ISGC2021: Joint DMCC, UND & Environmental Computing Workshop: Deeper Understanding of Natural Disasters 24~26 March 2021

Thailand's fires and smoke haze: current capabilities, lessons learned and needs

Veerachai Tanpipat

Hydro-Informatics Institute & Upper ASEAN Wildland Fire Special Research Unit

veerachai@hii.or.th & fforvrc@ku.ac.th

Contents

OVERVIEW

Fires and smoke haze become annual hazard for Thailand and the Upper ASEAN (or Lower Mekong River region) during the dry season of the region, particularly Norther Thailand and most part of the Lower Mekong River region (LMR).

The surface fire is a common fire type in Thailand and this region. Forest fires in Thailand and this region occur annually during the dry season from December to early May and with the most occurrences in March.

The forest fire situation in Upper ASEAN is more concerned to the people with increasing accessibility to information through rapid development of cyber-technologies.

OVERVIEW

The ASEAN transboundary haze has been ASEAN flagship tasks after 1997-98 El Nino since 1999. Lately, there was a goal of ASEAN Haze Free 2020 which was already passed, but we still have transboundary smoke haze problem annually. The problem will persist and continue as long as member states could not improve standard of living within their own countries.

Nevertheless, there are common fire causes in the Upper ASEAN which are agricultural land preparation, slash and burn agriculture (or shifted cultivation practice), and hunting. It is clear that those causes are all related to human's activities.

OVERVIEW

The lacking of the Science to Policy Makers (SOP) is also one of the main obstacles as delivering and communicating findings of forest fire, open burning and smoke haze studies and researches to policy makers are very crucial. SOP is very important and needed as usually those high level officers and politicians do not understand the scientific facts clearly. The lacking utilization of suitable and effective fundamental existing knowledge of fire and smoke haze science including tools and advanced technologies based on scientific proves as the part of Control, Management and Planning (strengthen Science-Policy Interface – SPI) is still there. Policy makers do not usually ask, so there is a need to create an effective mechanism to deliver messages to them. When they are creating any policy or have any discussion they have the right information and fact to cope with their decision process.

From AFoCO's Forest Fire Management Training Course's discussions among AFoCO's member states in 2019 and 2020

Myanmar's causes from Country Reports

1. Charcoal, firewood utilization
2. Slash and burn agricultural practice
3. Agricultural land preparation of cash mono-crop agriculture practice by burning and fires escape
4. Hunting
5. New grass shoot for Cattle

Needs: There are no projects related to community-based forest fire management in Myanmar. But the Forest Department carries out forest fire management for five years after establishment of forest plantations (mostly teak plantation) and special cases for the needs of prevention.

From AFoCO's Forest Fire Management Training Course's discussions among AFoCO's member states in 2019 and 2020

Lao PDR's causes from Country Reports

1. The slash and burn or shifting cultivation practice,
2. Land clearance for plantation project.
3. Agricultural land preparation of cash mono-crop agriculture practice by burning and fires escape
4. Hunting

Needs: Need more clear purposes of Community-based Fire Management. There are many international projects in the country, but most of them are not linked. The need of having forest fire control and management by government agencies is also needed.

From AFoCO's Forest Fire Management Training Course's discussions among AFoCO's member states in 2019 and 2020

Vietnam's causes from Country Reports

1. Agricultural land preparation burning fields
2. Harvesting honey
3. Carelessness

Needed: Better fire control and management and improving international collaboration to improve those.

From AFoCO's Forest Fire Management Training Course's discussions among AFoCO's member states in 2019 and 2020

Cambodia's causes from Country Reports

1. Slash and burn agriculture or shifted cultivation practice
2. Carelessness of local people
3. Resin collection
4. Land grazing for new grass shoot for cattle
5. Land clearing on concessions or social land concessions
6. Loggers use fire to clear roads and to clear the land after harvesting
7. Hunting
8. New settlement in forest area

Needed: a formal forest fire control and management agency and community-based fire management.

From AFoCO's Forest Fire Management Training Course's discussions among AFoCO's member states in 2019 and 2020

Thailand's causes from Country Reports

1. Gathering of forest non-timber products, 2. Agricultural land preparation,
3. Political conflict, 4. Hunting, 5. Timber, 6. Cattle grazing,
7. Agricultural land expansion and 8. Carelessness.

Needed: a combination of community-based fire and water management.

There are common causes in the region which are 1. agricultural land preparation, 2. slash and burn agriculture (or shifted cultivation practice), and 3. hunting.

7 Steps-of Forest Fire & Smoke Haze Control and Management

1. Prevention and Communication
2. Monitoring
3. Prediction, Forecasting and Modeling
4. Warning
5. Response
6. Recovery and Mitigation
7. After Action Review, Assessment, Identify ad/disad, ways out and Improvement

Main AF Information & Data Sources 1

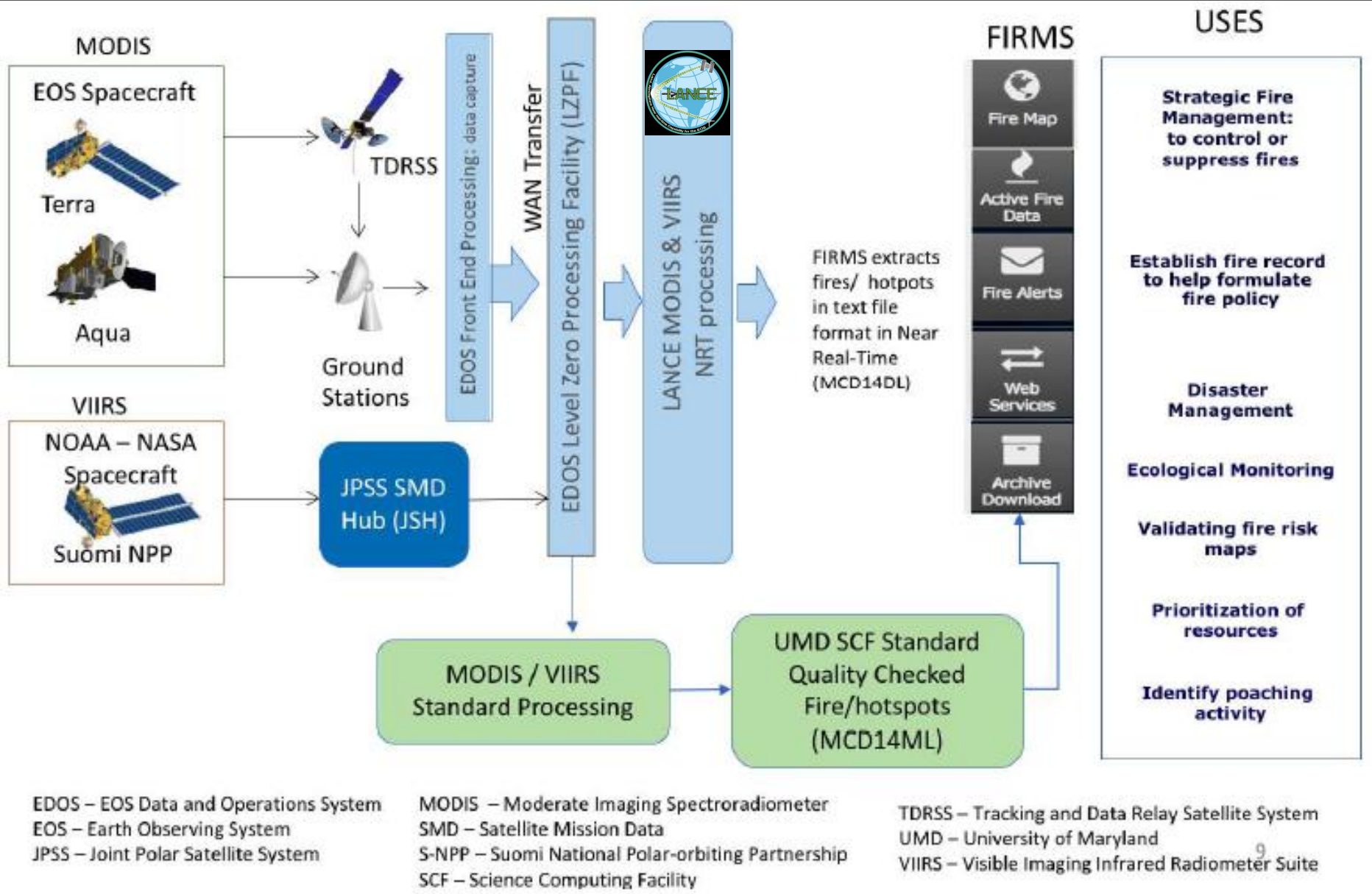
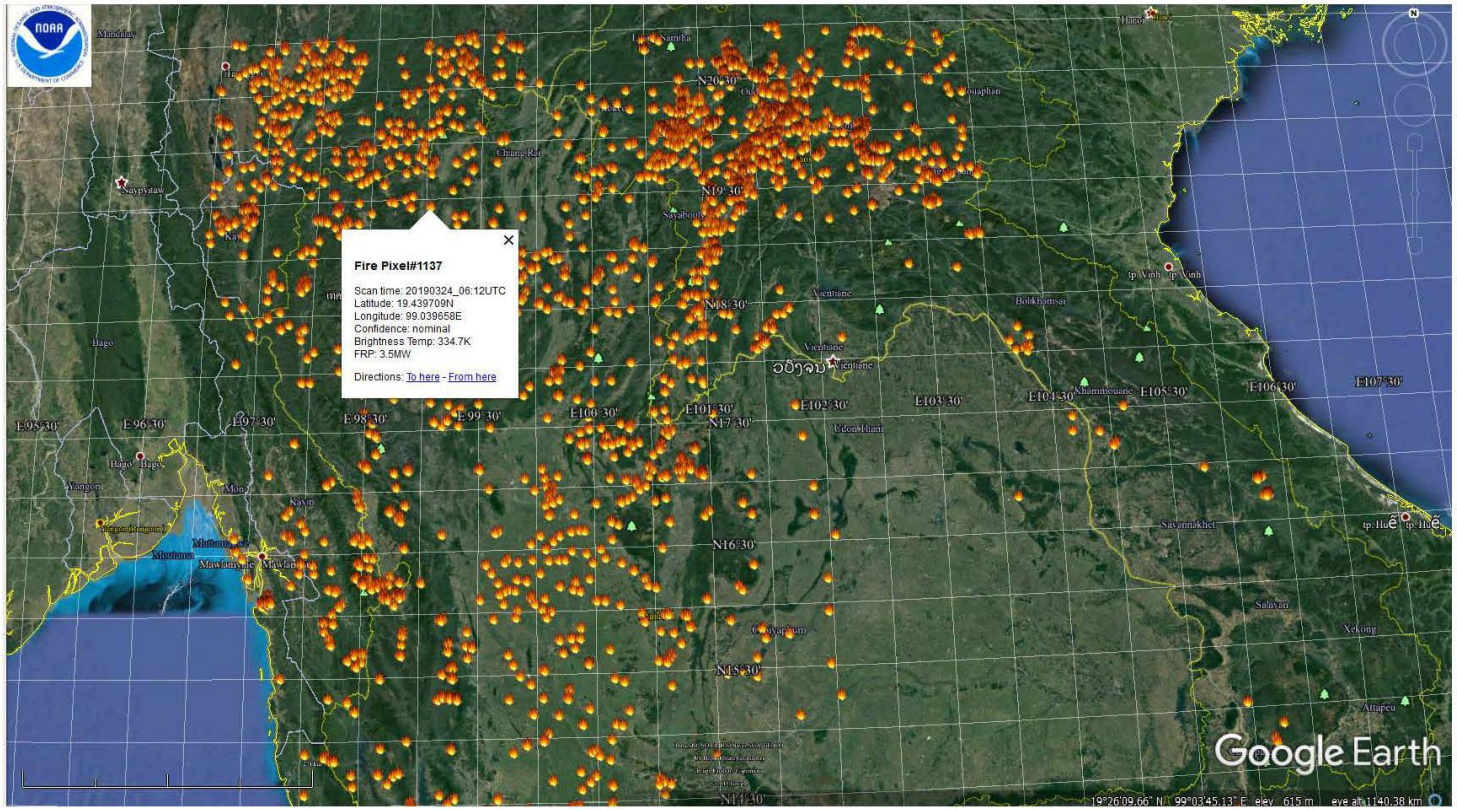


Figure 10: Overview of NASA's Fire Information for Resource Management System.

Source: Draft of Active Fire by the Global Observation of Forest Cover/Global Observation of Landcover Dynamics (GOFC/GOLD) Fire Programme, March 2019.

Main AF Information & Data Sources 2

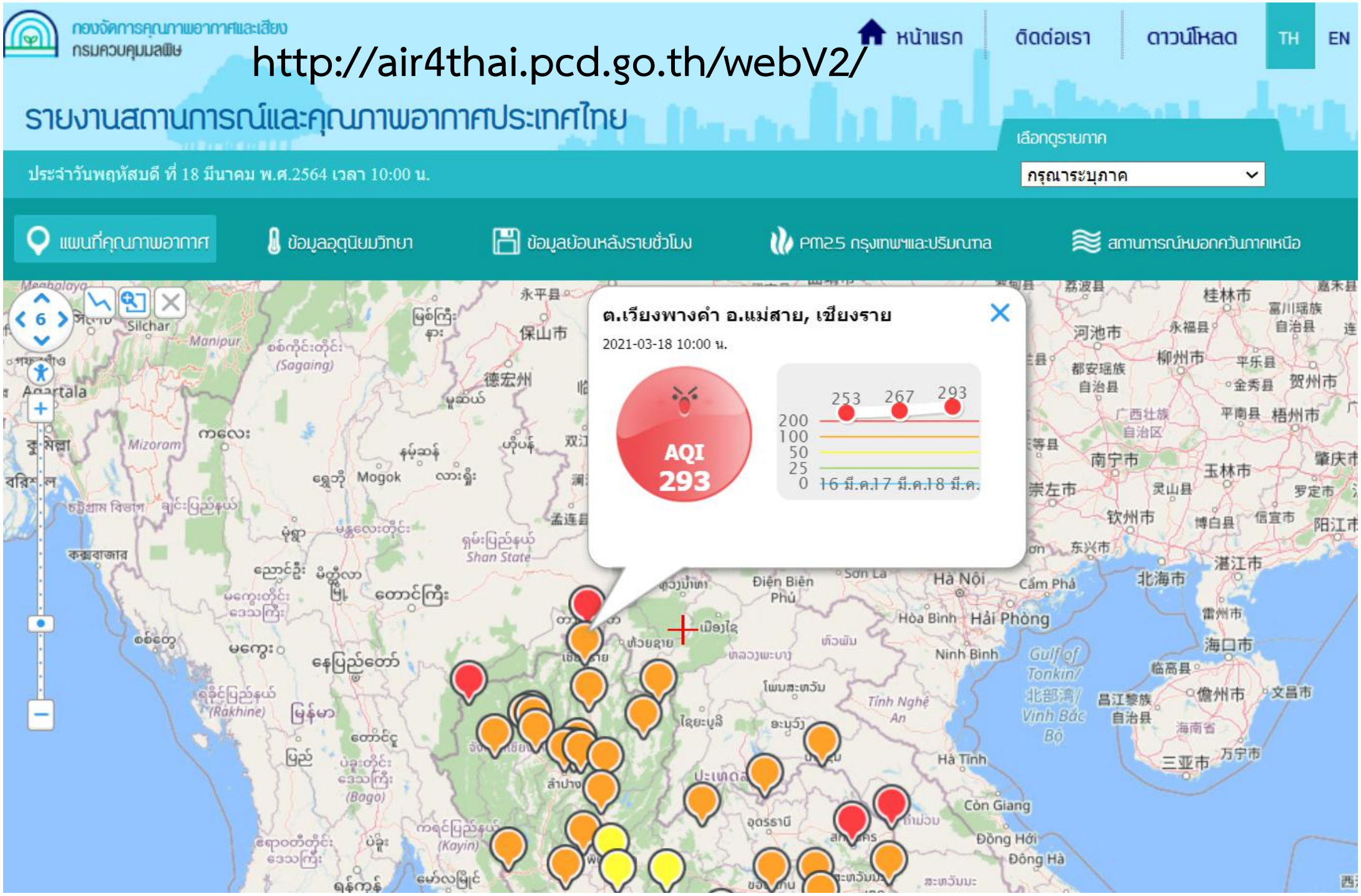
NOAA-National Environmental Satellite, Data, and Information Service, NESDIS (https://www.nesdis.noaa.gov/)

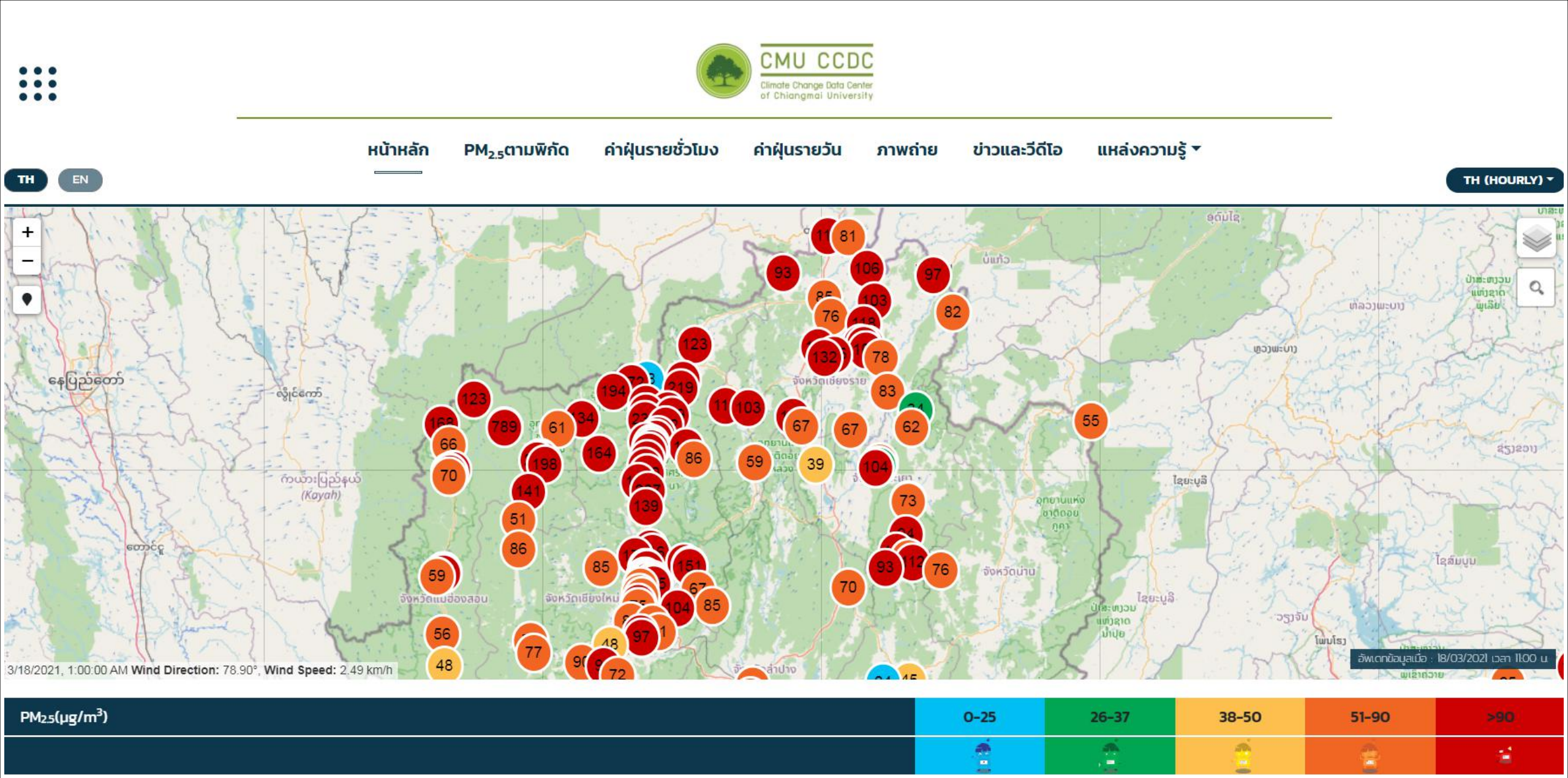


Reduce latency time from NASA 3 hrs to 1 hr or so for both **Suomi-NPP and NOAA-20** as Dr. Wilfrid Schroeder is the PI of Global VIIRS Active Fire Products began 14 Mar 19

Dr. Wilfrid Schroeder (wilfrid.schroeder@noaa.gov)
Dr. Davida Streett (davida.streett@noaa.gov)

ftp://ftp.star.nesdis.noaa.gov/pub/smcd/emb/fire/VIIRS/

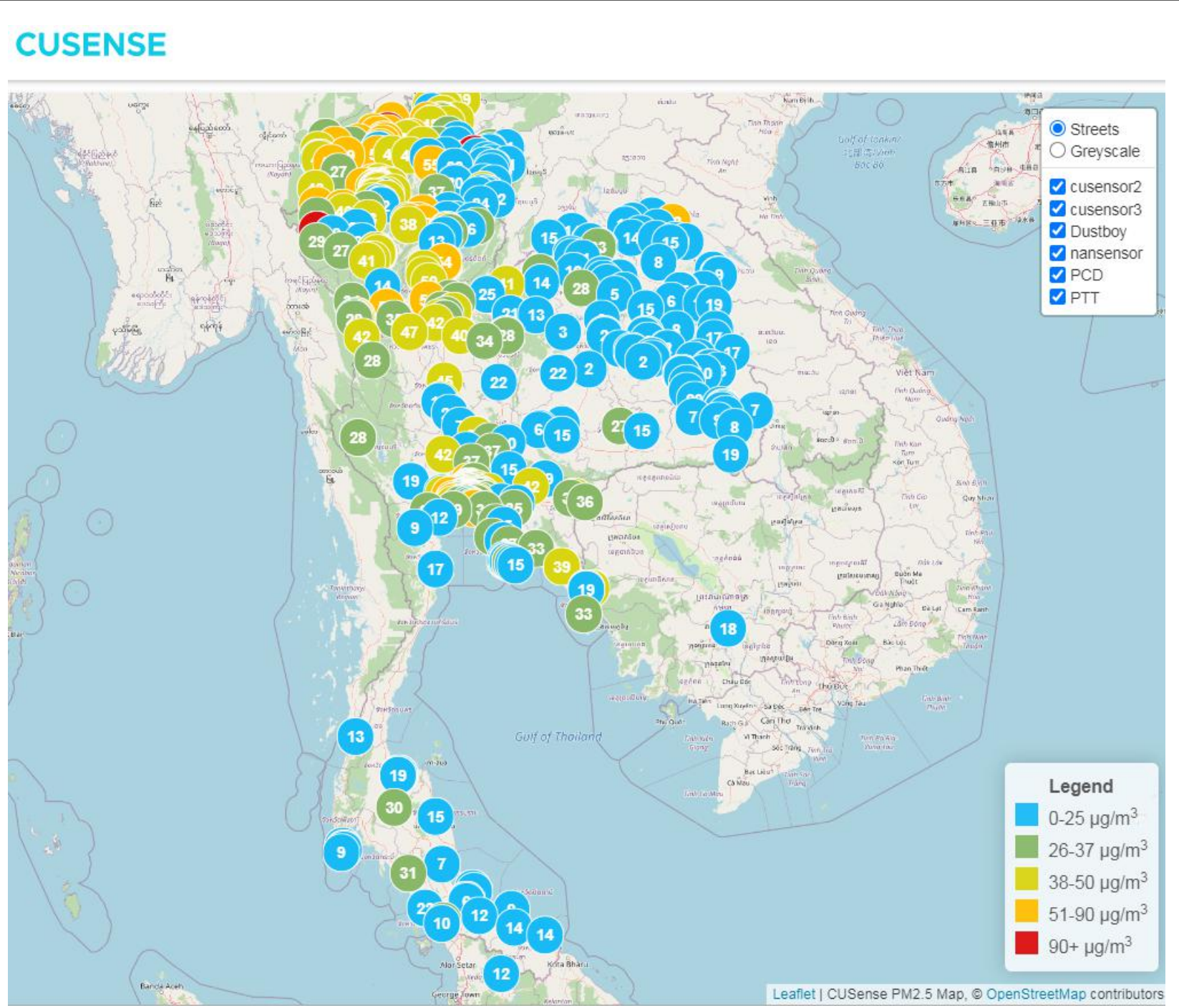

กองจัดการคุณภาพอากาศและเสียง
กรมควบคุมมลพิษ
http://air4thai.pcd.go.th/webV2/
หน้าแรก
ติดต่อเรา
ดาวน์โหลด
TH
EN
รายงานสถานการณ์และคุณภาพอากาศประเทศไทย
เลือกดูรายภาค
กรุณาระบุภาค
ประจำวันพฤหัสบดี ที่ 18 มีนาคม พ.ศ.2564 เวลา 10:00 น.
แผนที่คุณภาพอากาศ
ข้อมูลอุตุนิยมวิทยา
ข้อมูลย้อนหลังรายชั่วโมง
PM2.5 กรุงเทพฯและปริมณฑล
สถานการณ์หมอกควันภาคเหนือ
ต.เวียงพางคำ อ.แม่สาย, เชียงราย
2021-03-18 10:00 น.
AQI
293
253
267
293
200
100
50
25
0
16 มี.ค.
17 มี.ค.
18 มี.ค.

