Akademika No. 26, Januari 1985

VEGETATION AND FLORA CONSIDERATIONS IN THE DEVELOPMENT OF A NEW CAMPUS SITE OF UNIVERSITI KEBANGSAAN MALAYSIA (SABAH BRANCH) AT LIKAS BAY, MENGGATAL

SHAFIE AHMAD

SINOPSIS

Suatu kajian mengenai tumbuh-tumbuhan, flora dan topografi di tapak kampus baru Universiti Kebangsaan Malaysia (Cawangan Sabah) di Teluk Likas, arah ke utara Kota Kinabalu, Sabah telah dilakukan dalam bulan Oktober 1981. Jenis utama tumbuh-tumbuhan yang dikenalpasti ialah (1) tumbuhan pantai (2) belukar tanah rendah, (3) paya bakau dan (4) kawasan tanaman. Kecuali bagi kawasan tanaman, sejumlah tiga plot sampel (10 m^3 tiap satu) telah diwujudkan secara rambang di setiap kawasan tumbuh-tumbuhan tersebut. Kawasan hutan tanah rendah di situ telah dibalak dan ini jelas terbukti oleh tunggul-tunggul dan juga lorong-lorong lori yang masih tinggal. Tumbuh-tumbuhan pantai dan hutan tanah rendah yang terdapat di beberapa kawasan di sepanjang cerun dan bahagian rata di situ telahpun dibersihkan untuk kegiatan pertanian. Oleh kerana topografi kawasan Menggatal ini terdiri dari rabung and cerun melebihi 30%, maka pembangunannya perlulah mengambilkira program untuk mengawal hakisan dan kelodakan. Program ini hendaklah disediakan sewaktu tahap perancangan lagi supaya tumbuh-tumbuhan, flora dan sungai dapat diselamatkan. Beberapa cara bagi mengawal hakisan dan kelodakan juga dibincangkan.

SYNOPSIS

A survey of the vegetation, flora and the general topography of a new site for Universiti Kebangsaan Malaysia, Sabah Branch (UKMS) at Likas Bay north of Kota Kinabalu, Sabah was made in October, 1981. The main vegetation types identified were (1) beach vegetation, (2) lowland secondary forest, (3) mangrove swamps and (4) cultivated areas. With the exception of the cultivated area, a total of three sample plots of 10 m^2 each were laid out randomly in each type of vegetation for species enumeration and diameter breast height (DBH) measurement. The lowland forest had been logged and this was clearly revealed by the left-over stumps and old tracks presumably for heavy vehicles found there. The beach vegetation and some areas along the slopes and flat land of the lowland forest had been extensively cleared for argicultural activity. Since the topography of Menggatal is rugged consisting of ridges and slopes exceeding 30%, its development should include a programme for erosion and sediment control. This programme should be worked out during the planning and design stages before plans become finalised and construction begins so that the vegetation, flora and natural waterways could be saved. Some of the practical methods to control erosion and sedimentation are briefly described.

INTRODUCTION

A master plan for the establishment of a new campus of the Universiti Kebangsaan Malaysia, Sabah Branch (UKMS) has been duly completed and it is now awaiting the "green light" from the government for its implementation. The new site is approximately 360 ha. in area and is located on a coastal zone to the north of Kota Kinabalu, the capital of Sabah. Menggatal is a magnificient area bounded by the Gaya Bay in the west, the Menggatal and Inanam rivers in the north and south respectively. In the east, the two rivers and their tributaries join each other forming the eastern boundary (Figure 1). Topographically, the area is rugged with a series of ridges and high points forming the central part of the site. A number of these ridges are steep slopes descending towards the sea in the west and floodplains around the site. Most of the area which is not a floodplain is located on slopes exceeding 30 percent (Khan, 1981).

