Flooding in Singapore: An Overview

FUTURE FLOODS: An Exploration of a Cross-Disciplinary Approach to Flood Risk Forecasting

Prepared by Claire Kennedy of Impact Forecasting

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Empower Results®

Agenda

Section 1	Climate of Singapore
Section 2	Flooding
Section 3	Flooding in South-East Asia
Section 4	Historical Flooding in Singapore
Section 5	Current Status

Section 1: Climate of Singapore

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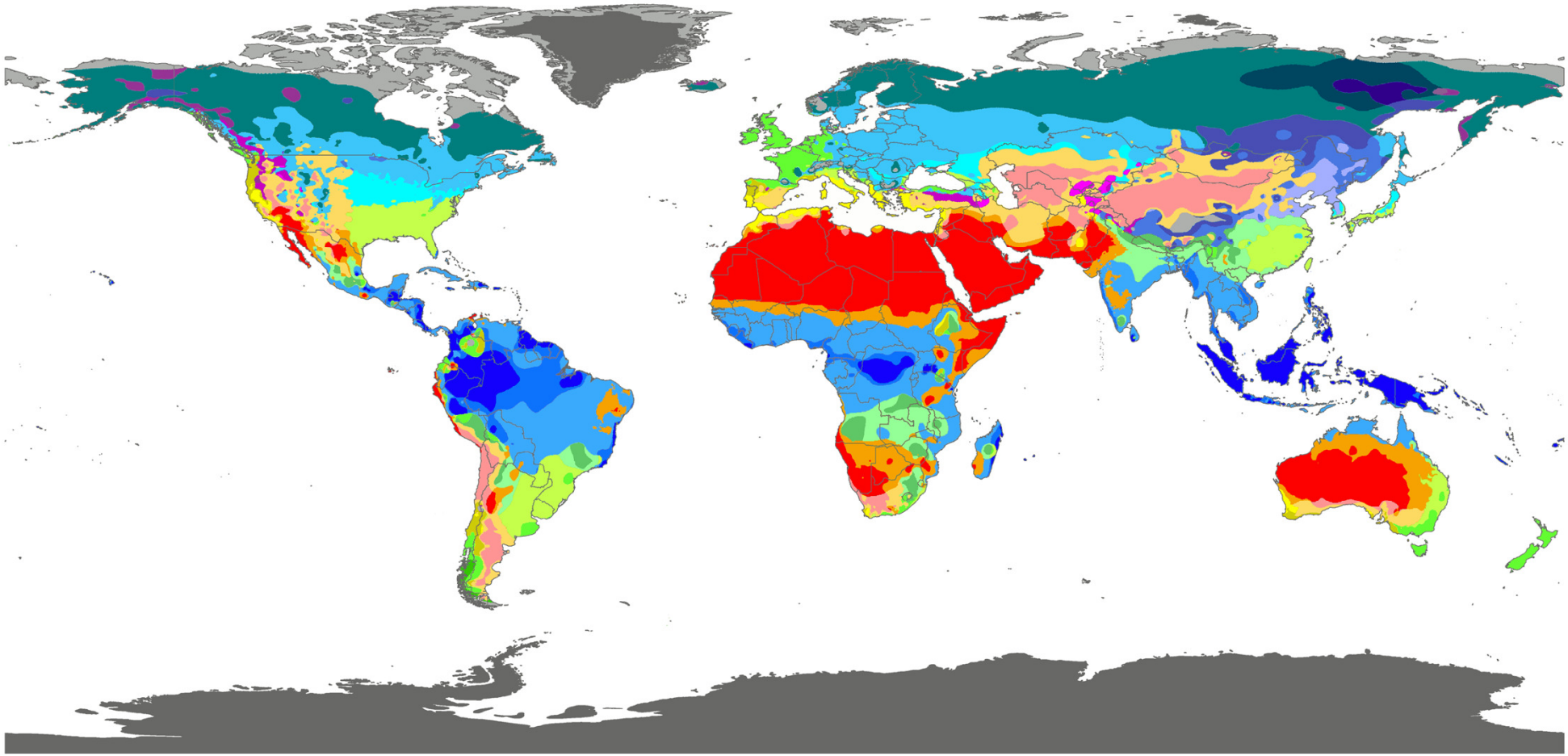
Climate of Singapore