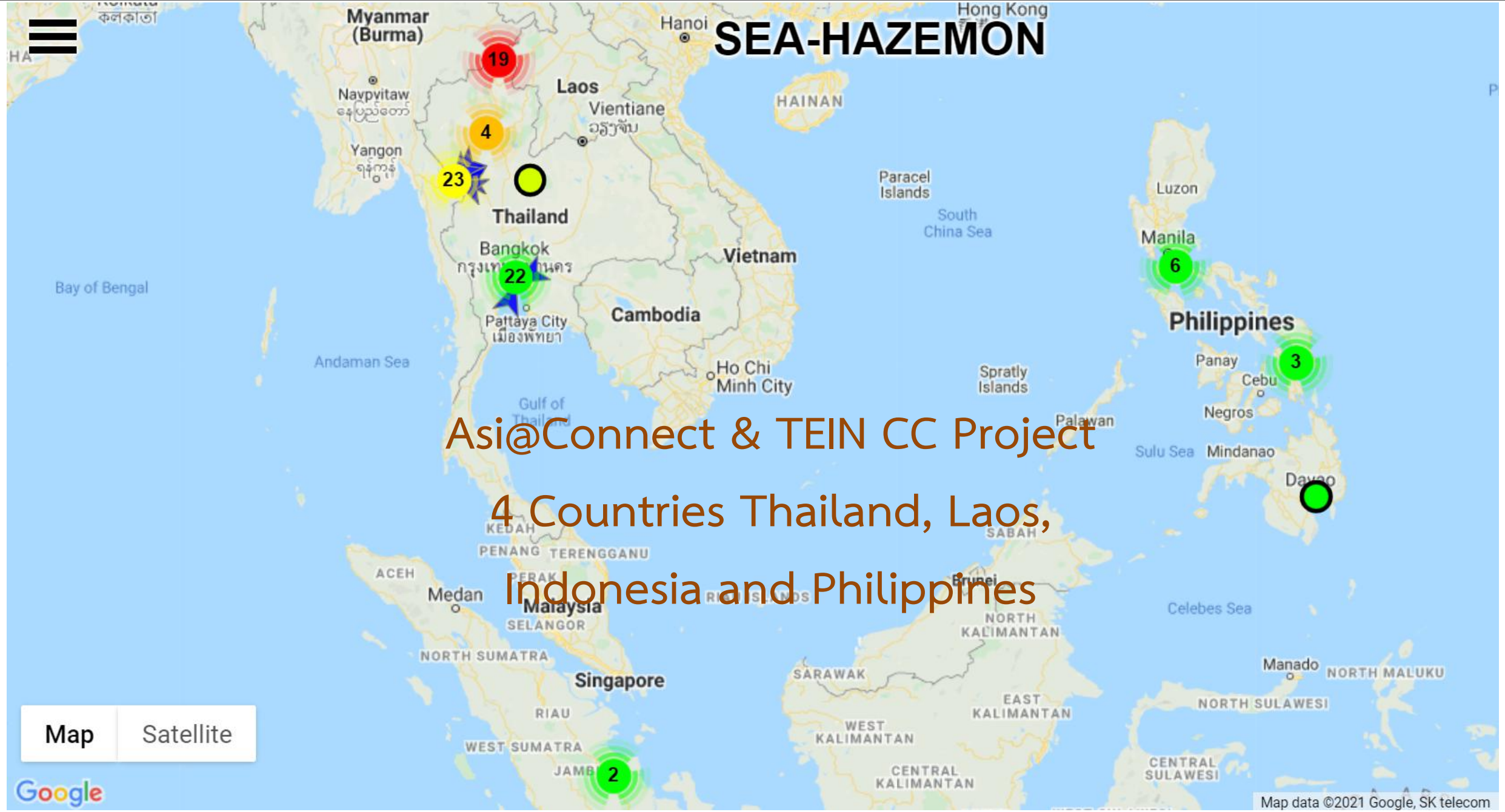


https://www.cmuccdc.org/

After the 19th March 2021 National Meeting at PCD, a test combination webpage was created from 6 air quality measurement sources.

https://cusense.net/map



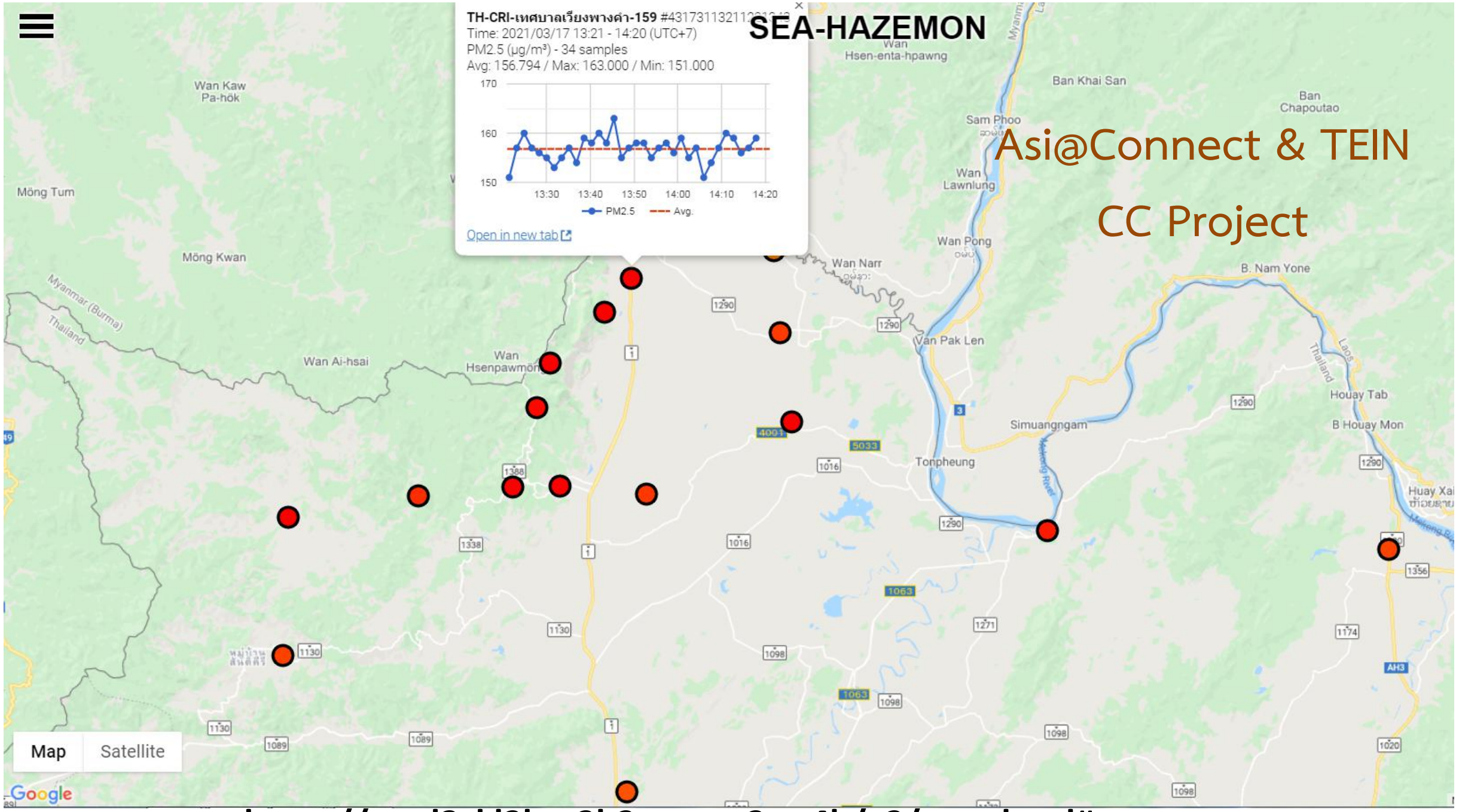


Asi@Connect & TEIN CC Project

4 Countries Thailand, Laos,

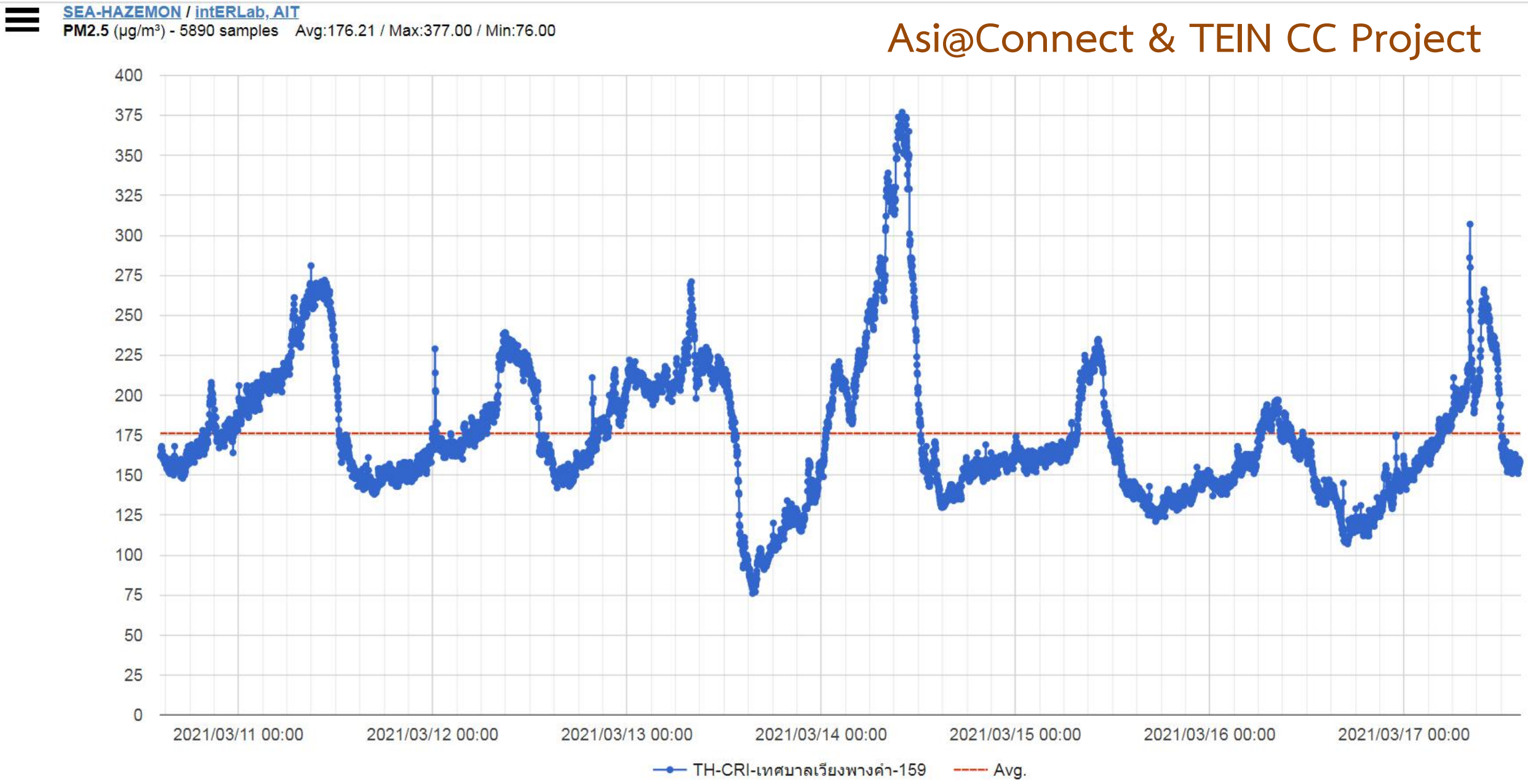
Indonesia and Philippines

https://xn--l3ckl2byc3b2g.xn--o3cw4h/v2/map.html#

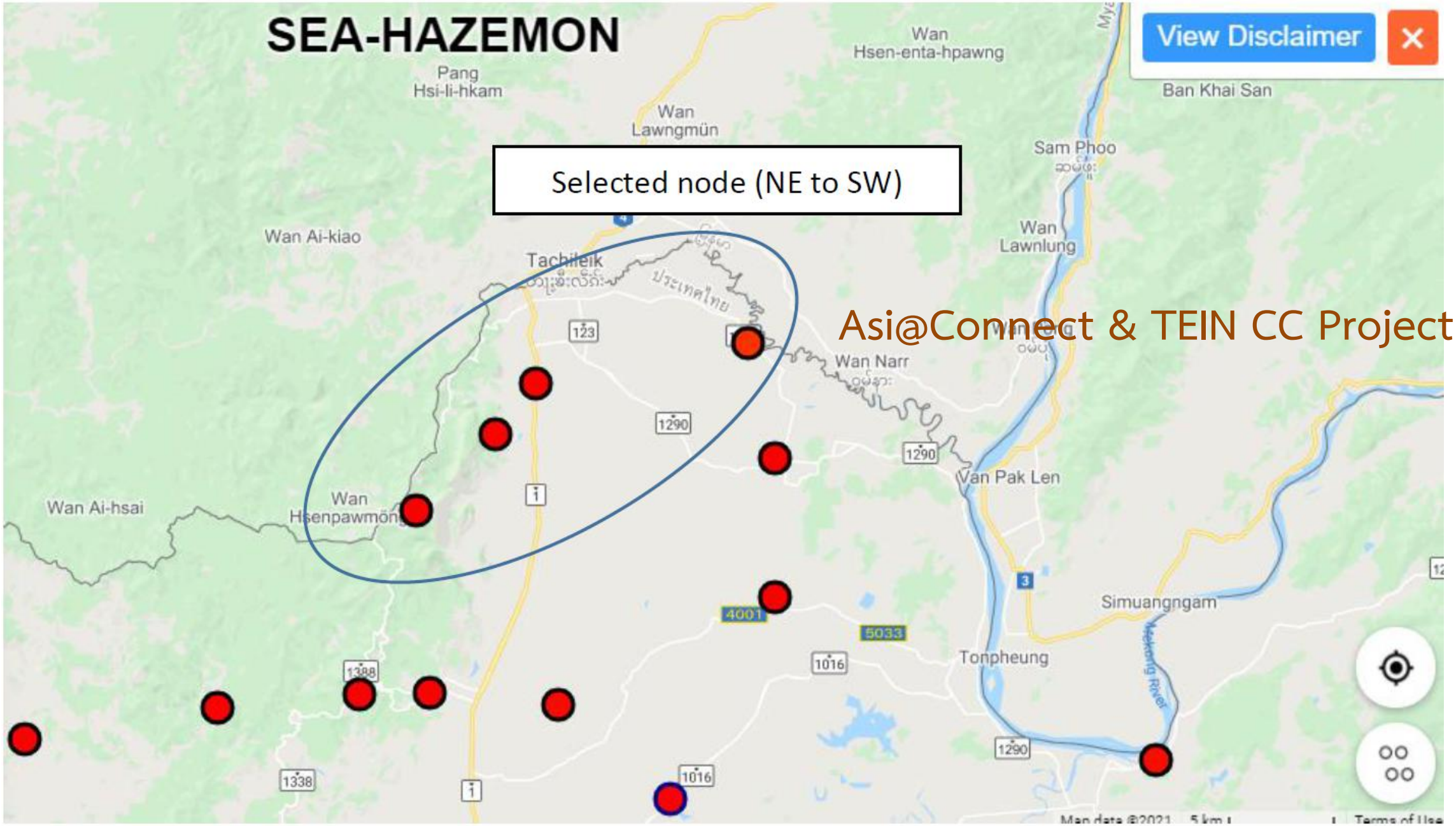


https://xn--l3ckl2byc3b2g.xn--o3cw4h/v2/map.html#

Asi@Connect & TEIN CC Project



https://xn--l3ckl2byc3b2g.xn--o3cw4h/v2/map.html#

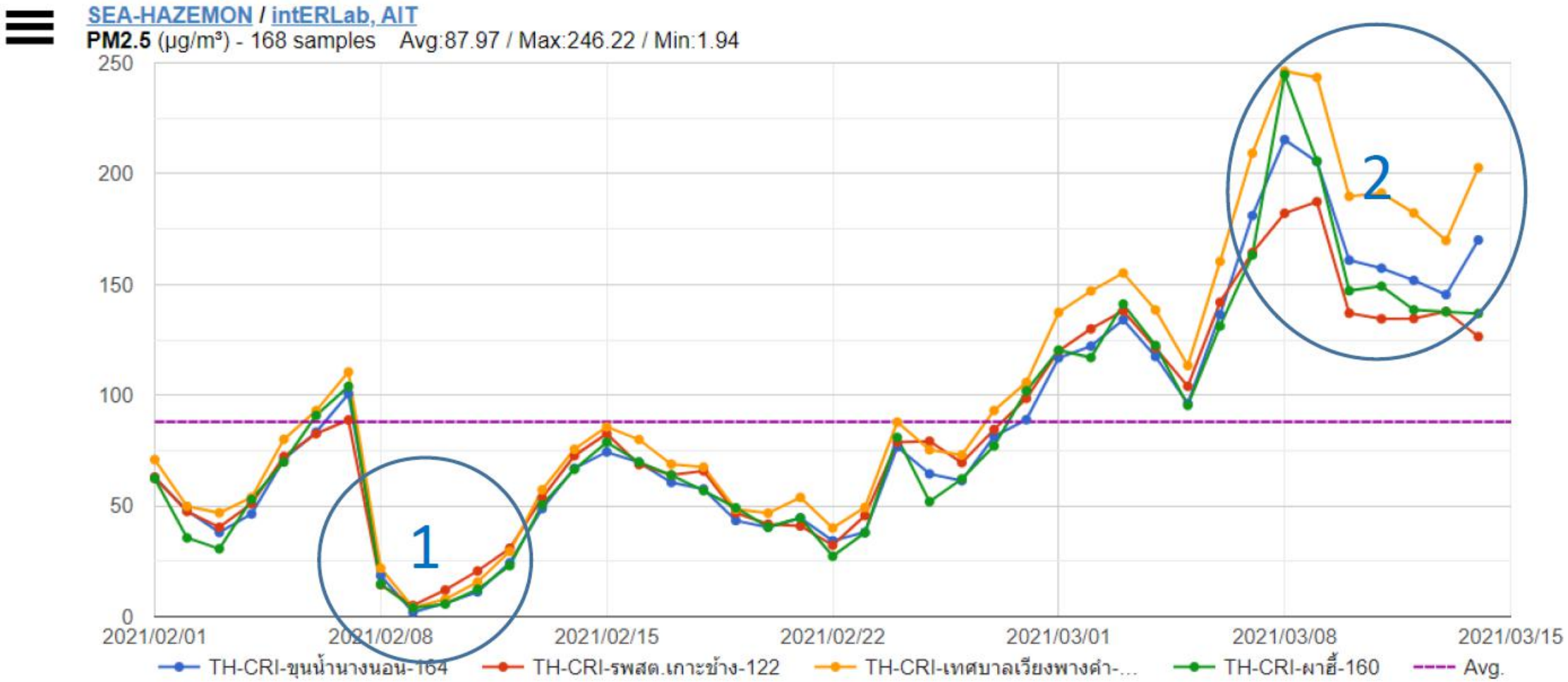


https://xn--l3ckl2byc3b2g.xn--o3cw4h/v2/map.html#

Thongchai Kanabkaew, 2021

Two separated episode were drawn for (1) low and similar values of PM2.5 and (2) high and different values of PM2.5 among 4 nodes.

