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URBANIZATION AND FLASH FLOODS
IN NIBONG TEBAL TOWN AREA,
SEBERANG PRAI SELATAN, PULAU PINANG.

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Abstract.

The urban process changes the earth surface from a permeable to an impermeable surface and reduces vegetation cover. Hence, the interception and infiltration processes are greatly lowered resulting in higher surface runoffs which produce higher peak discharges. As a result of these higher peak discharges, existing drains could overflow causing flash floods. The resulting flash floods are aggravated on areas that are influenced by tide. This is because the flood volumes could not be discharged off quickly into the river during high tide.

The potential impact of urbanization (i.e., flash floods) on Nibong Tebal Town area which is located on the coastal floodplain of Seberang Prai Selatan, Penang was studied. Potential flash floods for present and future conditions of urbanization were studied within the framework of integrated studies. The study area (Nibong Tebal Town and its peripheral areas) was divided into several sub-basins. These sub-basins were further divided into drainage units. The effects of key factors such as urban process, vegetation cover, soil types, infiltration rates, tidal levels and drainage systems on flash floods were examined for each of the drainage units.

The urban process and changes in vegetation cover from 1966 to February 1998 were studied. Data obtained from these studies were used to estimate the size of urban

and vegetated areas for each drainage unit. Estimations were computed for present and future conditions.

The infiltration rates for vegetated areas were computed using the Green-Ampt Method after their soil types were identified. The computed infiltration rates were used for producing runoff coefficients for the vegetated areas. As for urban areas, their runoff coefficients were estimated using the Pattison Method. Both runoff coefficients were combined to produce composite runoff coefficients for each drainage unit. The composite runoff coefficients were used to estimate peak discharges.

Peak discharges from each drainage unit were estimated using the Modified Rational Method according to rainfall intensities of 25 mm/hr (return period of 1 in 1 year), 60 mm/hr (return period of 1 in 10 years) and 85 mm/hr (return period of 1 in 50 years) and rainfall duration of 1 hour. The estimated values were used to calculate the accumulated peak discharges along a particular drainage network. Adjustments were made for the estimated values because the drainage networks were influenced by tides periodically.

Four scenarios representing different conditions of drainage and tidal relation were considered. They are:

- 1- free flow condition (no adjustment needed).

- 2- mean high tide (all the tidal gates are fully shut and pumps are not in operation).
- 3- mean tide (all tidal gate outlets are submerged and pumps are not in operation but tidal gates are fully opened).
- 4- mean high tide (all tidal gates are fully shut but pumps are operating at full capacity).

Considering the obtained results, the potential flood boundaries for present and future conditions were demarcated. The current drainage systems and flood mitigation measures were also evaluated.

The results of this study indicate that more severe flash floods could occur in the future when this area becomes more urbanized. Flood mitigation and preventive measures which included a new urban planning concept were recommended for the study area.

Abstrak.

Proses urbanisasi mengubah permukaan bumi yang telap air menjadi permukaan yang tidak telap air dan mengurangkan kawasan yang dilindungi tumbuh-tumbuhan. Akibatnya, proses pintasan dan penyusupan berkurangan. Ini menyebabkan air larian permukaan bertambah. Pertambahan air larian permukaan menghasilkan luahan puncak yang lebih tinggi. Luahan puncak yang tinggi boleh menyebabkan parit dilimpahi air dan banjir kilat berlaku. Banjir kilat yang berlaku bertambah buruk di kawasan yang dipengaruhi air pasang surut. Ini adalah kerana air banjir tidak dapat dinyahkan dengan cepat ke dalam sungai.

Kesan potensi urbanisasi (banjir kilat) terhadap Pekan Nibong Tebal yang terletak di dataran banjir pinggir laut Seberang Prai Selatan, Pulau Pinang telah dikaji. Banjir kilat potensi untuk keadaan pembandaran masa kini dan hadapan dikaji dalam kerangka kajian bersepadu. Kawasan kajian (Pekan Nibong Tebal dan kawasan-kawasan berdekatan) dibahagikan kepada beberapa sub-lembangan saliran yang seterusnya dibahagikan kepada unit-unit saliran. Kesan-kesan faktor utama seperti proses bandar, litupan tumbuhan, jenis tanah, kadar penyusupan, paras air pasang-surut dan sistem-sistem saliran ke atas banjir kilat dikaji untuk setiap unit saliran.

Proses bandar dan perubahan litupan tumbuhan dari 1966 ke 1998 Februari telah dikaji. Data yang diperoleh daripada kajian ini digunakan untuk menganggar keluasan

kawasan pembandaran dan kawasan litupan tumbuhan untuk setiap unit saliran. Anggaran dibuat untuk keadaan masa kini dan hadapan.

Kadar penyusupan untuk kawasan litupan tumbuhan dihitung menggunakan Kaedah Green-Ampt selepas jenis taninya dikenal pasti. Kadar ini digunakan untuk menghasilkan koefisien air larian untuk kawasan tersebut. Untuk kawasan pembandaran, koefisien air larian dihitung menggunakan Kaedah Pattison.

Luahan puncak dari setiap unit saliran dianggar menggunakan Kaedah Rasional Yang Dimodifikasi menurut intensiti hujan 25 mm/j (ulangan 1 dalam 1 tahun), 60 mm/j (ulangan 1 dalam 10 tahun) dan 85 mm/j (ulangan 1 dalam 50 tahun) serta janka masa hujan selama 1 jam. Nilai-nilai anggaran tersebut digunakan untuk menghitung luahan puncak terkumpul sepanjang suatu jaringan saliran. Pengubahsuaian dilakukan ke atas nilai-nilai tersebut kerana jaringan-jaringan saliran di kawasan ini dipengaruhi air pasang surut berkala.

Empat senario yang mewakili keadaan hubungan aras air pasang surut dengan saliran yang berlainan dikaji. Senario-senario tersebut adalah:

- 1- aliran bebas.
- 2- air pasang min dengan semua pintu air tertutup dan pam tidak beroperasi.
- 3- aras air min dengan semua bukaan pintu air ditenggelami tetapi terbuka dan pam tidak beroperasi.

4- air pasang min dengan semua pintu air tertutup tetapi pam beroperasi sepenuhnya.

Berdasarkan keputusan-keputusan yang diperolehi, sempadan-sempadan banjir kilat potensi telah ditentukan. Sistem perparitan dan langkah-langkah mitigasi banjir masa kini turut dinilai.

Keputusan-keputusan yang diperolehi daripada kajian ini menunjukkan bahawa banjir kilat yang lebih buruk boleh berlaku di sini pada masa hadapan apabila kawasan pembandaran menjadi lebih luas. Langkah-langkah mitigasi dan pencegahan banjir yang termasuk suatu konsep perancangan bandar yang baru telah disyorkan untuk kawasan kajian ini.

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List of Abbreviations.

cumecs-	Cubic metre per second.
DID -	Drainage and Irrigation Department.
DOA-	Department of Agriculture.
DP-	Design Points for drainage network.
DTM-	Digital Terrain Model.
dxf-	Data Exchange Files.
LSD-	Land Survey Datum.
MMS -	Malaysian Meteorological Service.
R.L.-	Reduced Level.
sq. km.-	Square kilometre.
Se.-	Effective Saturation for soil.