UNIVERSITI KEBANGSAAN MALAYSIA
*National University of Malaysia*

UNITED NATIONS UNIVERSITY
International Institute for Global Health

# Malaysian 2014 Floods : Health Impacts and Experiences

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# Introduction

- Flood is the most common natural disaster globally.
- It leads to the most devastating impacts from the economical, social and health perspectives.
- It affects the most people worldwide both in the developed and developing countries (Ahern *et al*., 2005).

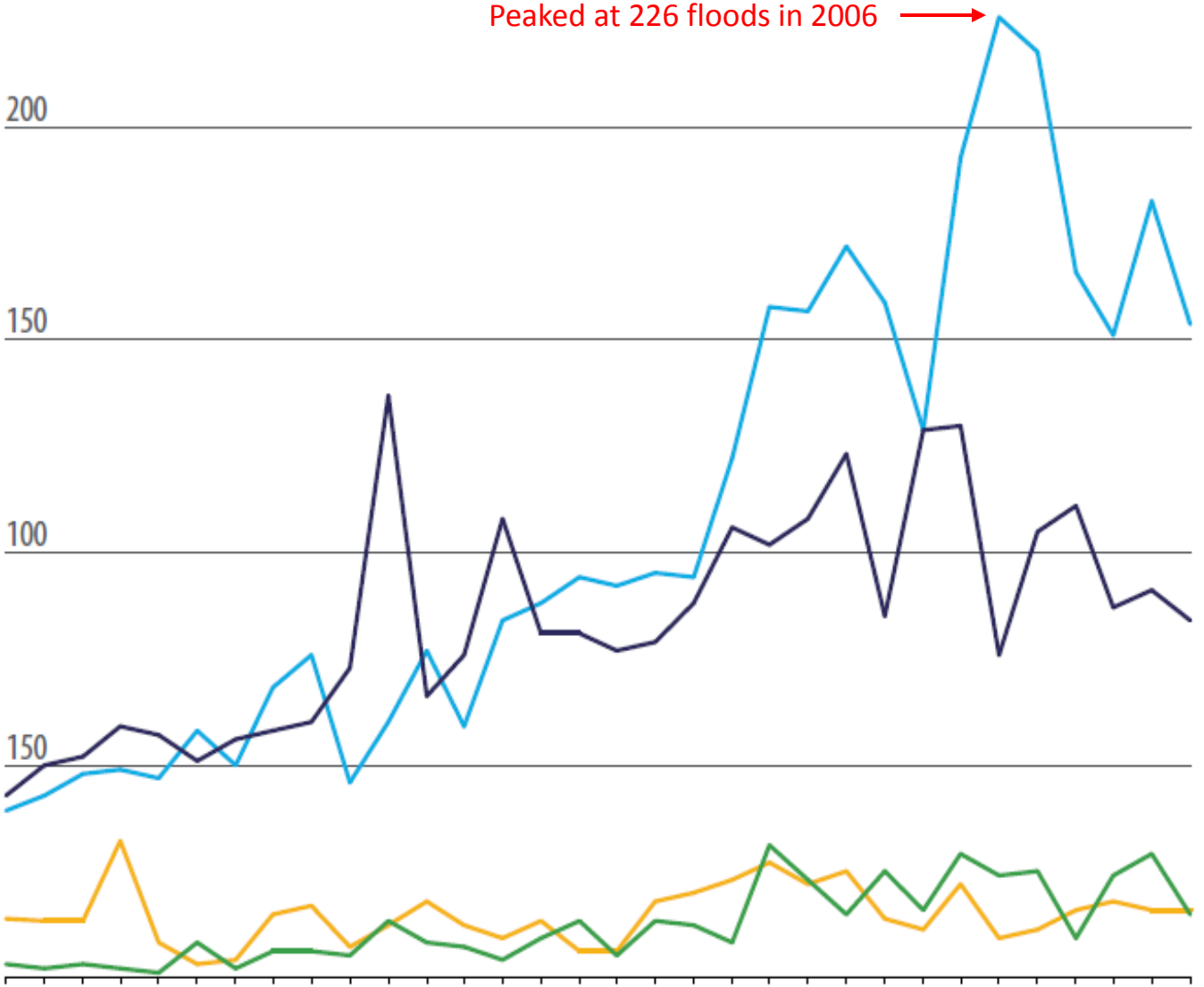
# Number of Climate-related Disasters Around the World (1980-2011)

**3455 FLOODS**

**2689 STORMS**

**470 DROUGHTS**

**395 EXTREME TEMPS**




UNISDR
The United Nations Office for Disaster Risk Reduction
http://www.unisdr.org

Created on 13 June 2012

DATA SOURCES

EM-DAT - http://www.emdat.be/ - The OFDA/CRED International Disaster Database; Data version: 13 June 2012 - v12.07

Humanitarian Symbol Set (2008): http://www.ungiwg.org/map/guideline.php

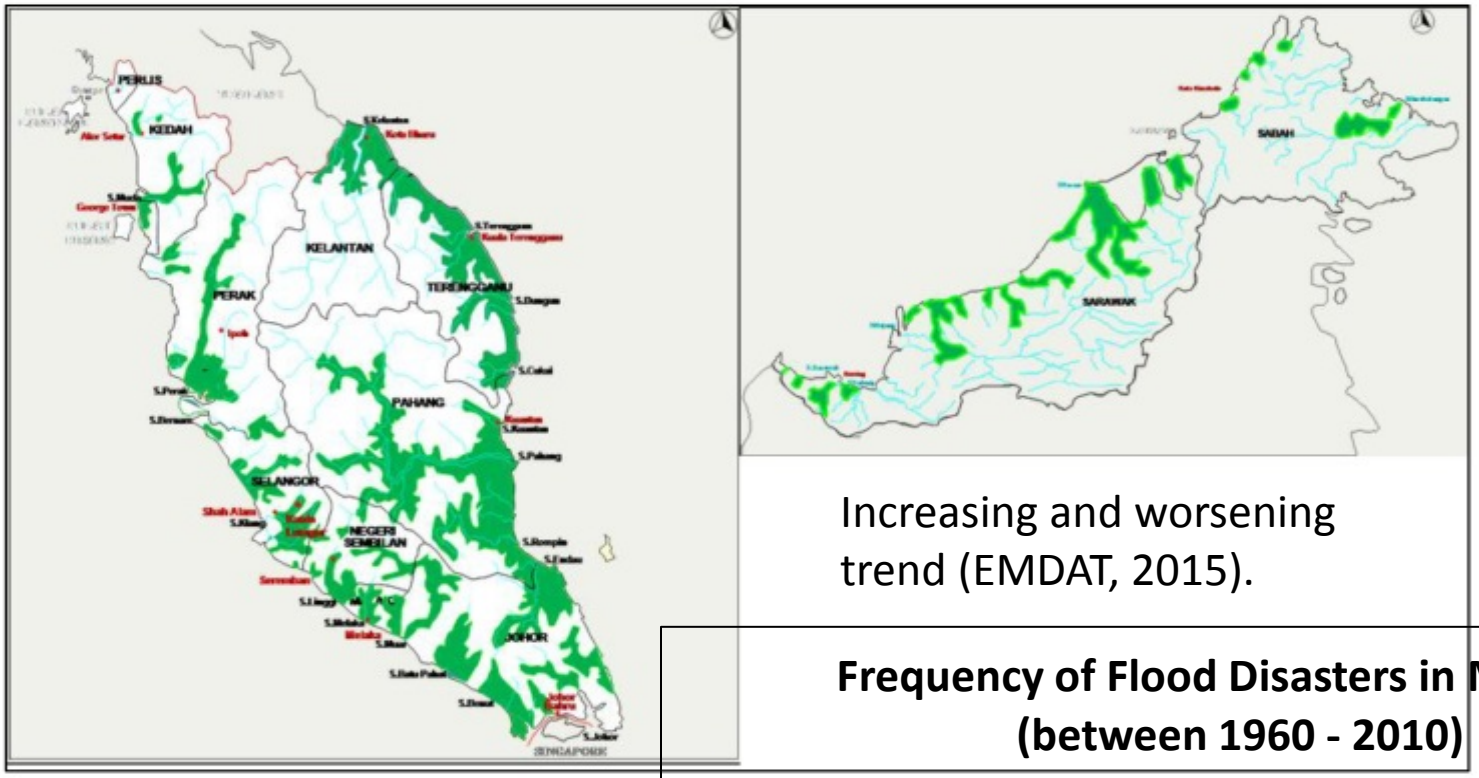
| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOOD | 39 | 43 | 48 | 49 | 47 | 58 | 50 | 68 | 76 | 46 | 60 | 77 | 59 | 84 | 88 | 94 | 92 | 95 | 94 | 122 | 158 | 157 | 172 | 159 | 129 | 193 | 226 | 218 | 166 | 151 | 183 | 154 |
| STORM | 43 | 50 | 52 | 59 | 57 | 51 | 56 | 58 | 60 | 73 | 137 | 66 | 76 | 108 | 81 | 81 | 77 | 79 | 88 | 106 | 102 | 108 | 123 | 85 | 129 | 130 | 76 | 105 | 111 | 87 | 91 | 84 |
| DROUGHT | 14 | 13 | 13 | 32 | 8 | 3 | 4 | 15 | 17 | 7 | 12 | 18 | 12 | 9 | 13 | 6 | 6 | 18 | 20 | 23 | 27 | 22 | 25 | 14 | 11 | 22 | 9 | 11 | 16 | 18 | 16 | 16 |
| EXTREME TEMPERATURE | 3 | 2 | 3 | 2 | 1 | 8 | 2 | 6 | 6 | 5 | 13 | 8 | 7 | 4 | 9 | 13 | 5 | 13 | 12 | 8 | 31 | 23 | 15 | 25 | 16 | 29 | 24 | 25 | 9 | 24 | 29 | 15 |

