SEA-HAZEMON Project: Real-time Air Quality Monitoring and Forest Fire Detection Platform

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Outline

• Introducing SEA-HAZEMON project
• IoT Community
• On-Going Research on IoT, PM2.5 and Forest Fire
Air Pollution Crisis

Air pollution illnesses to be studied

BANGKOK OFFICIALS ADMIT THAT PM2.5 PROBLEM CAUGHT THEM UNAWARES AS HAZARDOUS POLLUTING IN CAPILITON BEGINS TO EBB

The Nation

FIVE DAYS OF BANGKOK’S TOXIC AIR

The PM2.5 level of particular air pollution has been high over the past few days, causing breathing health problems for some people. This is the second of the PM2.5 daily average over the past few years, a health monitoring station in Bangkok.

PRACHBURNNARONG THAI

PM2.5; the killer

• Fine Particulate Matter with 2.5 micron diameters (size is smaller than human hair)

2016

Bangkok’s skyline yesterday morning: foggy air smog continues to blank the city.

The Nation

The Pollution Control Department’s safe standard for PM2.5 daily average level is 50 micrograms. According to the data, the PM2.5 level in Phayao province on Wednesday was 16.09 micrograms, while the country’s safe standard was at 50 micrograms. The phenomenon occurs every year during the change of seasons, as wind conditions transport pollution from the city and it accumulates over time until it reaches dangerous levels,” Thamrongnak said.

Source: http://aqicn.org/
Sources of PM2.5

SOURCE OF PM2.5 IN THAILAND (JAN - JUNE 2017)

- **Open Burning**: 54%
- **Industry**: 17%
- **Electricity Generating**: 9%
- **Transportation and Logistics**: 13%
- **Households**: 7%

Fine-grained Air Quality Monitoring

- Inadequate air quality station to report real-time air pollution (AQI, PM2.5, CO2, ...)
- One station for Lower Northern Thailand
- Station is very costly (Millions THB!)
- Use low cost micro sensor for fine grained measurement
- Village, School, Hospital, Household, National Park, Farm, etc.

Air Quality stations provided by Pollution Control Department (PCD), Thailand
STIC-ASIA: SEA-HAZEMON

LOW-COST REAL-TIME MONITORING OF HAZE AIR QUALITY DISASTERS IN RURAL COMMUNITIES IN THAILAND AND SOUTHEAST ASIA

2016

- Site surveys and preliminary work done by AIT’s master student demonstrating that out low-cost sensors can give reliable data.
- Designs of sensor nodes.
- AIT and UPMC — one research assistant from AIT will spend 3 months developing the SW for our Air Quality nodes.

- Project PI: Dr. Mongkol Ekpanyapong, intERLab/SET, AIT and Prof. Giovanni Pau, LIP6, UPMC, France
- Project Co-PI: Prof. Nguyen Thi Kim Oanh, SERD, AIT and Prof. Isabella Annesi-Maesano, INSERM, Paris, France
SEA-HAZEMON Platform (วัดฝุ่น.ไทย)

REAL TIME DATA COLLECTION

INTERNET

ANALYSIS

- Understanding of PM2.5 plume movement
- Formation + Disappearance of plume
- Prediction of PM2.5 concentrations

Low-Cost IoT Air Quality Sensor

www.hazemon.in.th

www.วัดฝุ่น.ไทย
Canarin: Low-Cost IoT Sensor Kits


Testing & Calibrating

Testing & Calibrating Sensor in Laboratory*

Reading consistency among different nodes

Calibrating with reference meters (PM, CO and CO2)

Testing & Calibrating Sensor in ambient environment

Co-location with Beta Ray Ambient Monitoring Station@ RamaIV Junction (Around August - November 2020)

*Environmental Engineering Department, KMUTT
IoT Community
IoT Community Model

- **Trainings**
- **Deployment**
- **Maintenance**

**Community Driven**
- Local Authorities (Forest Fire, Municipality)
- Villagers/ Volunteers

- **Forest Fire Notification**
- **Real-Time Air Quality Monitoring**
8 Air Quality Sensors and 1 Weather Station were deployed in Doi Chang Pa Pae, Lamphoon province, Thailand (900 - 1280 m above sea level).
Mae Ping Community