Köppen Climate Classification System



Source: University of Melbourne

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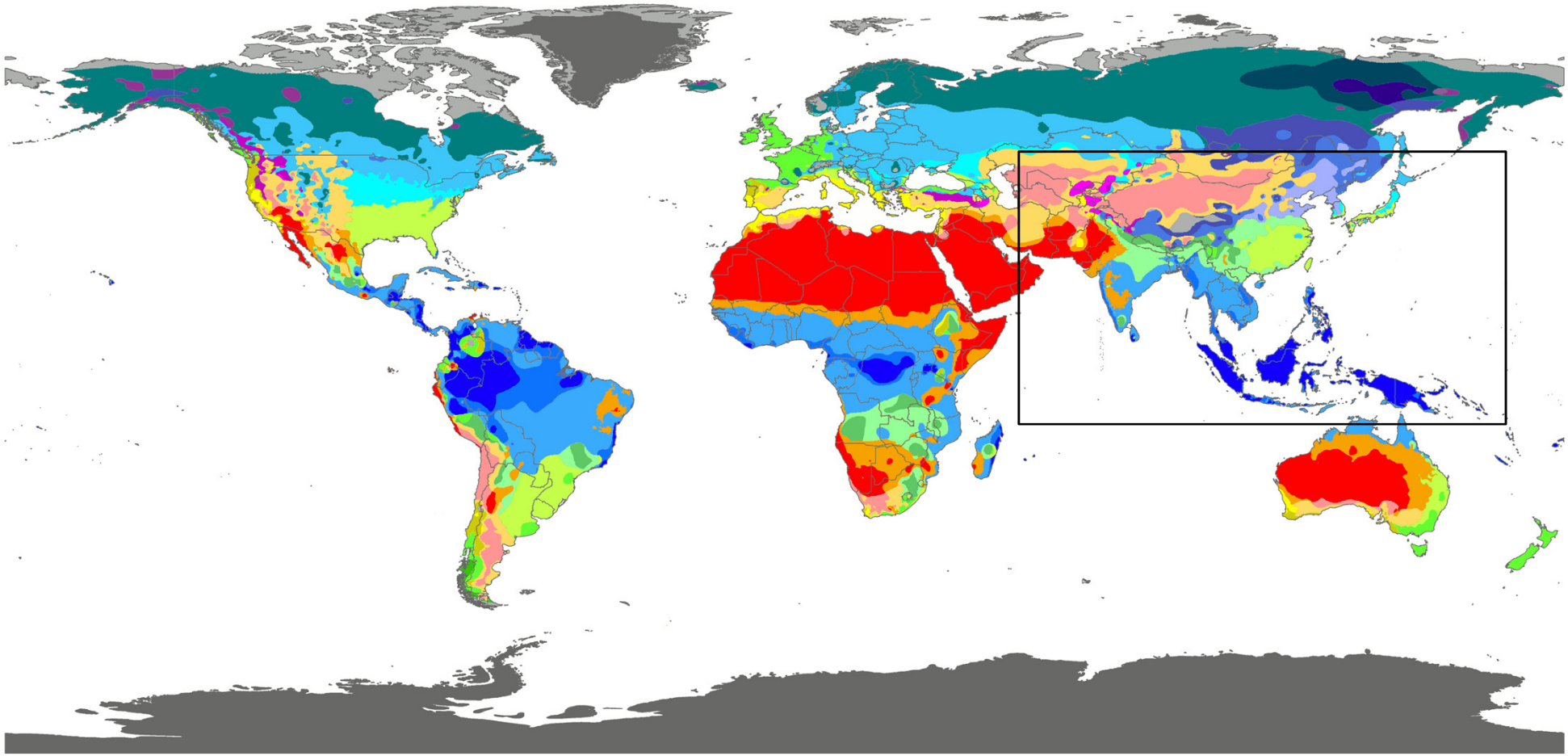

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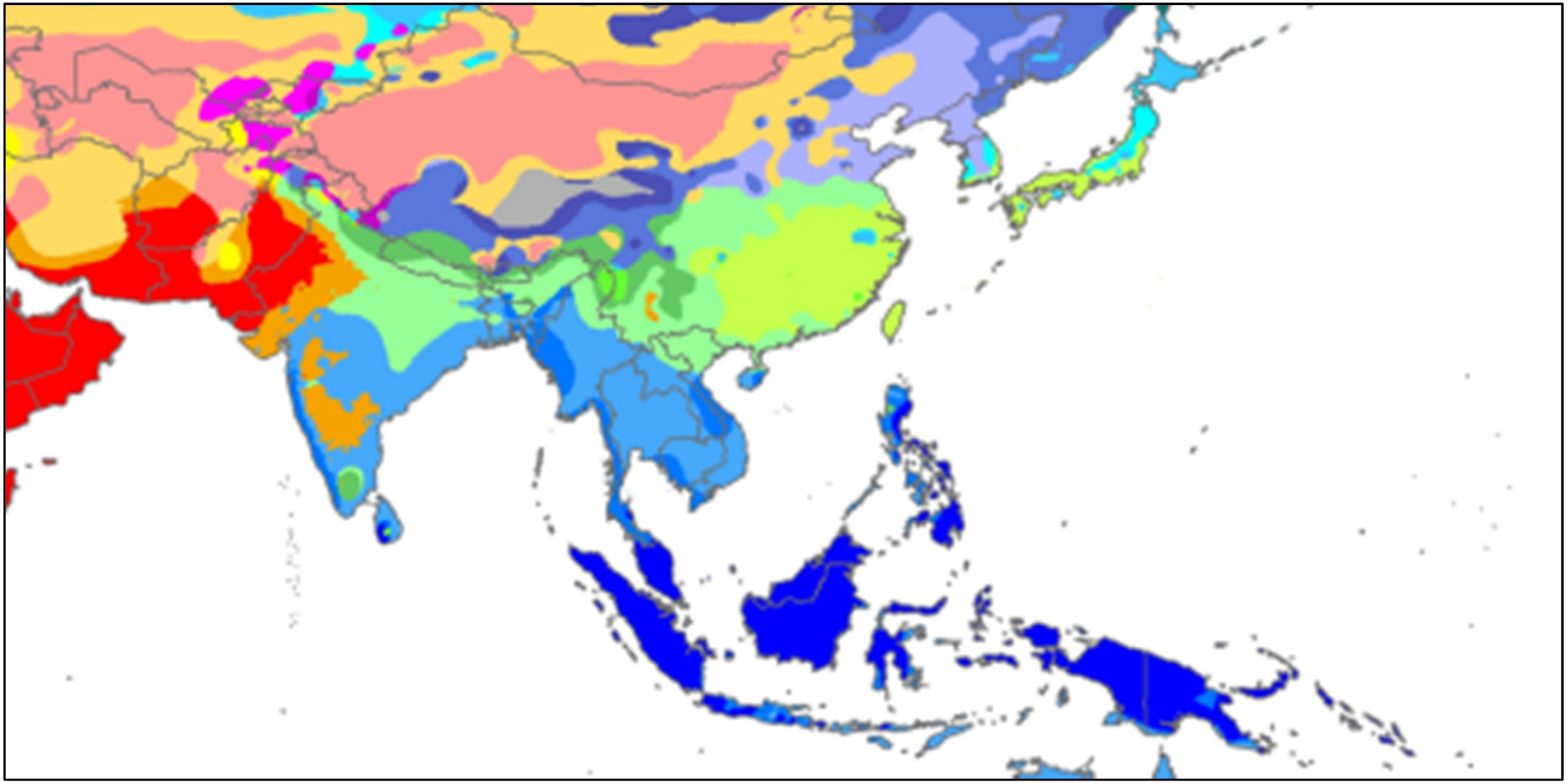
Köppen Climate Classification System - Asia



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Climate of Singapore

Köppen Classification Scheme: *tropical rainforest climate*

- constant high temperatures – average monthly temperatures of ≥18˚C (64˚F)
- average monthly rainfall of ≥60.0 millimeters (2.40 inches)

