Assessments of Risks, Hazards And Vulnerabilities Associated With Climate Change Impacts on The Key Sectoral And/Or Cross-Sectoral Bases

URBAN HEAT ISLANDS AND THE CLIMATE CHANGE IN MALAYSIA

Dr. Norlida Mohd Dom
The Regional Humid Tropics Hydrology and Water Resources Centre for Southeast Asia and The Pacific (HTCKL)
Department of Irrigation and Drainage
Ministry of Natural Resources and Environment
Malaysia
CONTENT

• Issues & threats associated with Climate Change
• **What is Urban Heat Islands (UHI)**
• **Urban Heat Islands In Malaysia**
• Effects of UHI In Malaysia
• Managing Climate Change
• Concluding remarks
“Over past 50 years, humans have changed ecosystems more extensively than any comparative period.......... resulted in a substantial loss in diversity of life......... degradation of many ecosystem services”
MILLENNIUM ECOSYSTEM ASSESSMENT (2005):

Ecosystem ↔ Climate?
A recent study shows that the capacity of many ecosystems to provide certain services has been declining...

(Source: Pilot Assessment of Global Ecosystems. 2000. WRI, IFPRI)
Urban Heat Islands And The Climate Change in Malaysia

Climate change is already affecting many ecosystems. A recent study shows that the capacity of many ecosystems to provide certain services has been declining...

(CLIMATE CHANGE & URBAN HEAT ISLANDS IN MALAYSIA)

Key

- **Excellent**
- **Good**
- **Fair**
- **Poor**
- **Bad**
- **Not Assessed**

(Source: Pilot Assessment of Global Ecosystems. 2000. WRI, IFPRI)
WHAT IS URBAN HEAT ISLANDS (UHI)
DEFINITION OF URBAN HEAT ISLAND (UHI)

“An area of higher temperatures in an urban setting compared to the temperatures of the suburban and rural surroundings. It appears as an ‘island’ in the pattern of isotherms on a surface map.”

Source: Glossary of Weather and Climate, Ira Geer, Ed.
"The respiration of humans and animals, above all the fumes of innumerable chimneys, maintain above Paris a rust-colored haze which blocks the sun... it is impossible that (Paris) should not have a notably higher temperature than the surrounding country."

(source: Emilien Renou, 1855)

“... the temperature difference between the countryside (and the city) is about 1° (C)”

(Source: Emilien Renou, 1868)
URBANISATION OF WORLD POPULATION

- **1800**  –  3% urban
- **1900**  –  14%
- **1950**  –  30% (83 cities >1M)
- **2000**  –  47% (76% in WDC, 40% in LDC)
- **2030**  –  estimated 60% urban, most of the growth in Least Development Countries (LDC).

(Source: Janet Barlow, 2008)
PROFILE OF UHI

Source: Hendrik Wouters, 2014
Urban Heat Islands And The Climate Change in Malaysia

Kuala Lumpur!

London!

San Francisco!

Manchester!

Tokyo!
How is an urban surface different to a rural surface?

• random array of obstacles, in horizontal and vertical
• “patchy” – inhomogeneous surface type
• rough surface (causes turbulence)
• warmer surface (range of building materials)
• sources of heat and pollution released at ground level
• reduced surface moisture
Reflection of sunlight (shortwave radiation)

- Materials used quite dark (e.g. tarmac, slate tiles, stone)
  → Reflect less sunlight

- Define albedo: the fraction of incident shortwave radiation which is reflected

\[ \alpha = 0 \text{ (no reflection)} \]
\[ \alpha = 1 \text{ (total reflection)} \]

e.g.
- tarmac \( \alpha \approx 0.05-0.1 \)
- grassland \( \alpha \approx 0.1-0.2 \)
- snow \( \alpha \approx 0.4-0.7 \)
Emission or absorption of heat (longwave radiation)

• Some built materials have high heat capacity, low thermal conductivity → they store heat, release it slowly (e.g. stone, brick, concrete)

• Some materials have low heat capacity, high thermal conductivity → they heat up rapidly to high temperatures, and cool down rapidly (e.g. “Cat on a Hot Tin Roof”!)

• Typically, urban areas store heat, release it slowly
Urban Heat Islands In Malaysia
MALAYSIA

North East Monsoon (Nov-Jan)
South West Monsoon
  (Apr – May for Peninsular Malaysia)
  (May-July for East Malaysia)
Temperature: 21°C – 32°C
Humidity: 80%
Rainfall: 2,420 mm – 3,830 mm
The Temperature

The Urbanisation

Urban Heat Islands And The Climate Change in Malaysia
EFFECTS OF UHI in MALAYSIA

• Large power consumption to cool down buildings
• Increase in ozone and chemical reactions causing smog and air pollution (when air temps rise)
• Hot day time temps in city > can be 10°C above rural temps
• Warm nights in city area – due to large latent heat energy stored during day time
• Increase in intensity and frequency of storm events (statistically proven for UHI KL city)

- resulting in increase of flood events
Urban Heat Islands And The Climate Change in Malaysia