LoRa gateway

4 Directional IP Cameras

Kor Police Station

Long Range Communication
Low power consumption

Smoke Detected
Ban Tak Community

8 Micro-sensors
5 Micro-sensors + Computation
2 Weather Stations
GRAB Riders Community

• Assessing Daily PM2.5 Exposure Over a 7-Month Period (Nov 23 - May 24)
• Investigating Potential Adverse Effects of Long-Term Exposure

5 volunteers in BKK
5 volunteers in CMI
Expansion of “วัตถุฝุ่น.ไทย” “SEA-HAZEMON”

OPERATING SINCE 2016

8 COUNTRIES CONNECTED

200+ ACTIVE SENSORS

Forest Fire Area

Rural Area

Mobile Air Quality

Roadside

Vertical Measurement in city

Farming Area
On-Going Research

Forest Fire Detection and Real-Time Tracking
Developing Forest Fire Detection Model

Tak Province, THA - Jan - May 2021

2582 Hotspots
1917 km²

รายงานสรุป สถานการณ์ไฟป่าและหมอกควัน ปี 2564 โดยใช้เทคโนโลยีภูมิสารสนเทศ GISTDA2021

25 Air Quality Sensor nodes
PM1/2.5/10, CO, CO2, Humidity, Temperatue, Air Pressure

3 Weather Stations
Wind direction and Speed

1MS = แม่ฮ่องสอน
2TS = ไท่ลา
3MG = แม่กลอง
4PW = พระองค์
5MZ = มุ่งedio
6MT = เมืองยาง
7MW = มหาวัน
8PP = พบพระ

25 Air Quality Sensor nodes
PM1/2.5/10, CO, CO2, Humidity, Temperatue, Air Pressure

3 Weather Stations
Wind direction and Speed

intERLab
Internet Education and Research Laboratory

AIT
Identify Burned Periods and Factors

Study period: January May 2021

Geographical Distribution of Hotspots in Mae Sot from January to May 2021

Correlation between PM2.5 and CO levels recorded during Burn periods
Forest Fire Detection Model

Sensor sending data every ~1:45 min

PM2.5_{av} = \text{Average (PM2.5, T=15min)}

CO_{max} = \text{Maximum(CO, T=15min)}

Data Pre-Processing

PM2.5_{av} > 121.22

121.22 \Rightarrow PM2.5_{av} > 71.22

CO_{max} > 0

Burn (High)

Burn (Medium)

No Burn (Low)

Source: Lertsinsrubtavee A., Kanabkaew T., Raksakietisak S., “Detection of forest fires and pollutant plume dispersion using IoT air quality sensors”, Submitted to Environmental Monitoring and Assessment (under review)
Forest Fire Alert (5 April 2022)

Forest fire incident was found near by node 220 and 215 (less than 3 km)

Notified messages were sent to Forest Fire authority
Forest Fire Alert in 2023
22/02/23 9:00 - 13:00
**ActiveNDN: Fire Detection and Tracking**

"Winds have the capacity to disperse the PM2.5 plume across vast regions" Where is the source of the emission (Burning)?

- Executing the fire tracking algorithm by enabling nodes to collect information from one another.
- Validated results with hotspots FIRMS satellite images and ground inspections (post-burning - identified on 19 Feb).

Validated the results through site survey  *Credit to Prof. Kanchana Kanchanasut

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**PM2.5 : 18 Feb 5PM – 19 Feb 5PM**

<table>
<thead>
<tr>
<th>Time</th>
<th>Node Code</th>
<th>PM2.5</th>
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</thead>
<tbody>
<tr>
<td>2024-02-19 08:55</td>
<td>KP-176</td>
<td>315</td>
</tr>
<tr>
<td>2024-02-19 09:40</td>
<td>KP-200</td>
<td>427</td>
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<tr>
<td>2024-02-19 09:40</td>
<td>KP-286</td>
<td>212</td>
</tr>
<tr>
<td>2024-02-19 18:55</td>
<td>KP-176</td>
<td>345</td>
</tr>
</tbody>
</table>

**Found Hotspots**

- Burning source 18:55 19/02/2024
- Alerted at 8:55 19/02/2024

**MAP**

- SEA-HAZEMON
- 165
- 200
- 122
- 286
- 176

- Burning source 18:55 19/02/2024
- Alerted at 8:55 19/02/2024
- 2.9 km
Thank you

Q&A

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