CHAPTER 3

Existing Environment.

3.1: Physiography and drainage.

This is a coastal area flanked by Jawi River (North) and Krian River (South) and a chain of hills on the East; covering an area of 96 sq. km. The relevant area for this study is about 60 sq.km. The narrow coastal strip (tidal flats) that is located at the western side, facing the Penang South Channel, covers about 5% of the area. This coastal strip have an elevation ranging from 0 to 0.5 m. . This area is below the mean high tide level. Therefore it is flooded often. This inter tidal zone continued into the inland; forming riverine mud flats. The saline areas are inhabited by mangrove forest, wherelse, riverine mudflats are inhabited by 'nipah' forest.

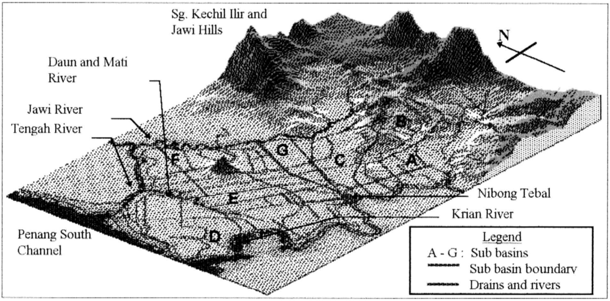
Running parallel to the coastal strip, is the peneplain. This peneplain occupies about 65 % of this area. It is about 9 km wide. It has an elevation ranging from 0.5 m to 15 m. The gradient is almost flat at the western side. However, the gradient gradually increases towards the inland. The lower parts of the peneplain originally forms part of the flood plain of the major rivers flowing across this area, but it is now separated from them by a series of levees.

The undulating region is in between the peneplain and the highland. It has an elevation ranging from 15 to 30 m. Its gradient moderately increases towards the eastern side.

The highland consists of a short chain of hills with elevation ranging from 30m to 400 m. Part of this area is in Kedah state.

The physiography of this area can be visualized using the 3D model shown next page. The terrain details for relevant areas will be described later.

Figure 3.1
Digital Terrain Model of Study Area



There are four major rivers that flow westward in this area. Jawi River flows on the North from the Jawi hills into Tengah River. Daun and Mati River flow towards the Northwest into Tengah River. On the South, Krian River flows from the Bintang Range (about 100 km away) into the Straits of Malacca. Krian River is the main river in this region. A series of levees wère built along Jawi, Tengah and Krian River, to protect settlements and plantations from tidal flooding.

This area is divided into several sub-basins (Figure 3.1). In turn, the sub basins are divided into smaller drainage units. These drainage units and their networks are listed in Table 3.1 and Figure 3.2.

Table 3.1
Sub Basins and Drainage Units.

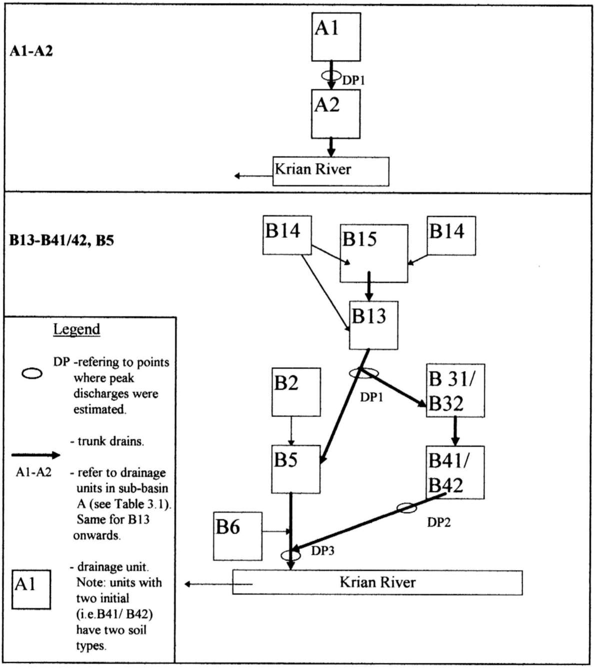
Sub- Basin	Drainage Units	Area Size (km.sq)	Description:
A	A1	2.994	-plain to undulating; covering part of Sungai Kechil villages up to Paya Kemian.
	A2	0.166	-riverine wetland.
B	B13 (+B11,12)	3.155	-plain to slightly undulating; covering Bukit Panchor Industrial Park.
	B14	1.502	-undulating; plantations.
	B15	1.805	-undulating; plantations.
	B2	0.174	-plain; covering Taman Belatuk and Taman Serandau.
	B31	0.153	-plain; plantations.
	B32	0.08	-plain; plantations.
	B41	0.276	-plain;plantations.
	B42	0.075	-plain; covering Bukit Panchor Technical Secondary School.