# Global Impacts of Floods

- 15 countries account for 80% of population exposed to river flood risk worldwide.
- They include the least developed or developing countries like India, Bangladesh, China, Vietnam, Pakistan and Indonesia.
- An average of USD 96 billion of GDP affected annually (World Resource Institute, 2015).

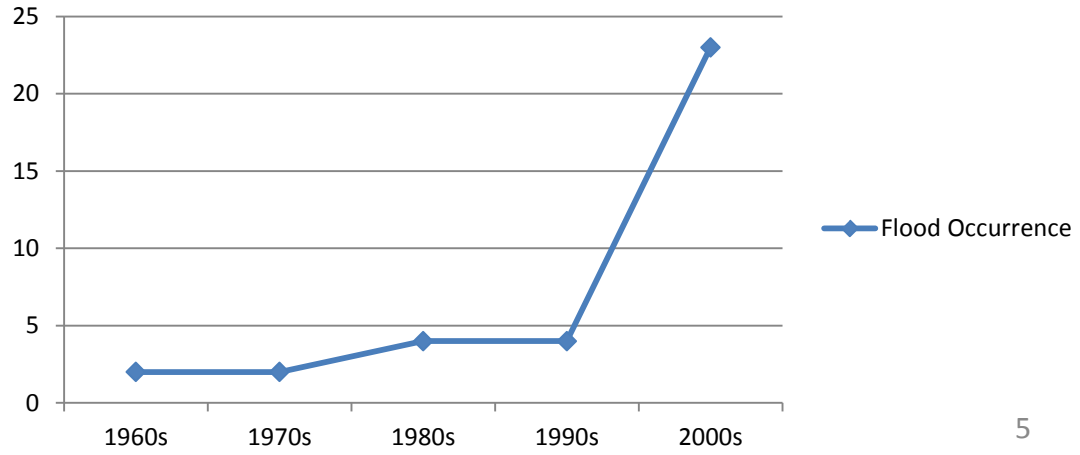
Flood in Bangladesh (Credit: AP Photo).

# Malaysian Flood Scenario




Increasing and worsening trend (EMDAT, 2015).

**Frequency of Flood Disasters in Malaysia (between 1960 - 2010)**



2014 Flood in Kelantan (Credit: Daily Times)

# Impact of Climate Change on Flooding

- The National Hydraulic Research Institute of Malaysia (NAHRIM) predicted that floods will worsen in the future based on their projection that sea level rise in Malaysia for the year 2100 will be between 0.3-1.0 meter, with the highest increase in low lying areas along the Kelantan and Kedah, Sabah and Sarawak coasts (NAHRIM 2010).

- Sea level rise of 0.2 – 4.4 mm per year.
- 0.4 to 1.1 m rise in Kedah, Kelantan, Sabah and Sarawak by 2100.

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# Impact of the 2014 Malaysian Floods

- 541,896 flood victims; 319,156 (58.9%) in Kelantan
- 2,076 homes destroyed
- 6,698 homes damaged
- 1,335 evacuation centres
- 25 flood-related deaths; 11 in Kelantan
- RM 2.85 billion in public property loss (not including personal and private properties)

Source : Malaysian National Security Council

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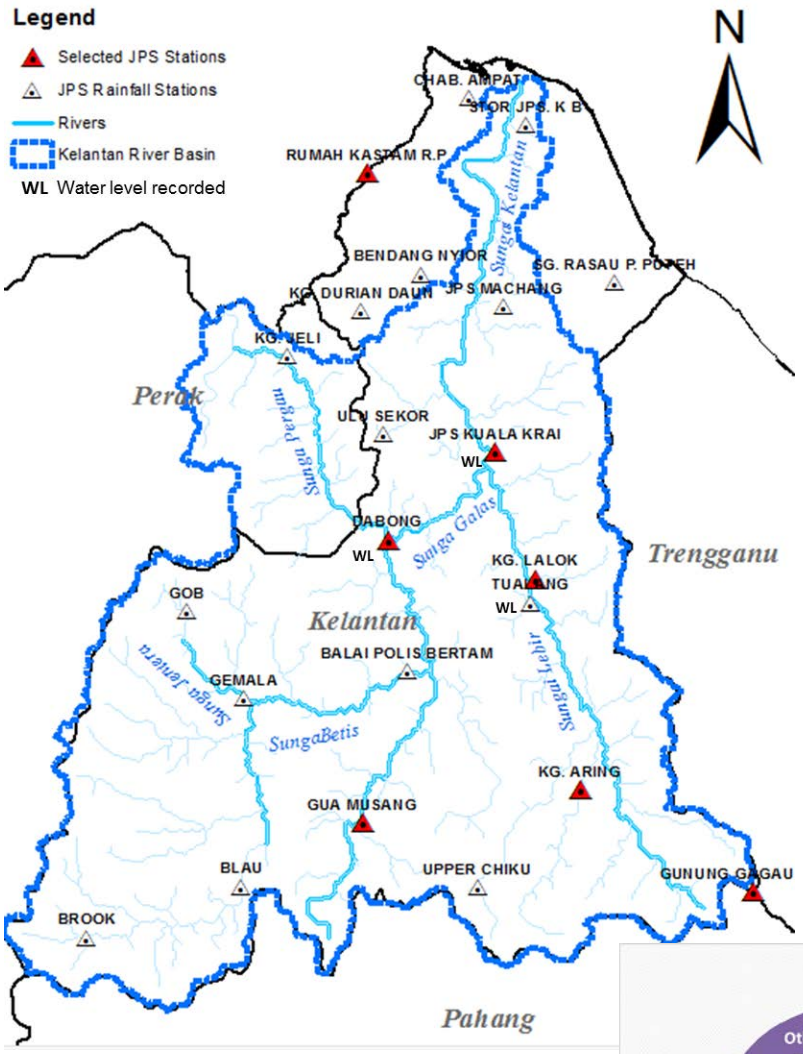
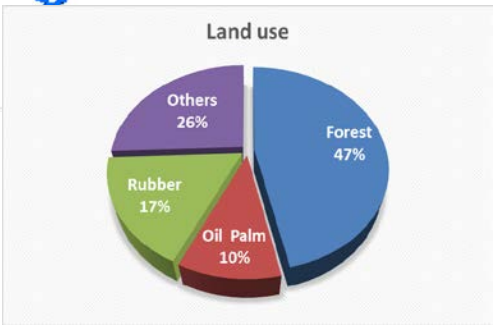
# The Kelantan River Basin




Kelantan River Basin catchment and water gauging stations (Zulkifli Yusop, 2015).




