouraged. Integration of livestock in oil palm and rubber plantations has been also propegated. NAP also contributed to the preservation of forestland and protection of the environment through discouraging the clearing of new land.

National Forest Policy that was introduced in 1978 and was revised in 1992, and National Forest Act (1984) provides guidelines for the development, conservation, management, utilization, and protection of forests. The basis of the national forest policy is to establish permanent reserved forests (PRF) that ensure the sustainable management of forests. Approximately 4.84 mha of forested land comprising 36.8% of the whole land in Peninsular Malaysia are designated as PRF for sustainable management to benefit both current and future generations. Regarding to the numerous roles of the forests, the PRF could be categorized into functional classes such as wood production forests for sustainable harvests, flood control forests, soil protection forests, sanctuary forests for wildlife, water catchments, virgin jungle reserves, education forests, amenity forests and research forest for promoting the sustainable use and management of forests. However, 1.90 mha from the 4.84 mha of the PRF or 39.2% of the total area are classified as protection forests and the remaining 2.94 mha are for production forests.

The Forestry Department prohibits opening of new land in areas 1,000 above masl for any form of development; hence, this would stop accelerated degradation of land resources and preserves the fragile ecosystem at this elevation. Additionally, several guidelines for controlling the different forms of land degradation in Malaysia are available. The Department of Irrigation and Drainage (DID) of Malaysia introduced in 2001 a guideline and manual entitled Urban Storm Water Management Manual for Malaysia. This guideline provides sufficient information for planners, engineers, developers and contractors involved in planning of project developments, and design and/or construct appropriate measures as well as select the best management practices (BMPs) to be adopted in the areas reserved for development. The DID of Malaysia has introduced a Guideline for Erosion and Sediment Control in 2011 so as to strengthen the control measures for soil erosion and sediment process. Guidelines are also existence for the development of sloping land. Land with slope greater than 25 degree is classified as steep-land and is not recommended for any LU in agriculture. Land less than 25 degree slope has to undergo conservation measures such as terracing, silt traps, contour ditches, constructing appropriate systems for drainage, and ground covers, before developing it for agriculture.

Soil and Water Conservation and Erosion Control Measures

Conservation is defined as managing resources in a way that assures the resources will continue for a long-term in providing the maximum benefits to human. The aims of soil conservation and erosion control measures are to prevent degradation of soil and the environmental pollution, which are actually essential in sustaining the long-term productivity of the environmental resources. Soil conservation is a set of management strategies for preventing soil from being eroded from the surface of the

Earth or chemically becoming altered by overuse, salinization, acidification or other means of chemical soil contamination. Soils conservation entails utilization of soil without causing any waste on it to produce continuously a high level of crop production without environmental degradation.

According to Mohsen (2014), soil and water conservation practices such as terracing, silt pits and organic mulches are the most common methods that had been practicing several decades in Malaysia. In addition, Malaysia have been applying numerous soil and water conservation practices. This paper presents the common methods of soil conservation in Malaysia:

1) **Terracing**

Terracing is the construction of embankments across the slope to intercept runoff and carry it to a steady outlet without causing any erosion, and to reduce the slope length. Terraces are constructed across the slope with the aim of reducing runoff and soil erosion (Morgan, 2005; Troeh et al., 2004). Usually, the construction of contour terraces and platforms are employed on steeper and undulating areas. Terraces with adequate back slope and stop bunds should be made at regular intervals along the planting terrace to reduce soil erosion. According to Goh (1995), highly erodible soils on slopes more than 6 degree should be terraced regardless of the soil type, especially in the areas experiencing frequent and high intensity of rainfall of more than 25 mm hr^{-1}.