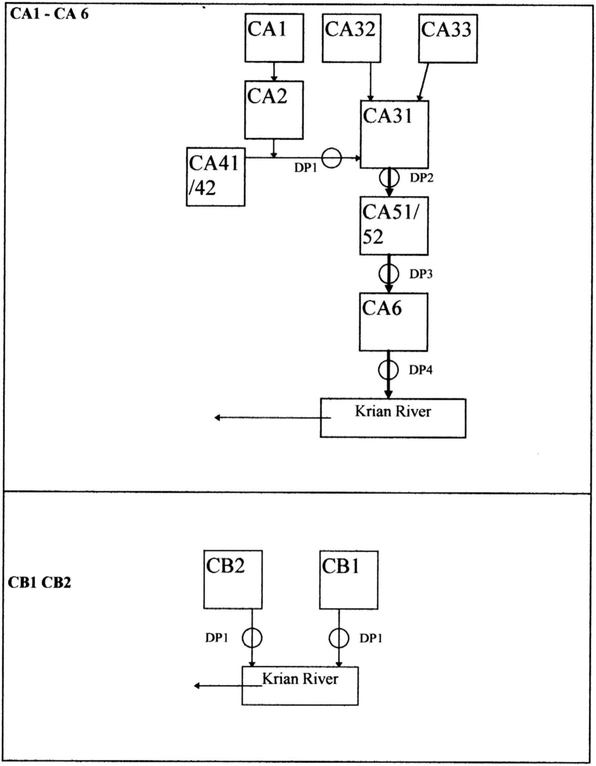
	B5	0.43	-plain; covering JKR quarters, Bukit Panchor low cost housing scheme.
	B6	0.412	-plain; plantations
C	CA1	1.048	-slightly undulating; plantations.
	CA2	0.27	-slightly undulating; covering a section of the North South highway.
	CA31/34	2.86	-slightly undulating; covering Taman Sintar, villages and plantations.
	CA32	0.054	-undulating; plantations.
	CA33	0.72	-undulating; plantations.
	CA41/42	0.811	plain; covering Taman Cenderawasih, few small scale factories and plantations
	CA51/52	0.841	plain; covering Taman Merbah , Taman Penting, Taman Grand, a new housing scheme (under construction), Police Station, Telekom exchange station and some plantations.
	CA6	0.417	plain; covering Taman Verappan, Taman Permai, Sang Lang village and Tunku Abdul Rahman Secondary School.
	CB1	0.107	plain; covering JKR quarters and part of Nibong Tebal town.
	CB2	0.052	plain; covering the older section of Nibong Tebal town.
	CC1	0.343	plain; industrial area.
	CC2	0.305	plain; covering Taman Nibong Tebal Jaya, Sheikh Adam

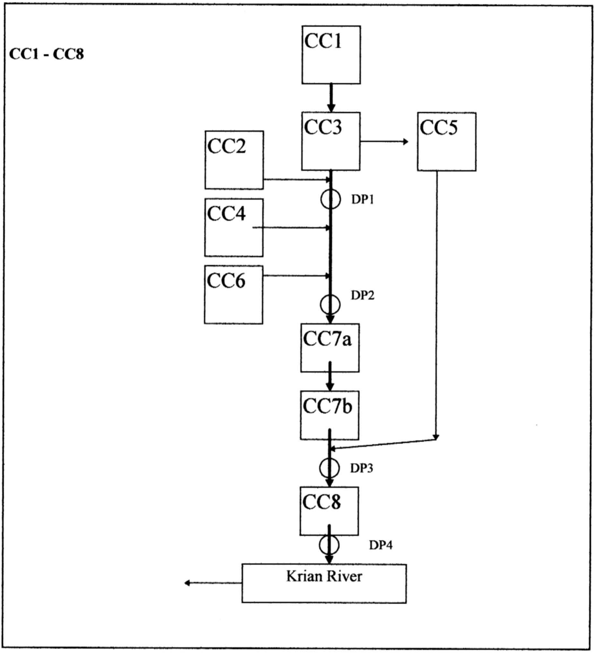
			village and part of Tong Hai village.
	CC3	0.045 .	plain; covering part of Tong Hai village.
	CC4	0.3	plain; covering Methodist School and part of Taman Sri Nibong, Taman Sri Maju, Taman Bahagia and Taman Berjaya .
	CC5	0.085	plain; covering Pinang Village and older section of Nibong Tebal town.
	CC6	0.281	.plain; covering the other part of Taman Sri Nibong, Taman Bahagia, Taman Sri Maju and Taman Berjaya.
	CC7a	0.153	plain; covering Taman Nibong Tebal, Taman Sentosa and Sri Sentosa Primary School.
	CC7b	0.1	plain; covering Victoria quarters.
	CC8	0.01	plain; covering Chanda Sherif's flat and former police barracks.
	CD1	1.342	plain; covering Telok Ipil and Tanjung Berembang villages, government clinic and Nibong Tebal National Primary School.
	CD2	0.24	plain; covering Nibong Tebal Town Centre (under construction) and plantations.
	CD3	1.817	plain; covering Victoria village, a secondary school (under construction), Victoria EstateTamil Primary School, Pai Teik Chinese Primary school, Taman Cowin, part of Taman Bistari and few plantations.
	CD4	3.004	plain; plantations and few factories.
E	E1	0.247	plain; covering few factories and plantations.