- Triangular shaped.
- Rivers flow northwards.
- Main tributaries include Sg. Lebir, Sg. Galas, Sg. Pergau and Sg. Nenggiri.
- Around 13,088 km² of catchment area (88% of Kelantan state).
- Steep, mountainous topography upstream.
- Previous major floods in 1923, 1926 and 1967.
- Maximum rainfall fell in Gunung Gagau; 1765 mm (77%) from 17 to 24 Dec., compared to 2300 mm average annually.

# Vulnerability Analysis to Flood-Related Communicable Diseases with Assessment of Environmental Health Preparedness, Response and Recovery following the Severe Kelantan River Basin Flooding

## Research Team Members

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Co-Principal Investigator, UKM

Prof. Dr. Jamal Hisham Hashim
Principal Investigator, UNU-IIGH

Dr. Azmawati Mohammed Nawi
Co-researcher, UKM

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Co-researcher, UKM

Dr. Gul Muhammad Baloch
Co-researcher, Taylor's Univ.

Dr. Rohaida Ismail
Co-researcher, MOH

Dr. Mohd Firdaus Mohd Radi
DrPH candidate, MOH & UKM

Dr. Natasha Kuruppu
Co-researcher, UNU-IIGH

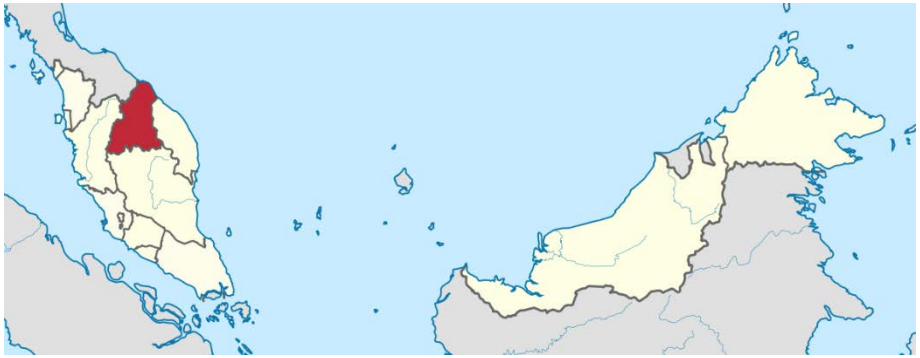
Nur Izzah Farakhin Ayub
Research Assistant, UKM

# Study Objectives

- General objectives
  - To determine the spatial-temporal distribution as well as clustering and vulnerability analysis of flood-related communicable diseases in relation to environmental factors following the major flooding in Kelantan.
  - To asssess the environmental health preparedness, response and recovery following the event.

# Methodology

- Study locations :
  - 8 districts (out of 10 in the State) along the Kelantan River Basin namely Kota Bharu, Pasir Mas, Tumpat, Tanah Merah, Machang, Kuala Krai, Jeli and Gua Musang covering an area of about 13,000 $km^2$.
  - These 8 districts are located along the main river of Sungai Kelantan, as well as its tributaries of Sg. Lebir, Sg. Galas and Sg. Pergau.



# Methodology

- Study design :
  - There are two phases of the study :
    - Phase 1 is a quantitative cross-sectional study looking into the spatial and temporal distribution of communicable diseases, 3 months before, 3 weeks during, and 3 months after the 2014 flood in Kelantan, which will then be analyzed using geographical information system (GIS) and remote sensing (RS).
    - Phase 2 is a qualitative research employing focused group discussions (FGDs) among health care, rescue and welfare personnel involved directly during the flood disaster, as well as the affected community.

# Methodology

- Types of communicable diseases of interest :
  - Food and water-borne diseases : cholera, typhoid, dysentery, hepatitis and acute gastroentritis.
  - Zoonotic diseases : leptospirosis and melioidosis.
  - Acute respiratory diseases : pneumonia.
  - Direct contact : measles and bacterial meningitis.
  - Wound related diseases : tetanus.
  - Vector-borne diseases : malaria and dengue fever.

# Focus Group Discussions (FGDs)

## State Level FGD

## District Level FGD

## Community level FGD

- MKN
- PDRM (Police)
- JPAM/APM
- Fire & Rescue
- State SUK Office
- District Office

- Health Dept.
- Welfare Dept.
- Army (Brigade 8)
- Community

# Main FGD findings

| State Level Officers | District Level | Community Representatives |
| --- | --- | --- |
| • Poor multi-agency coordination and line of command.<br>• Communication breakdown prohibiting effective relay of message.<br>• Difficulty in deployment of transportation assets.<br>• Challenges in allocation of supplies to workers and affected communities. | • Limited usable transportation means due to topography problems.<br>• Inadequate number of workers and personnel.<br>• Insufficient clean water and food storage and supplies to workers and general public.<br>• Communication break down prohibiting effective relay of message.<br>• Inaccessibility to shelters and temporary settlements.<br>• Challenges in clearing and cleaning solid wastes and mud post flood. | • Minimal preparations due to unexpected or unforeseen severity of flood.<br>• Challenges in securing belongings due to prospect of looting.<br>• Temporary shelters were inadequate and packed beyond their capacity.<br>• Limited clean water supply for drinking and daily use during stay in shelters.<br>• Sanitation problems during stay in temporary shelters from lack of clean water. |