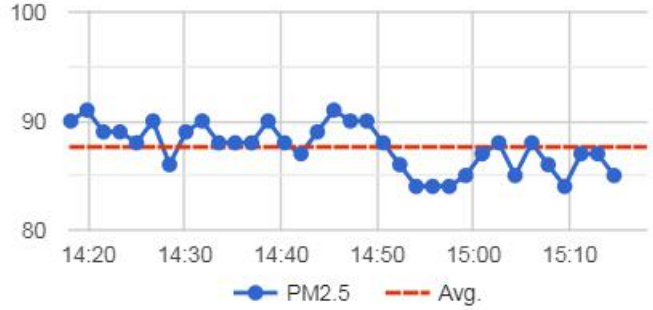
Asi@Connect & TEIN CC Project



https://xn--l3ckl2byc3b2g.xn--o3cw4h/v2/map.html#

Thongchai Kanabkaew, 2021

TH-CRI-เทศบาลเวียงพางคำ-159 #43173113211221343
Time: 2021/03/22 14:18 - 15:17 (UTC+7)
PM2.5 (µg/m³) - 34 samples
Avg: 87.618 / Max: 91.000 / Min: 84.000



วัดฝุ่น.ไทย

https://www.ecowitt.net/home/index?id=23387

THUM LUANG
Reported 49 seconds ago

Indoor
Temperature 31.2 ℃ (↑ 31.2 ℃ ↓ 25.2 ℃)
Humidity 54 %

Solar and UVI
Quarter Moon
Solar 16.8K (↑ 70.4K lx)
UVI 1 (↑ 5)
Sun Rise Today 6:22 AM
Sun Set Today 6:32 PM

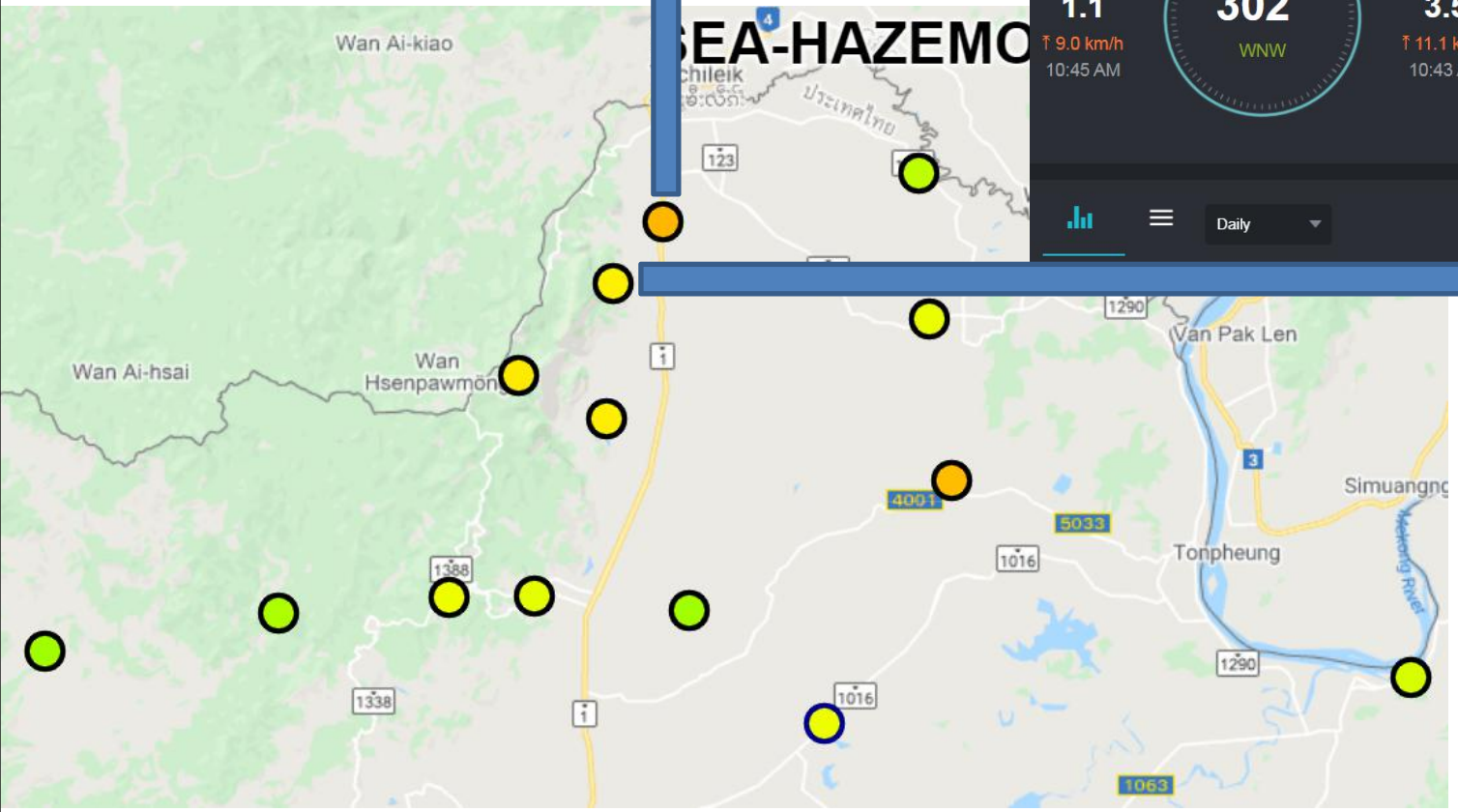
Rainfall
Rain Rate /hr 0.0
Daily 10.7
Event 10.7 mm
Hourly 0.0 mm
Weekly 10.7 mm
Monthly 10.7 mm

Wind
Wind 1.1 (↑ 9.0 km/h) 10:45 AM
302 ° WNW
Gust 3.5 (↑ 11.1 km/h) 10:43 AM

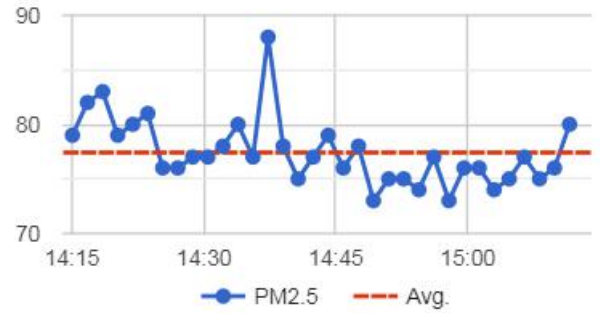
Pressure
Relative 1008.0 (↑ 1012.7 hPa ↓ 1005.7 hPa)
Absolute 961.1 (↑ 965.8 hPa ↓ 958.8 hPa)

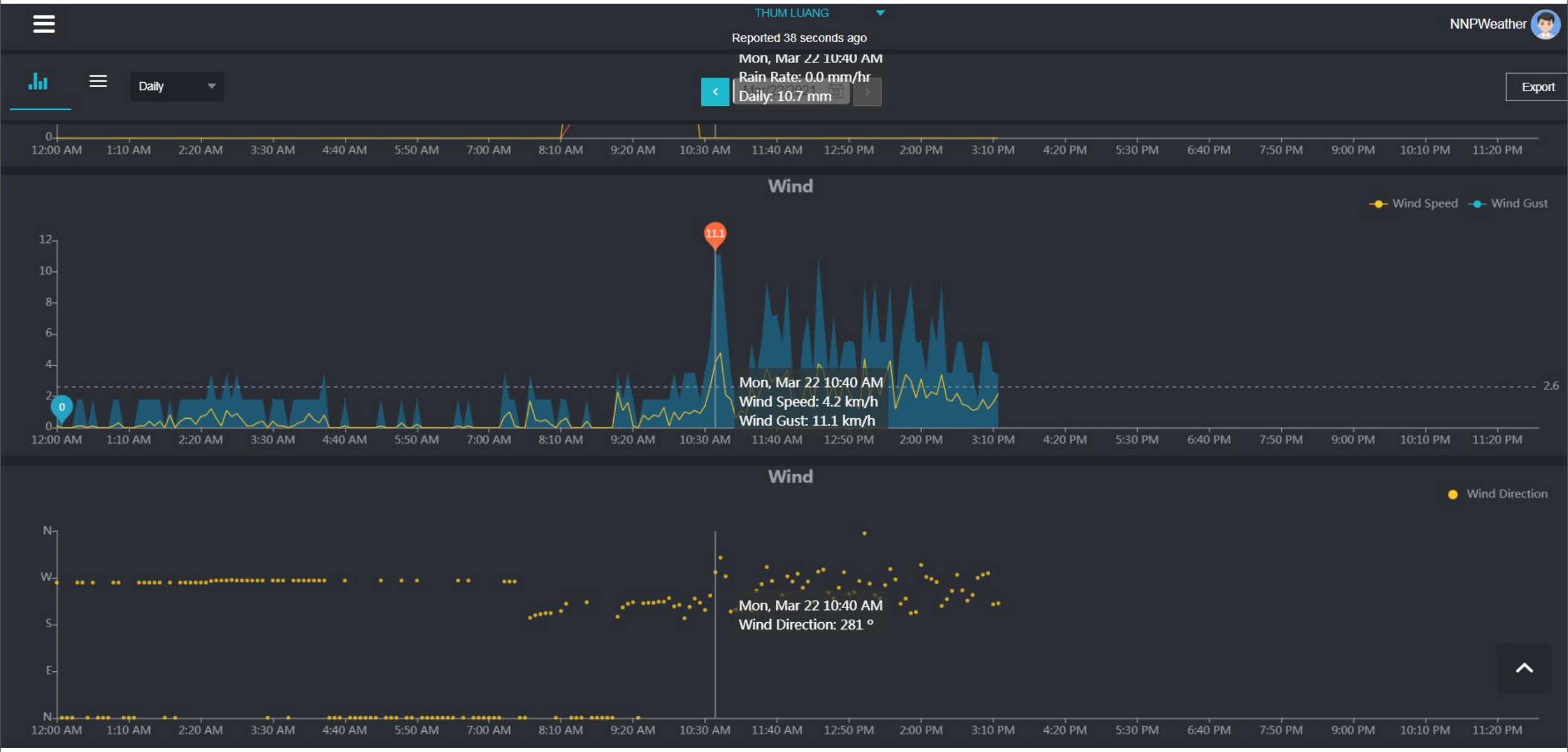
Outdoor
Temperature 31.4 ℃ (↑ 32.3 ℃ ↓ 21.6 ℃)
Humidity 57%
Feels Like 34.9 ℃
Dew Point 21.9 ℃

Daily
Mar/22/2021



TH-CRI-ขุนน้ำนางนอน-164 #43173113217213343
Time: 2021/03/22 14:14 - 15:13 (UTC+7)
PM2.5 (µg/m³) - 34 samples
Avg: 77.412 / Max: 88.000 / Min: 73.000





https://www.ecowitt.net/home/index?id=23387

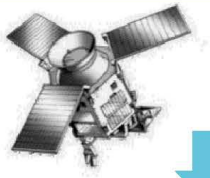
http://atmosphere.copernicus.eu/

CAMS Services

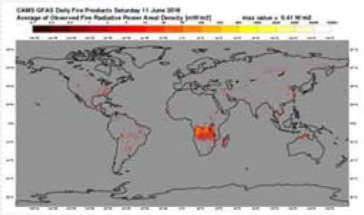
FULL – FREE – OPEN DATA

Atmosphere Monitoring

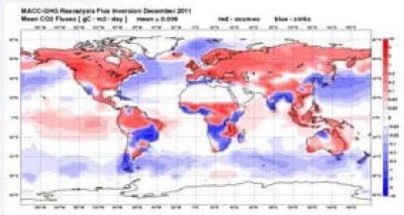
Space Agencies



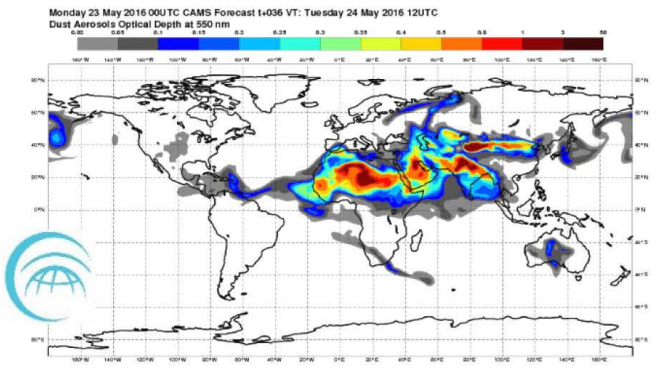
In situ observations



Fire emissions

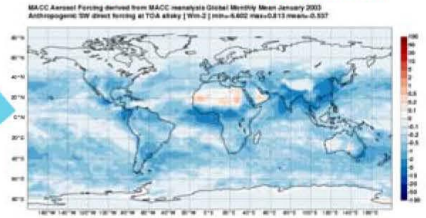


GHG fluxes

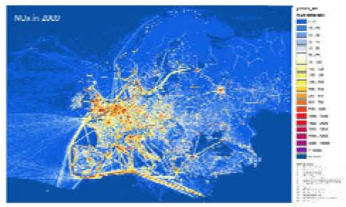


Global

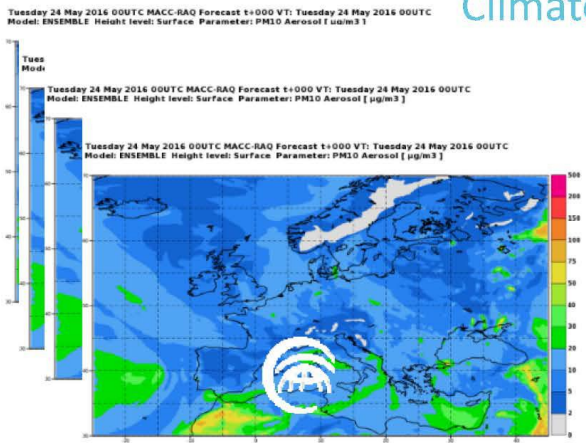
Solar radiation



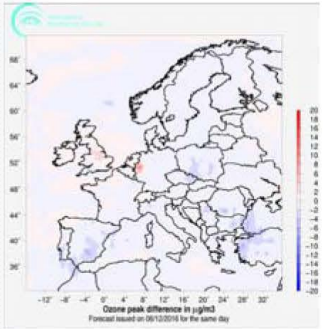
Climate forcing



Anthropogenic emissions



Policy



Regional

ECMWF Copernicus Europe's eyes on Earth

European Commission

WFSRU

An on going collaboration among Royal Forest Department, Office of Information Technology Administration for Educational Development (UniNet), Upper ASEAN Wildland Fire Special Research Unit, Forestry Research Center, Faculty of Forestry, Kasetsart University, Webster University Thailand and Chulalongkorn University

Source: http://wildlandfire.thairen.net.th/

Fire Emissions In Upper SEA

Home Parameters About US Contact US

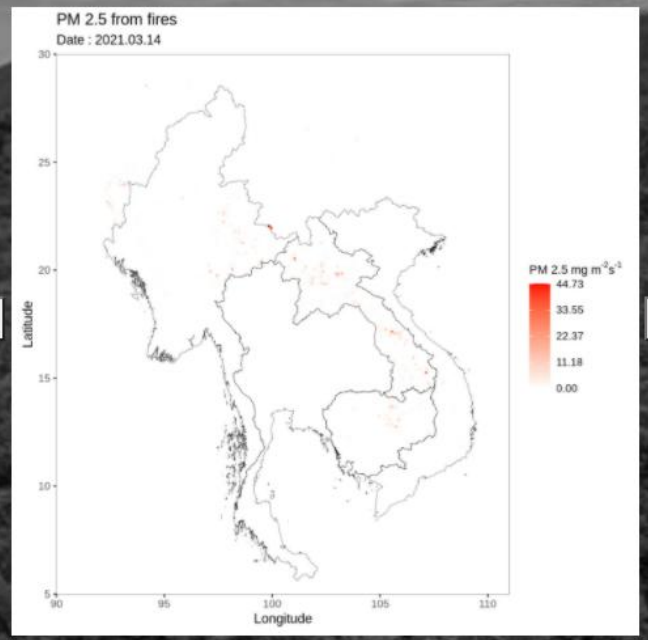
Upper South East Asia Wildfire Flux PM 2.5 Level

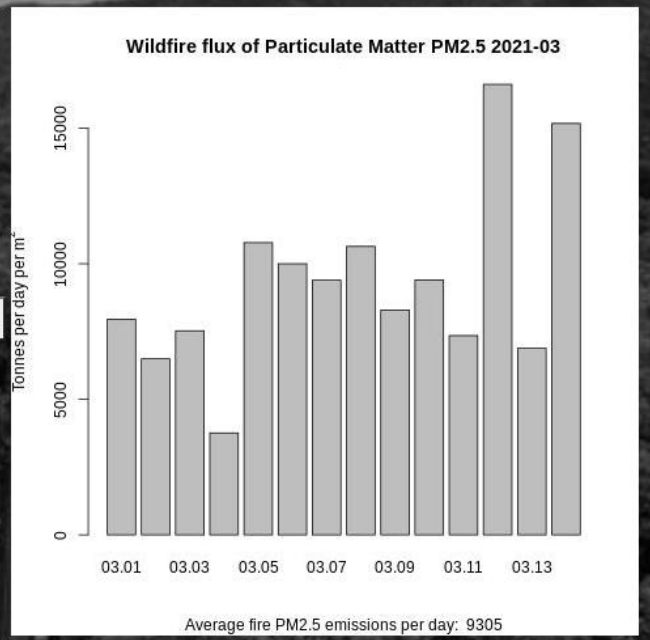
What is PM 2.5?

Enter the date: 03/14/2021

Select a country

Fire Radiative Power

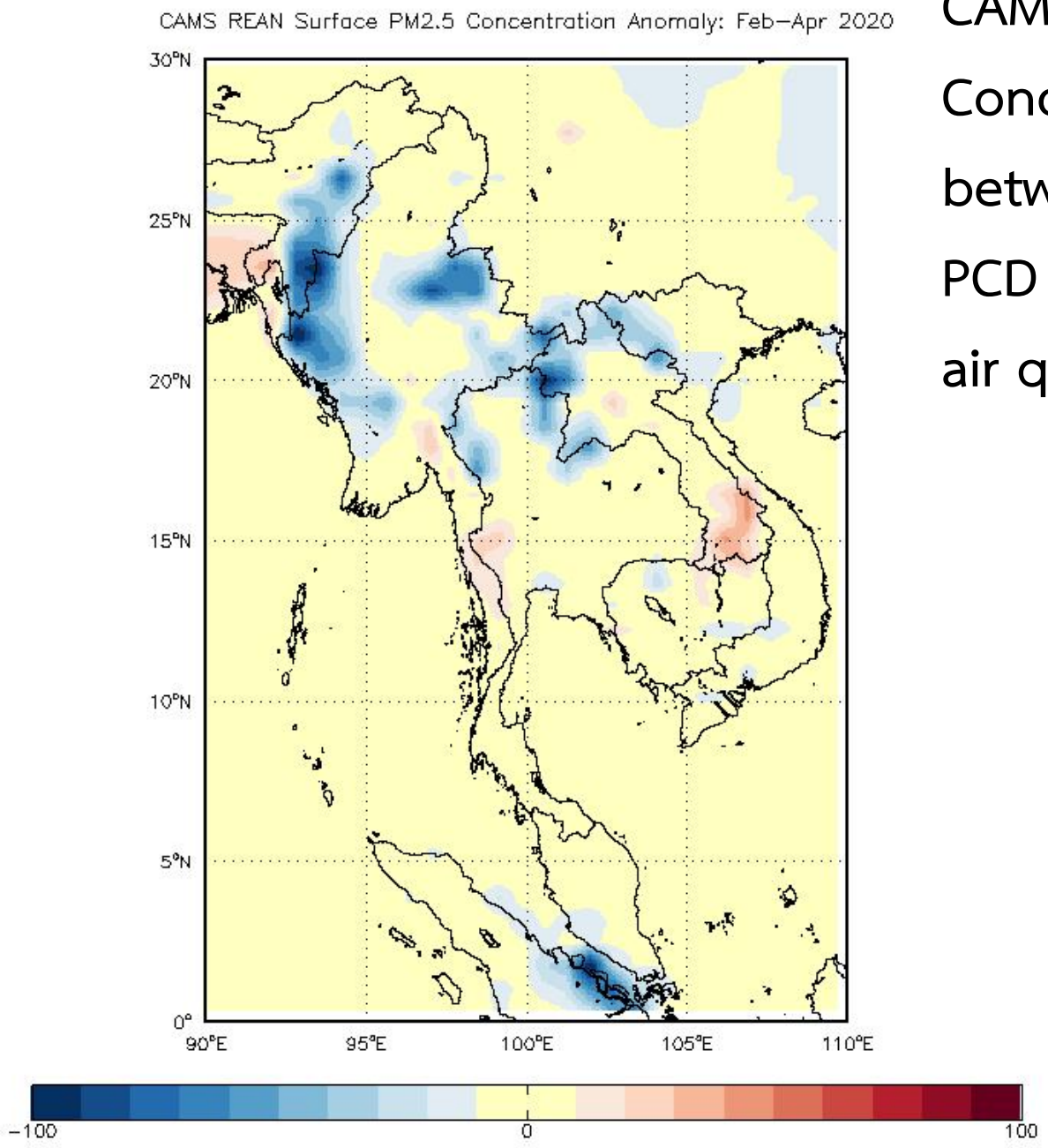




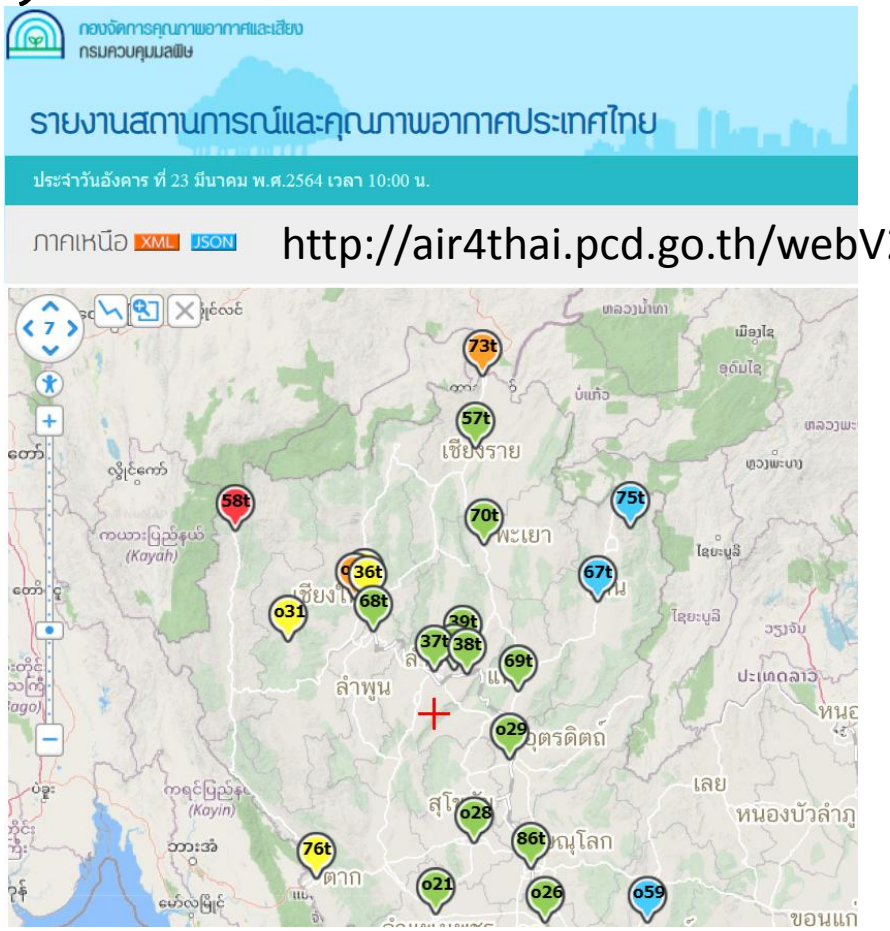
Mobile App for both IOS and Android will be developed by th end of 2021

Data are 3 days latency.