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Warmest month is *June*: 27.8˚C (82.0˚F)

Coolest months are *January* and *December:* 26.0˚C (78.8˚F)

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Rainfall

Wettest month is *December:* 288.4 millimeters (11.35 inches)

Driest month is *July:* 158.6 millimeters (6.24 inches)

Average annual rainfall: 2,344.0 millimeters (92.28 inches)

Climate of Singapore – Seasons

North-East Monsoon (November to March)

- north-easterly winds prevail
- December and January characterised by rainy afternoons
- February until early-March often drier
- Annual average wind speeds reach a peak in January and February

South-West Monsoon (May to October)

- south-easterly to south-westerly winds prevail
- “Sumatra Squalls” are common
- Hazy periods

Inter-Monsoon (March to May)

- light, variable winds
- afternoon and early evening thunderstorms

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Section 2: Flooding

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Definitions

What is a flood?

The inundation of a normally dry area caused by high flow, or overflow of water in an established watercourse, such as a river, stream, or drainage ditch; or ponding of water at or near the point where rain fell. Source: NOAA

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Flooding is a longer term event than flash flooding: it may last for days, weeks, or even months

Characteristics

Flood

- different types, different causes
  - areal floods (rainfall-related)
  - riverine floods
  - estuarine and coastal floods

Characteristics

Flash Flood

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Section 3: Flooding in South-East Asia

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Flooding in South-East Asia

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- caused insured losses in excess of US$215 million
- damaged/destroyed more than 180,000 homes
- claimed more than 357 lives

Flooding in South-East Asia

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- Insured losses have exceeded US$17.7 billion (2015)
- More than 12.4 million homes were damaged/destroyed
- Almost 16,000 lives were lost

Flooding in South-East Asia

Malaysia

- Since 2000, economic damages from floods in Malaysia have exceeded US$2.1 billion (2015)
- More than 330,000 homes were damaged/destroyed
- More than 280 lives were lost

Flooding in South-East Asia

Indonesia

- Since 2000, economic damages from floods in Indonesia have exceeded US$8.1 billion (2015)
- More than 790,000 homes were damaged/destroyed
- More than 3,280 lives were lost

Flooding in South-East Asia

Singapore

- Since 2000, economic damages from floods in Singapore have exceeded US$23.8 million (2015)
- Approximately 550 homes were damaged
- No lives were lost

Section 4: Historical Flooding in Singapore

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Historical Floods in Singapore - 1950s

October – December 1954:

- Bedok, Potong Pasir, Braddell Road, Long Tai Seng, Geylang Serai…
- 50,000+ people affected
- 5,000 made homeless
- 5 killed
- 40 injured
- S$1,000,000 (1954) of damage; >S$4,000,000 (2015)

Historical Floods in Singapore - 1960s

December 1969:

- Worst floods in 35 years – up to 75% of Singapore submerged
- 355.6 millimetres (14.0 inches) of rain fell in 12 hours
- 3,100 rendered homeless
- 5 killed
- Floodwaters up to 2.5 metres (8.2 feet) deep
- S$4,300,000 (1969) of damage; >S$16,000,000 today

Historical Floods in Singapore - December 1969

Newton Circus (Source: National Archive of Singapore)

Bideford Road (Source: National Archive of Singapore)

Location unknown (Source: National Archive of Singapore)

Opera Estate (Source: National Archive of Singapore)

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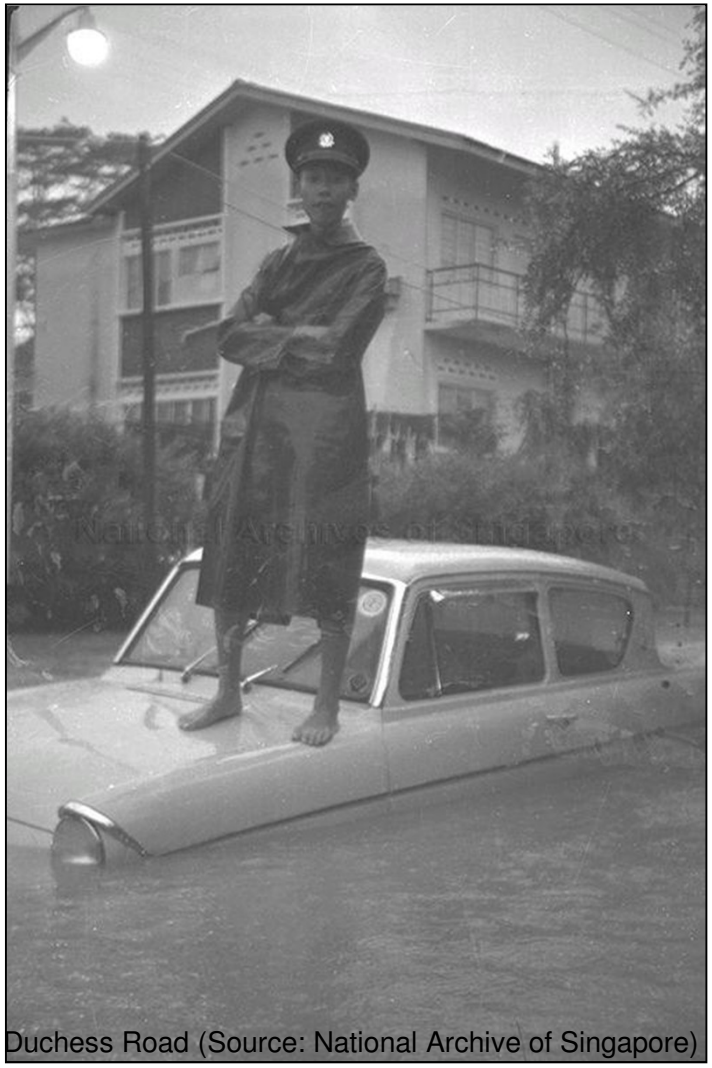


Duchess Road (Source: National Archive of Singapore)