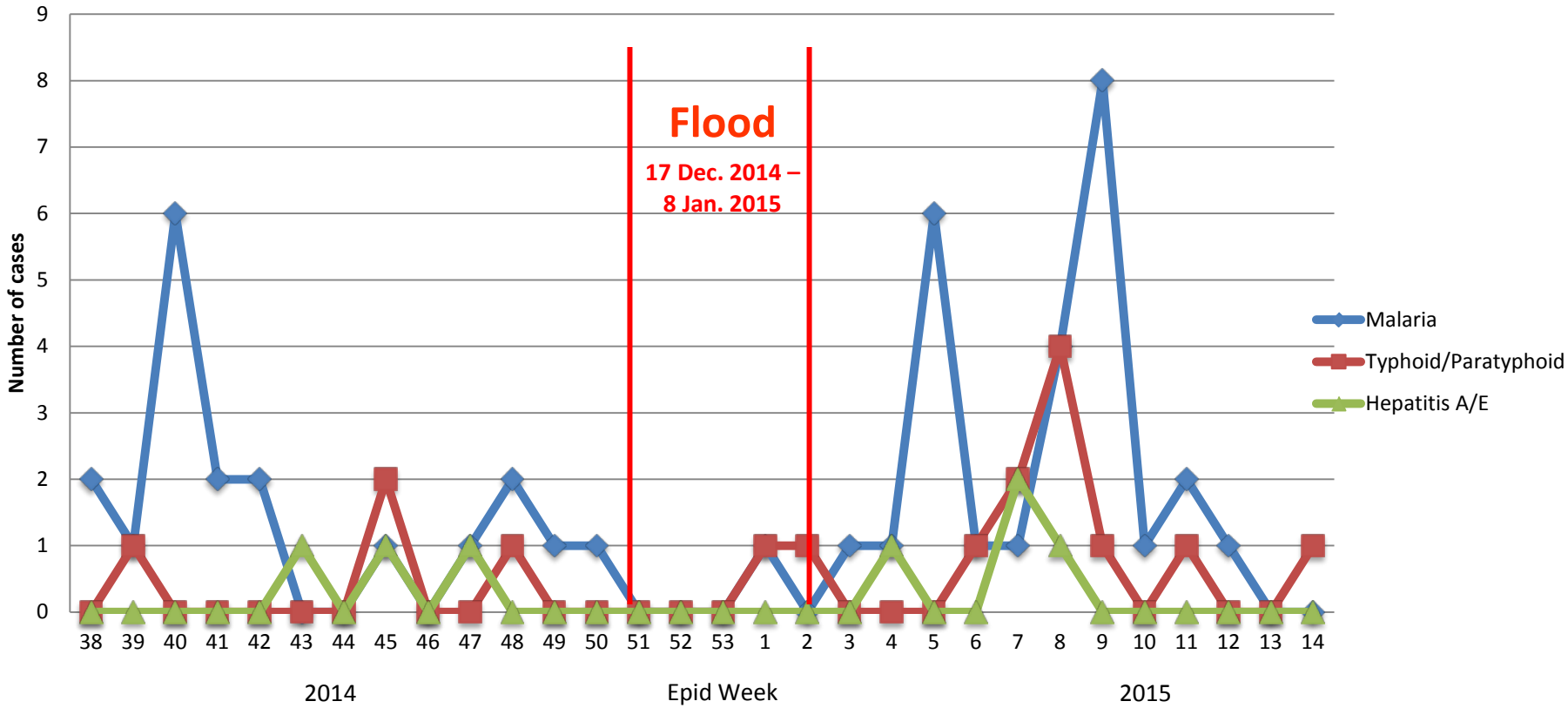
# Incidence of Communicable Diseases Before, During and After the Kelantan River Basin Flooding

| Type of Communicable disease | Pre-Flood (17/9/2014-16/12/2014) | During Flood (17/12/2014-8/1/2015) | Post Flood (9/1/2015-9/4/2015) |
|---|---|---|---|
| Dengue | 2053 | 221 | 438 |
| Leptospirosis | 357 | 147 | 725 |
| Malaria | 19 | 1 | 26 |
| Typhoid/Paratyphoid | 4 | 2 | 11 |
| Hepatitis A/E | 3 | 0 | 4 |
| Cholera | 0 | 0 | 0 |
| Dysentery | 0 | 0 | 0 |
| Tetanus | 0 | 0 | 0 |

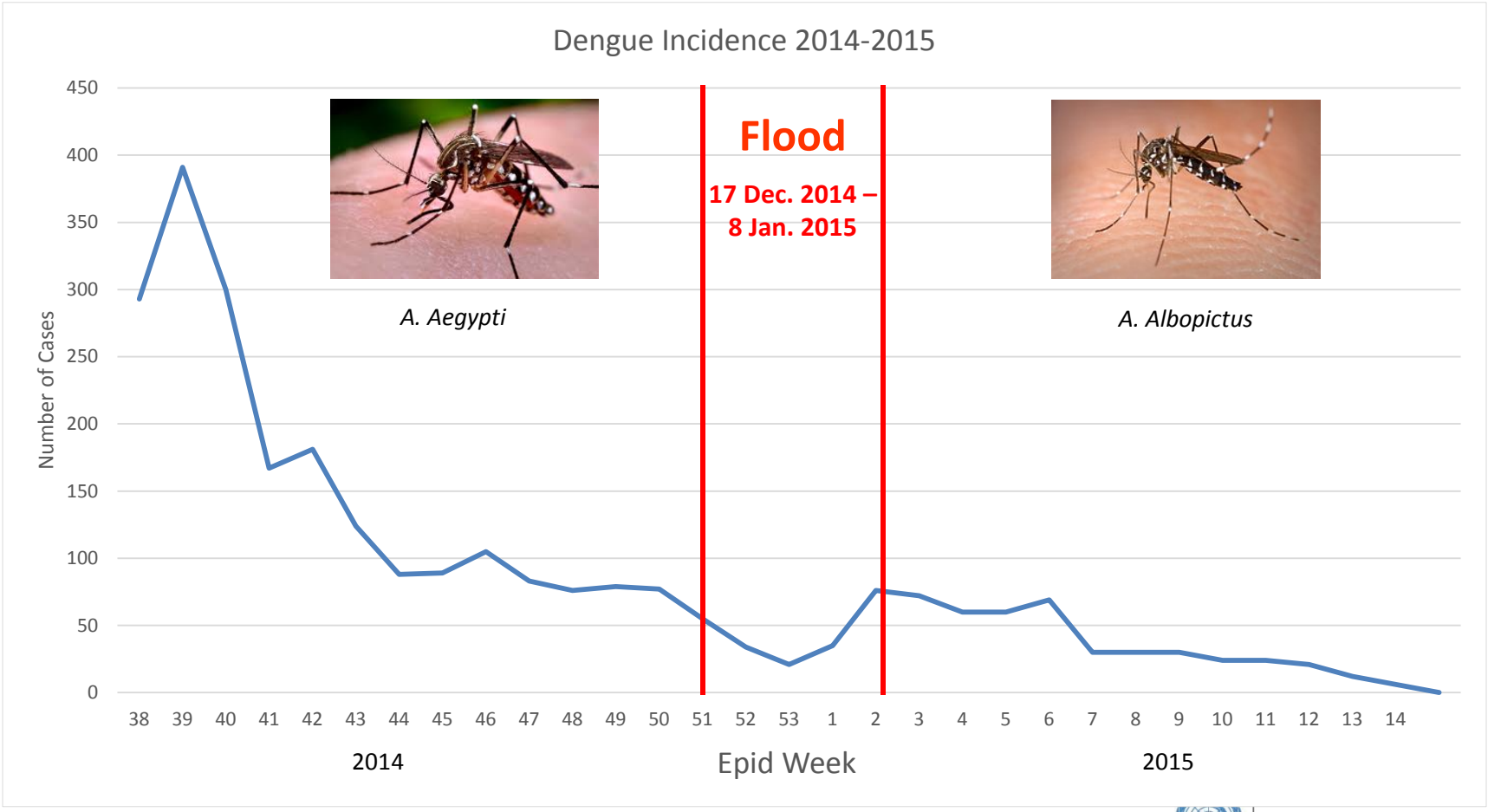
Disease incidence period in Epid week :

- Pre Flood: Epid weeks 38/2014 to 50/2015
- During Flood: Epid weeks 51/2014 to 2/2015
- Post Flood: Epid weeks 3/2015 to 15/2015