Source: http://wildlandfire.thairen.net.th/pm2.5.html



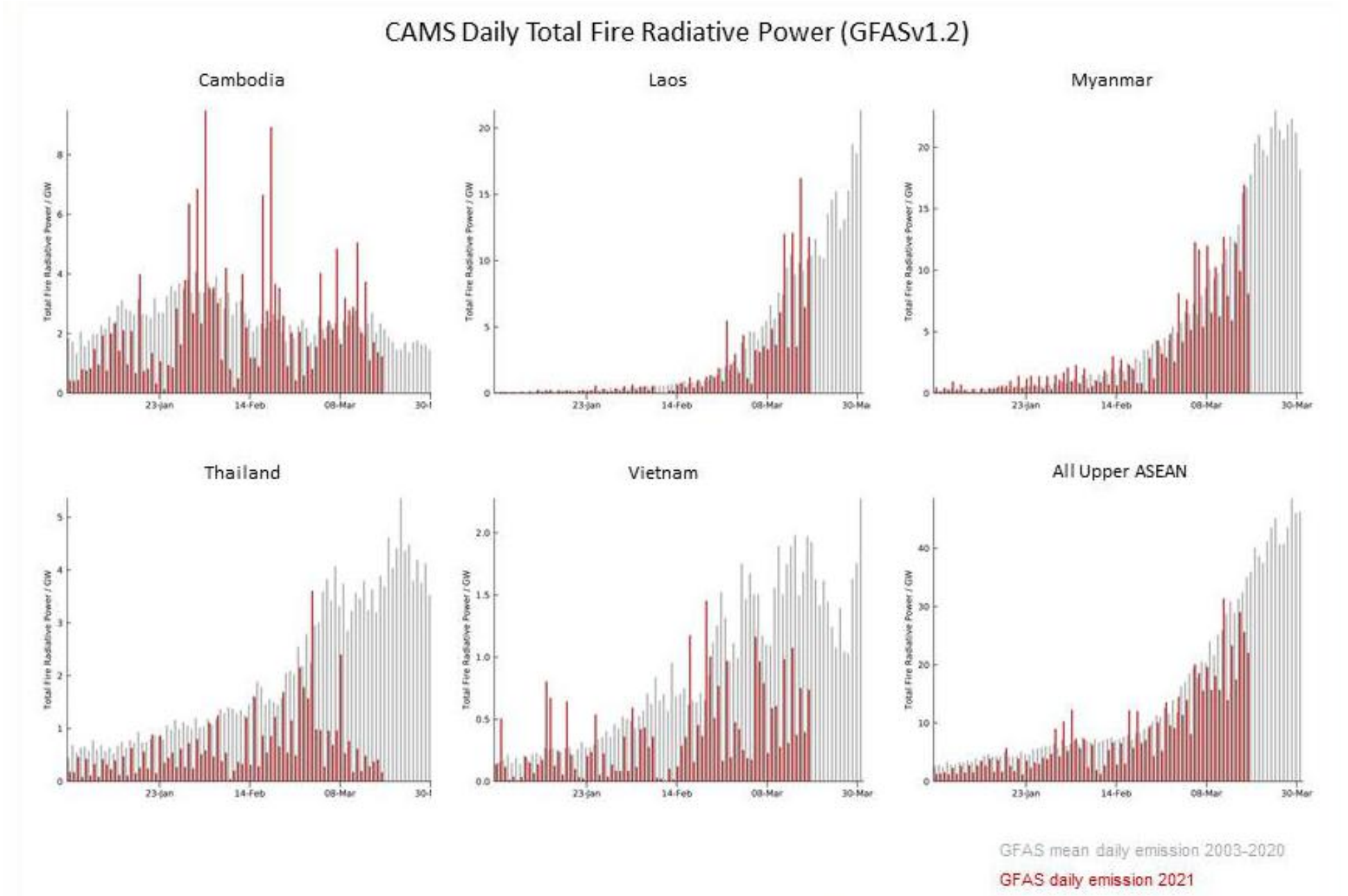
CAMS REAN (Reanalysis Data) Surface PM 2.5 Concentration Anomaly of Thailand Validation between Dr. Mark Parrington CAMS-ECMWF and PCD using PCD's field mesurement data from 11 air quality measurement stations



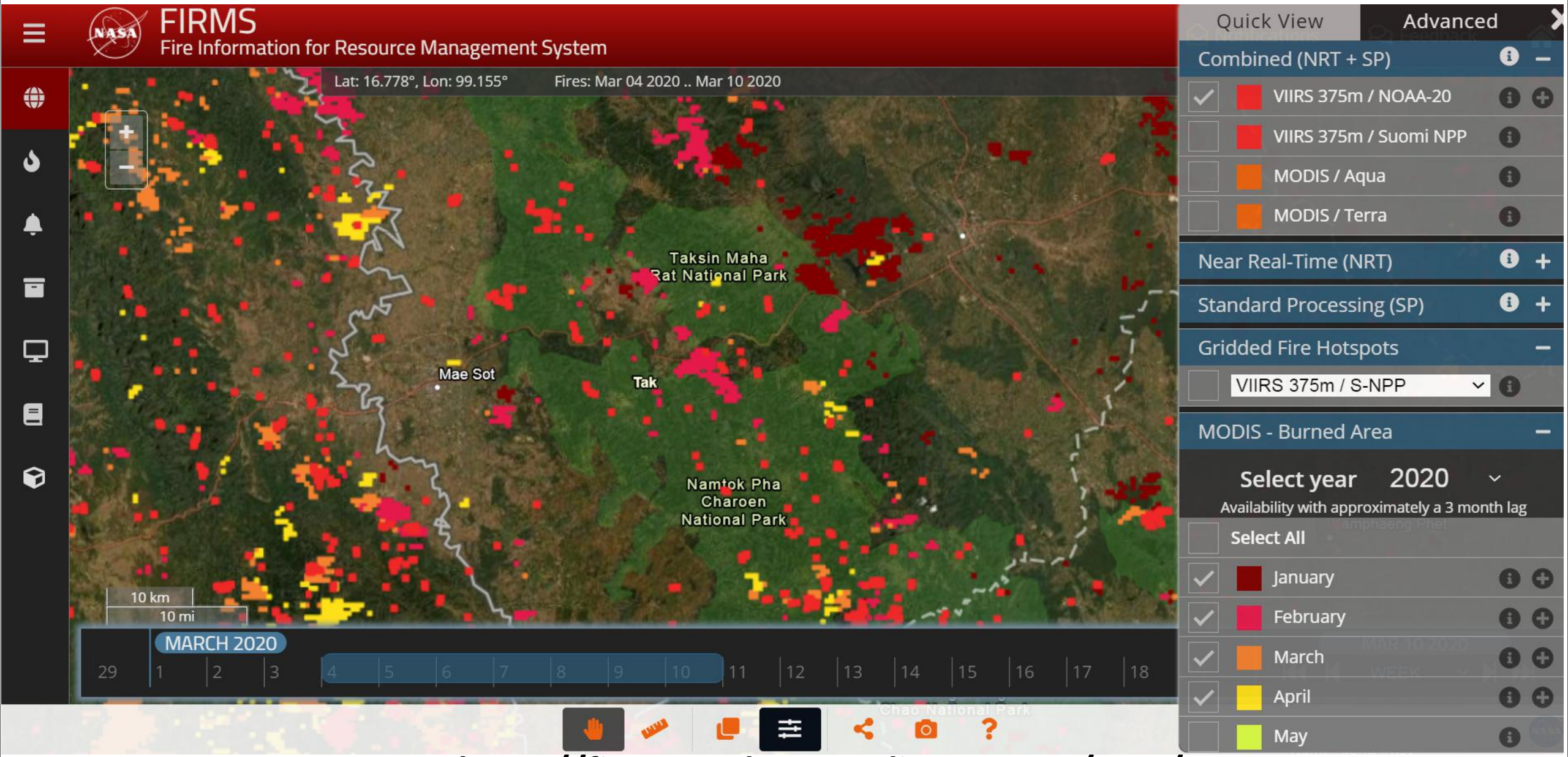
By Dr. Mark Parrington, CAMS-ECMWF

At

18 March 2021

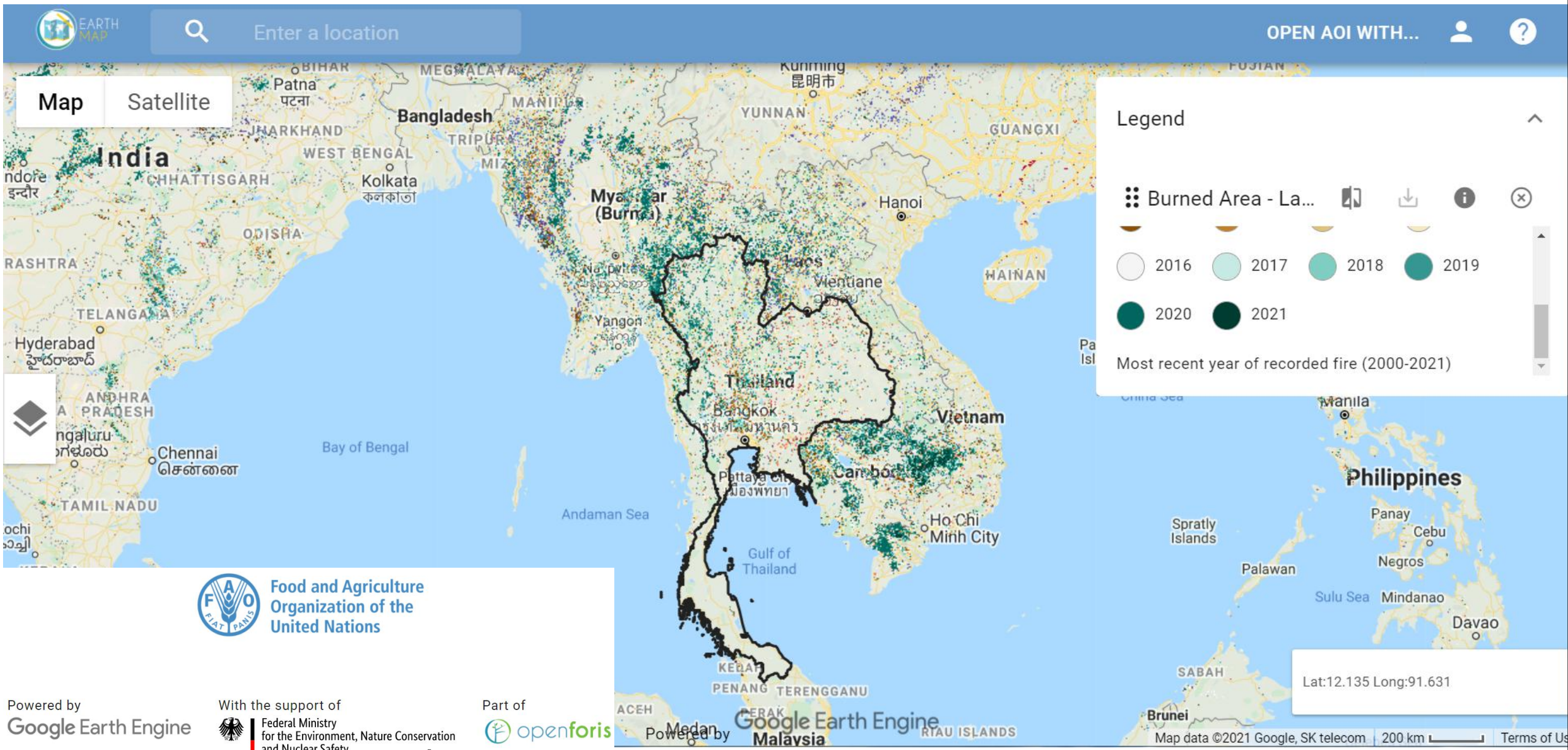


Both Hotspot and Burned Areas Information together



Source: https://firms.modaps.eosdis.nasa.gov/map/

MODIS Burned Areas Info by Earth Map FAO



Food and Agriculture Organization of the United Nations

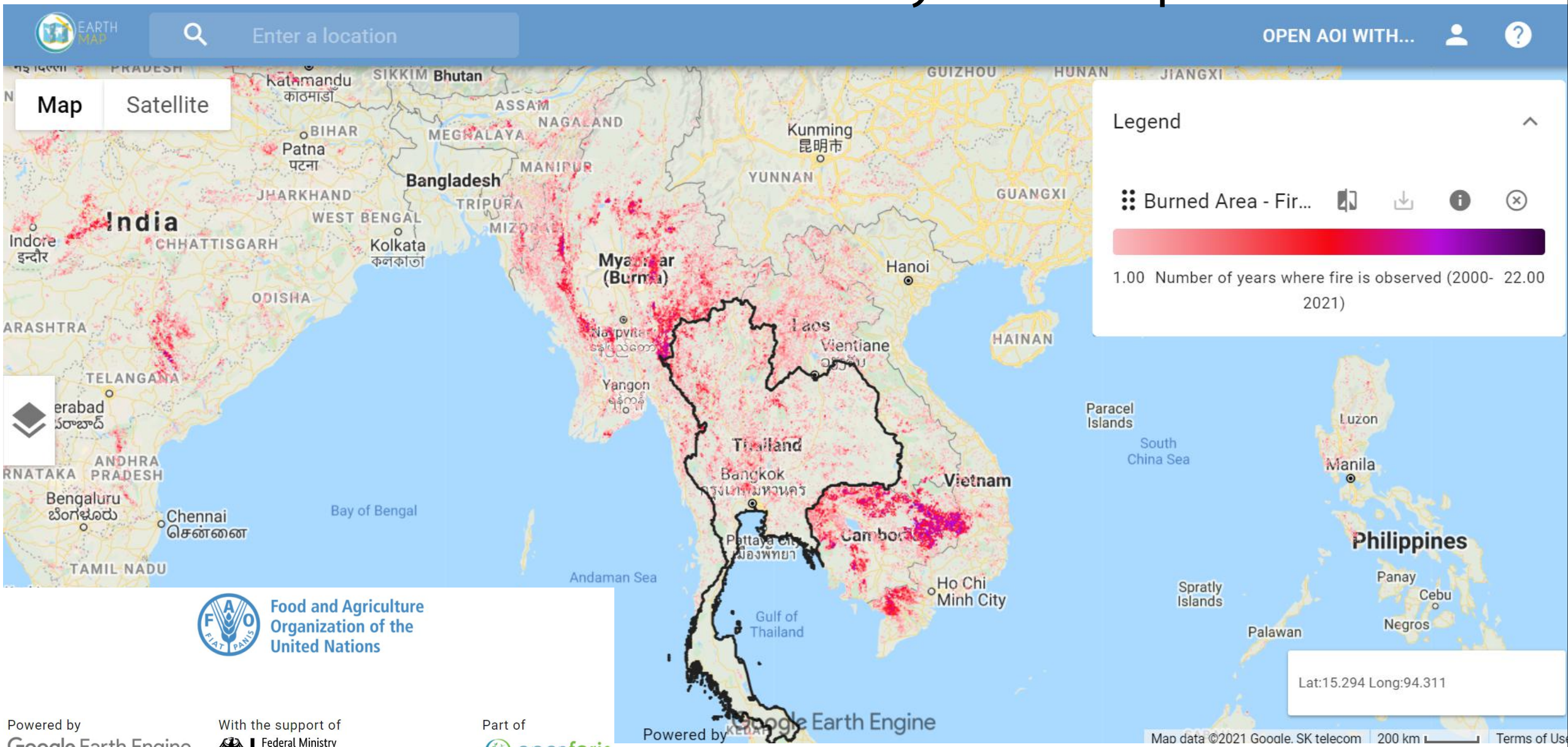
Powered by Google Earth Engine

With the support of Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Part of openforis

earthmap.org

MODIS Burned Areas Info by Earth Map FAO



Food and Agriculture Organization of the United Nations

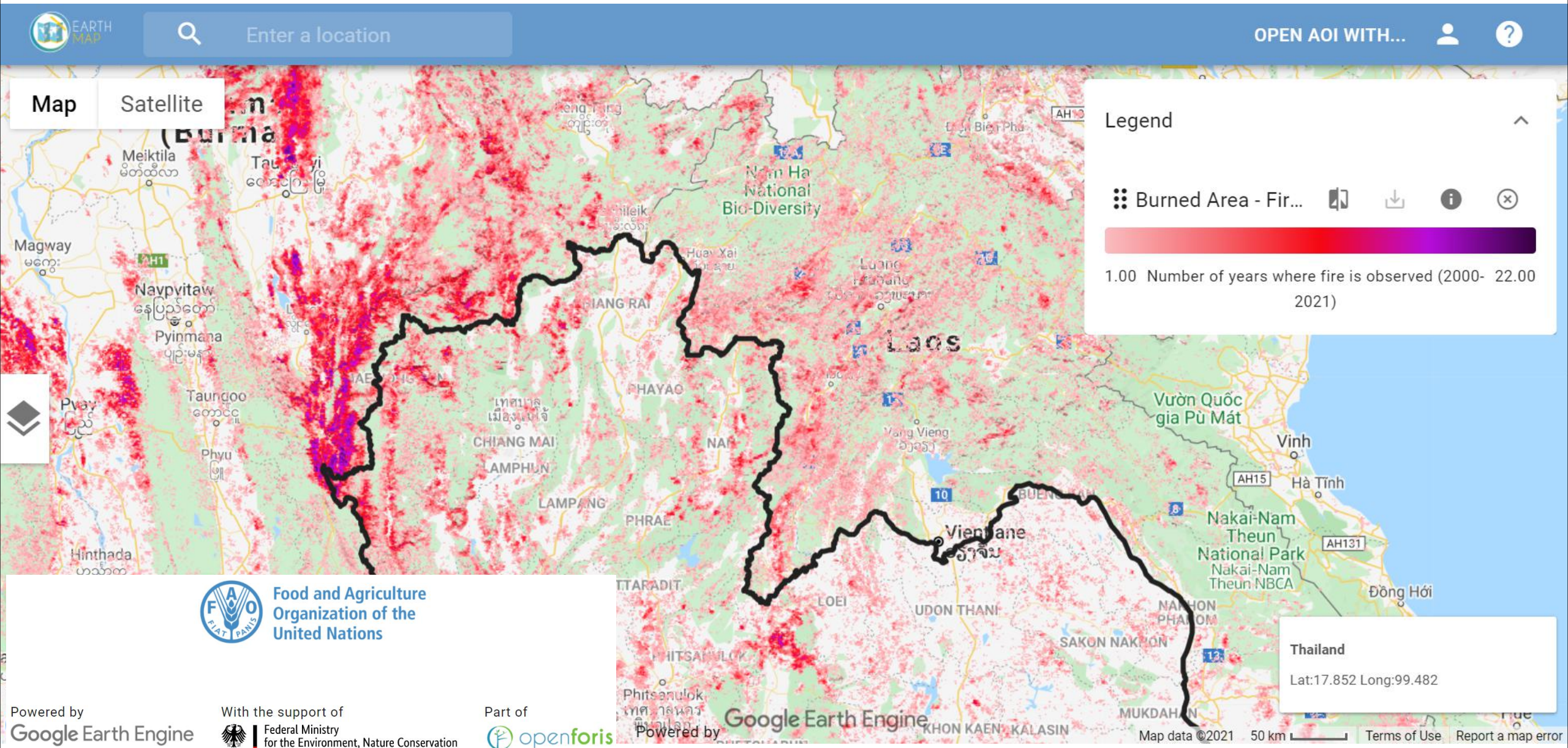
Powered by Google Earth Engine

With the support of Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Part of openforis

earthmap.org

MODIS Burned Areas Info by Earth Map FAO



Food and Agriculture Organization of the United Nations

Powered by Google Earth Engine

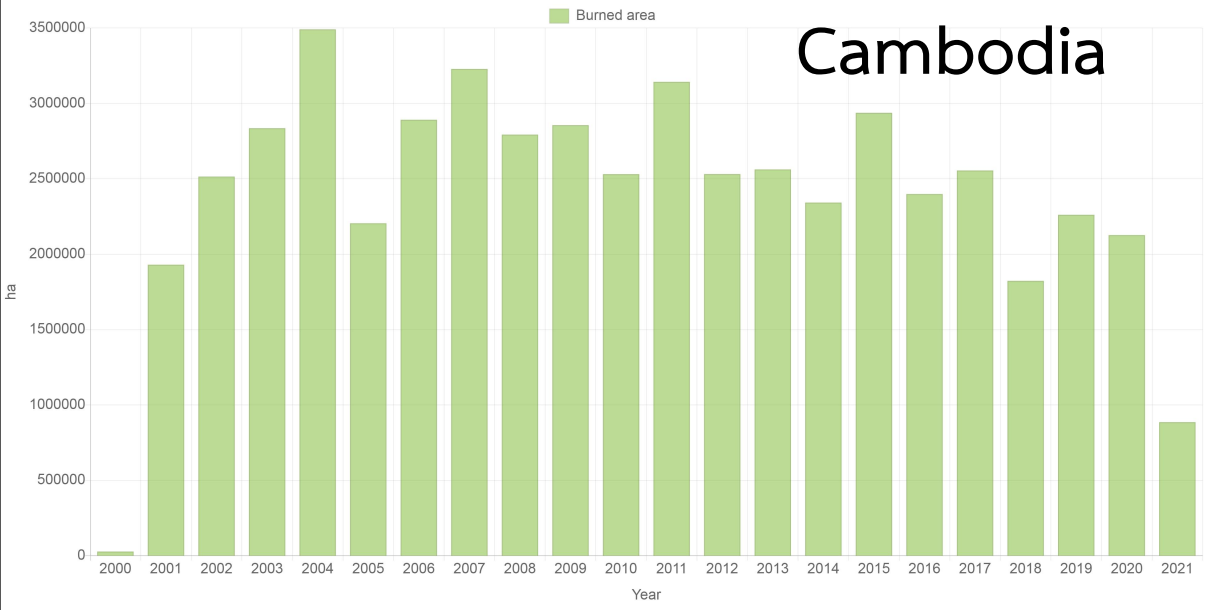
With the support of Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Part of openforis