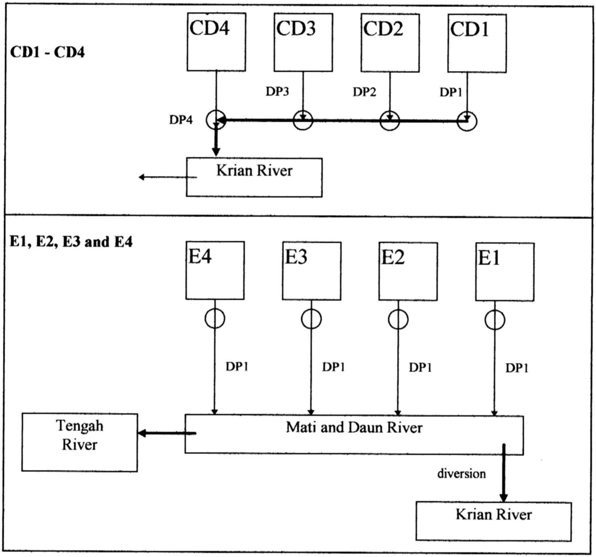
	E2	0.535	plain; covering part of Taman Bistari, Caledonia village and plantations.
	E3	0.7	plain; plantations.
	E4	0.916	plain; plantations.

Figure 3.2.
Drainage network and flow directions for each sub basin.

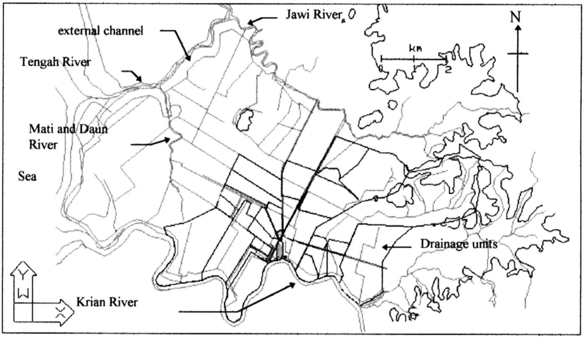



CA1 - CA 6
CA1
CA32
CA33
CA2
CA31
CA41
/42
DP1
DP2
CA51/
52
DP3
CA6
DP4
Krian River
CB1 CB2
CB2
CB1
DP1
DP1
Krian River


CC1 - CC8
CC1
CC3
CC5
CC2
DP1
CC4
CC6
DP2
CC7a
CC7b
DP3
CC8
DP4
Krian River


CD1 - CD4
CD4
CD3
CD2
CD1
DP3
DP2
DP1
DP4
Krian River
E1, E2, E3 and E4
E4
E3
E2
E1
DP1
DP1
DP1
DP1
Tengah River
Mati and Daun River
diversion
Krian River

Map 3.1
Drainage units and drain network (relevant) within study area.



The drainage system is shown in Map 3.1 where the 20m contour line (in red) is shown. It is obvious that most of the drainage units are located below 20 m. Because of the low terrain and tidal effects, the study area is subjected to a complex process of floodplain management. This includes management of flows by diversion channels and tidal gates with some channels leveed as shown in Map 3.3.

All the unit discharged into Krian River except for drainage units E1 to E4. Drainage units E1-E4 discharge into both Krian and Mati-Daun River. This is because a diversion channel was built at the tail end of Mati-Daun River. This diversion flows into Krian River. Presently, Mati-Daun River does not discharge into Tengah River because of sedimentation at the outlet of Daun River. Therefore, it flows into Krian River through the diversion channel. This Krian-Mati-Daun River network is very important in future flood mitigation effort. This will be further discussed in the Chapter 6. All drainage lines that extend into the Krian River, have tidal gates.

Note that, in addition to the networks shown earlier, there is an external channel that runs parallel to the levees. This external channel (irrigation) connects the drainage networks.

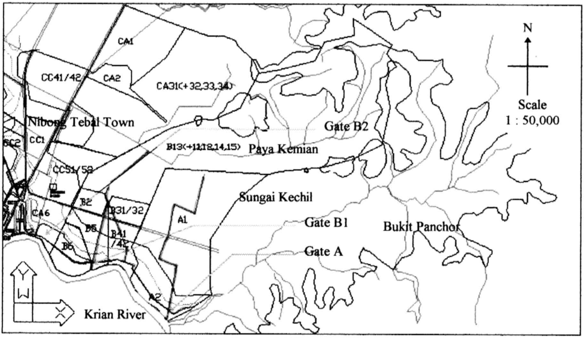
On the Eastern side of Nibong Tebal, the external drain connects drainage unit A1 to drainage unit B41/42. From there it connects to drainage unit B6 before it finally ends at drainage unit CA6. However, its flow pattern does not follow these linkages. This is because the flow direction is depended on which tidal gate is open.