This survey attempts to describe the major types of vegetation, flora, man's activity currently found in the area and identify measures that should be taken to reconcile necessary development activities so that any adverse effects generated can be controlled or at least minimized. In the development of a new campus on a rather rugged topography of Menggatal, the surrounding vegetation, flora and natural waterways would be inevitably threatened by hazardous action of erosion, runoff and sedimentation if a programme of control measures is not worked out in the planning stage before construction begins in the area.

BRIEF DESCRIPTION OF THE VEGETATION AND FLORA

The UKMS site consists of four major types of vegetation, viz:

1/ Beach vegetation

2/ Secondary lowland forest

3/ Mangrove swamps

4/ Cultivated area

BEACH VEGETATION

This develops on sandy soil and behind marine beaches and in some areas, extends between 30 to 150 m inland bordering the hill slopes. Most of the area has been extensively cultivated for agriculture, such as food crops and coconuts. A few wooden houses are also found along the beach of the academic and staff housing sites (Figure 2). In uncultivated areas or those abandoned presumably several years ago, wild plant species found on three sample plots are shown in Table 1.

From the table, most of the trees recorded are at "pole stage" with DBH ranging 4 – 15 cm. Trees which are mostly under "pole stage" is a reflection of the fact that the fores had been cleared before but then abondoned (Wyatt-Smith, 1966).