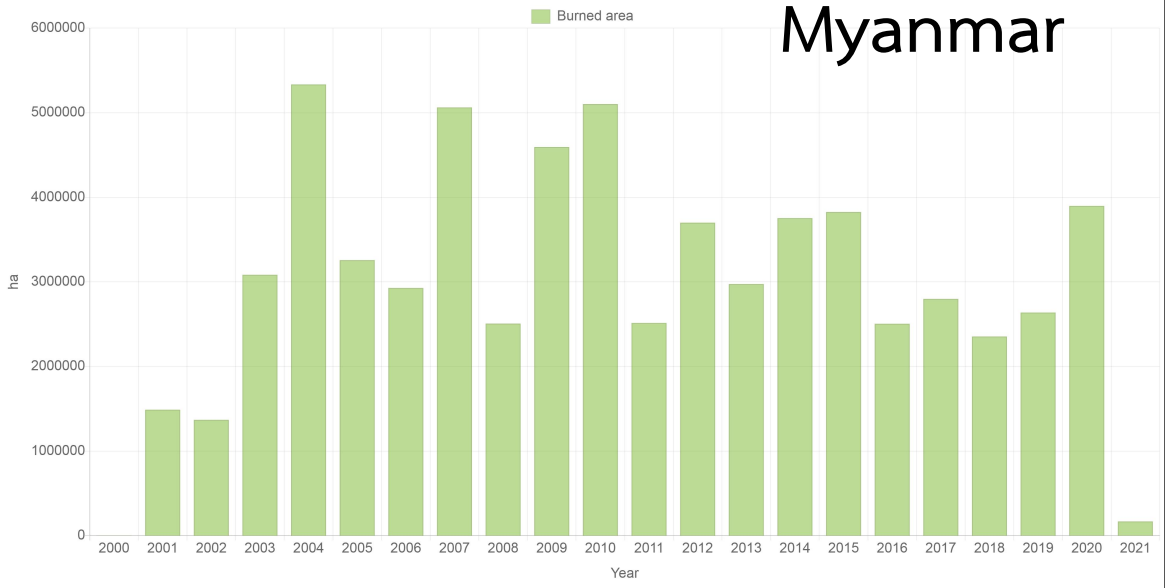
earthmap.org

MODIS Burned Areas Info by Earth Map FAO

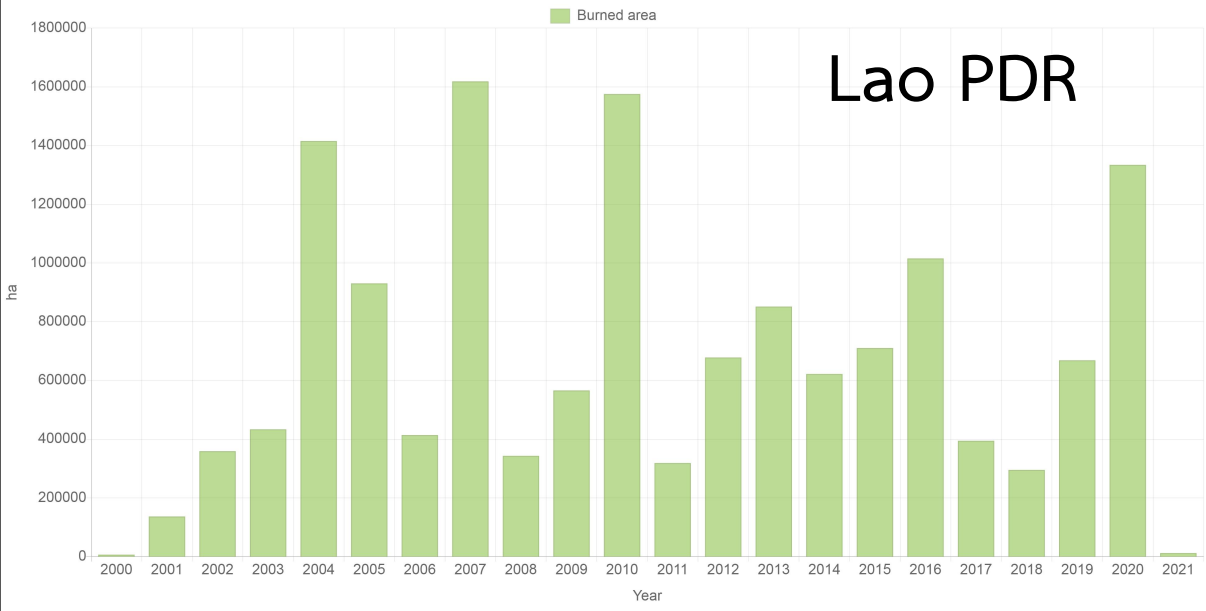
Cambodia



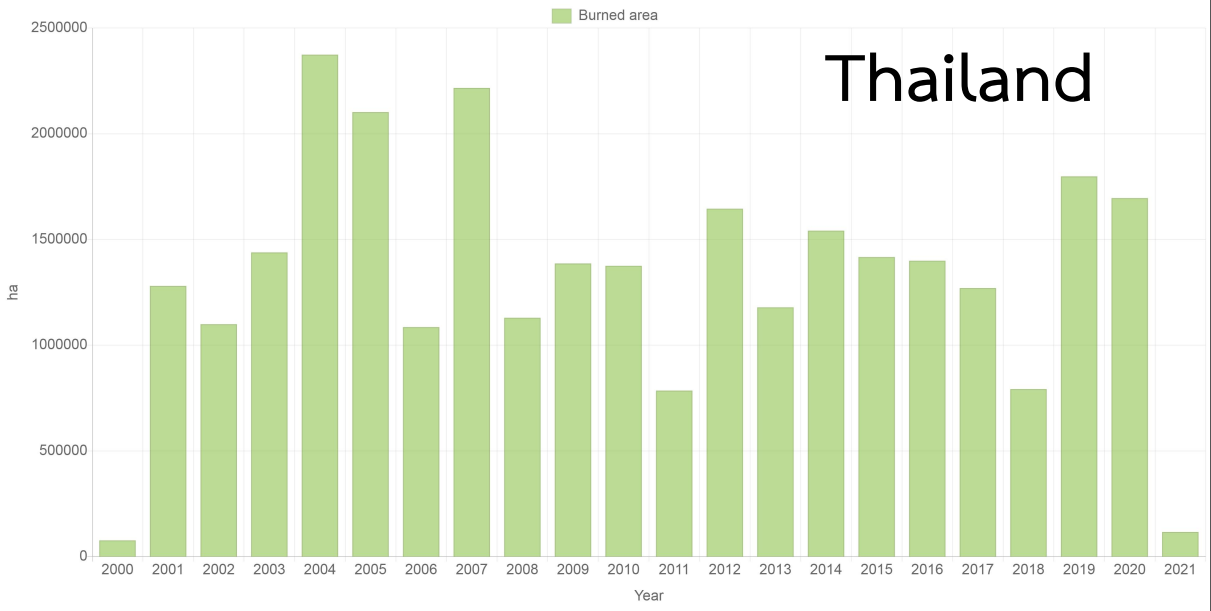
Myanmar



Lao PDR

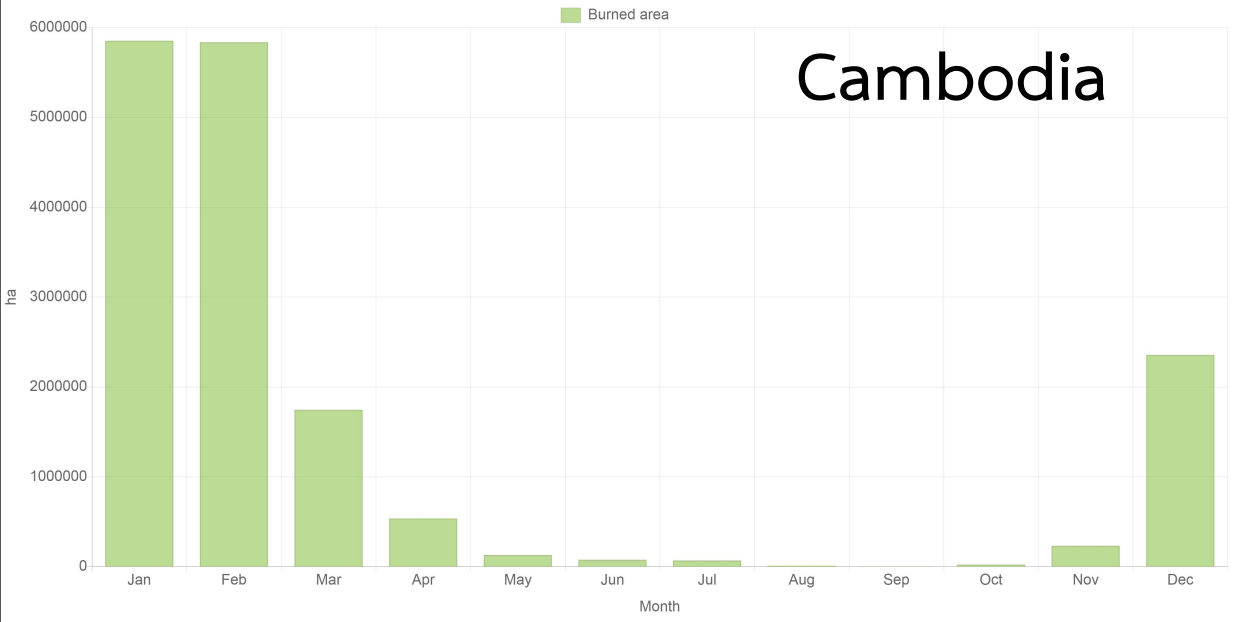


Thailand

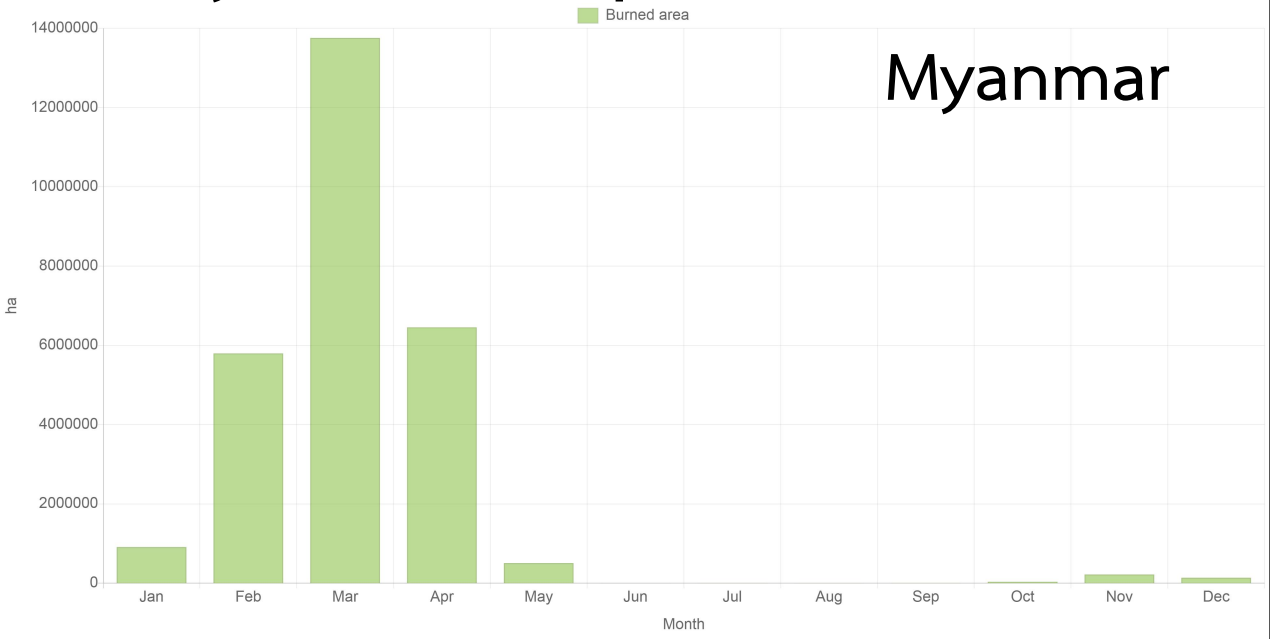


MODIS Burned Areas Info by Earth Map FAO

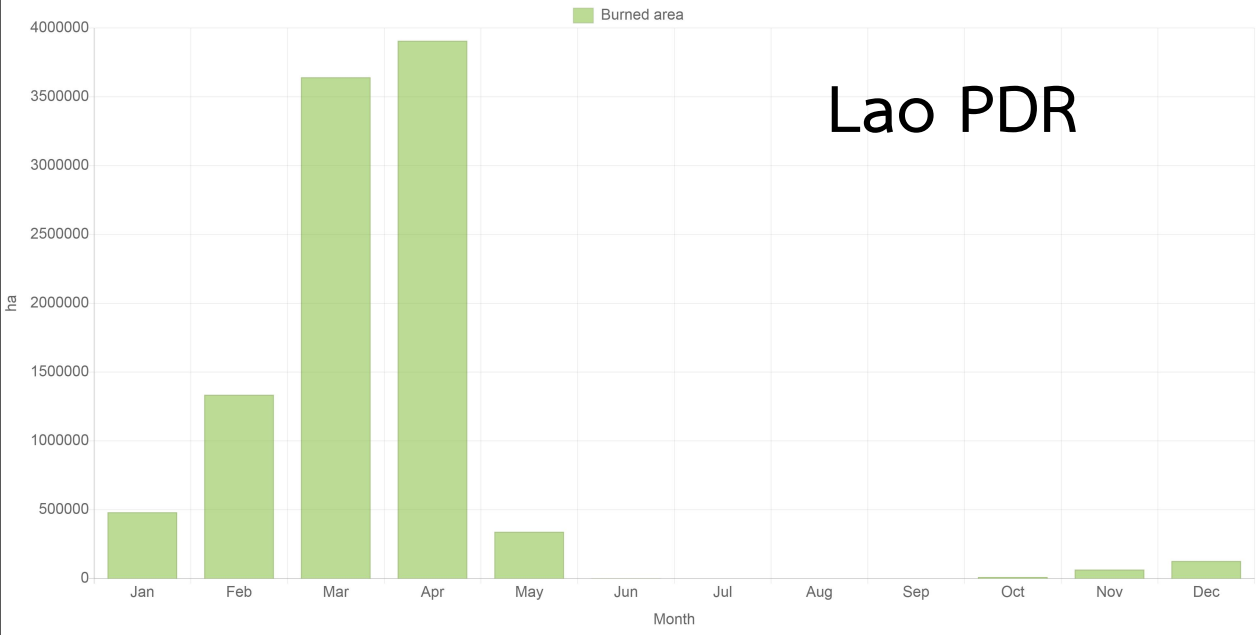
Cambodia



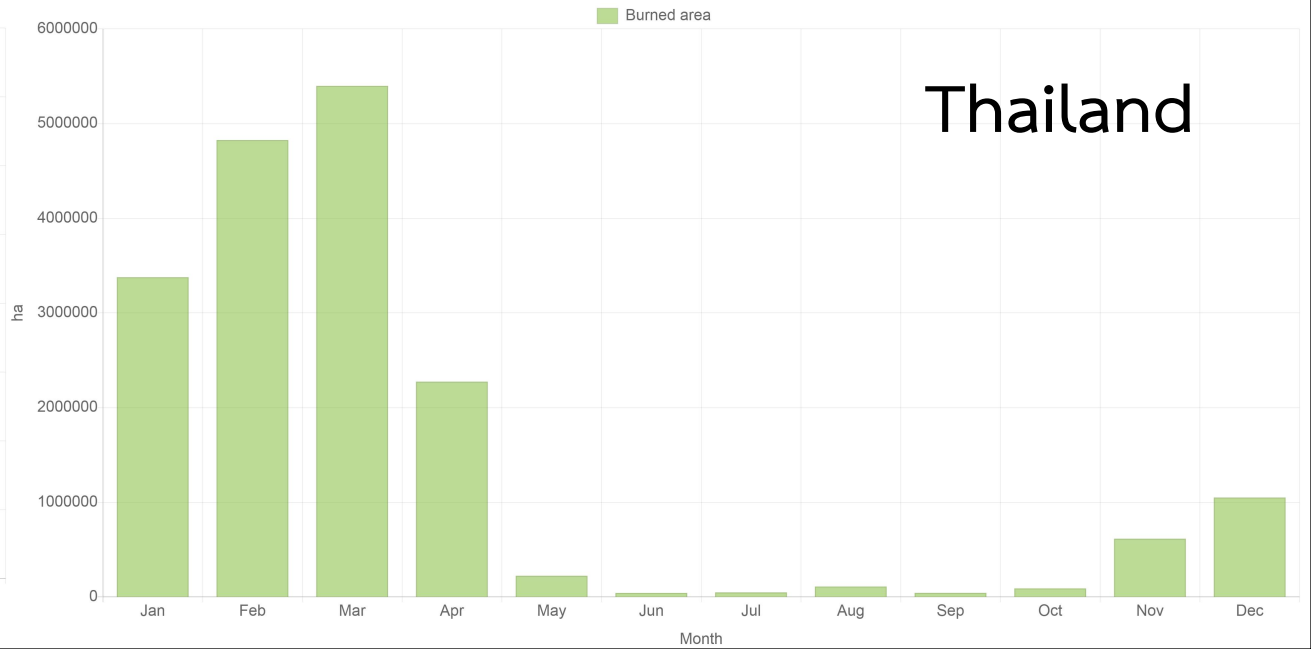
Myanmar



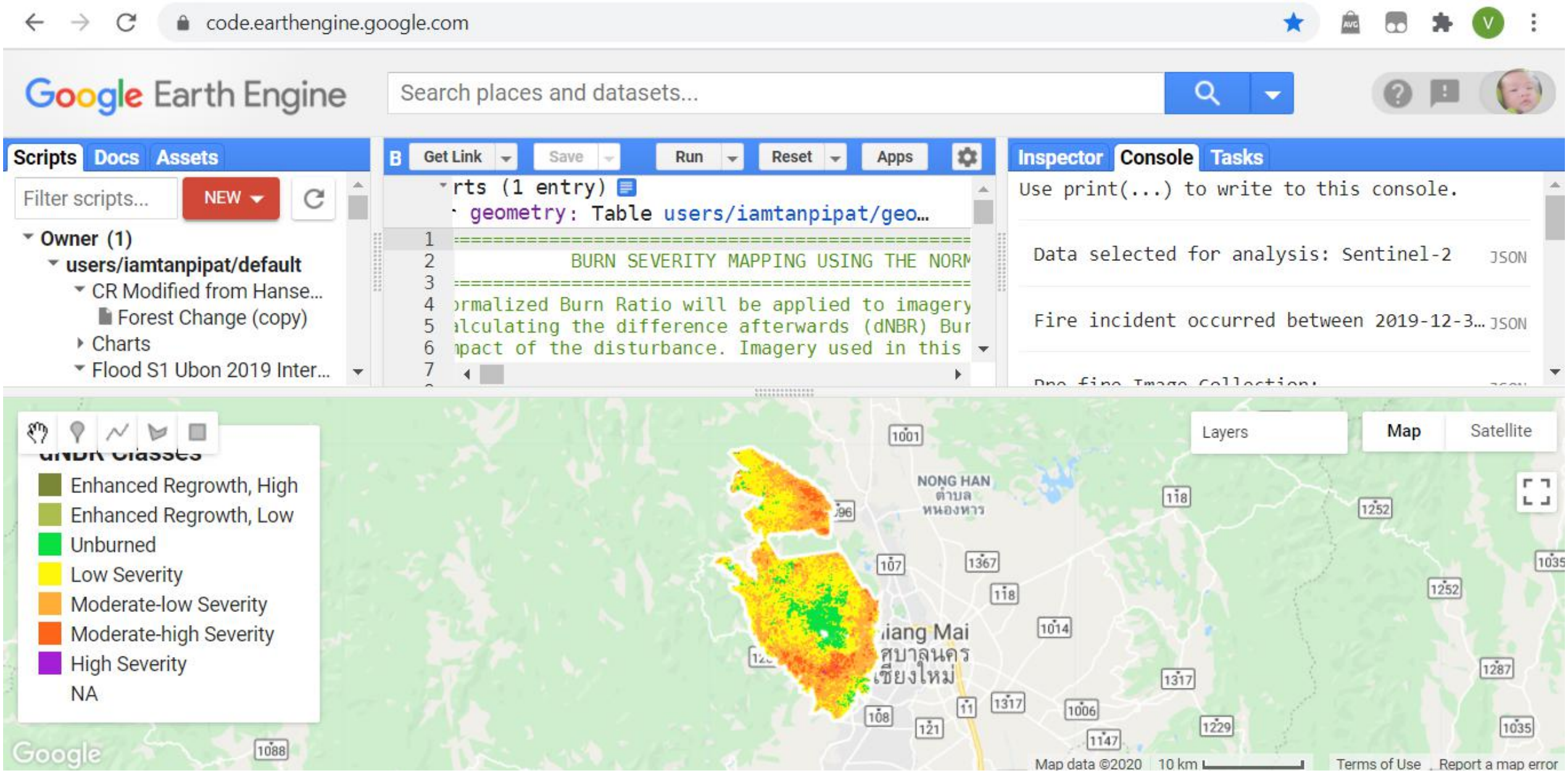
Lao PDR



Thailand



Google Earth Engine



Forecast Fire Danger Rating for Upper ASEAN and Thailand

Forest Fire Control
Forest Protection and Fire Control Office
Department of National Parks,Wildlife and Plant Conservation

By Manomaiphiboon, K., Tanpipat, V., Nhuchaiya, P., Jaroonrattanapak, N., Buaniam, C. (2017)

DNP | DNP GIS

Source: http://www2.dnp.go.th/gis/FDRS/FDRS.php/

การพยากรณ์ระดับชั้นอันตรายของไฟที่ความละเอียดสูง

Fine-Resolution Forecast Products of Fire Danger Rating

ค่าดัชนีไฟป่าประจำวันเพื่อปรับป้าย FDRS Table for Fire Risk Signs	เอเชียตะวันออกเฉียงใต้ตอนบน Upper Southeast Asia	คณะทำงาน Working Group	ข้อมูลประกอบ Supplemental Info
ภาคเหนือตอนบนของประเทศไทย Upper Northern Thailand	จังหวัดเชียงใหม่ Chiang Mai	เอกสารอ้างอิง References	กิตติกรรมประกาศ Acknowledgements
ประเทศลาว Laos	ประเทศกัมพูชา Cambodia	รวมลิงค์ Useful Links	ภาพเคลื่อนไหวรายปี Motion Image
ประเทศพม่า Myanmar			

Forecast Fire Danger Rating for Upper ASEAN and Thailand

Forest Fire Control
Forest Protection and Fire Control Bureau
Royal Forest Department

By Manomaiphiboon, K., Tanpipat, V., Nhuchaiya, P., Jaroonrattanapak, N., Buaniam, C. (2017)

Source: https://wildfire.forest.go.th/fdrs/FDRS.php

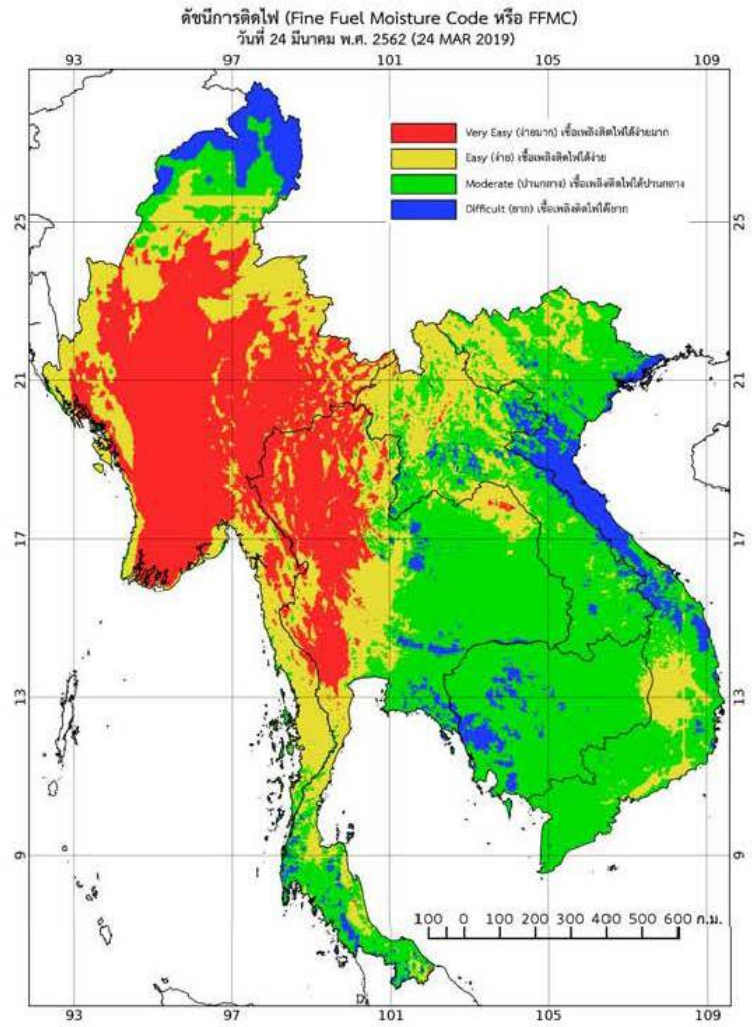
การพยากรณ์ระดับชั้นอันตรายของไฟที่ความละเอียดสูง