UHI

URBAN AND RURAL RAIN COMPARISON

EXCEED LONG TERM MEAN VALUE STATION NO 3117070

MORE TIMES EXCEEDED

EXCEED LONG TERM MEAN VALUE STATION NO 2818110

GREEN AREA

UNIFORM PATTERN
Urban Heat Islands And The Climate Change in Malaysia

LONG TERM ANNUAL RAINFALL (1965 - 2002)
TREND COMPARISON

URBAN AND GREEN AREA

Rainfall mm/year

Year

Small difference

large difference
UHI

STATE OF JOHOR
LONG TERM ANNUAL RAINFALL

RAINFALL TREND COMPARISON

_URBAN AND GREEN AREA_

Small difference

large difference
Urban Heat Islands and the Climate Change in Malaysia

### Gap in Rainfall Trends Between Urban and Green Areas

#### Small Difference

- **Urban Heat Federal Territory Kuala Lumpur**
- **Urban Heat W.P Kuala Lumpur**

#### Large Difference

- **Urban Heat Johor Bahru, Johor**

**Legend:**
- `1538117`
- `1834122`
- `3117070`
- `2818110`
24 hour Mean Temperature for Petaling Jaya, Selangor

\[ y = 8 \times 10^{-5} x + 26.84 \]

Data source: MMD
Urban Heat Islands And The Climate Change in Malaysia

24 hour Mean Temperature for Senai, Johor

\[ y = 1E-04x + 25.477 \]

+ 1.09 °C
Study Conclusion:

**Urban Heat Islands (Climate Change in Malaysia)**

The medium of the long term rain and temperature are able to forecast for the year up to 2050.
MANAGING CLIMATE CHANGE
KEY STRATEGY

- Catchment and zonation in National Structure Plan
- Requires Multi-agency management attention
- Proposed as stated in National Physical Plan
- Management planning to synchronize with Local Areas Planning.
- Endorsement by policy makers & state authority
POLICIES

- Every Sector
- Promote
- Ensure
- Control
- Conserve
- Ensure provision of adequacy
- Infrastructure
HOW TO MANAGE AND WHAT TO MITIGATE FOR UHI?

Malaysia ‘National Physical Plan’:  
A Five years Strategic Planning. Some of them are as listed below:

- **Water Resources**: National Water Resources Council (MSAN), NWRP (National Water Resources Policy), IRBM, IWRM, MSMA; MWP, GWP, National Land Council (MTAN), National Forestry Council and National Mineral Council; Hydrological Procedure (HP1), etc.

- **Environmental Sensitive Areas (ESA)**
  Guidelines for State Land Logging 

  National Slope Master Plan 2009-2023
HOW TO MANAGE AND WHAT TO MITIGATE FOR UHI?

Malaysia ‘National Physical Plan’:
(continue)

• **Local Areas Planning**: Policy statements in planning and protecting green areas – ex; Kuala Lumpur Structure Plan 2020

• A strategy for integrated management of land, water and living resources that promotes conservation and sustainable use.

• **Framework** for action under CBD

• **Endorsement** by policy makers & state authority
HYDROLOGICAL PROCEDURE NO.1
(DID, revised and updated 2015)

### Minimum, Mean, Median and Maximum Values of Climate Change Factors for Region 4 (Mountainous)

<table>
<thead>
<tr>
<th>Station Name</th>
<th>Climate Change Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Bukit Bentong</td>
<td>1.21</td>
</tr>
<tr>
<td>Gunung Berinchang</td>
<td>1.43</td>
</tr>
<tr>
<td>Brook</td>
<td>1.23</td>
</tr>
<tr>
<td>Gob</td>
<td>1.11</td>
</tr>
<tr>
<td>Minimum</td>
<td>1.11</td>
</tr>
<tr>
<td>Median</td>
<td>1.22</td>
</tr>
<tr>
<td>Mean</td>
<td>1.25</td>
</tr>
<tr>
<td>Maximum</td>
<td>1.43</td>
</tr>
</tbody>
</table>

**Example** : Region 4, Mountainous Area CCF
IMPLEMENTATION APPROACH
A 5-year Strategic Planning

• Considers the entire range of services and ecosystems. (Stakeholders involvement)
• Attempts to optimize the mix of benefits within a given services and across ecosystems
• Uses adaptive management (SWOT, BOS)
• Ensures inter-sectoral involvement & cooperation
• Follow through
SUMMARY

• Sustainability of the ecosystems:
  – balance and integrate conservation vs wise use
  – involve all relevant sectors
• Develop & Implement Integrated Mgmt Plan
  – Action plans & guidelines
• Progressive awareness raising by public awareness program (POP)
• Participatory process
Concluding Remark

SCIENCE TO POLICY INTERFACE
THE CHALLENGES

- IRBM based on LU planning + MASMA + on-site flood detention is essential. Because of land constraints
  - **options are running out.**
- Biggest issue on land acquisition
  - administrative/cost/social/political implications
THE CHALLENGES (cont’)

• Rapid population increase
• Limited potential land for development
• Privately owned green areas
• Competing demand of land for various uses
KLCC Park
THANK YOU
Acknowledgement:

i. Fund by The Ministry of the Environment of Japan (MOEJ)
ii. Organizer by the Institute for Global Environmental Strategies (IGES)