# Communicable Disease Incidence Before, During and After the Kelantan River Basin Flooding



# Dengue Incidence Before, During and After the Kelantan River Basin Flooding

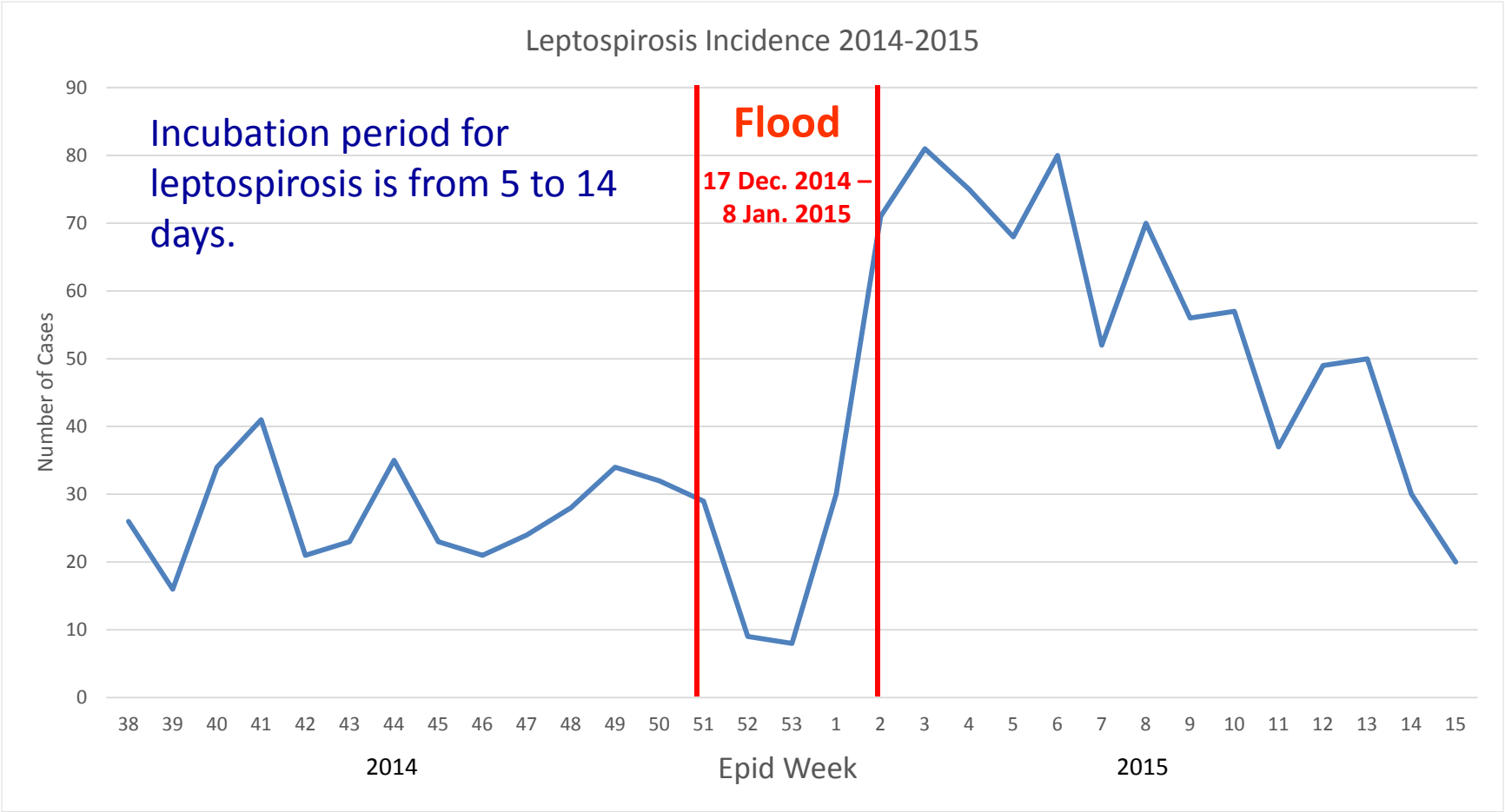



Dengue is transmitted by the *Aedes aegypti and Aedes albopictus* mosquitoes which breed in clear and stagnant water.

# Leptospirosis Incidence Before, During and after the Kelantan River Basin Flooding

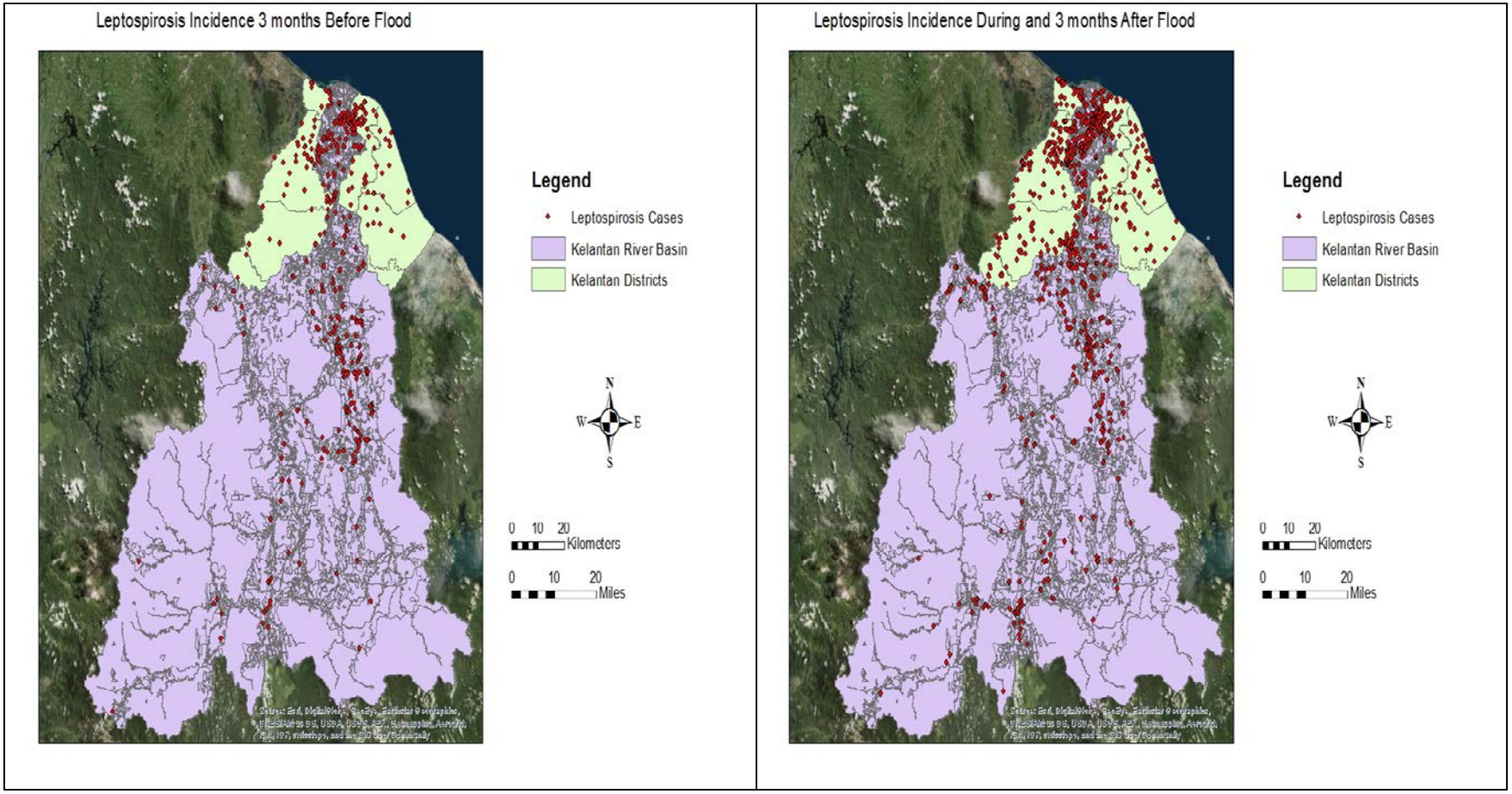
| | n | % | Total |
|---|---|---|---|
| Gender | | | 1284 (100%) |
| Male | 747 | 58.2 | |
| Female | 537 | 41.8 | |
| | | | |
| Race | | | 1284 (100%) |
| Malaysian | | | |
| Malay | 1185 | 92.3 | |
| Chinese | 25 | 1.9 | |
| Indian | 6 | 0.5 | |
| Orang Asli | 9 | 0.7 | |
| Others | 11 | 0.9 | |
| Foreigner | 48 | 3.7 | |
| | | | |
| Age | | | 1276 (99.4%) |
| ≤4 | 60 | 4.7 | |
| 5-14 | 215 | 16.8 | |
| 15-24 | 270 | 21.2 | |
| 25-44 | 372 | 29.1 | |
| 45-64 | 269 | 21.1 | |
| ≥65 | 90 | 7.1 | |
| | | | |
| Flood Period | | | 1229 (95.7%) |
| Pre | 357 | 29.0 | |
| During | 147 | 12.0 | |
| Post | 725 | 59.0 | |

# Leptospirosis Incidence Before, During and After the Kelantan River Basin Flooding




Leptospirosis is transmitted through human contact with water contaminated by urine of infected rodents.