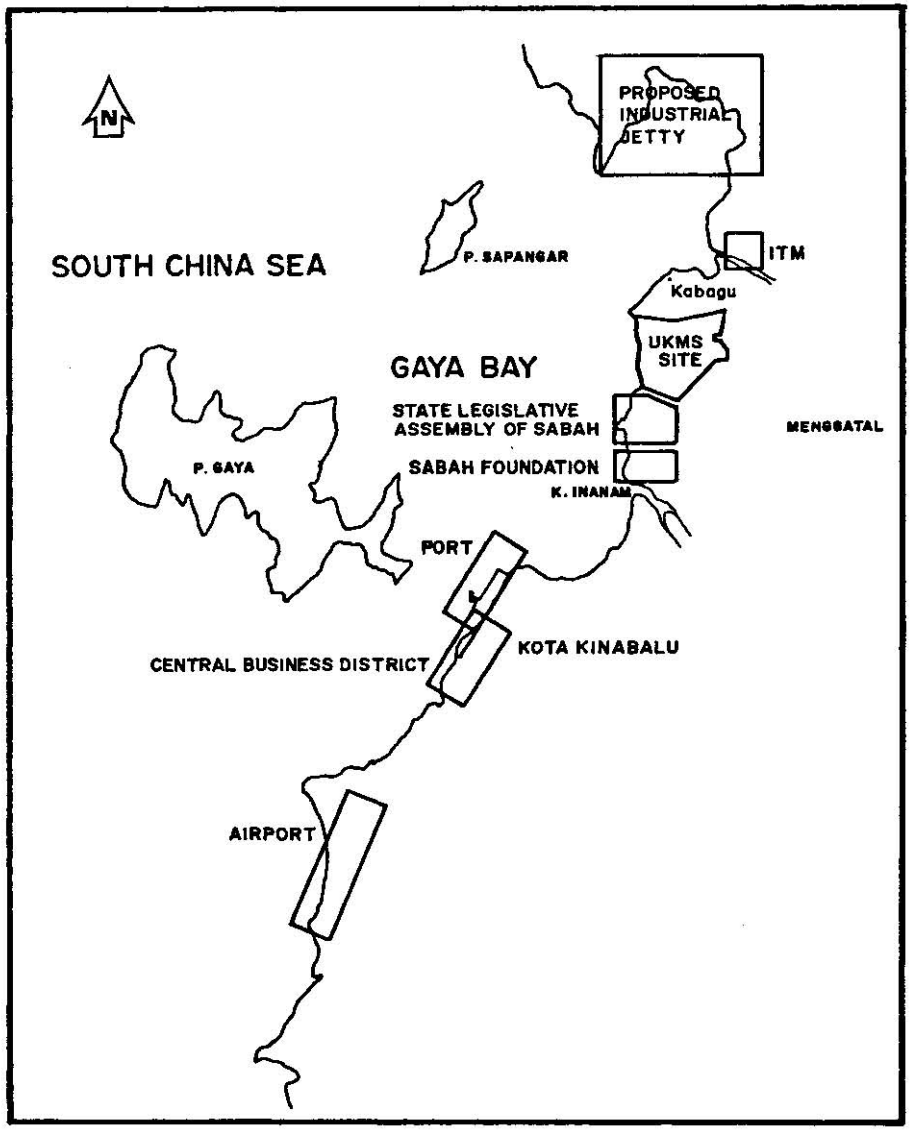

FIGURE 1. Site for Universiti Kebangsaan Malaysia, Sabah Branch

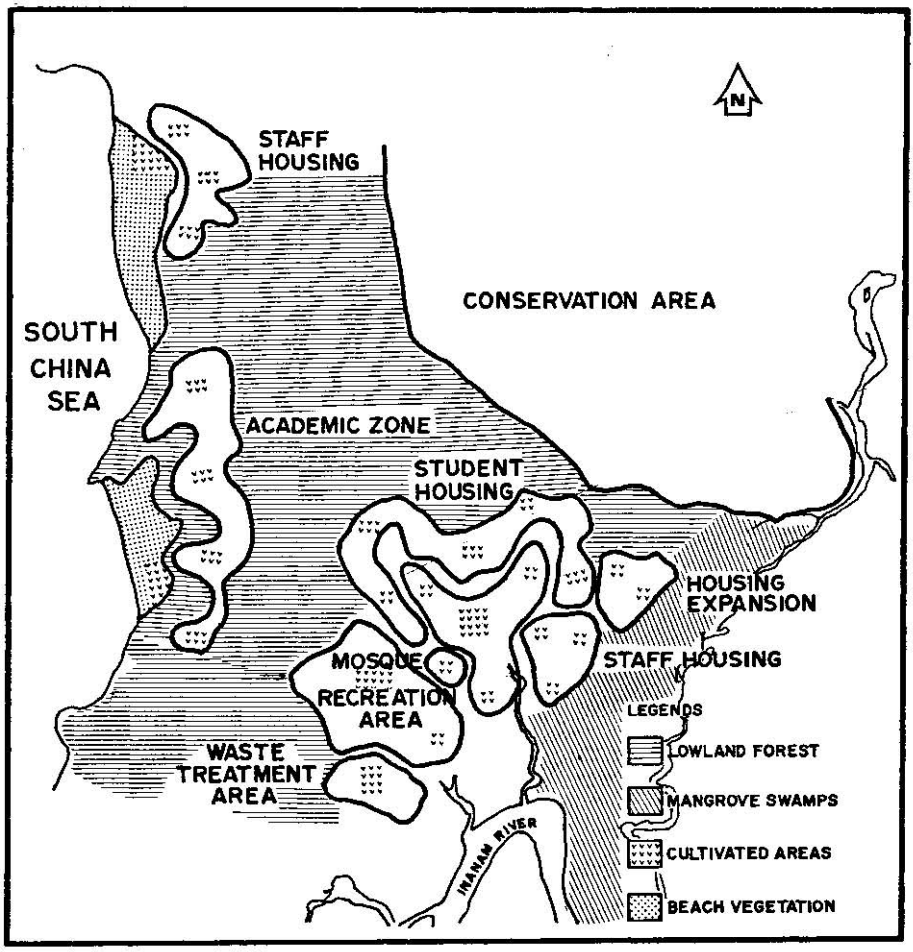

FIGURE 2. Map Showing the Area for Development and Vegetations of the Site of Universiti Kebangsaan Malaysia, Sabah Branch