A study done on its bed levels revealed that the deepest section was found at outlet B1 (at drainage unit B5). Therefore, water can in flow either directions between Gate B2 (at drainage unit CA6) and Gate B1 (at drainage unit B5) depending on which gate is open.

In the South East and Western region of the town, there is another external channel (22 km in length) that starts from drainage unit CD1 of sub basin C and ends at sub basin G (discharges into Jawi River). As for this external channel, its flow pattern is generally confined within each sub-basin.

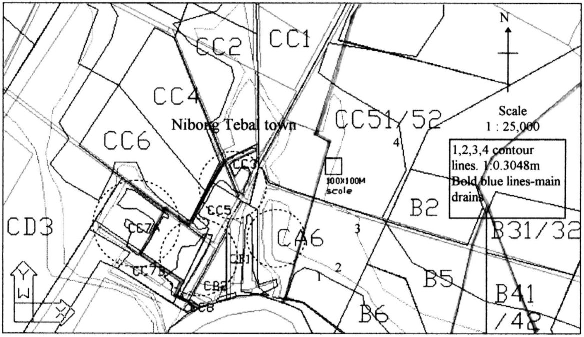
In this study, only relevant sections of these external channels are included within their respective drainage units. The exchange between drainage networks through these external channels, was negligible for flash flood study. This was because from field observations it was noted that its velocity is less than 0.25 m/s (at certain section, almost stagnant). Therefore, movement between network was very slow. For example, between drainage units CD1 to CD4, the external channel linked them to sub basin E and D. The travel time taken to reach the next sub-basin outlet (2 km away) would be more than 2 hours. This surpassed the concentration time of drainage units CD1 to CD4. As a result, the transmission of flow to the neighbouring drainage network was considered to be insignificant.

Map 3.2a.
Drainage Units A1-A2, B13-B5 and CA1-CA6.



The outlet for drainage units CA1-CA6 is located at Gate B2 and drainage units B13-B5 at Gate B1 and drainage units A1-A2 at Gate A (see Map 3.2a). The tidal gate for the Nibong Tebal Town area located at drainage unit CC8 (see Map 3.2b).

Map 3.2b.
Drainage Units CC1-CC8.

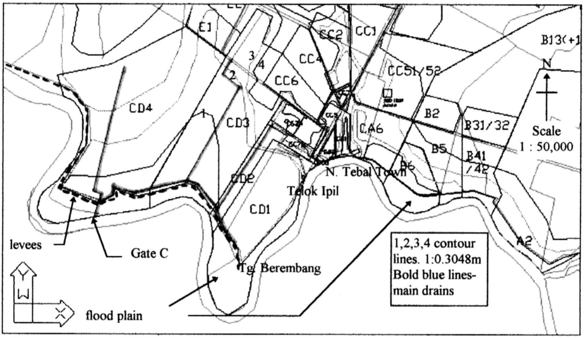


Note: areas circled -- is flood prone areas; observed the contour lines.

Map 3.2b shows the Nibong Tebal Town area where the circled areas are actually depression areas. This can be clearly observed from their contour lines. These areas are flood prone and floods can be serious because thay are the convergence zone of all flows.

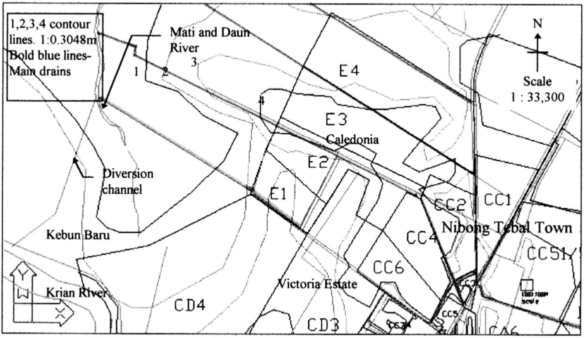
The outlet of flows for drainage units CD1-CD4 is at Gate C (see Map 3.3). Flood waters would accumulate behind the levees. The levees are built to control floods. These are about 1.5 m higher than normal ground level, separating the peneplain from the narrow strip of flood plain (ranging from 20 to 50m wide except at Tanjung Berembang), as shown in Map 3.3.

Map 3.3.
<u>Drainage Units CD1-CD4.</u>



Drainage units E1-E4 do not discharge directly into Mati-Daun River (see Map 3.4). Instead, their drains continued through another drainage unit before reaching their outlets. Mati and Daun River basin is generally below 0.3048 m and is also prone to flooding .

Map 3.4
Drainage Units E1-E4.



3.2: Hydrogeology.

The chain of hills located at the East of the study area are granitic. The bedrock for the coastal plain is shale and its surface layer is generally marine clay.