# Leptospirosis Incidence in Kelantan from September 2014 to April 2015



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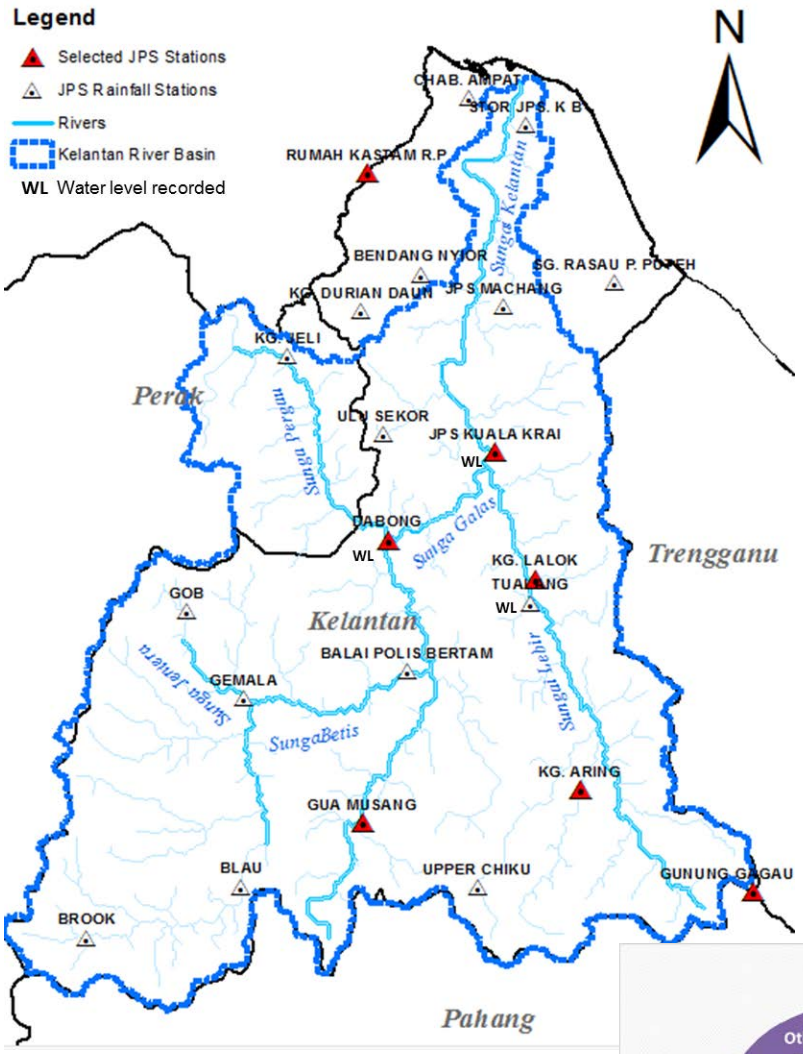


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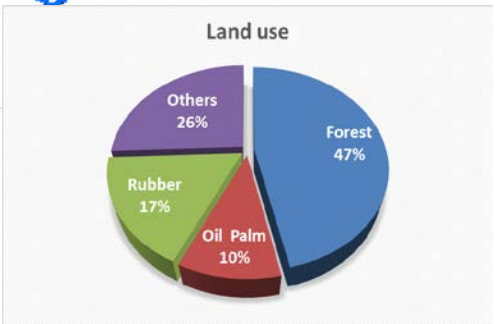