TABLE 1. Tree Species of Beach Vegetation

No.	Species	DBH (cm)						
		3 – 6	6 – 9	9 – 12	12 – 15	15 – 18	18 +	Total
1/	*Dellinia suffruticosa*	4.20	5.60	9.30	12.1	15 – 80		
			6.0			15.10		
			7.10			16.80		
			6.80					
			8.30					
			8.30					12
2/	*Litsea* sp.	4.0				15.80	18.50	
						15.10		
						16.80		5
3/	*Aquilaria malaccensis*	6.10	9.70					
		7.20						3
4/	*Pithecellobium kunstleri*	4.10		10.20				2
5/	*Fagraea racemosa*	4.50		9.50				
		4.60						
		4.0						
		5.80						
		6.0						
		5.70						
		6.20						
		5.50						9
6/	*Ardisia littoralis*	5.20		10.30				
		4.50						
		5.50						
		4.60						5
7/	*Eugenia densiflora*					15.50		1
8/	*Decaspermum fruticosum*	4.30	6.30	11.60				
		5.70	6.70					5
9/	*Xanthophyllum borneensis*		6.50	10.40				2
10/	*Trema orientalis*	4.0						1

(Cont'd)

TABLE 1. Tree Species of Beach Vegetation (Contd.)

11/	*Adenanthera pavonina*						20.90	1
12/	*Palaquium gutta*		11.20					1
13/	*Oncosperma tigillaria*					15.50		1
14/	*Planchonella obovata*	4.10				15.20	35.50	
							22.10	4
15/	*Elaecarpus stipularis*						27.60	
							52.20	
							63.60	3
16/	*Blumeodendron* sp.						28.0	1
17/	*Gynotroches axillaris*				14.20			1
18/	*Symplocos odoratissima*		7.30					1
	Total number of trees	19	12	8	2	9	8	58

SECONDARY LOWLAND FOREST

This lowland forest is found between the beach vegetation in the west and magrove swamps in the east of the site. It consists of a main ridge extending in the NS direction of the UKM site with a number of secondary ridges with steep slopes exceeding 30 percent descending towards the sea and the floodplain surrounding the site. The area of lesser slopes is covered with abandoned rubber plantations of over 25 years old. In the eastern part of the site where the slopes are gently descending towards Menggatal and Inanam rivers, a new settlement consisting of at least 30 wooden houses, has been established. The area around the village has also been cultivated for fruit trees, vegetables and padi. Other areas which are not under cultivation are believed to have been logged before. This is evident by the leftover stumps and old tracks of heavy vehicles, presumably bulldozers and lorries, found in the NS ridge. For identification and enumeration purposes, a total of 3 sample plots of 10 m^2 each are set randomly in the uncultivated areas of the steeper slopes and on the main ridge. The tree species and their DBH measurement form the 3 sample plots are given in Table 2.

From the table, it is evident that most of the trees are within the range of 3 – 9 cm DBH or at "pole stage". Floristically, the forest is not very rich, certainly not so in comparison with most of the forests of Sabah. This is attributed mainly to serious logging practice done several years ago and

TABLE 2. Tree Species of Lowland Forest

No.	Species	DBH (cm)						
		3 – 6	6 – 9	9 – 12	12 – 15	15 – 18	18 +	Total
1/	*Gynotroches axillaris*			10.60	13.20			2
2/	*Elaecarpus stipularis*	5.3	6.50	11.80	14.10	17.50	21.0	
			6.30		14.7	17.0		9
3/	*Planchonella obovata*		7.60	9.50	13.0	15.20		
			8.0	10.80	13.0	16.40		
				11.50.				
				10.20				10
4/	*Flacourtia indica*		9.90					1
5/	*Xanthophyllum borneensis*	5.20						
		5.60						2
6/	*Buchanania lucida*			10.50	13.0			
				10.90				3
7/	*Urophyllum* sp.	5.5	6.50					2
8/	*Pternandra* sp.		7.0					
			7.0					2
9/	*Timonius* sp.		6.30		12.50			2
10/	*Garcinia bancana*	4.70	6.0	10.50				
		5.30	6.80					
			6.40					6
11/	*Stemanurus secundiflorus*			10.90				1
12/	*Garcinia parvifolia*						20.80	
							20.50	2
13/	*Vitex pubescens*	5.0	6.70		13.80	15.50		4
14/	*Eurycoma longifolia*	4.50						1
15/	*Decaspermum fruticosum*	4.80		10.20				
		5.50						3

(Contd.)