There are two types of terraces: 1) Conservation terraces; and 2) Planting terraces. As they can also work as soil and water conservation measures, terraces for planting are constructed mainly to facilitate harvesting, maintenance and evacuation operations for the crops. They should be sloped inwards and a vertical drop of about 50 cm is constructed in between the rear and the lip of the terrace to trap the runoff water. Additionally, along the terraces there should be regular stops for the same purpose. Conservation terrace, on the other hand, is sufficient on milder slopes and significantly reduces runoff and erosion for slopes from 6 to 20 degree (Abo Hammad et al., 2006). Some terraces have shown negative effect on soil productivity. If this happens, it is necessary of the management of oil palm plantations to practice organic mulching and/or silt pits on slopes without terraces. However, terracing loses its efficiency in areas with gentler slopes; thus, they have to be replaced with other conservation practices (Corley and Thinker, 2003).

2) **Silt pits**

According to Roslan and Haniff (2004), silt pits are long, narrow and deep close-ended trenches that are dug in between the rows of oil palm plants to hold and collect runoff water during rainy days (Figure 1). They are one of the conservation methods for soil and water recommended in Malaysia (Teh et al., 2011). This is one of the land management practices that can generate yield intensification to increase maximum oil palm yield production in Malaysia (Goh et al., 1994). Silt pits reduce soil erosion, control surface runoff, prevent sedimentation of channels, increase yield in oil palm by providing more moisture particularly during dry period, and increase and protect the fertility of the soil by reducing the loss of nutrients and redistributing them in the eroded part of the land. Additionally, pits serve to trap sediments from surface runoff that contains nutrients, and redistribute the trapped water and nutrients to the soil to be fully utilized by the palms (Bohluli et al., 2012). Silt pits can help support areas where soil erosion and runoff are very severe; therefore, in addition to the terraces, silt pits should be dug in these areas to reduce the path of water flow. In this way, water infiltration into the soil is increased; hence, moisture conservation is maximized. Depending on the slope degree and the severity of soil erosion, silt pits in the plantation are spaced at the intervals of 20 to 30 m.

Figure 1 A typical silt pit used in oil palm plantations in Malaysia

3) **Mulching**

Mulching is covering the soil with organic or inorganic materials. Among the organic mulches, crop residues (such as straw, maize stalks, palm fronds or standing stubble) are the most commonly used in agriculture, and favorable effects of these residues on soil fertility have long been recognized. These materials contain carbon and other major nutrients that are released during decomposition process (Wagner and Wolf, 1999). Mulch protects the soil from the impacts of raindrop and lowers the velocity of runoff and wind. Mulching is a useful and alternative practice to cover crops in dry areas where insufficient rain does not allow the establishment of ground covers or where a cover crop may compete for moisture with the main crop. They can also be used under tree crops to reduce soil erosion. For example, as recorded on unprotected paths, using pruned fronds to cover harvesting paths in oil palm plantation in Johor, Malaysia has reduced annual soil loss from 14.9 t ha^{-1} to 4.2 t ha^{-1} (Maene et al., 1979). Moreover, oil palm frond is a residue from the oil palm plant that have been commonly used as mulch between oil palm rows. The pruned fronds are placed on the soil surface to reduce runoff as well as soil erosion. When the fronds are decomposed, nutrients in them are released into the soil for oil palm uptake. For the same reason, empty fruit bunches (EFB) are also used for mulching in oil palm plantations in Malaysia.

4) **Cover cropping**

Cover crops have been used as a conservation measure either during the off-season or on season as ground protection under trees. Ground covers are planted under tree crops to protect the impact of raindrops striking the soil or the water falling from the canopy on the soil. The most common cover crops used are *Calapogonium mucunoides, Pueraria phaseoloides* and *Centrosema pubescens.* In addition, legume cover crop plants such as *Pueraria javanica, Calopogonium caeruleum* and *Mucuna bracteata* are frequently planted in most large plantations and smallholdings of rubber and oil palm in Malaysia. Cover crops are important particularly with tall tree crops such as rubber where the height of fall is sufficient to cause the drops to approach their terminal velocity. With bare soil beneath the trees, erosion rates greater than 20 t ha^{-1} have been observed under oil palm in Malaysia, even with bench terracing (Lim 1988). More importantly, cover crops could be used to reduce erosion to less than 0.5 t ha^{-1} although the harvesting paths remain vulnerable (Maene et al. 1979). Leguminous cover cropping are mostly practiced in oil palm plantations in Malaysia. Therefore, where erosion of soil occurs, establishing legume cover crops with a full cover of the ground is necessary as quickly after land preparation is completed. According to Ling et al (1979), a 10 degree gradient Munchong soil can have a soil loss of eight-fold higher on bare land than that of the natural or legume covers. It is also reported that a reduction of soil loss from 9.0 t ha^{-1} yr^{-1} at 0-30% covered ground to 0.1 t ha^{-1} yr^{-1} at 90-100% covered ground (Ling et al., 1979). Similarly, a marked reduction in runoff losses were also found. Furthermore, it is well known that legumes have beneficial effects on the physical properties, fertility, and biological activities in soils.