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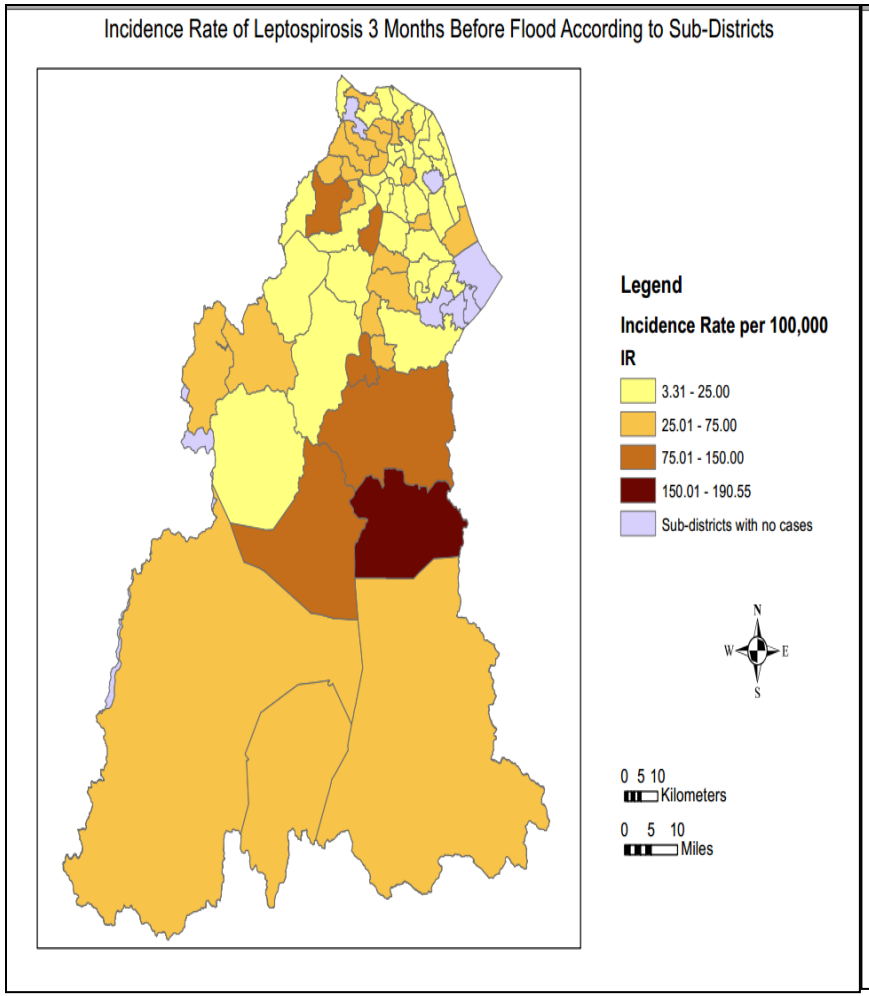
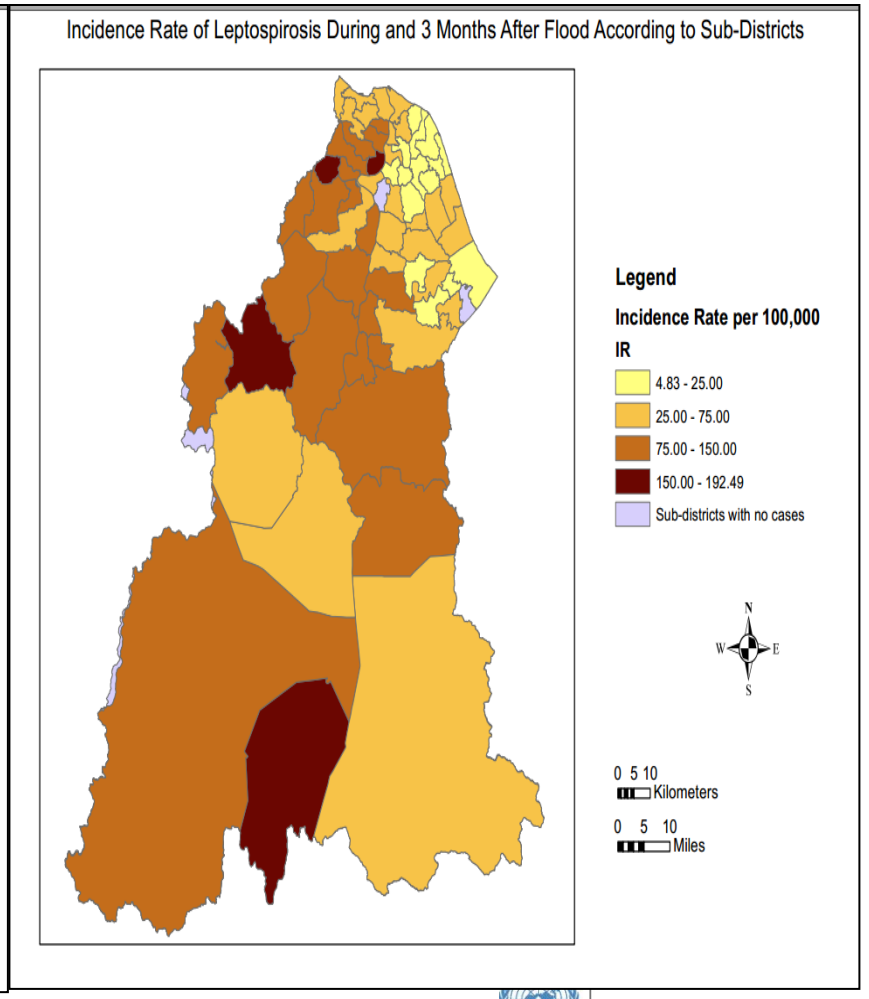
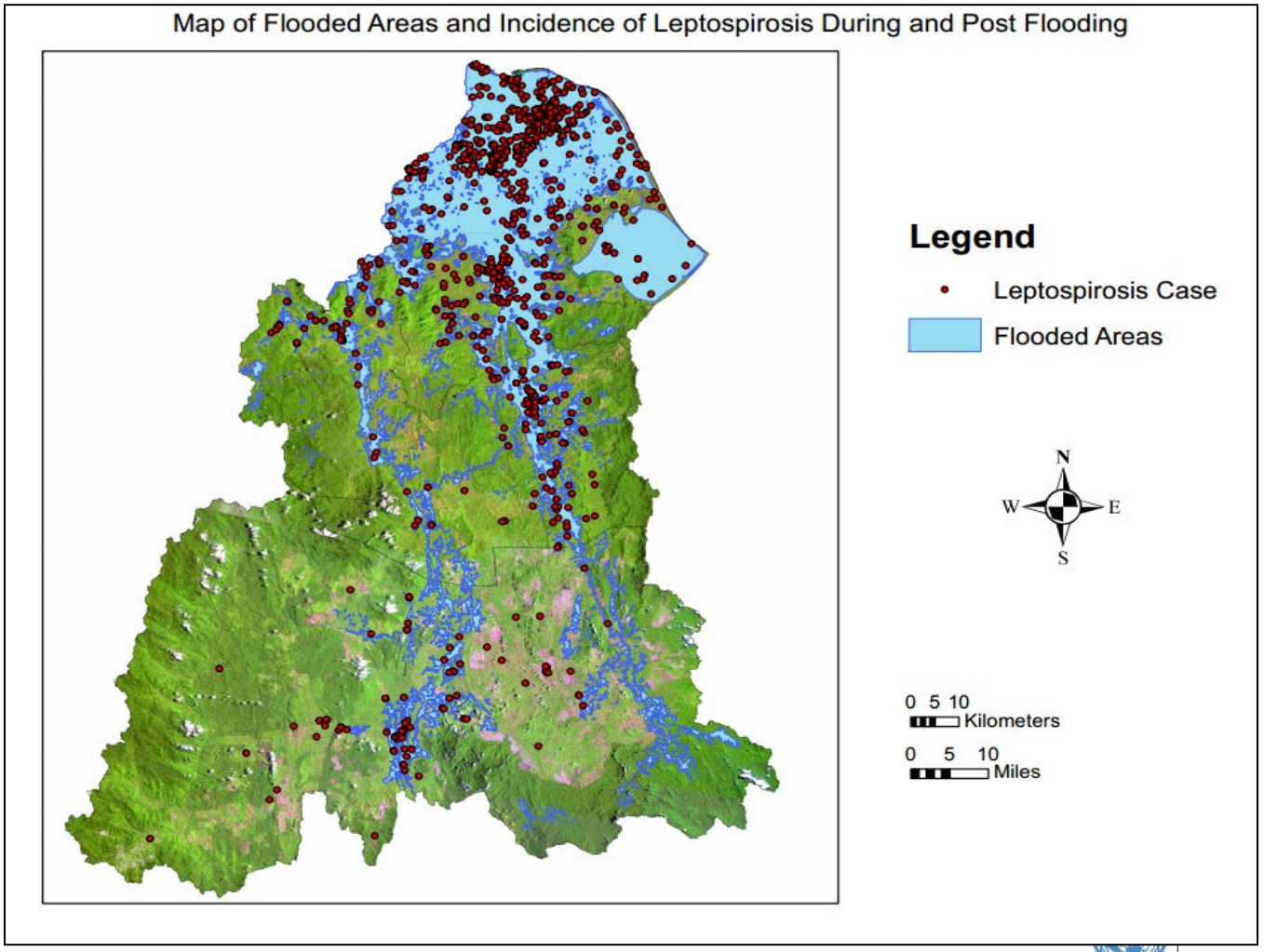
# Leptospirosis Incidence Rate Before Versus During and After the Kelantan River Basin Flooding