TABLE 2. Tree Species of Lowland Forest (Contd.)

16/	*Dillenia suffruticosa*	5.70		9.50				
		5.50						
			6.70					
		5.50						6
17/	*Sympolcos odoratissima*		6.80					
			6.50					2
18/	*Eugenia longifolia*		8.0					
		5.20						
		5.20						
19/	*Fagraea racemosa*		6.40					
		5.60						2
20/	*Guioa* sp.	4.50						1
21/	*Ficus fistulosa*		6.50					1
	Total number of trees	16	21	13	8	5	3	66

cutting by the inhabitants living in the neighbourhood. It is interesting to note that no dipterocarp trees were found during the survey.

THE MANGROVE SWAMPS

The areas in the east between the tributaries of Menggatal-Inanam rivers and the lowland forests are either flat or lowlying, the latter being closer to the river tributaries forms the mangrove swamps. Like other vegetations described previously, considerable area of mangrove in the north has also been cleared, leaving only a few strangling plants here and there. The only mangrove area tha has not been disturbed is in the south. For enumeration purpose, 3 sample plots of 10 meter square each were ramdomly placed in the undisturbed area. The tree species and their DBH recorded from the 3 sample plots are shown in Table 3.

Rhizophora mucronata is the sole species which grows densely in the mangrove swamps. This area is undisturbed presumably due to the fact that the adjacent area is the research station of the Fishery Department of Sabah.

TABLE 3. Tree Species in Mangrove Swamps

No.	Species	No. of Plants 3 – 6 cm DBH	No. of Plants 6 – 9 cm DBH	No. of Plants 9 – 12 cm DBH	No. of Plants 12 – 15 cm DBH	No. of Plants 15 – 18 cm DBH
1/	*Rhizophora mucronata*	23	55	7	1	2

CULTIVATED AREAS

Agricultural areas are found an parts of the beach, on the lesser slopes of the secondary forest and on most of the flatland. The flatland located between the eastern slopes of the secondary forest and the mangrove swamps has been established as a new village and during the survey, a total of not less than 30 wooden bouses are found there. The land is also extensively used for agriculture (Table 4).

TABLE 4. Agricultural Crops Grown on Cultivated Area

No.	Species	Local Name
1/	*Artocarpus heterophylla*	Nangka
2/	*Eugenia grandis*	Jambu Laut
3/	*Mangifera indica*	Mango
4/	*Areca catechu*	Pinang
5/	*Ipomoea batatas*	Ubi Keledek
6/	*Naphelium lappaceum*	Rambutan
7/	*Oryza sativa*	Padi
8/	*Hevea brasiliensis*	Getah
9/	*Manihot esculenta*	Ubi Kayu
10/	*Cocos nucifera*	Kelapa
11/	*Ananas comosus*	Nenas
12/	*Musa* sp.	Pisang

Rubber and coconuts are the major crops grown on the lesser slopes of the secondary forest and on the beach respectively.

PROBLEMS ARISING FROM CLEARING THE SITE FOR DEVELOPMENT AND CONTROL MEASURES TO BE UNDERTAKEN

The academic building, the student and academic housing are in the south-west, south-east and north-east of the site respectively (Figure 2). The buildable areas are mostly on the lower gradient of the slopes. Road and pipline constructions and other amenities need to pass in parts through steep slopes that need earth cutting and substantial amount of earth moving. In some areas, earth filling may be necessary. Apart from having modern building and other facilities, it is also in the interest of the university to maintain and preserve the surrounding vegetation, flora, waterways and swamps naturally. These natural resources, available at the "doorsteps" of the university not only add beauty and attraction to the campus, but more importantly is their utilization for academic purposes.