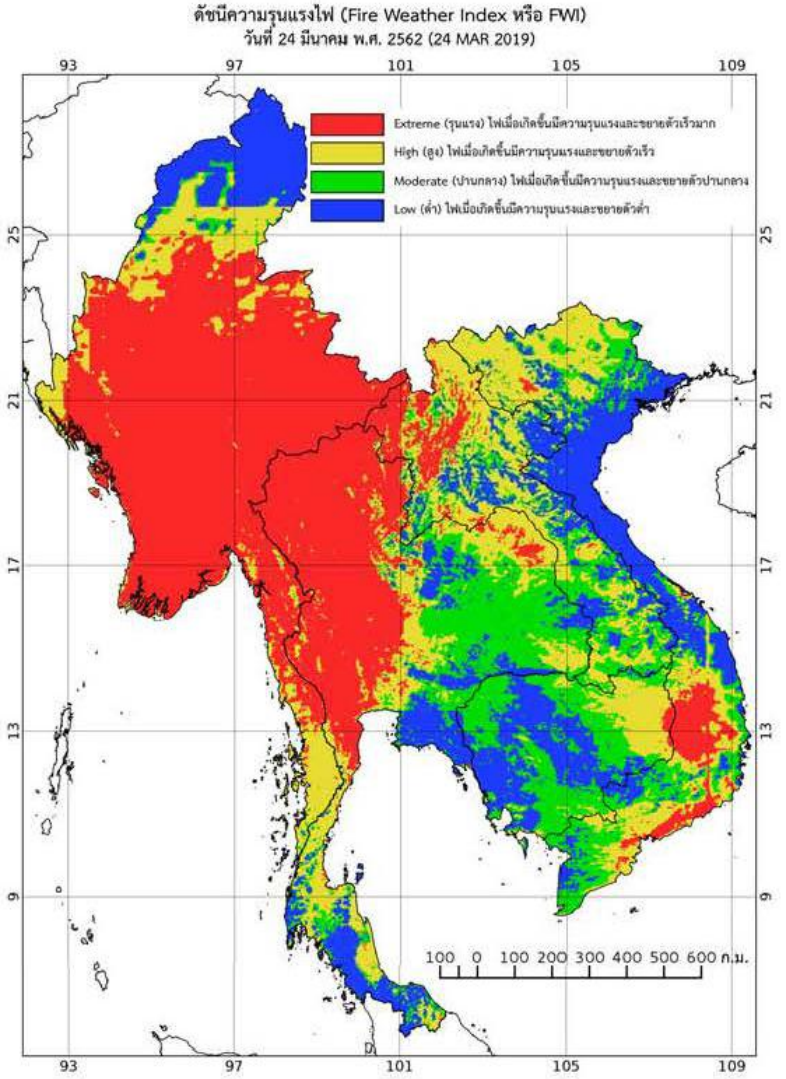
Fine-Resolution Forecast Products of Fire Danger Rating

ค่าดัชนีไฟป่าประจำวันเพื่อปรับป้าย FDRS Table for Fire Risk Signs	เอเชียตะวันออกเฉียงใต้ตอนบน Upper Southeast Asia	คณะทำงาน Working Group	ข้อมูลประกอบ Supplemental Info
ภาคเหนือตอนบนของประเทศไทย Upper Northern Thailand	จังหวัดเชียงใหม่ Chiang Mai	เอกสารอ้างอิง References	กิตติกรรมประกาศ Acknowledgements
ประเทศลาว Laos	ประเทศกัมพูชา Cambodia	รวมลิงค์ Useful Links	ภาพเคลื่อนไหวรายปี Motion Image

Upper ASEAN Forecast FDRS

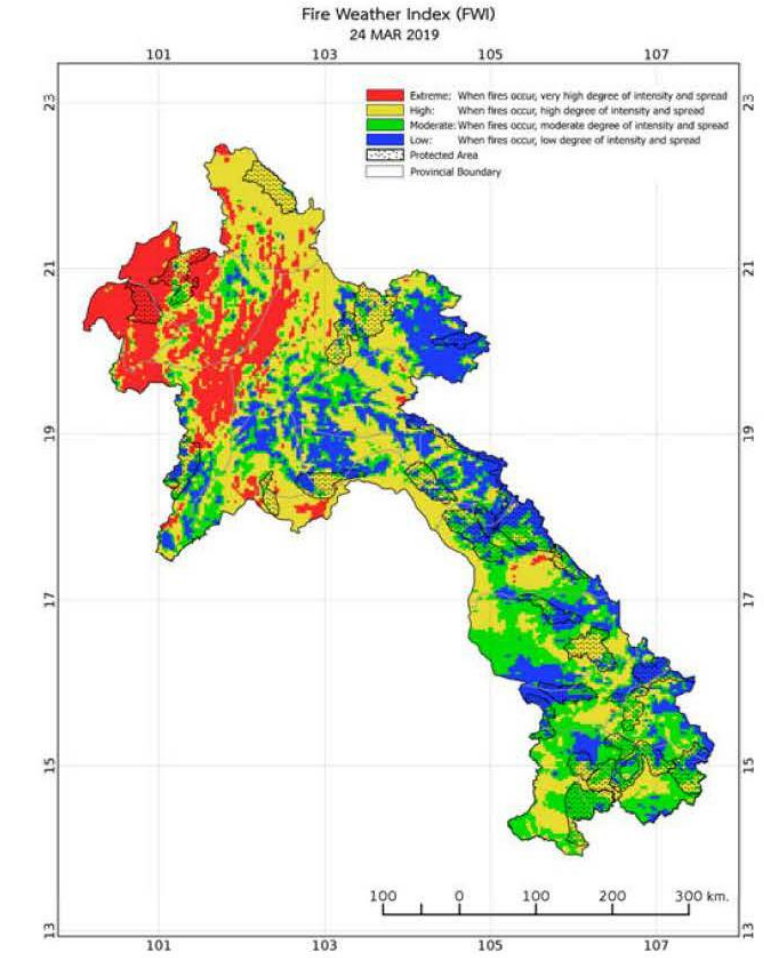
http://www2.dnp.go.th/gis/FDRS/FDRS.php

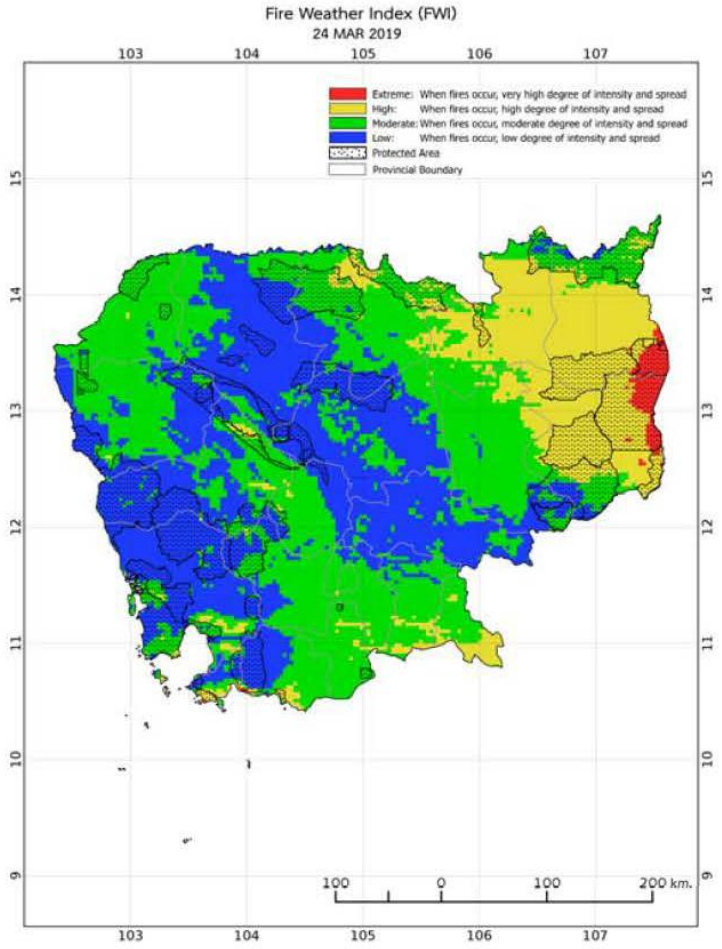


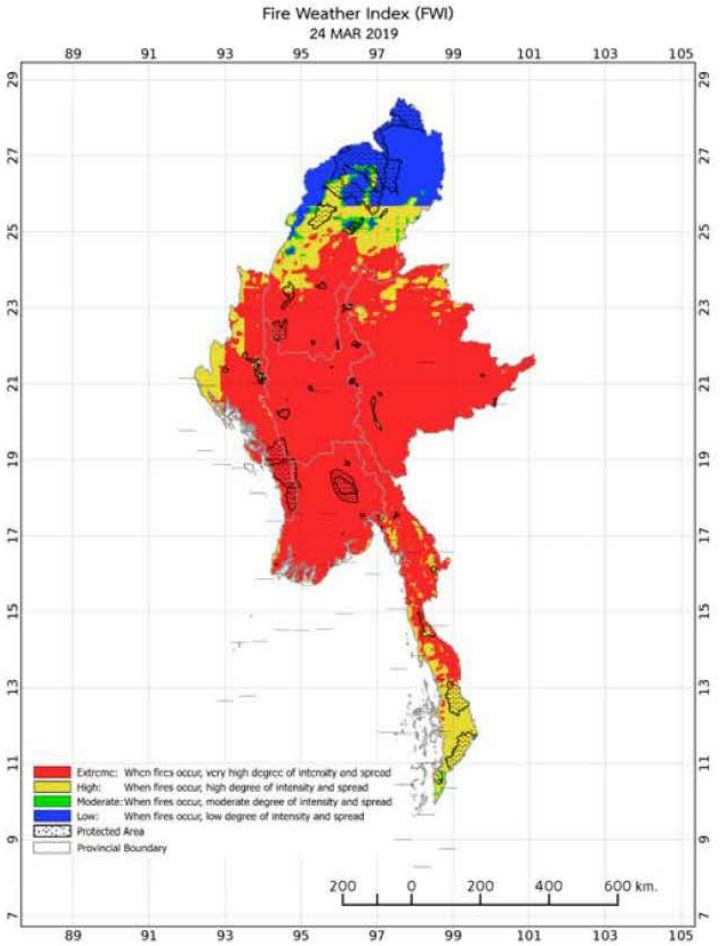


Provided new Upper ASEAN calibrated thresholds to Dr. Bill de Groot for Global Fire Early Warning System (http://canadawildfire.ualberta.ca/gfews/) !!!Still Need Further Calibration!!!

Upper ASEAN Forecast FDRS Co-ordinating with Met.Malaysia and ASEAN Secrectary to combine the North and South ASEAN FWI products!!!!!!!

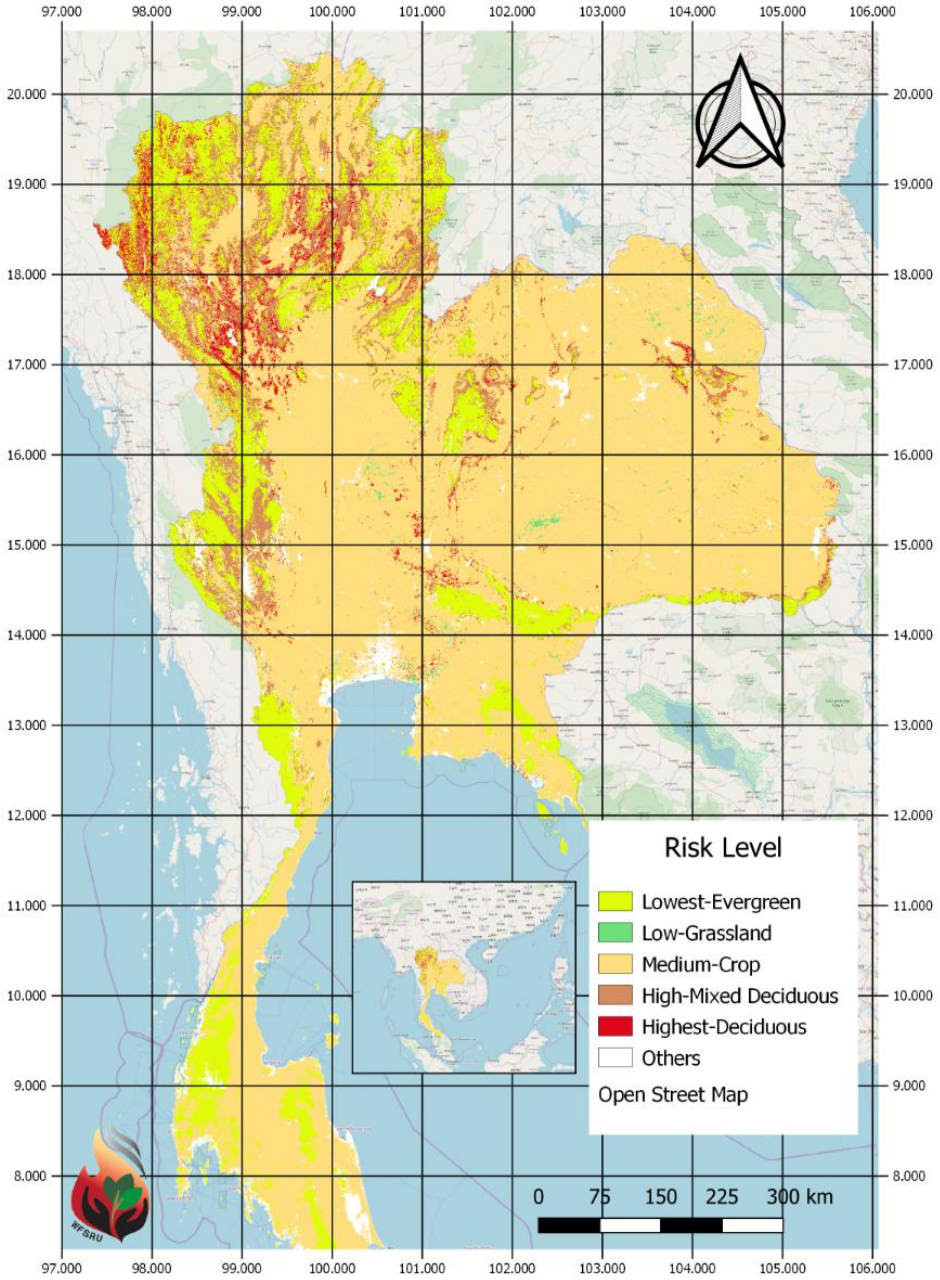






http://www2.dnp.go.th/gis/FDRS/FDRS.php

Thailand Fire Risk Map



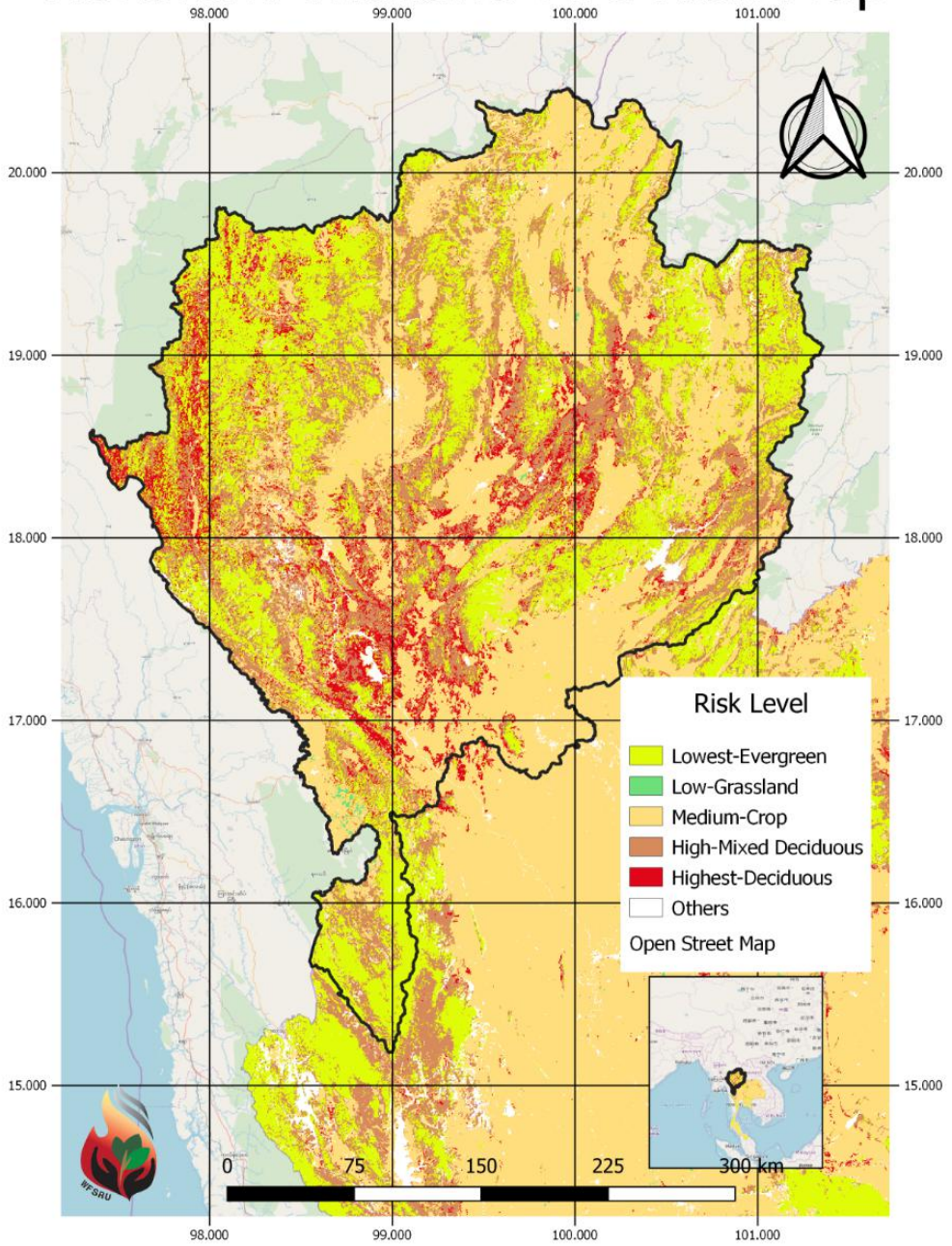
Source: European Space Agency Climate Change Initiative (https://www.esa-landcover-cci.org/)

From

Wonthongchai-

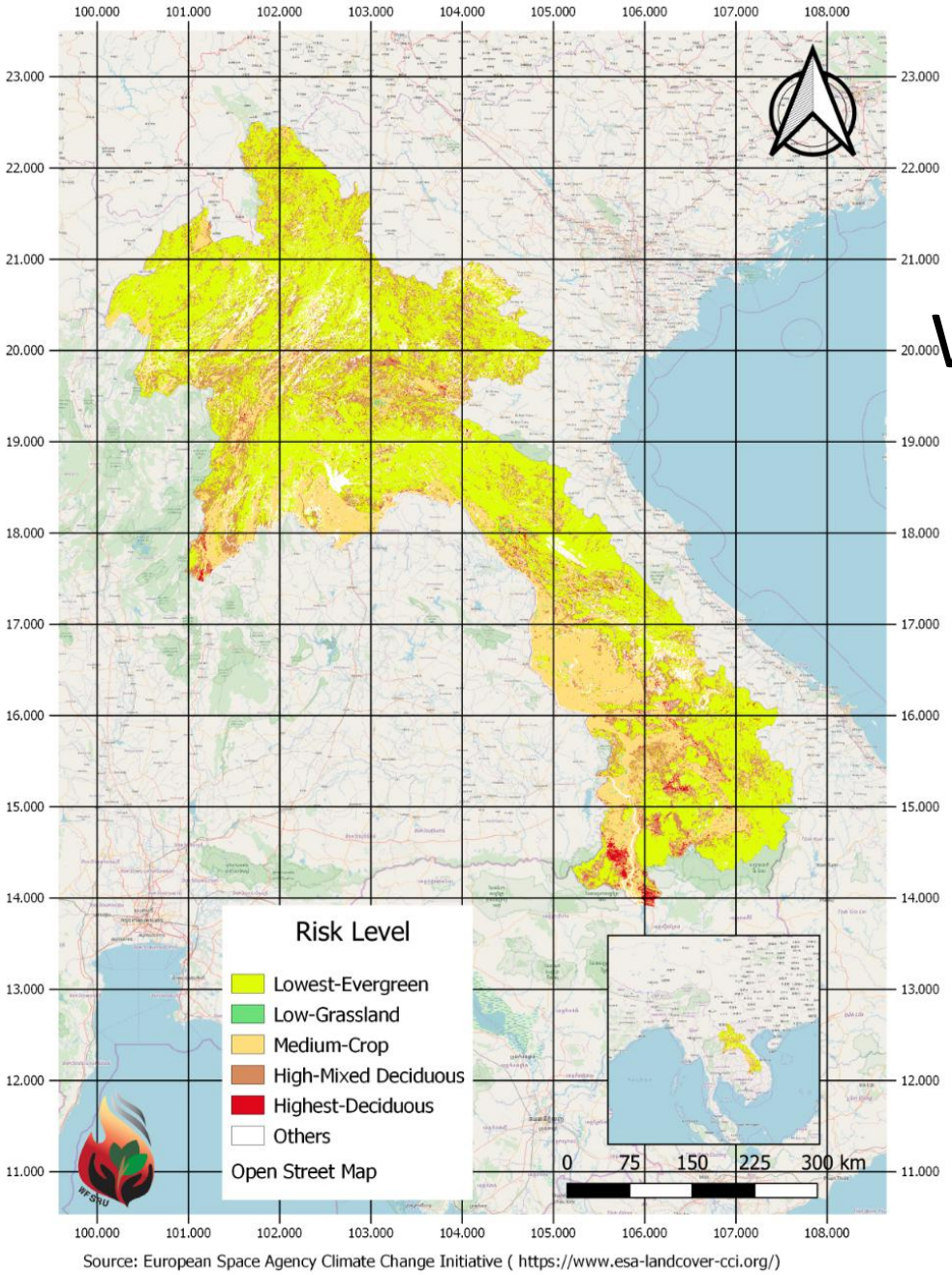
APN Study

Northern Thailand Fire Risk Map



Source: European Space Agency Climate Change Initiative (https://www.esa-landcover-cci.org/)