Historical Floods in Singapore - 1970s

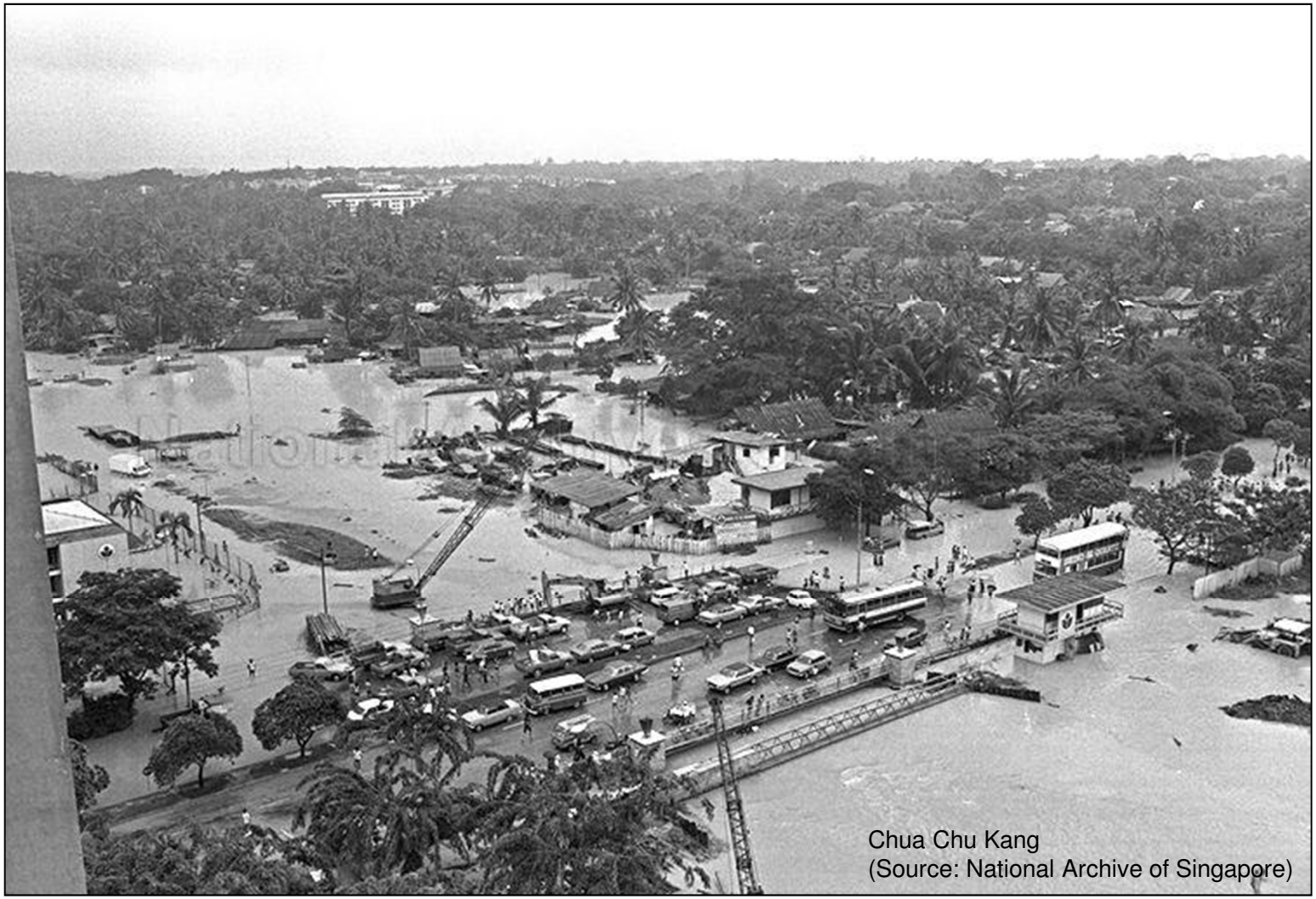
November 1978

- Floods around Yio Chu Kang Road
- 2 killed

December 1978

- Singapore's all time record 24-hour rainfall set on 2nd – 512.4 millimetres (20.2 inches)
- Landslides at Telok Blangah, York Hill, Mount Faber, Cairnhill Road, Changi Road, and Jurong Road
- Floodwaters reached 2.0 metres (78.7 inches)
- 7 killed
- S$10,000,000 (1978) of damage; >S$22,500,000 (2015)

Historical Floods in Singapore - December 1978



Chua Chu Kang
(Source: National Archive of Singapore)

Historical Floods in Singapore - December 1978

Braddell Road (Source: National Archive of Singapore)

Potong Pasir (Source: National Archive of Singapore)

Jalan Eunos (Source: National Archive of Singapore)

Woodlands (Source: National Archive of Singapore)

Historical Floods in Singapore - 1980s onward

January 1980

- Potong Pasir, Yio Chu Kang, Tampines, Eunos, Paya Lebar, Mountbatten, Farrer Park, Newton, Boon Keng, Bukit Panjang, Bukit Timah…
- Floodwaters up to 1.3 metres (51.2 inches) deep for two days

September 1984

- Lim Chu Kang Rd, Jalan Murai, Bukit Timah Rd, Wilby Rd, Coronation Rd…
- Floodwaters up to 0.45 metres (17.7 inches) resulting from a Sumatra Squall

Historical Floods in Singapore - 1980s onward

November 2009

- Bukit Timah
- Minister of Environment and Water Resources: “1 in 50 year” event
- 110 millimeters (4.3 inches) of rain in 2 hours
- “knee-high” floodwaters submerged ground-floors of buildings and cars
- According to local reports, worst flood in over a decade

Historical Floods in Singapore - 1980s onward

June 2010

- Orchard Road, Bukit Timah
- 100 millimeters (3.9 inches) of rain in 2 hours
- Floodwaters up to 30 centimetres (1 foot) deep
- 100 shops and 48 vehicles damaged along Orchard Road
- 868 insurance claims ensued totalling S$23 million (2010)

Historical Floods in Singapore - 1980s onward

June 2011

- Orchard Road
- 124 millimetres (4.9 inches) of rain. Maximum intensity of 65 millimetres (2.6 inches) in half an hour
- Floodwaters up to 30 centimetres (1 foot) deep