Some of the problems that are likely to occur following development of the campus can be categorically stated as follows.

HYDROLOGICAL PROBLEMS AND CONTROL MEASURES

The effect of clearing the vegetation especially on the steep slopes, as in UKMS site, on the various components of the hydrological cycles are well known, but they are less appreciated, e.g. river floods and low river yields. Under forest cover, the floor is thickly covered with litter with highly water absorbent capacity. Under this condition, the top soil layers are also rich with humus which promotes maximum infiltration during precipitation and thus surface runoff is reduced to a minimum. However, when the forest is cleared for development, the litter part of the forest floor is removed followed by a reduction in humus content. The soil becomes less absorbent and surface runoff is increased causing river floods, while the low river yields are reduced.

An experimental study undertaken by the Hunting Technical Services Ltd. during the regional Master Planning Study of Johor Tengah and Tanjung Penggarang areas (Anon, 1971), measurements of runoff were made on two adjacent catchments; one with forest cover and the other mainly under rubber and oil-palm crops for a period of 13 months. The result of the study showed that the peak storm runoff per unit area of the catchment under plantation crops was approximately twice that from the jungle catchment while the low flows were approximately halved. Studies on 12 river catchments in Cameron Highlands also showed that the low flow yields were reduced by approximately 50% in catchment of 50 square kilometeres and by about 75% in catchment of 500 square kilometeres when the area was transformed from forest to agriculture (Shallow, 1956). Serious problems will arise if due recognition is not given to such consequential effects in an attempt to transform an area to a development project.

An effective way to control or minimize surface runoff is to do felling only on the area earmarked for development. Very often developers tend to clear more areas than are necessary, presumably to provide more working space and movement for their heavy machines.

SOIL EROSION AND CONTROL MEASURES

Erosion is a process of detachment and transportation of soil particles especially during rainy seasons. Rain falling on bare soil or on soil with sparse cover detaches soil particles which are carried by runoff drum the slope. Often rills and gullies are cut by the force of the moving water. Water moving over the land and in downstream channels carries soil material in amount proportional to the volume and velocity of the water, soil types, steepness of slopes, the intensity o rainfall and the construction methods. Much of the erosion occurs during the construction period but areas below the contruction site may erode more after construction is completed because of the rapid runoff from impervious pavements, parking lots or compacted soil. The situation could be worst for UKMS as the area above the buildable site consists mainly of ridges with steep slopes. The amount of runoff from the area above during rainy seasons would be voluminious eroding the slopes and the soil around the building. In the course of time, buildings would crack with sinking beams and concrete floors. It would wash out roads and streets, undercut pavements and pipelines, clog storm sewers, flood basements, and deposit sediments and debris in the area causing hazards to the campus. Runoff would also damage the river banks causing flood below the construction site. The sediments pollute the flatland, swamps and rivers and eventually damage the area where it comes to rest, seriously impairing the aesthetic value of the natural vegetation, flora and environment of the campus.

Roads and building layout can minimize or encourage erosion during construction and complement or spoil the natural environment. Steep slopes and areas with highly erodible soils can be protected or left exposed; clearing and grading can save or destroy trees and can result in limited or excessive soil disturbance; cut-and-fill slopes can be stable or unstable, protected or left bare for long periods. These are the kinds of considerations that need to be taken into account during planning and design stage to get erosion control into the site development plan. If a proper programme for erosion and sedimentation control is worked out during the planning and design stages problems associated with soil erosion, runoff and sedimentation may be avoided or minimized.

Apart from identifying and evaluting problems that may cause serious impacts during construction it is also necessary to obtain information on the soils, topography, geology and hydrology at the propored site. Runoff originating from the actual site as well as there from above and below it must be considered in order to provide for its proper measures. There are several alternative ways of effectively controlling erosion and sediment problems on most sites. The final plan should be based on such factors as the

time of the year that construction will take place, the extent of grading and the amount of cover on the land.