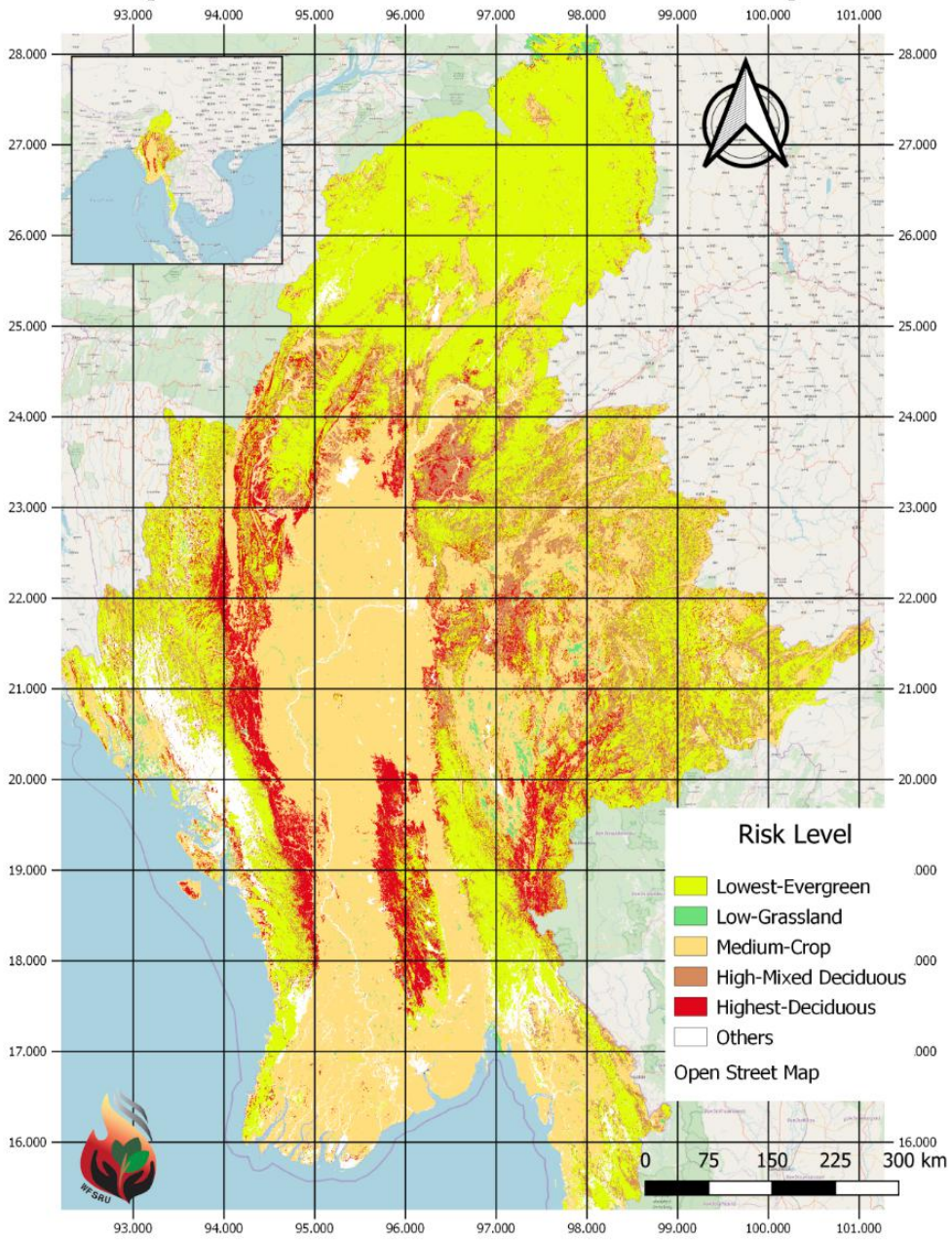
Lao PDR Fire Risk Map



Source: European Space Agency Climate Change Initiative (https://www.esa-landcover-cci.org/)

From Wonthongchai- APN Study

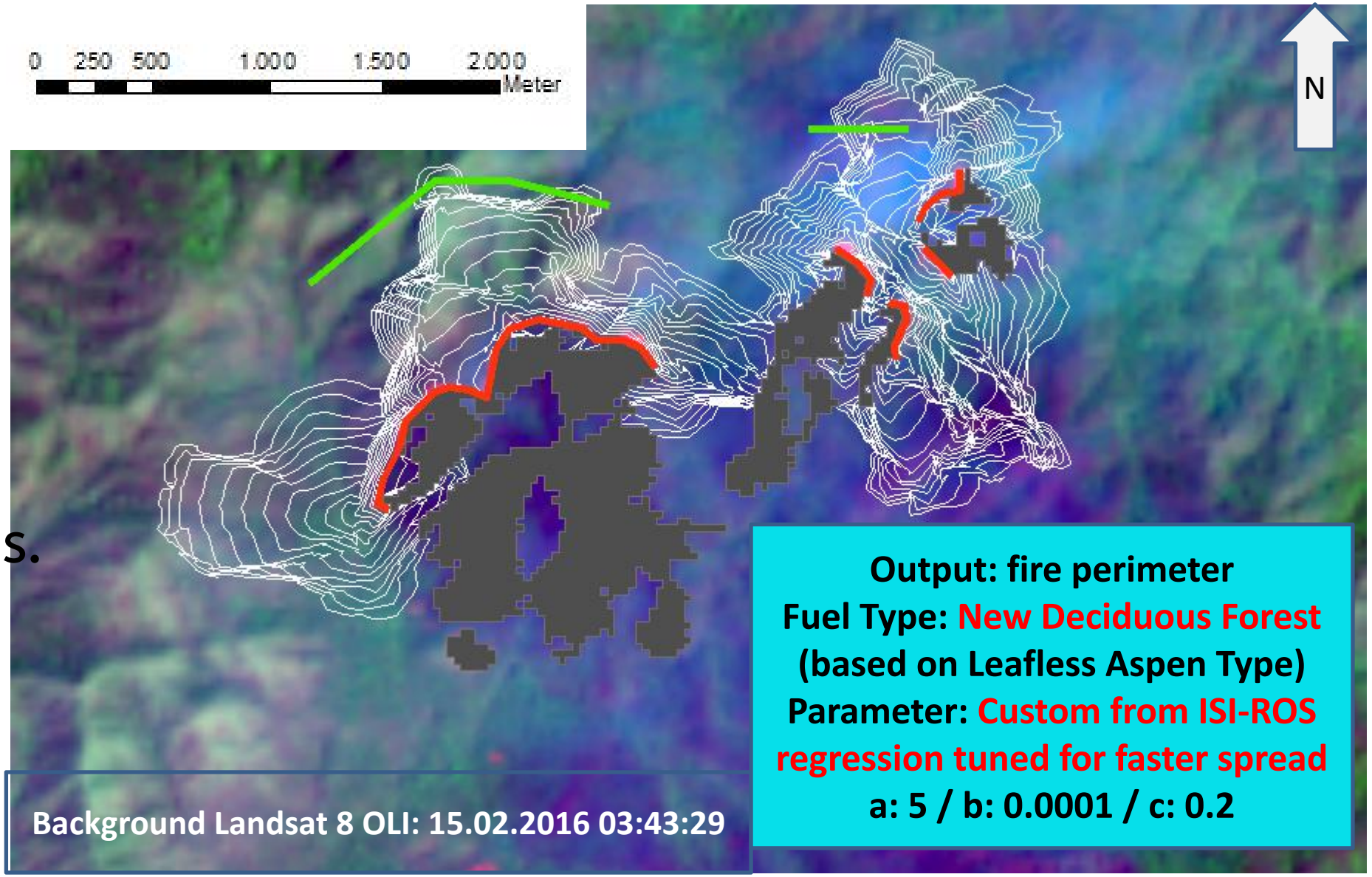
Myanmar Fire Risk Map

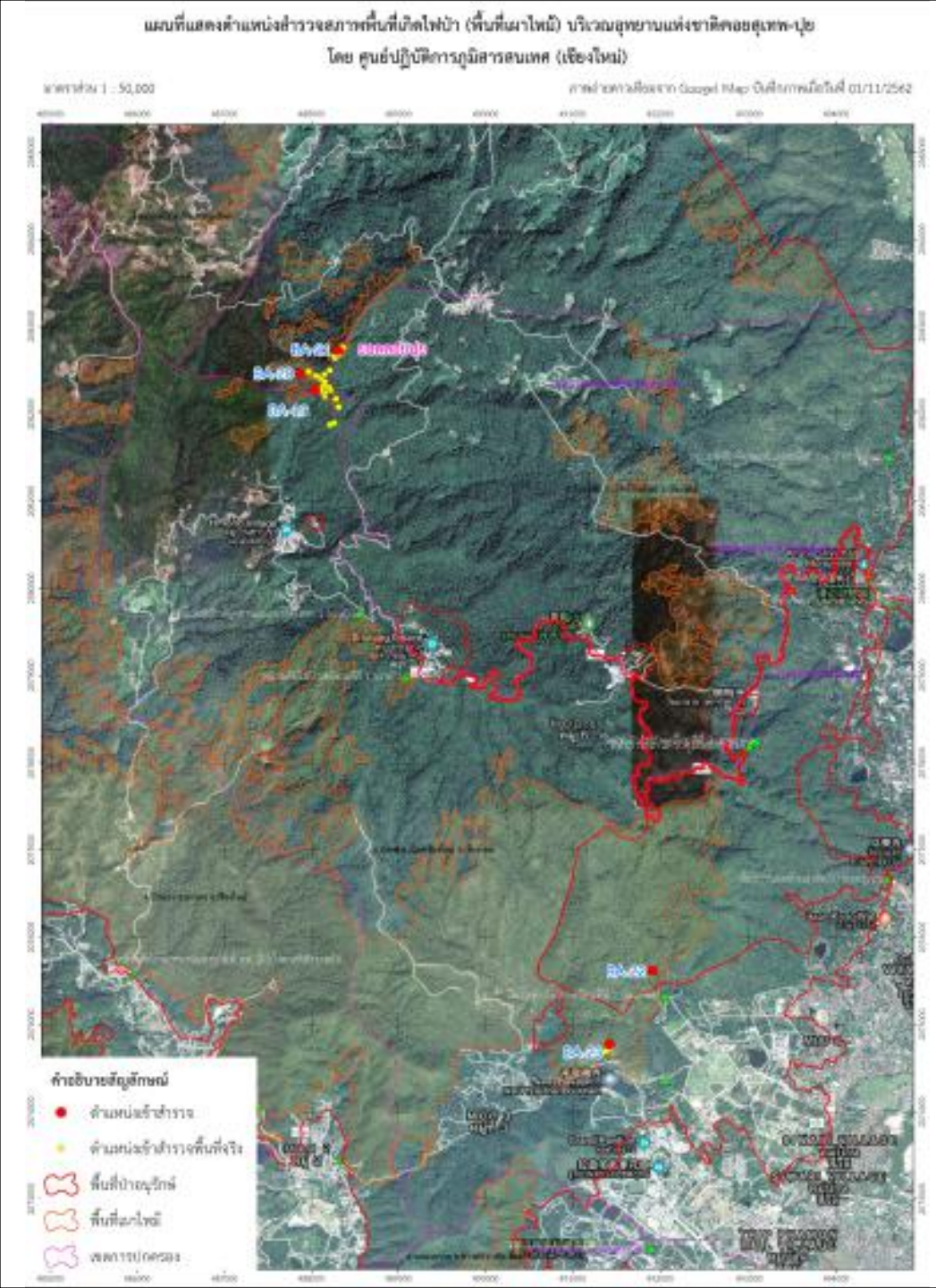


Source: European Space Agency Climate Change Initiative (https://www.esa-landcover-cci.org/)

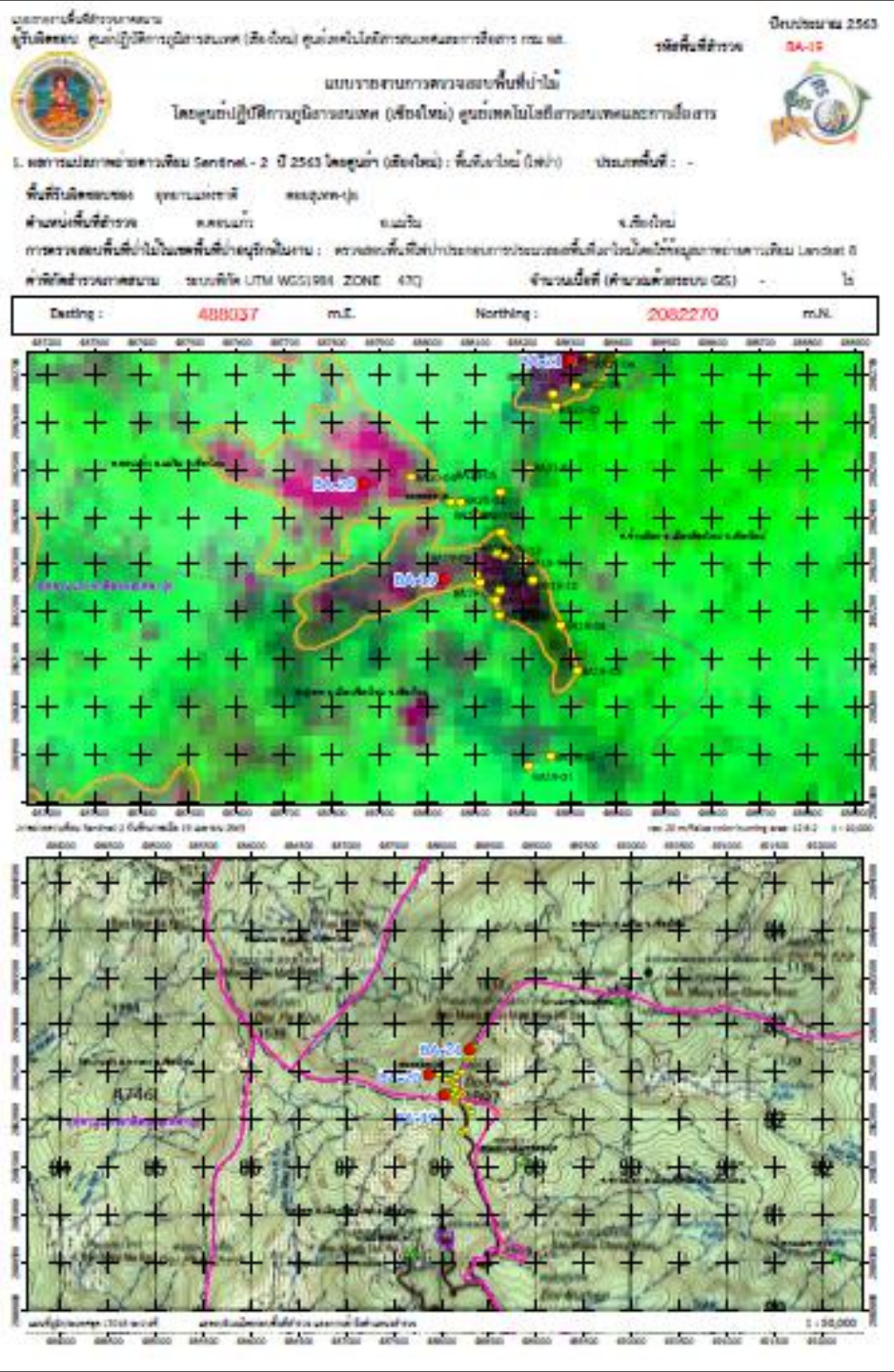
Simulation in developing process

Gernot Rucker, Firemaps.net





Goinformatics Center, Regional Office 16



ปีงบประมาณ 2563

ชื่อหน่วยงานผู้สำรวจ: ศูนย์ปฏิบัติการภูมิสารสนเทศ (เชียงใหม่)

*รหัสพื้นที่สำรวจ BA19-01

แบบรายงานการสำรวจสภาพพื้นที่เกิดไฟป่าในเขตพื้นที่ป่าอนุรักษ์

โดย ศูนย์ปฏิบัติการภูมิสารสนเทศ (เชียงใหม่) ศูนย์เทคโนโลยีสารสนเทศและการสื่อสาร

2. การตรวจสอบพื้นที่ป่าไม้ในเขตพื้นที่ป่าอนุรักษ์ในงาน : สำรวจพื้นที่เกิดไฟป่า (พื้นที่เผาไหม้) ประกอบการแปลภาพถ่ายดาวเทียม

3. ผลการตรวจสอบภาคสนาม

☐ ไม่สามารถเข้าพื้นที่สำรวจได้

*วันที่เข้าสำรวจ : 11 กรกฎาคม 2563 *ระดับความสูงในพื้นที่ 1,647.47 เมตร

*พิกัดในพื้นที่จริง (UTM) โซน : 47Q *E : 488212.87 / *N : 2081873.38

4. สภาพพื้นที่สำรวจเป็น ☑ พื้นที่ป่าไม้ ระบุ: (F103) ป่าดิบเขา / ☐ ไม่ใช่พื้นที่ป่าไม้ ระบุ:

5. ระดับความรุนแรง* ☐ ไม่ปรากฏพื้นที่เผาไหม้ ☐ รุนแรงน้อย ☑ รุนแรงปานกลาง ☐ รุนแรงมาก

*คำอธิบาย: พบร่องรอยไฟป่าพื้นดินเป็นขี้เถ้าดำ โคนต้นไม้มีรอยดำชัดเจน ต้นไม้ขนาดใหญ่ยอดใบเป็นสีเขียว ต้นไม้ขนาดกลางใบเป็นสีน้ำตาลยืนต้นตาย พืชพื้นล่างมีการฟื้นตัวขนาดประมาณ 50 cm แต่ยังมีความหนาแน่นน้อยทำให้เกิดพื้นที่โล่ง

*ภาพถ่ายพื้นที่สำรวจ ทิศเหนือ (N)

*ภาพถ่ายพื้นที่สำรวจ ทิศใต้ (S)

*ภาพถ่ายพื้นที่สำรวจ ทิศตะวันออก (E)

*ภาพถ่ายพื้นที่สำรวจ ทิศตะวันตก (W)

*ภาพถ่ายพื้นที่สำรวจ ทิศเหนือ (N)

*ภาพถ่ายพื้นที่สำรวจ ทิศใต้ (S)

*ภาพถ่ายพื้นที่สำรวจ ทิศตะวันออก (E)

*ภาพถ่ายพื้นที่สำรวจ ทิศตะวันตก (W)

5. ระดับความรุนแรง* ☐ ไม่ปรากฏพื้นที่เผาไหม้ ☐ รุนแรงน้อย ☐ รุนแรงปานกลาง ☑ รุนแรงมาก

*คำอธิบาย: พบร่องรอยไฟป่าพื้นดินเป็นขี้เถ้าดำ โคนต้นไม้มีรอยดำชัดเจน ต้นไม้ขนาดใหญ่ยืนต้นตายบางส่วน และพบต้นไม้ล้มจากการถูกไฟไหม้ และโค่นเองเนื่องจากรากไม่สามารถยึดติดกับพื้นดิน ต้นไม้ขนาดกลางใบเป็นสีน้ำตาลยืนต้นตาย ไม่ปรากฏพืชพื้นล่างทำให้เกิดพื้นที่โล่ง

A Collaboration among Royal Forest Department, FTS, WFSRU and Engineering Department CMU Toward Fire Weather Understanding in Thailand

FTS

Quick Deploy (QD)

Portable RAWS (Remote Automated Weather Station)

On-site weather monitoring for prescribed burning, wildfire and emergency response applications.

EXTREME ENVIRONMENTS
EXTREMELY RELIABLE

15 minutes. 1 person. No tools.

The FTS Quick Deploy portable weather station is the fire community's most widely used weather station for prescribed burns and temporary monitoring applications.

The last GOES and GPS antenna you'll ever need.

The EON2 CS2 requires no assembly, and no aiming in most locations. Rugged by design, it is completely sealed for marine environments and dome-shaped for superior ice/snow shedding. Smaller, lighter and more durable than a Yagi.•

Key Features:

- Increased reliability
- No assembly
- Lasts longer (better investment than Yagis)
- Does not need aiming in most locations
- Optional aimable mount available if aiming required
- Cabinet top mounting eliminates exposed wiring
- Extremely rugged
- Optional: Integrated GPS Antenna available.
- Optional: aim-able mount (if required).

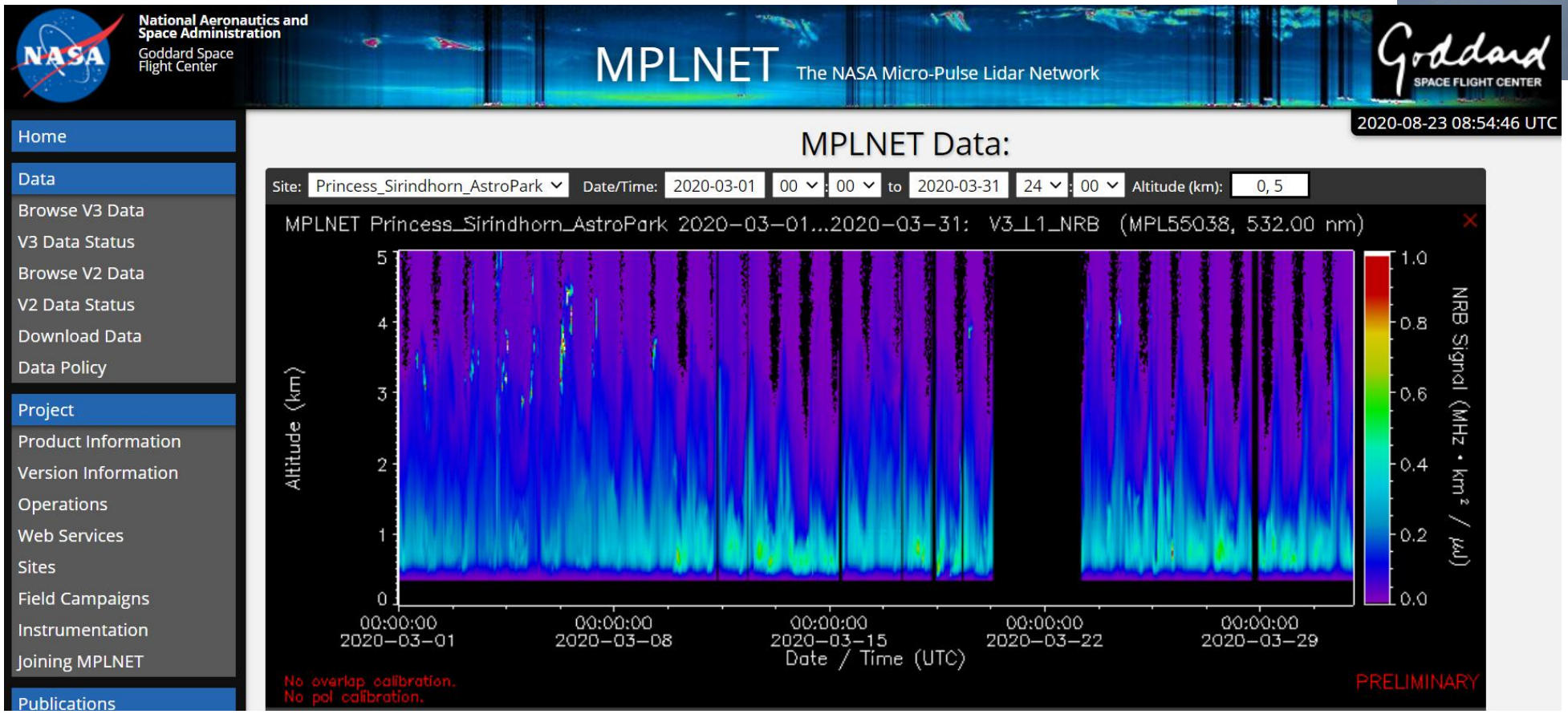
Real-time weather conditions on demand.

The optional AirTalk gives you mobility by allowing you to call in to the QD via any DTMF capable voice radio for current weather conditions.

- Allows multiple access codes for different sets of weather information—get only the data you need, based on the inquiry code sent.
- Minimizes air time, saves radio power and improves safety by conserving air time for others.
- Instant voice alerts of exceeded weather parameter thresholds provide real-time decision-making, maximizing firefighter and public safety.