Recent riverine alluvium covers the marine clay on the floodplains where the study area is located. However, towards inland, surface layers are basically sandy clay interspersed with gravels. This is because the parent material is granite.

Clay and sand layers overlapped each other in the sub-surface layers. Their actual full depths are unknown. They are estimated to be 80 to 90 m deep based on deep boring conducted by the Malayan Mining Cooperation at Changkat Keledang. The thickness of the sand and clay layers ranged from 1 m to 20 m. The top clay layer, had thickness ranging from 5 to 20m before reaching the uppermost aquifer. The sand layers formed multi layer aquifers and are unconfined.

Recharge mainly comes from the granitic hills. Contributions from the coastal plain are minor because the uppermost clay layer is thick, making percolation process difficult.

The groundwater discharge rate is unknown. Flow retardation as a result of saline water intrusion is normal for coastal regions. Therefore, discharge is often considered to be low. This causes the water table to have minor fluctuations only, even during drier seasons. This is because the fall in water level is offset by an increase of saline water intrusion. This condition was implied by the minor differences of the measured water table levels during boring activities (throughout Seberang Prai).

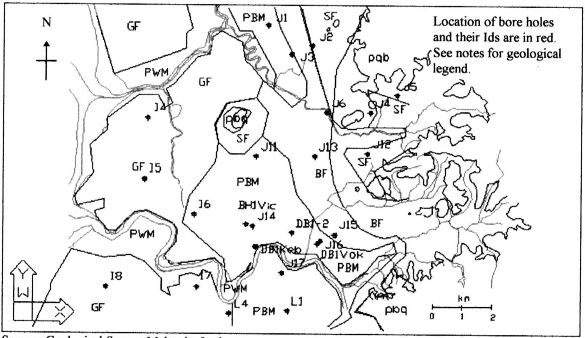
The water table levels measured during boring activities were analyzed. The results of water table analysis are shown below. The weighted mean and modulated range pointed out that the water table is generally high and its variation is minor. These phenomenon has an important implication on flood occurrence and mitigation (Table 3.2 and Map 3.5).

Table 3.2
Results of water table analysis.

Number of observations.	Mean.	Range and standard deviation
26 - total cases analized.	1.203 m 1.042**	4.170 m* (crude) ; 0.925 1.29 m **
17- analized for lower limit; assumed to represent drier season.	0.753 m	1.00 m; 0.326
7- analized for upper limit; assumed to represent wetter season.	2.043 m	1.10 m ; 0.416

Sources: boreholes data of Geological Survey Malaysia, Ipoh; Jabatan Kerja Raya (Public Works Department), Prai.
**- weighted mean and modulated range (difference between upper and lower limit mean) *extreme cases included.

Map 3.5
Bore hole locations and quaternary geology in the Southern District of Seberang Prai.



Source: Geological Survey Malaysia, Ipoh.
Notes: BF-clay, sand, gravel and silt with local lenses of peat; generally less than 10m thick. Deposited by fluvial processes as channel fill, point bar, flood basin and flood plain deposit.
PBM- Clay, silt. locally minor sand and gravel with organic sediment;generally less than 3m thick; Deposited in shallow basins and poorly drained surfaces back of mangrove environment.
PWM- Clay, silt. locally minor sand and gravel, minor organic and organic sediment; Deposited in supratidal and intertidal zone in mangrove environment.

GF- clay, silt, sand and minor amount of gravel. Deposited as tidal flat, estuarine, lower parts of lagoon and shallow shelf deposits. (all above from Halocene age).
SF- clay, silt, sand, gravel and minor amount of peat. Deposited by fluvial processes as channel fill, point bar, overbank and flood bank deposits (from Pleistocene age).

Inland extend of marine Halocene deposits; Inland limit of marine Halocene transgression coastline during 5000 to 6000 BP.

3.3: Climate: Temperature and Rainfall.

The monthly mean air temperature for last 22 years (1976-1997) fluctuates between 22.2 to 25.6 degree Celsius for 8.00 a.m. MST (Malaysian Standard Time) and in the afternoon between 29.5 to 33.5 degree Celsius (Chart 3.1 and 3.2).

Chart 3.1

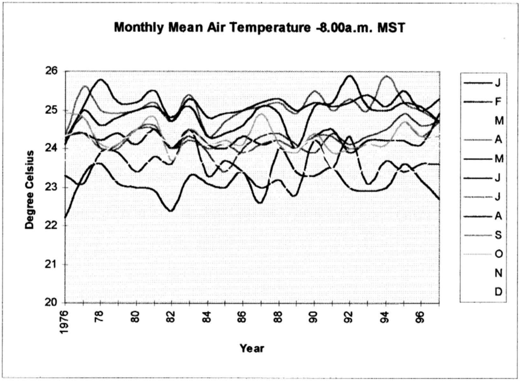
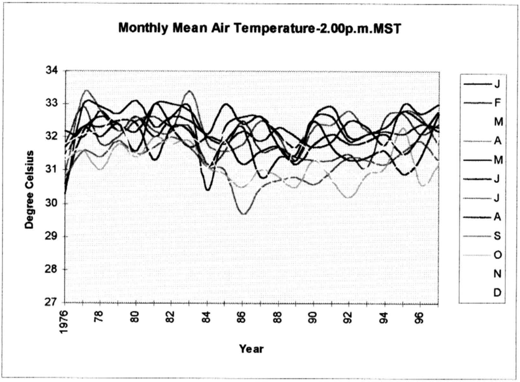


Chart 3.2



Source: Malaysian Meteorological Service, Petaling Jaya.