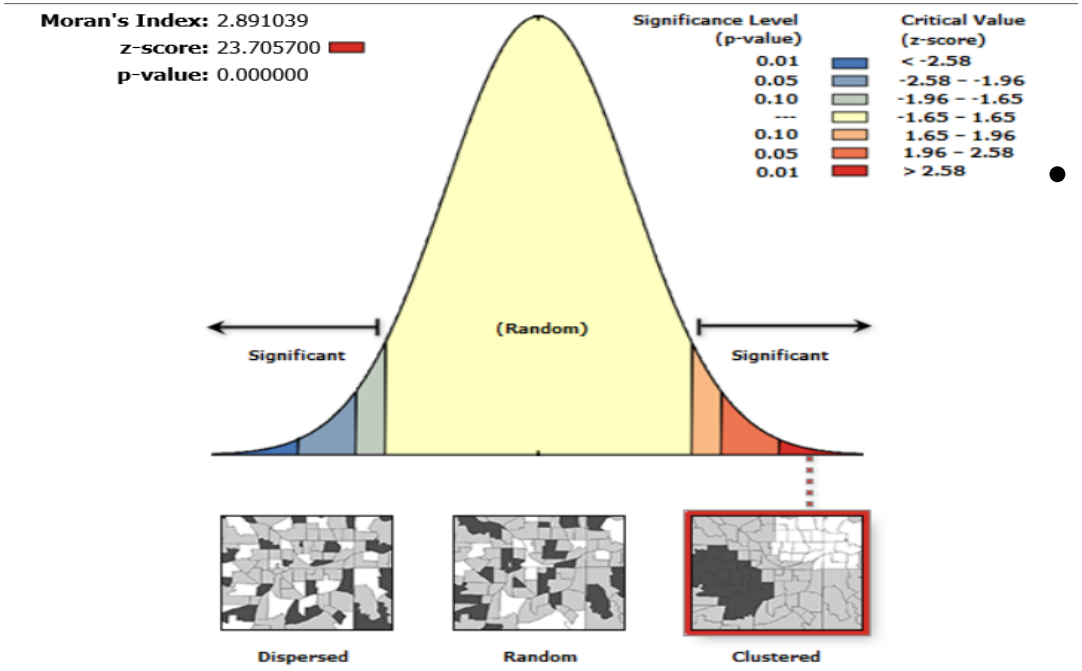


# Leptospirosis Incidence in Flood Zone During and After the Kelantan River Basin Flooding



# Clustering of Leptospirosis Cases During and After the Kelantan River Basin Flooding

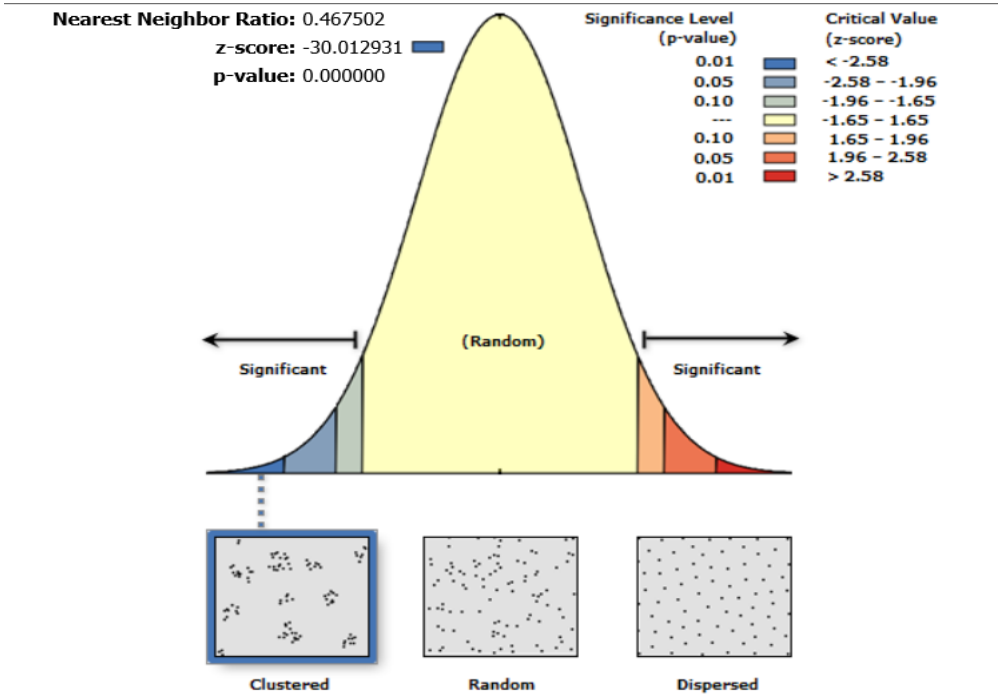



Given the z-score of 23.7057002734, there is a less than 1% likelihood that this clustered pattern could be the result of random chance.

| Global Moran's I Summary | |
|---|---|
| **Moran's Index:** | 2.891039 |
| **Expected Index:** | -0.001161 |
| **Variance:** | 0.014885 |
| **z-score:** | 23.705700 |
| **p-value:** | 0.000000 |

- Cases of Leptospirosis during and post flooding were highly clustered with a significant Moran's Index of 2.89 (p-value < 0.01)

# Clustering of Leptospirosis Cases During and After the Kelantan River Basin Flooding



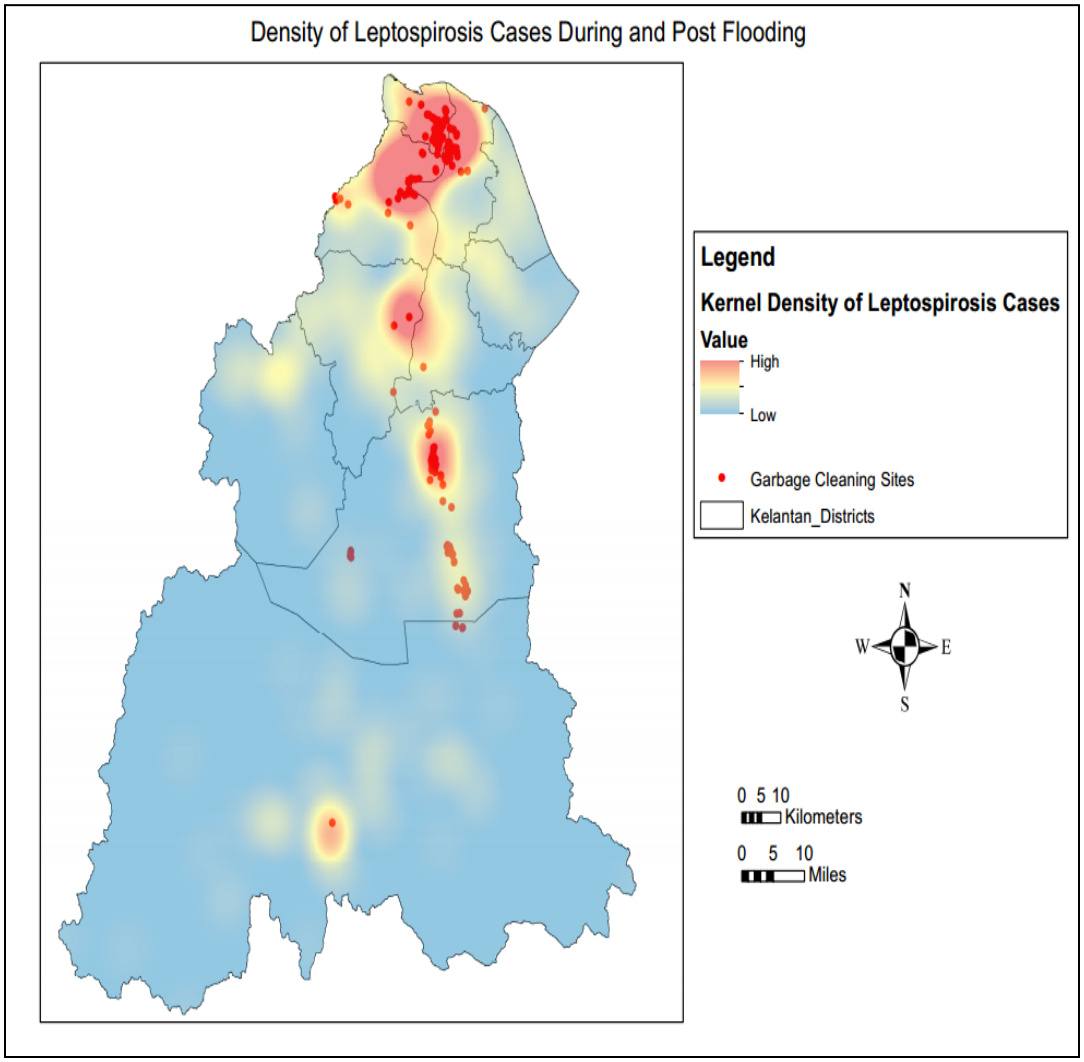

Given the z-score of -30.0129309165, there is a less than 1% likelihood that this clustered pattern could be the result of random chance.

**Average Nearest Neighbor Summary**

| | |
|---|---|
| **Observed Mean Distance:** | 976.5631 Meters |
| **Expected Mean Distance:** | 2088.8944 Meters |
| **Nearest Neighbor Ratio:** | 0.467502 |
| **z-score:** | -30.012931 |
| **p-value:** | 0.000000 |

- Cases of leptospirosis during and post flooding were highly clustered with observed mean distance of 976.6 meters compared to the expected mean distance of 2088.9 meter between each cases ($p < 0.01$).

# Leptospirosis Incidence Associated with Post Flood Temporary Dump Sites



# Summary

- The big Kelantan flood seems to have a cycle of every 40+ years.
- The impact of climate change on future floods is unknown.
- Preparedness, response and recovery were hampered by lack of coordination, communication, transportation assets, inadequate relocation centres and shelters with poor sanitation, and poor garbage management.
- Increase in leptospirosis and malaria cases during and post flood.
- Leptospirosis incidence was associated with poor garbage management.

# Thank You