NASA Micro-Pulse Lidar Network-MPLNET

Source: https://www.micropulselidar.com/top-5-differences-between-micro-pulse-lidar-and-ceilometer-technology/

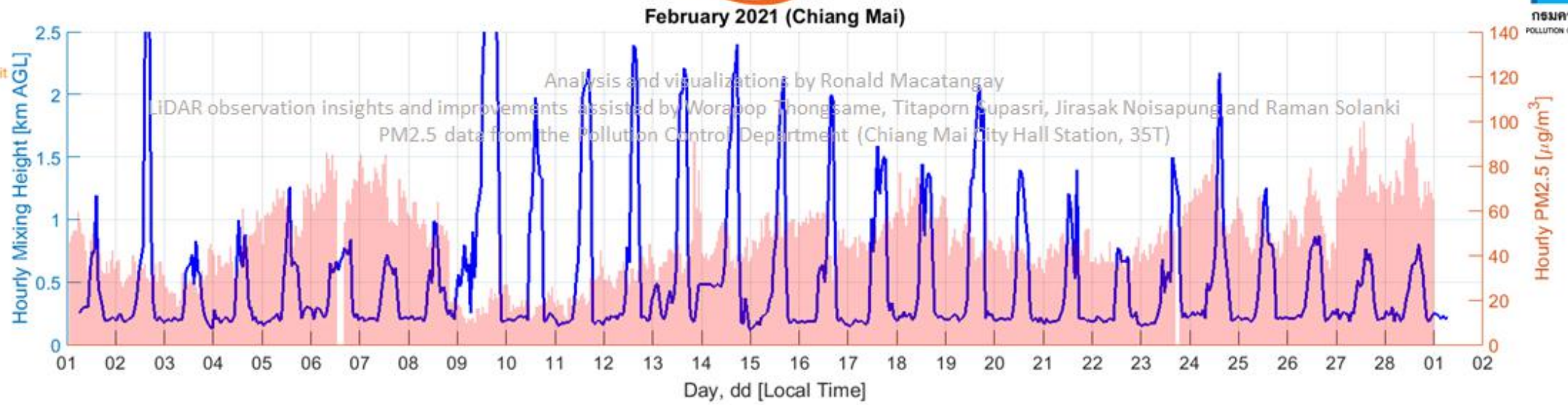


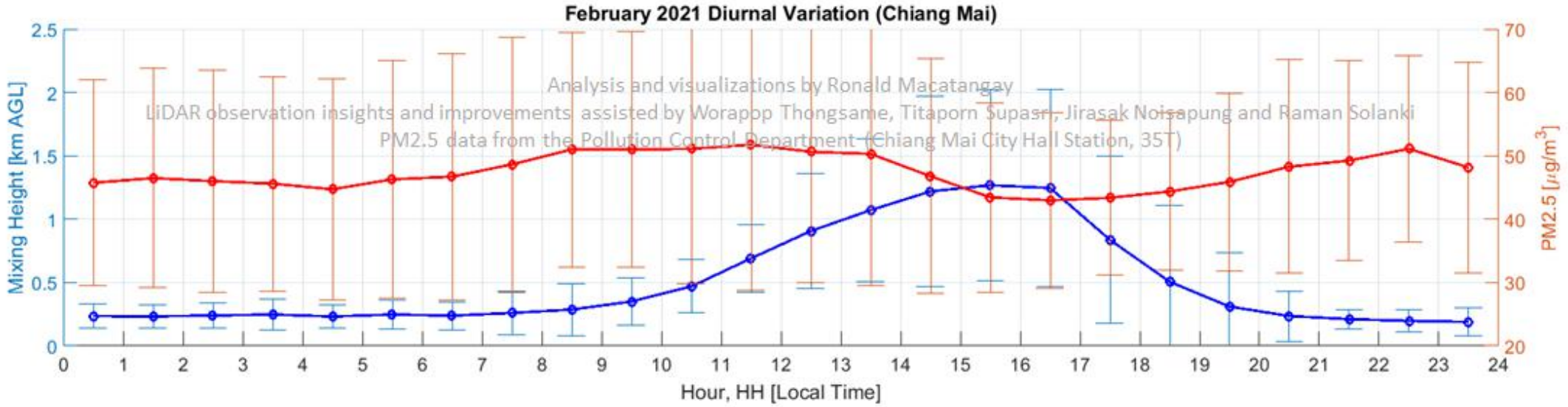
Source: https://mplnet.gsfc.nasa.gov/data?v=V3&s=Princess_Sirindhorn_AstroPark&t=20200304

ARUN
Atmospheric Research Unit of NARIT

NARIT

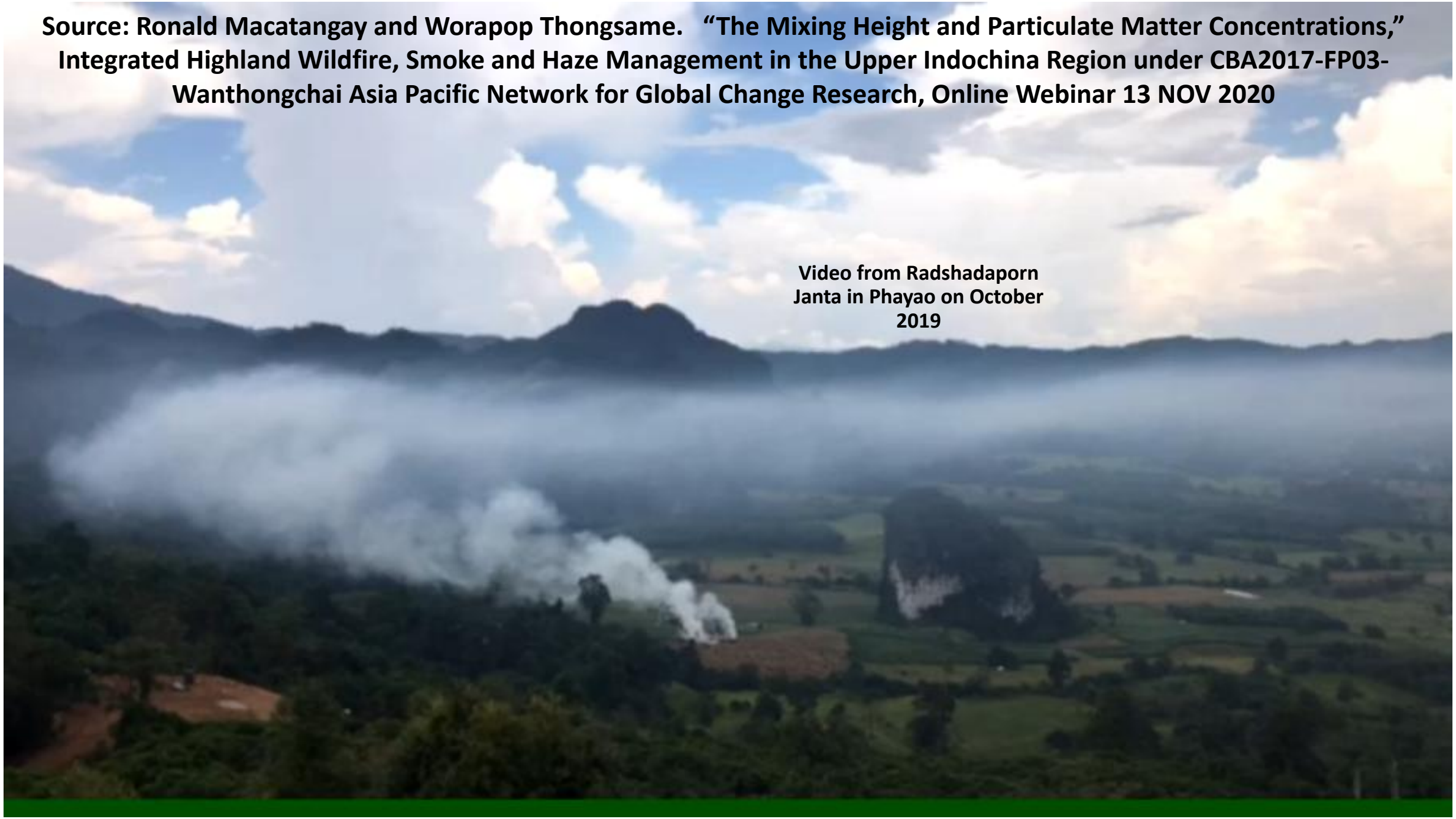
กรมควบคุมมลพิษ
POLLUTION CONTROL DEPARTMENT





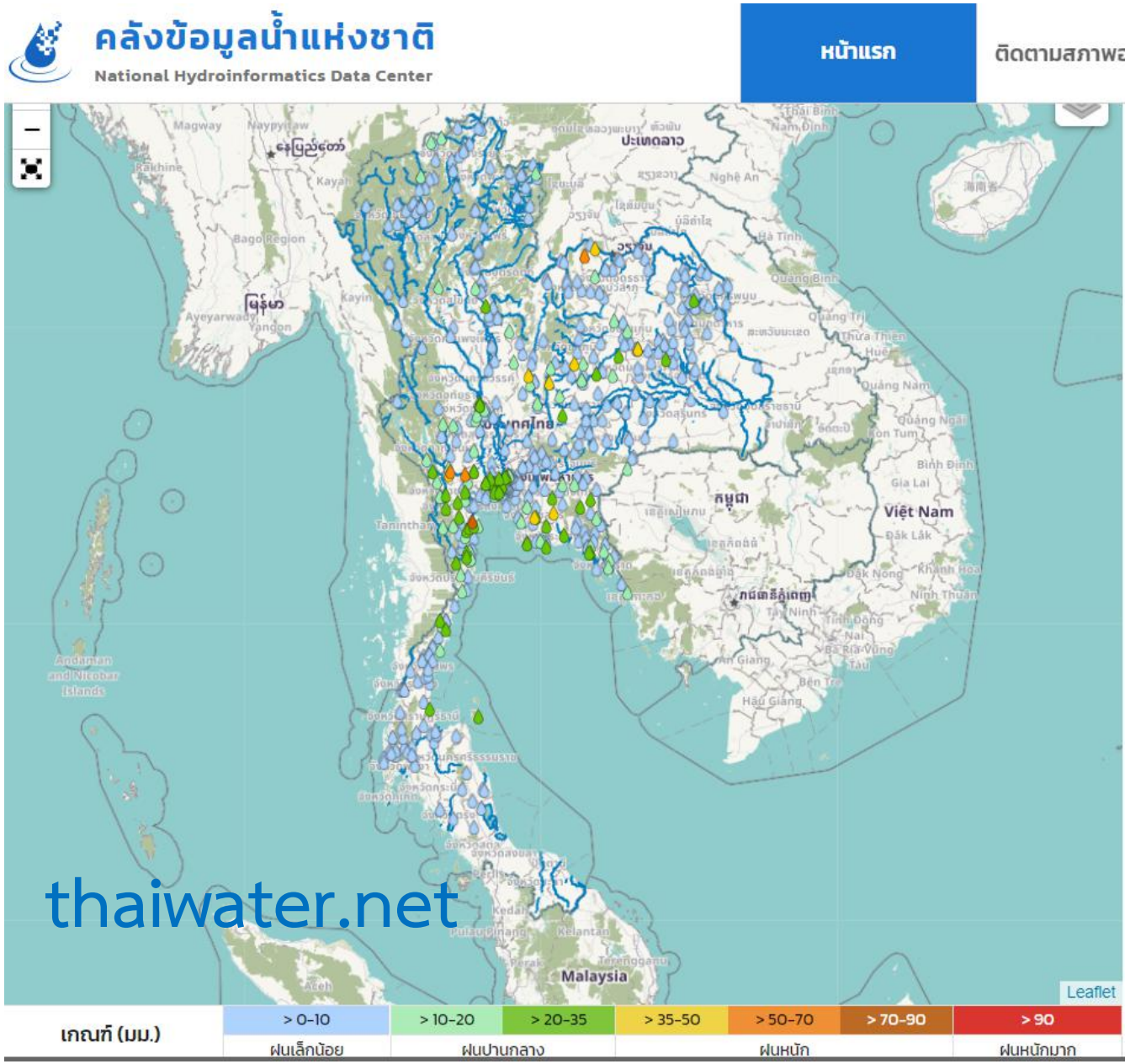
National Astronomical Research Institute of Thailand

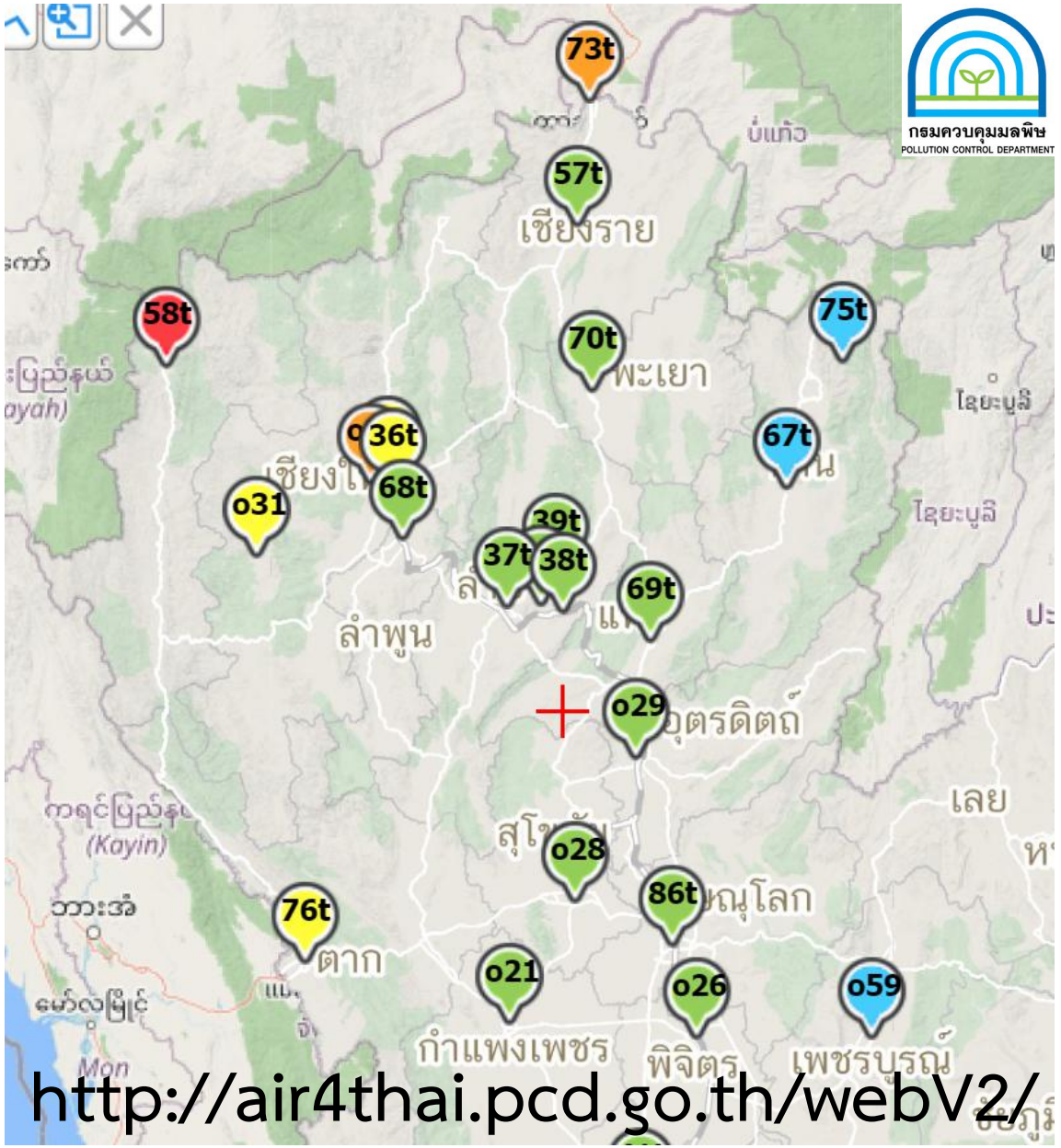
Source: Ronald Macatangay and Worapop Thongsame. "The Mixing Height and Particulate Matter Concentrations," Integrated Highland Wildfire, Smoke and Haze Management in the Upper Indochina Region under CBA2017-FP03-Wanthongchai Asia Pacific Network for Global Change Research, Online Webinar 13 NOV 2020



Source: https://www.facebook.com/pannavej
Dr. Pongsakorn Sangsuwan

Rain arrived on the 22nd Air Quality Improved on the 23rd March 2021





NSTDA Supercomputer Center: ThaiSC

- One of the **National Science and Technology Infrastructure (NSTI)** founded in 2019
- Provides **cutting-edge HPC-AI resources** for R&D community as a leadership computing center

Relevance: ThaiSC for National S&T Development

THE GLOBAL GOALS
For Sustainable Development

SUSTAINABLE DEVELOPMENT GOALS

1 NO POVERTY · 2 ZERO HUNGER · 3 GOOD HEALTH AND WELL-BEING · 4 QUALITY EDUCATION · 5 GENDER EQUALITY · 6 CLEAN WATER AND SANITATION · 7 AFFORDABLE AND CLEAN ENERGY · 8 DECENT WORK AND ECONOMIC GROWTH · 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE · 10 REDUCED INEQUALITIES · 11 SUSTAINABLE CITIES AND COMMUNITIES · 12 RESPONSIBLE CONSUMPTION AND PRODUCTION · 13 CLIMATE ACTION · 14 LIFE BELOW WATER · 15 LIFE ON LAND · 16 PEACE, JUSTICE AND STRONG INSTITUTIONS · 17 PARTNERSHIPS FOR THE GOALS

9.5 "Upgrade the technological capabilities of industrial sectors in all countries,

- encouraging innovation
- substantially
- increasing the number of research and development"

Thailand's 20 Year Strategic Roadmap

Strategic 2: **Building National S&T Competitiveness:** Improving national productivity using science, technology, R&D, and innovation

Strategic 8: **Development of S&T, Research, and innovation:** Build national S&T infrastructure to support exponential growth in technology development

Goal 4: **Infrastructure and human capacity development for national research and innovation ecosystem**

สวทช NSTDA

Strategic Initiative 7 (2019): Establishment of National S&T Infrastructure

ThaiSC HPC Service

Resources	2019 “TARA”	2022 “LANTA”
Computing power (CPU cores)		
- Compute nodes	2,400	5,400 - 9,600
- High-mem node	1,920	360 - 640
- GPU Units	28 V100 GPU	480 A100 GPU
Storage (PB)	0.8	10
Double-Precision Performance	**252 teraFLOPS**	**5-6 petaFLOPS**
AI Performance (Tensor-core)	**3.5 petaFLOPS AI**	**1.1-1.2 exaFLOPS AI**

“LANTA” A countrywide HPC service is expected to begin its service around early 2022

Asia Pacific Advanced Network

Connecting People, Cultures, Research and Education

Home | News | About | Membership | Activities | Meetings | Proceedings | Contact

Home » Working Groups » Open and Sharing Data Working Group (OSDWG)

Open and Sharing Data Working Group (OSDWG)

Chair : Veerachai Tanpipat [veerachai AT hii.or.th]
Co-Chair : Basuki Suhardiman [basuki AT itb.ac.id]
Co-Chair : Markus Buchhorn [markus AT apan.net]
Co-Chair : Eric Yen [Eric.Yen AT twgrid.org]
Co-Chair : J. Adinarayana [adi AT csre.iitb.ac.in]
Co-Chair : Kiura Takuji [kiura.naro AT gmail.com]
Mailing List: osdwg@apan.net

https://apan.net/node/197

Introduction | Objectives | Activities | Proposals in APAN52 Indonesia

Lessons Learned:

-Users do not clearly understand the limitations of information given (most of the time resulting in information misused and lead to further complicated problems as active fires detected by polar orbit satellites are only snapshots during a short period of time e.g. using number of hotspot detected as a government agencies' KPIs is not good as people ignite fires after satellites already passed over to pass such KPIs.

-ONLY Numbers of fire hotspots detection do not reflect the total picture of smoke haze situation which affects air quality, there are other factors such as wind, air pressure, etc.

-More active fires detected in near by countries do not simply mean those are sources of bad air quality of the concerned country. The movement of smoke is the key.

-Users do not know what a fire ‘hotspot’ really is.

-Users become too much obsessed with fire hotspot information, so they depend on and wait for it too much.

What still needs to be known:

-Quicker delivery time to users as the fundamental of fire control depends on that. In the future, additional satellites in the EOS with better than VIIRS' capabilities with faster delivery time, within 10-15 minutes, are needed to provide more complete information for more efficient forest fire control. The faster delivery time of high quality active fire products reach fire managers, the better problems can be managed and controlled; therefore, the less damage it can cause.

-Combination with traditional fire detection methods is still needed to reflect the real situation as close as possible.

-The online analysis tools with all the statistics and data of active fire, burned areas, fire emissions and other related infromation could be analyzed on the same platform is essential.

What still needs to be known:

-Closer and Better international collaborations on forest fire control and smoke haze management as it is also a transboundary issue.

-Improvement of geostationary thermal detection sensors and systems within the region.

-Faster estimated size of burned areas information (by both optical and microwave data) is needed as all assessment and mitigation cannot wait that long.

-Fire spread direction and speed including intensity are needed for more efficient fire control and suppression.

-Faster fire emissions information from satellites and models for smoke haze and air quality management is also needed.

-Smoke movements simulation of both local (< 1 km grid) and larger scale (1 km grid) are needed for smoke haze and prescribed burning management.

Conclusions and Challenges

- Be prepared and ready by following those **7 fundamental preparation steps** (Prevention, Monitoring, Prediction, Warning, Response, Recovery/Mitigation and After Action Review, Assessment, Identify ad/disad, ways out and Improvement); especially *"Prevention"*
- Need to put fire early warning (Forecast FDRS) information into forest fire control planning process and daily operation
- Need to develop **better and higher accuracy of high resolution medium range weather forecast inputs** (DA and Ensemble) for **FDRS**, so we can plan further ahead and be more efficient.
- Need to **develop, calibrate and validate Forecast Ventilation or Dispersion Index** to use during prescribed burning planning and smoke haze management.
- Need to study and understand more on "**Fire Weather**".

Conclusions and Challenges

- Need to study and understand more on “Smoke Behavior”
- Need to have a reliable and scientific proved Fire Decision Support System
- Need to understand behaviors of people who use fire as a tool better for more efficient prevention
- Need to find feasible and possible alternatives incomes for people, so they can reduce their fire ignition habit and change from monocrop like maize to multi-crops with sure incomes and sustainable market
- Need to find easier and simpler communication schema to deliver scientific information to decision and policy makers or so call Science-Policy Interface (SPI) and be able to educate them including the people!!
- **NSTDA Supercomputer Center: ThaiSC**

Take Home Messages

- Case studies are important information to have, but we do not have enough.
- Actually, it does not matter much that we really have reliable decision support systems to use as long as people who use them do not understand and use them properly or as they suppose to be used for.
- With Climate Change, there will be a lot more of natural adjustments and changes that we have to study, learn, understand and adapt.
- Open and sharing data and information is the fundamental approach to cope with future climate changes and disasters we will face.
- If you cannot explain something in simple terms, you do not understand it enough yet, so keep studying, researching and learning.