5) **Geotextile for erosion control and slope stabilization**

Geotextile is a fibrous material made of element like filaments, individual fibers, tapes, yarns, etc. which are long, small in cross section and strong in tension. One important characteristic of geotextile is its flexibility, which is useful for both in good contact conditions and in avoiding stress concentration within the fibers. There are two types of geotextile, biodegradable and non-biodegradable. Biodegradable geotextile is made of natural fibers, (like pedunculata fiber, or *Raffia Vinifera*) which can be obtained from raffia palm fronds through sun drying and beating it with a piece of wood to create the fiber. On the other hand, the non-biodegradable geotextile is a synthetic material, like polypropylene and polyester. There are several purposes for using geotextiles in Malaysia, including erosion control by preventing the raindrop impact and for slope stabilization. The primary functions of geotextiles include prevention of soil surface erosion, promotion of seed germination, protection of young vegetation, prevention of seed erosion, prevention of seed or mulch dispersal by wind, and easy for both seeding and mulching (DID, 2010).

Geotextile has been used to stabilize landslides in the residual soils or weathered rocks in Malaysia, which are generally induced by the impact of heavy rainfall. After heavy rainfall and when the soil is saturated, because all of its pores are closed by the high infiltration of the rainwater into the ground, the shear strength of the soil is largely reduced. Consequently, the slope becomes unstable and eventually it fails. Therefore, geotextile has been used effectively in various occasions to stabilize steep slope in residual soil and weathered rock. Geotextile had been used in Malaysia as tensile reinforcement and filter for slope or embankment stabilization. Usually, it is placed in horizontal layers within the slope along the slope cutting across the most likely sliding surfaces of the soil. Geotextile reduces the water pressure in the pore within the slopes during rainy periods, thereby increasing the shear strength. Geotextile also acts as a filter, where it prevents the migration of soil or sometimes termed as the internal erosion within the slope.

6) **Riparian zone**

A riparian zone can be essentially defined a land adjacent to streams and/or rivers and a unique transitional area between aquatic and terrestrial habitats. Plant communities in this area is called riparian vegetation. Riparian zones in Malaysia constitute only a small part of the landscape, but they are important habitats for biodiversity that provide environmental services essential for the well-being of human. Riparian habitats are not homogeneous and have varying assemblages of plants and animals depending on factors such as elevation, hydrology and soil. Riparian zones have several functions in the general ecosystem. Some of its functions are improvement of the quality of the water, mitigation of flood, stabilization of riverbank, cultural/recreational values, wildlife corridors, maintenance of stream ecology, etc., and they have a big role in soil conservation.