September through November 2013

- 3 separate flash flood incidents
- Central and Southern areas worst affected
- Floodwaters up to 50 centimetres (1.6 feet) deep
- All floods were reported to have subsided within 30 minutes

Section 5: Current Status

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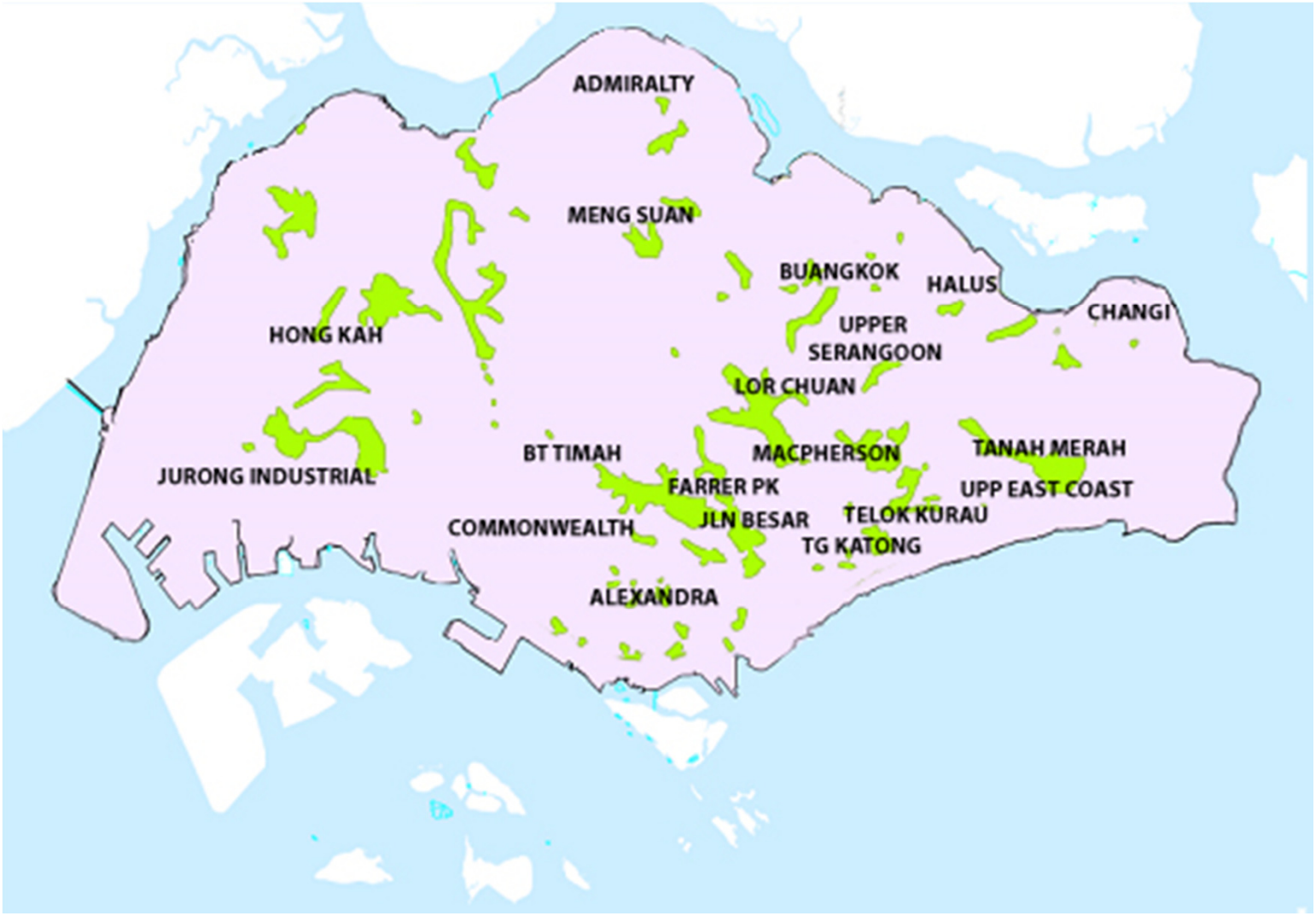
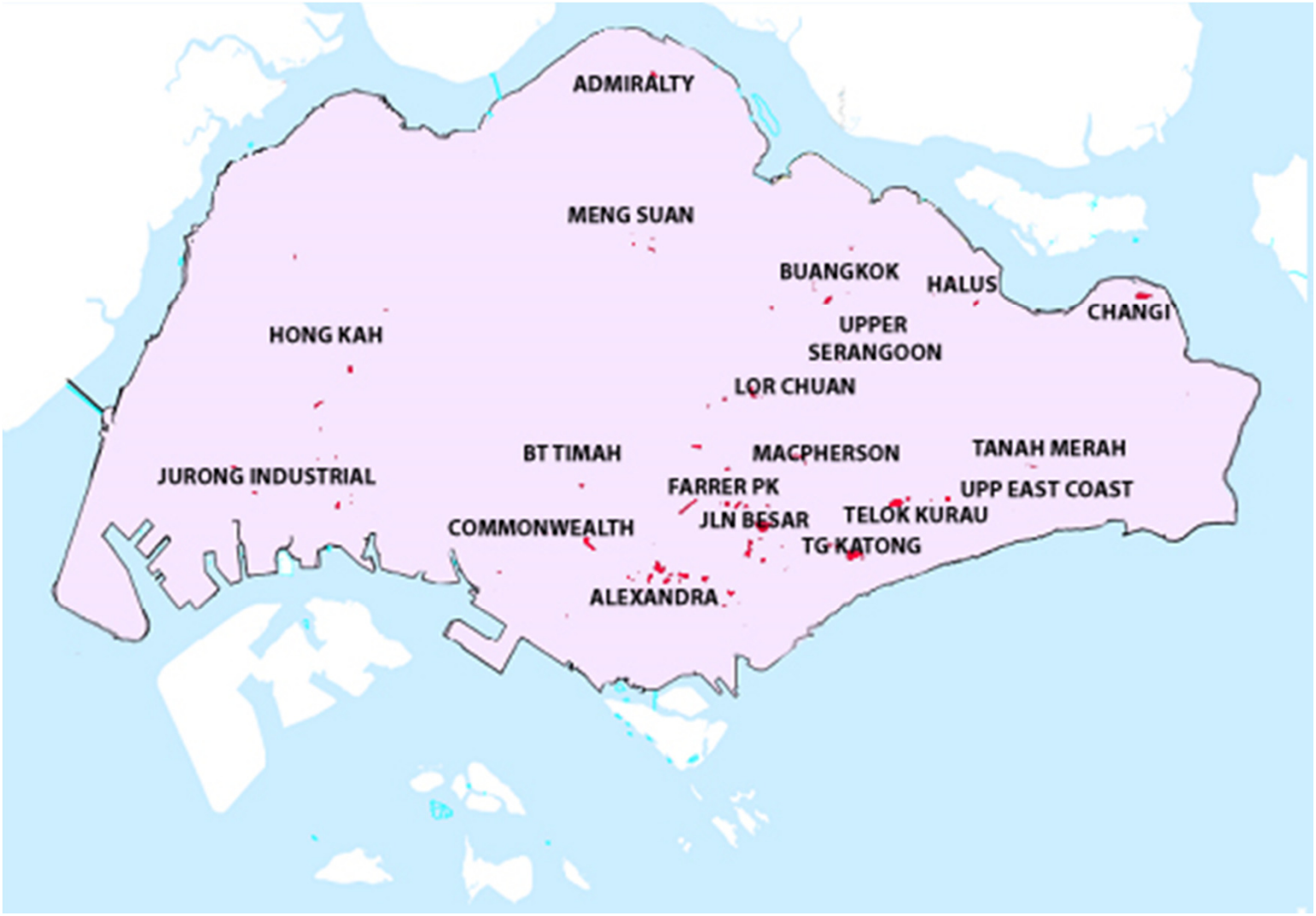
Flood Prone Areas 1970s