The 22 years monthly mean and annual mean are shown in Chart 3.3. The annual mean is about 28.02 degree Celsius. It is higher than national average. The warmest months are from April to June; 28.7 degree Celsius. November to January have the lowest temperature; 27.6 to 27.4 degree Celsius. The temperature range from 27.4 to 28.7 degree Celsius.

Chart 3.3

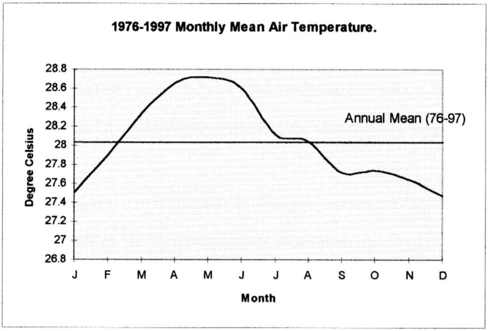
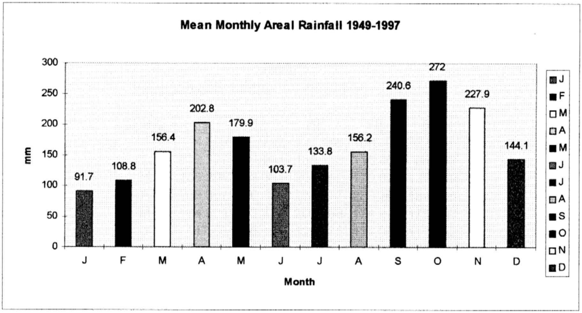


Chart 3.4



Source: Malaysian Meteorological Service, Petaling Jaya and Drainage and Irrigation Department, Ampang.

The average annual areal rainfall is 2017.9mm (Chart 3.4). This is considered to be moderate. The wetter months are April to May and September to October, which are inter monsoonal periods. January and June generally have lower rainfall. There are some abnormal years, where monthly rainfall can reach 500 mm or drop to zero. Rainfalls during monsoon season are generally lower. The North East monsoon is hindered by the Titiwangsa Range, and the South West monsoon by the Minangkabau Range (Sumatra).

Convectional rain type is common. It produces intense rainfall which normally last for 1 hour. Details on rainfall distribution for each station are shown in Table 3.3 and Chart 3.5.

Rainfalls for all station do not differ much. Annual rainfall distribution pattern is the same for all station. Bukit Panchor and Sungai Bakap generally have higher rainfall.

Table 3.3
Mean monthly rainfall for all stations-1949-1997

Month.	PB	SA	BP	SB	BK
J	114.809	91.2702	127.448	108.308	82.9269
F	112.227	97.9904	135.713	116.465	86.892
M	156.398	143.381	205.452	170.625	127.099
A	206.367	190.805	238.217	233.265	184.815
M	184.508	183.474	209.698	174.246	175.248
J	117.66	116.161	129.575	114.082	117.552
J	127.403	142.609	165.059	145.469	149.813
A	150.558	163.634	168.348	153.78	153.677
S	210.96	224.039	236.378	231.112	242.312
O	292.16	303.218	336.614	314.659	281.721
N	235.605	211.112	297.4	258.197	207.33
D	166.09	140.411	197.243	180.505	133.366

Source: Drainage and Irrigation Department, Ampang; Malaysian Meteorological Service, Petaling Jaya.
Note: PB - Parit Buntar Hospital; SA- Sungai Acheh; BP-Bukit Panchor Filtration Plant; SB-Sungai Bakap National School; BK-Batu Kawan Plantation. All values are in mm.