Runoff from plantations and agriculture lands, construction sites and failed septic tanks, introduce a range of pollutants into the river system. These pollutants, which include organic wastes, sediments, chemicals, nutrients and metals are difficult to measure, control and monitor. Thus, riparian zones serve as buffers that intercept these non-point sources pollutions. In particular, riparian vegetation absorbs heavy metals (HM) and nutrients, traps sediments suspended in surface runoff and provide habitat for microorganisms that help the breakdown of these pollutants. In addition, riparian vegetation creates and/or increases the roughness of the surface and channels, which serves to slowdown surface water runoff, decrease water entering into the river, and reduce the flow rates within the river. Creating surface roughness and reducing runoff means soil erosion is controlled and curtailed. Although flood mitigation requires a good management of the entire river basins, riparian vegetation can contribute flood mitigation control by slightly alleviating the magnitude and intensity of flooding downstream. The unique microclimate and proximity of riparian vegetation to water streams make riparian zones excellent habitats for various animal species, particularly birds and the amphibians. Riparian vegetation is essential to the aquatic organisms. Trees and shrubs of the riparian vegetation provide shade that can reduces water temperature, thereby allowing many aquatic species to survive. This shade also limits the amount of light reaching the river, which in turn prevents the excessive growth of water plants and algae.

7) **Sediment/Silt fence**

Sediment fence also known as silt fence is used temporarily as sediment blockade and consists of a fabric filter stretched across and supported with posts and backed with a wire fence for support, depending on the strength of the fabric. This sediment fence does not filter runoff, but acts as a linear fence that creates upstream ponding, allowing soil particles to settle down, thereby reducing the amount of soil leaving from a disturbed area. Silt fences reduce stream sedimentation as they trap the soil. They are control fences which encourages reduction of the velocity of sheet flow; thus, reduces the rate of soil erosion. They effectively retain suspended solid particles coarser than 0.02 mm. Their construction is simple, relatively cheap and can easily be moved to a new area while the construction is in progress.

8) **Sediment trap**

A sediment trap is a small provisional ponding area that is typically constructed with a gravel outlet and formed by excavation and/or construction of an earthen embankment. This sediment trap is used for detaining runoff from bothered zones for a long time enough to be allowing for the bulk of the suspended coarser soil particles in the runoff to be settled down. It is intended to use where there is small catchment area that does not require complex drainage features and where a construction can be completed in a short time. It is a short-lived measure designed for an approximate lifespan of six months, which should be maintained until the site of the bothered area is eternally protected with vegetation or structures or any other permanent structure for preventing or controlling the intensity of soil erosion. It is an efficient method for sediment control which is cost-effective that should be done as the first step in soil conservation practices.

9) Temporary waterway crossing

A temporary waterway crossing is a short-term culvert, bridge, or ford placed across the waterway to be easily accessible for construction in a period of less than a year. The temporary crossing of the waterways is to have a safe and erosion-free access point across the waterway for the construction equipment. The engineer establishes the least standards and specifications for the design, construction, maintenance, and removal of the structures. Crossings may also be required to prevent the construction equipment from causing erosion of the waterway. Generally, two main types of temporary waterway crossings are available for construction. Temporary bridge crossing is the first method, which brings the least risk of erosion of a stream channel crossing during installation of the bridge and even when removing it. In addition, it provides the minimum obstruction to flow or migrate the fish. When appropriate materials are used to properly design the temporary access bridge, there will be a high possibility that the structure can typically exists for a long time period with no or little maintenance requirement. It may also be used for another time in the future when the current project ends. The design of the construction of the temporary bridge crossing is rather costly. Safety hazard is increased if the structure is not properly designed, installed, and maintained. A temporary culvert crossing is the second method which can effectively control the erosion; however, during the installation and removal may result in some erosion.

Conclusion

Land degradation is a long-term loss in the productivity and functions of the ecosystem by the disturbances of several activities from which the land is not possible to recover without help via mitigation procedures which have been put in place by the authority. It is a major global issue on land, which is of concern to the development of economic activities and environment. In Malaysia, several forms of land degradation occur that include degradation of forestland, soil erosion, salinity problem, decline of soil fertility and waterlogging. Several mitigation measures are introduced to curtail land degradation in the country. Among these are in the form of policies and legislations, guidelines awareness campaigns, soil conservation methods and erosion control practices. Malaysia has been continuously promoting sustainable use of land resources to the developers and users. Although Malaysia is committed to sustainable development by way of promoting mitigation procedures throughout the length and breadth of the country, land degradation is still going on. Therefore, the government should impose strict regulations to be adhered to by everyone using land to make their living.

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