Source: PUB, Singapore's National Water Agency

Flood Prone Areas 2014



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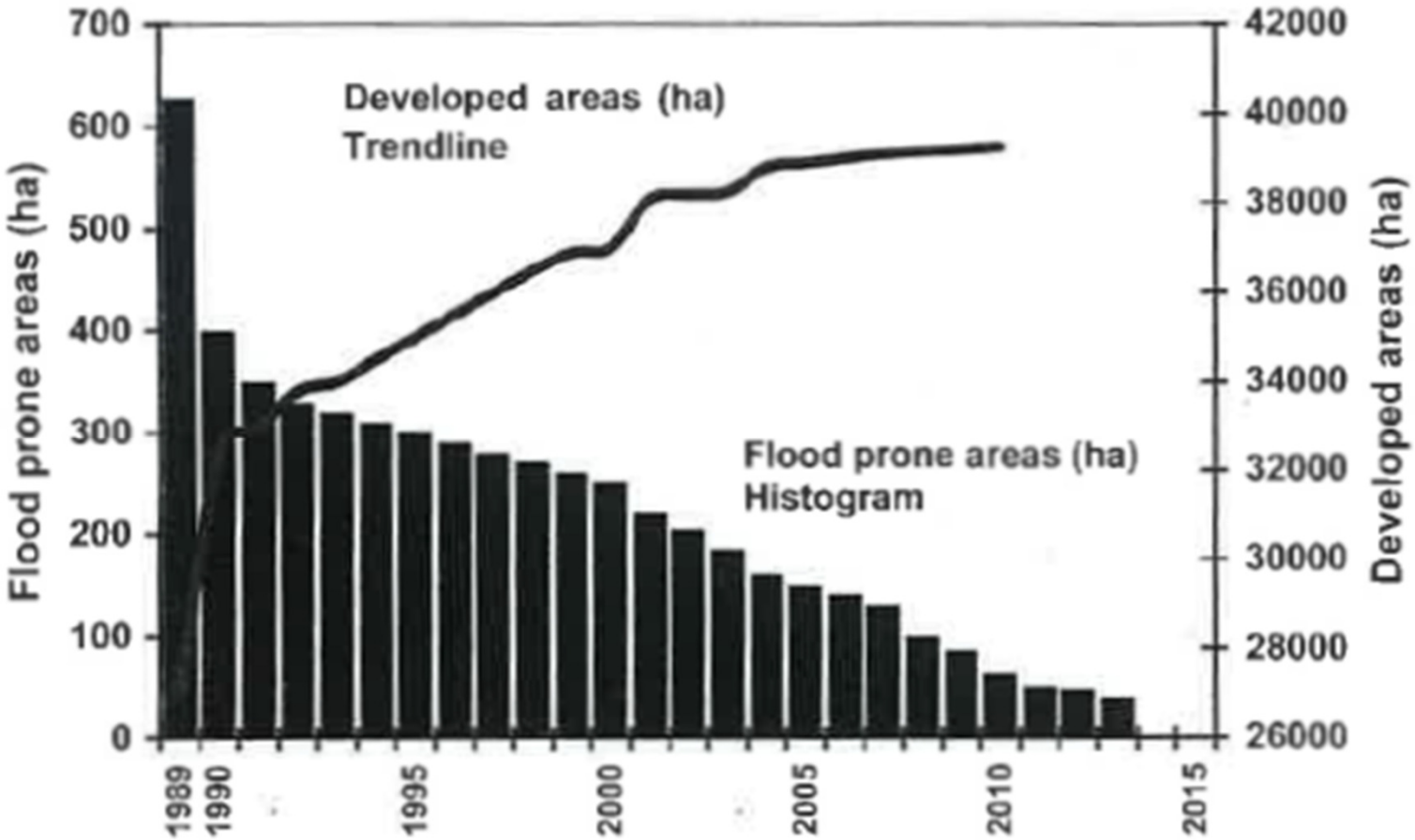


Source: Tortajada et al, 2013

What Has Changed?

1972

- Drainage Department set up within Ministry of the Environment
- Tasked with construction of an **effective land drainage system to prevent and alleviate floods**
- Drainage Master Plan drawn up and implemented
- Bukit Timah Flood Alleviation Scheme completed

What Has Changed?