Chart 3.5

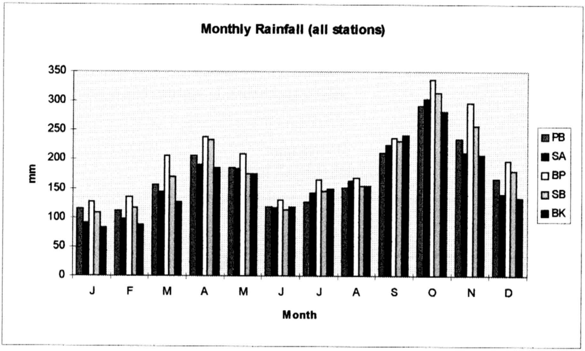
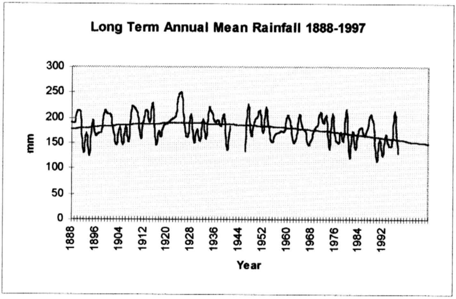


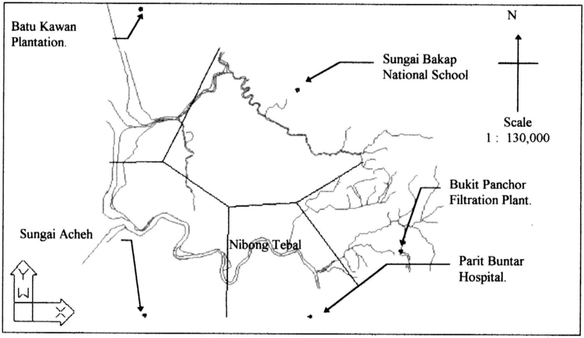
Chart 3.6



Source: Malaysian Meteorological Service, Petaling Jaya and Drainage and Irrigation Department, Ampang.
Note: missing data due to World War Two.

The long term annual mean rainfall (110 years) is taken from Parit Buntar Hospital (Chart 3.6). There is a clear cyclic pattern, indicating climatic fluctuations. The long term trendline indicates gradually decreasing annual rainfall. These imply that current flood phenomena can not be attributed to climatic factor only but rather factors like poor drainage and increase of impervious surface.

Map 3.6
Location of Rainfall Stations.



Source: Drainage and Irrigation Department, Kuala Lumpur (locations of rainfall stations).
Note: Theissen Polygons are shown in purple.

3.4: Soils.

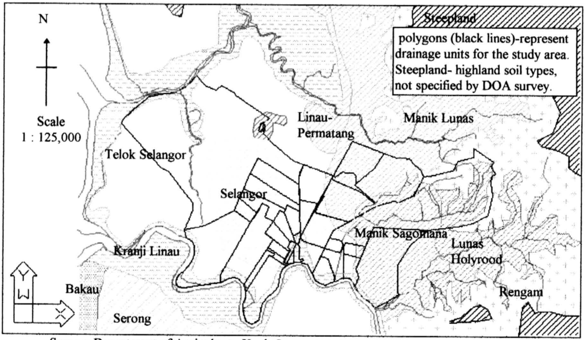
The types of soil exist in this area listed in the Table 3.4. Their locations are shown in Map 3.7.

Table 3.4
Soil Types.

Malaysian Series	USDA
Kranji- Linau	clay
Manik-Sagomano	sandy loam and clay
Selangor	clay
Manik- Lunas	sandy clay loam and sandy loam
Lunas -Holyrood	sandy clay loam and loamy
Rengam	sandy loam
Telok Selangor	clay
Linau Permatang	clay

Source: Soil Science Division, Ministry of Agriculture.

Map 3.7
Soil map of study area.



Source: Department of Agriculture, Kuala Lumpur.

Soil types within each drainage unit are listed in Table 3.5 and their infiltration rates in Table 3.6.

Table 3.5
Drainage units and soil type.

Drainage units	soil
A1	sandy loam+clay*
A2	clay
B11	clay
B12	sandy clay loam+sandy loam
B13	sandy loam+clay
B14	sandy loam
B15	sandy clay loam+sandy loam
B2	clay
B31	clay
B32	sandy loam+clay
B41	clay
B42	sandy loam+clay
B5	clay
B6	clay
CA1	sandy clay loam+sandy loam
CA2	sandy clay loam+sandy loam
CA31	sandy clay loam+sandy loam
CA32	sandy loam
CA33	sandy loam+clay
CA34	clay
CA41	clay
CA42	sandy clay loam+sandy loam
CA51	clay
CA52	sandy clay loam+sandy loam
CA6	clay
CB1	clay
CB2	clay
CC1	clay
CC2	clay
CC3	clay
CC4	clay
CC5	clay
CC6	clay
CC7a	clay
CC7b	clay
CC8	clay
CD1	clay

CD2	clay
CD3	clay
CD4 •	clay
E1	clay
E2	clay
E3	clay
E4	clay

Note: *-this do not indicate there two type of soil, rather, it indicates that soil textural class lies in between this two. This is because its soil type is an association of two different Malaysian series.