There are two kinds of erosion and sediment control measures, viz; 1/ mechanical and 2/ vegetative methods. Both methods should be properly designed, installed and maintained if they are to accomplish their intended purpose.

1/ MECHANICAL METHOD

Among the mechanical measures that could be used are as follows.

a/ Land Grading Areas that are only meant for immediate construction should be graded. This would help immensely in controlling erosion as opposed to grading the entire area. As the workable size area is graded and construction in a specified schedule completed, grading and construction will proceed to the next area. As a general rule, grading should be held to the minimum without increasing runoff appreciably. Heavy cutting, filling or reshaping of the natural topography is sometimes necessary to increase the percentage of usable land but appropriate erosion control measures should be taken to reduce erosion hazards. Constructed slopes should be limited to a degree of steepness that will provide stability and allow easy maintenance. Retaining walls in this case may be required. Stumps, decaying material, soft and mushy soil are not suitable for fills to support biulding or other structures as the area will eventually sink.

b/ Bench Terraces Bench terraces are often used to break long slopes and slow the flow of runoff. They are constructed across the slopes and fitted to the naural environment. The cut-and-fill slopes of bench terraces, however, are always steeper than the natural slopes so that land-slides may be a threat. In this connection, therefore, engineering studies should always be made to guide the design of the slopes and to ensure a reasonable degree of slope stability and safety.

c/ Subsurface Drains Subsurface drains are sometimes required at the base of the filled slopes to remove excess ground water. In heavy grading, drainage channels below the surface may be necessary to prevent accumulation of ground water. Subsurface drains may be necessary also in vegetated channels to lower a high water table which would otherwise prevent the establishment of an effective plant cover.

d/ Diversions Runoff can be diverted to avoid damage to the lower area. This can be accomplished by constructing a channel and a ridge across the slopes, especially above the critical slopes. For a construction area with sloping topography, a series of diversions can be constructed. It is however important to have a stable outlet to dispose the water safely. For diversions which are meant to be permanent, grasses should be planted to cover the surrounding areas so that the ridges would be firm.

e/ Berms Berms, a type of diversions, are compacted earth ridges with no channels. In newly constructed slopes, berms could be used to protect the former until they are stabilized with vegetation. Berms could also be constructed across graded roads in a series or at intervals to intercept runoff but it is important to design the berm slopes properly so as to allow vehicles to cross over them without much hazard.

f/ Storm Sewers Storm sewers are used to dispose of runoff from the streets and adjacent areas. However, sewers do not prevent sediment from being deposited downstream. The sediment load carried by runoff through storm sewers can be reduced by establishing small sediment basins adjacent to sewers inlets. The sediments collected in the basins is removed following each runoff.

g/ Outlets: Outlets serve to dispose water safely from diversions, and from parking lots, roads and other areas. The number of outlets should be adequate so that during heavy storms, the water in the entire area could be drained out easily and quickly. The outlets should be grassed to protect them from erosion. Natural waterways or swales used as outlets can be improved by grading, reshaping and vegetating. If the outlets are man-made, they should be constructed with flat side slopes and a wide bottom so that they can be maintained easily. The flat slopes and shoulders are preferably planted with grasses such as *Axonopus compressus, A. affinis, Chrysopogon aciculatus* or other suitable species, to protect the channels against erosion by reducing the velocity of flow. For immediate protection, jute netting or fibre glass can be used as channel liners to protect them from erosion until vegetation becomes established.