1985

- Stamford Canal completed

1987

- Siglap Canal in operation

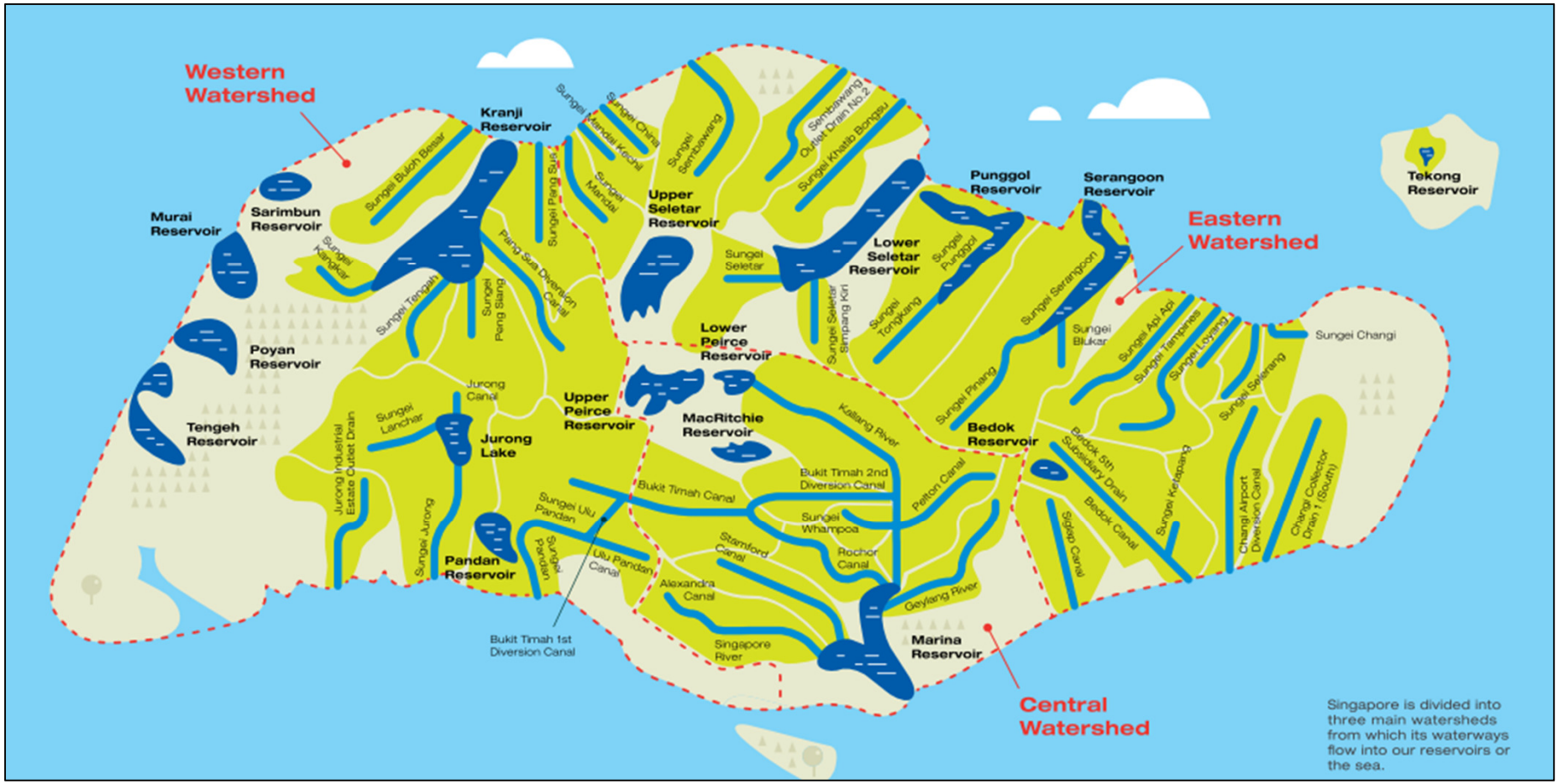
1991

- Bukit Timah Second Diversion Canal completed

1993

- Tanjong Katong Drainage Scheme completed

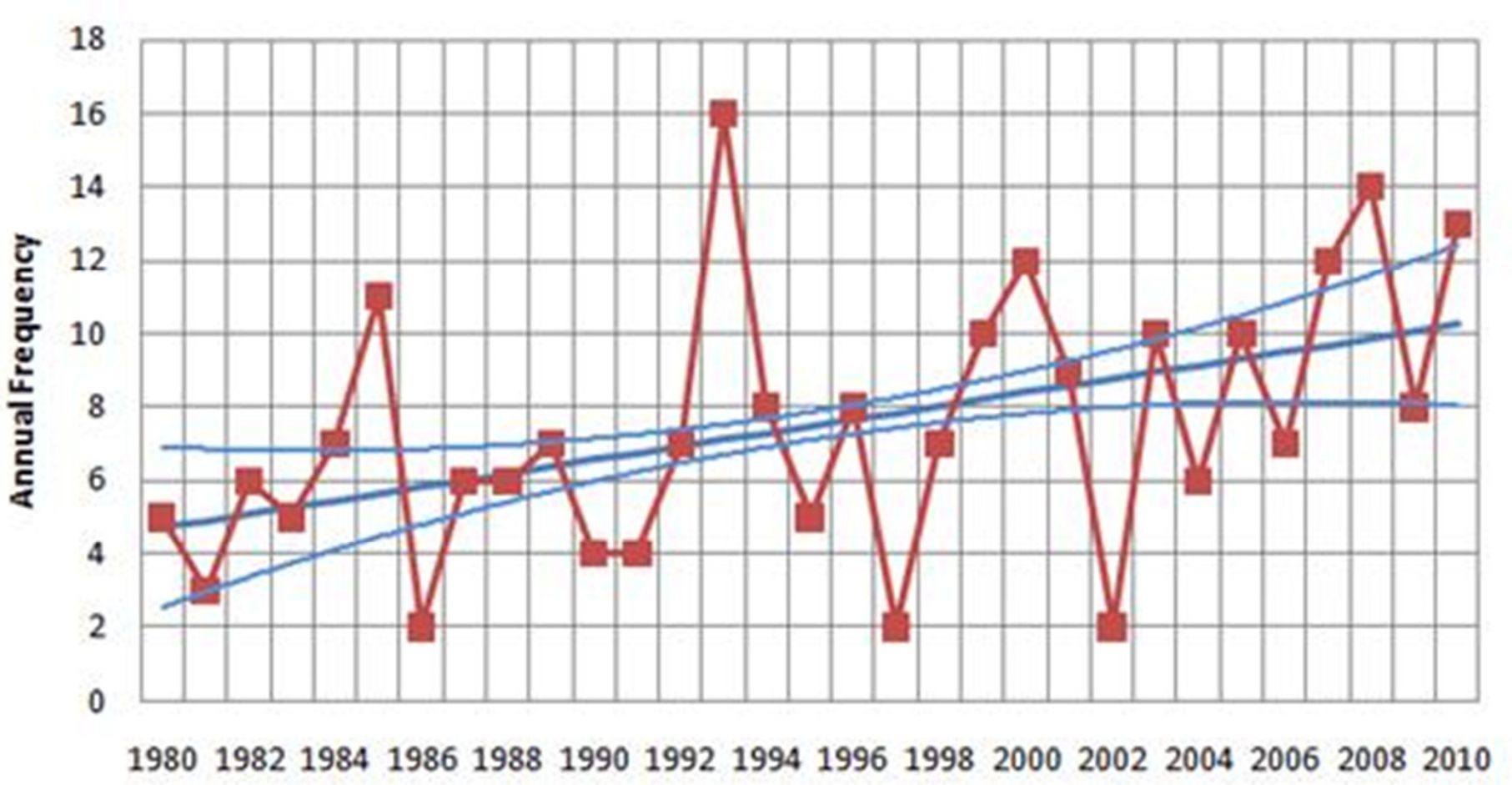
What Has Changed?



Source: PUB, Singapore's National Water Agency