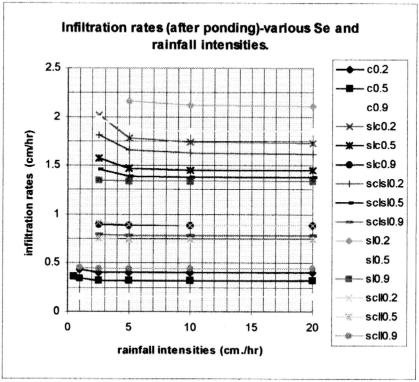
Table 3.6
Infiltration rate (potential and after ponding) at various Se and rainfall intensities.

Rainfall Intensities	Soil types and infiltration rates (cm/hr) at various Se.					
(cm/hr)	c0.2	c0.5	c0.9	slc0.2	slc0.5	slc0.9
0.5		0.35534	0.15994	**		
1	0.4307	0.33537	0.15622			
2.5	0.40444	0.32268	0.15516	2.01885	1.57284	0.89602
5	0.40168	0.3215	0.15486	1.77532	1.47305	0.88889
10	0.40092	0.32112	0.15457	1.73451	1.45352	0.88732
20	0.40055	0.32009	0.15457	1.72524	1.44878	0.88694
fp	0.44404	0.35655	0.17117	1.87726	1.56942	0.93807
	sclsl0.2	sclsl0.5	sclsl0.9	sl0.2	sl0.5	sl0.9
0.5						
1						
2.5	1.81102	1.45948	0.78731		1.98001	1.34622
5	1.65282	1.39321	0.78672	2.16552	1.87444	1.33839
10	1.6243	1.37968	0.78665	2.12242	1.85419	1.33691
20	1.6181	1.37638	0.78663	2.11346	1.84975	1.33658
fp	1.75272	1.48266	0.93563	2.26014	1.96453	1.38131
	scll0.2	scll0.5	scll0.9			
0.5						
1			0.45744			
2.5	0.91937	0.75587	0.44715			
5	0.89328	0.7434	0.44574			
10	0.88717	0.74058	0.44558			
20	0.88607	0.73973	0.44549			
fp	0.96996	0.80954	0.47609			

Notes: Se- initial degree of saturation or effective saturation.
**- no ponding at this rainfall intensity. c-clay; scll-sandy clay loam +loam; sclsl-sandy clay loam+sandy loam; sl-sandy loam; slc- sandy loam +clay. The figures beside the soil types denote saturation degrees where 0.2 is equal to twenty degrees and so on. fp-potential infiltration.

Clay is the main soil type here. Infiltration rate, both potential and after ponding, do not differ significantly (Table 3.5 and 3.6). The rates are generally low, almost all is below 1.0 cm/hr. The rates tend to decrease gradually to almost constant (refer to Chart 3.7) when the rainfall intensities increase. However, the change is insignificant; less than 0.25 cm/hr.

Chart 3.7



Initial degrees of saturation have a direct influence on infiltration rates. The infiltration rates decreases, when initial saturation increases. Twenty degrees represent dry soil with only residual moisture, whereas, ninety degrees represent almost saturated soil.

The above condition implies:

1- Surface runoffs are expected to be generally high from non-urban areas without good crop cover.

2- Higher surface runoff with higher rainfall intensities.

3.5: Tides

Tide type is semidiurnal. Mean tide level is 0.479m LSD; mean high tide, 0.847m LSD; mean low tide, 0.13m LSD. These values are higher than drainage outlets of this area. The crude range is 3.95 m (+2.3 to -1.65m LSD), modulated range is 3.11m (+2.00 m to -1.11m LSD). Neap range is 0.276m to 0.655 m LSD and spring range is -0.597m to 1.084m LSD.

Table 3.7
Seasonal tidal variations.

Month	Mean modulated range m LSD	m	Mean spring range m LSD	Mean neap range m LSD
November-February	0.869 - 0.056	0.813	1.099- -0.498	0.696-0.316
February - May	0.682 - -0.264	0.946	0.946- -0.693	0.468-0.116
May- August	0.896 - 0.154	0.742	1.122- -0.287	0.718-0.632
August-November	0.926 - 0.153	0.773	1.162- -0.392	0.747-0.387

Source: Drainage and Irrigation Department, Bagan Serai.
Note: LSD - Land Survey Datum.

Seasonal variations are listed in Table 3.7. Where the variations are based on solstices and equinoxes. Comparing these variations with the rainfall distribution, it was found that the wetter inter-monsoon months (September- October) coincided with the period (August-November) when tidal ranges were narrower and higher than other seasons. Therefore, under normal circumstances all the outlets are submerged and the tidal prism is small; minimizing the discharge of flood water and lengthening the flood duration. September to October could be considered sensitive (flood prone) months.

3.6: Landuse

The region where the study area is located is mainly under oil palm plantations. Pockets of old rubber estates are scattered among oil palm plantations. The natural forest is confined to wetlands located along the narrow coastal strip and river banks. Hill dipterocarp occupies the Bukit Panchor forest reserve .

All the lowland forest had been cleared for either agriculture or settlement purposes. Non-agriculture areas consist of residential, commercial and small to medium scale industrial areas.