2/ VEGETATIVE MEASURES

Vegetative measures could provide temporary cover to help control erosion during construction. Permanent cover, on the other hand, are used to stabilize the site after construction is completed. The measures include the use of mulches and temporary and permanent crops. In an area such as Menggatal where steep slopes are quite dominant, the establishment of permanent cover would be difficult on some areas because of exposed subsoil of slopes, a draughty exposure and other conditions. These "critical areas" are exposed to severe erosion and are the source of sediment if they are not well established.

a/ Mulch In areas such as steep and cut-and-fill slopes where plants are difficult to get established, mulch is essential in establishing good stands of grasses. Mulch reduces runoff flow and allows more water to infiltrate the soil. It also reduces the loss of soil moisture by evaporation; holds seeds, lime and fertilizers in place and reducing seedlings damage caused by heavy storms. However, when mulch is used, it must be anchored to prevent it from being blow or washed away. Achoring methods are by tucking the

mulch into the soil with a straight-blade disk, stapling netting over the mulch, and driving pegs into the mulched area and interlacing them with wire or strong strings.

b/ Temporary Cover: Temporary cover is used where cover is needed for a few months or a year or two. If construction is delayed on a site that has been cleared, temporary cover crops can be used to protect the site against erosion. Rapidly growing annual grasses are most often used for temporary cover.

c/ Permanent Cover There are various species of grasses, shrubs and ground covers which can be chosen for permanent cover. However, the choice of cover should be based on the ability of the species to adapt to the soil, ease of establishment, suitability for specific use, longevity or ability to self-reseed, maintenance requirements, aesthetic values and other special qualities. For instance, grasses used for waterway stabilization must be able to withstand submergence at least for a few days, and provide a dense cover to prevent scouring of the channel. The notable species commonly used are the *Axonopus* spp, *Chrysopogon aciculatus* and *Panicum* sp. On steep slopes and other inaccessible areas, it is preferable to select plants that require little or no maintenance. Most native grasses, legume plants and shrubs grow well with little or no maintenance.

Methods of establishing vegetation vary for different parts of the area depending on the plant and soil. As a general rule, when seeding grasses and legumes, it is best to prepare proper seedbeds with application of fertilizer and lime on poor pH soil. If tress are used to stabilize steep slopes, they are usually planted in pure stands. Mulching after seeding or planting of trees and achoring the mulch are essential.

CONCLUSION

Menggatal, the new site for Universiti Kebangsaan Malaysia, Cawangan Sabah, consists of 4 types of vegetation. They are beach vegetation, secondary lowland forest, mangrove swamps and the cultivated areas. Most of the trees found in the area are at pole stage indicating that the area, especially the lowland forest, has been logged several years ago. This is also indicated by the left-over stumps and heavy machinery tracks found along the main ridge. Some areas along the beach, the lesser slopes and the flatland have been cultivated for agricultural crops. The flatland between the eastern slopes of the lowland forest and the mangrove swamps has been established as a new village.

As Menggatal is generally rugged consisting of ridges and steep slopes of approximately 30% and above, special consideration should be given to fitting developments to the site. A programme for erosion, runoff and sedimentation control is necessary during the planning and design stages before plan becomes fixed and construction begins so that serious impacts as a result of the development in the area can be avoided or minimized.

ACKNOWLEDGEMENTS

I am grateful to Encik Abd. Rahim Hj. Osman for helping me to identify the plant species. I thank Prof. Madya Dr. Abdul Latiff Mohamed, Head of the Botany Department, Universiti Kebangsaan Malaysia, for reading the manuscript.

REFERENCES

Anon (1971). *Johor Tengah and Tanjung Penggarang Regional Master Plan, Hunting* Technical Services Ltd., 1 – 37.

Khan, F.R. (1981). *Universiti Kebangsaan Malaysia Kampus Sabah Master Plan. Skidmore,* Owing and Merrill, Chicago, 1 – 61.

Shallow, P.G. (1965). River flow in the Cameron Highlands. *Hydro-Electric Technical Memo.* No. 3. C.E.B. Kuala Lumpur.

Wyatt-Smith, J. (1956). Ecological Studies on Malayan Forest. *Malay. For. Dept. Research Pamphlet,* No. 52.