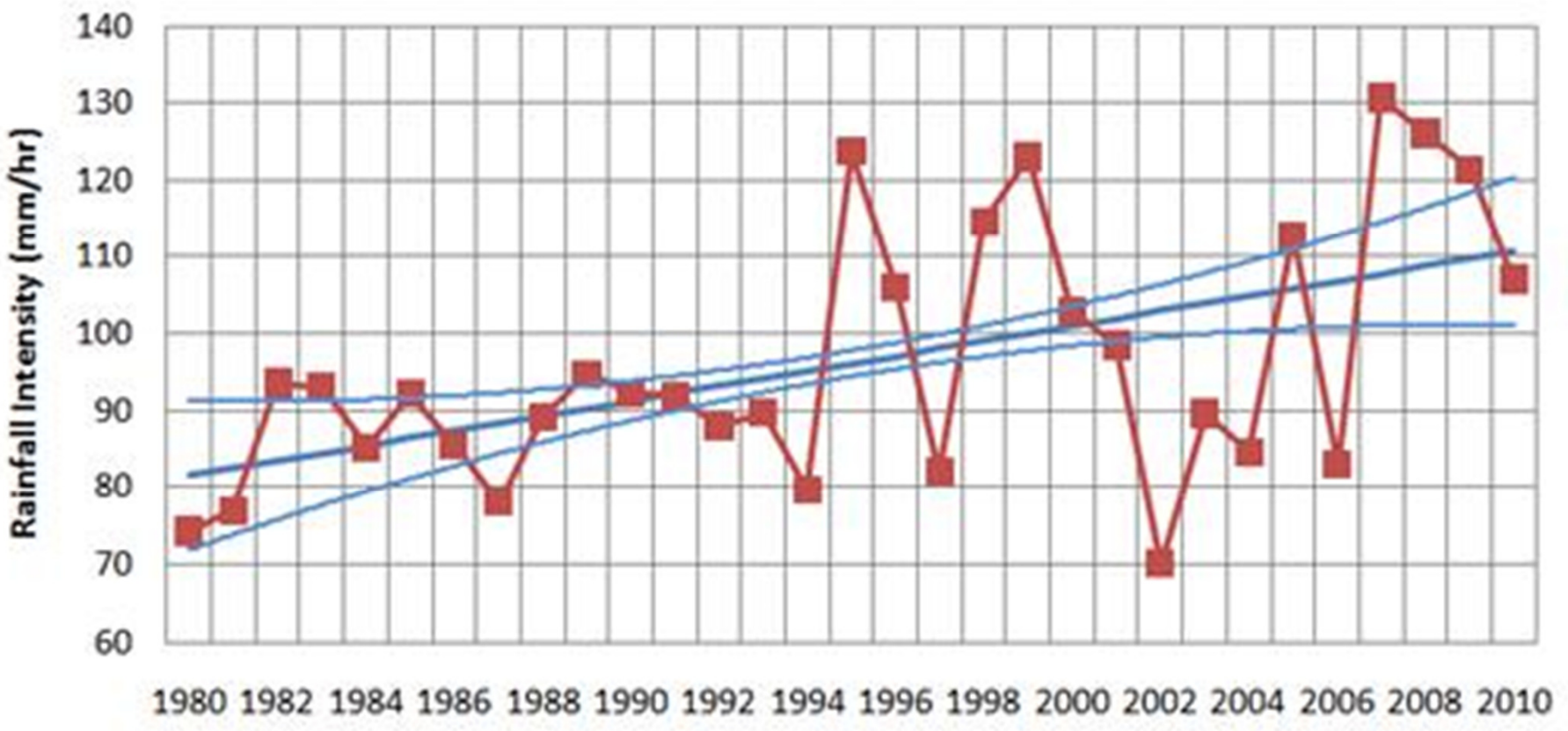
Future?

More “Heavy Rain” Days



Source: PUB, Singapore’s National Water Agency

More Intense Rainfall



Source: PUB, Singapore's National Water Agency

Future?

These trends are expected to continue in the future.

Contacts

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