

Disaster Resilient Cities: Forecasting Local Level Climate Extremes and Physical Hazards for Kuala Lumpur

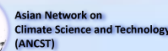
Near-real-time Atmospheric Hazards Platforms

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28-29 June 2018, Le Meridien Hotel, Kuala Lumpur



Summary

- NUOF Hazard Forecasting project
- Urban heat forecasts
 - Why and how
- Air pollution forecasts
 - Why and how
 - Air Pollutant Index schemes
- Existing air quality platforms

NUOF Hazard Forecasting Project

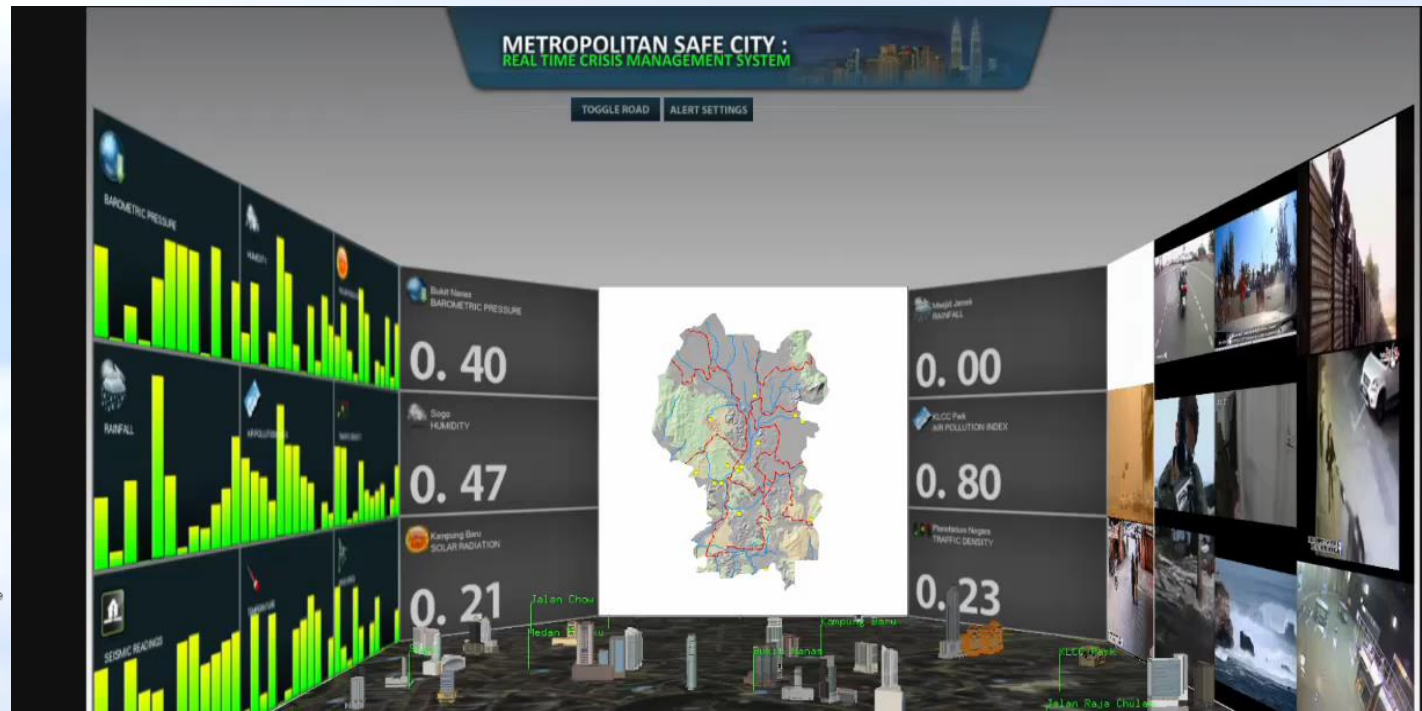


NUOF Hazard Forecasting project

- 2017 –2019
- 16 organisations (UK and Malaysia)
- Forecasting hazards common in Kuala Lumpur i.e. flash floods & floods, landslides, sinkholes, strong winds, **urban heat and local air pollution**
 - **Short-term** and long-term forecasts
 - Forecasting models are being developed
- Develop prototype **multi-hazard platform** for managing and communicating risks to enhance disaster resilience
 - Beginning to design platform

Multi-Hazard Platform concept

- **Input:** hazard models provide physical risk information for next few days
- **Output:** tailored products for decision makers



Multi-Hazard Platform design

Users

Kuala Lumpur City Hall (DBKL)

Ministry of Federal Territories

National Disaster Management Agency

Department of Town and Country Planning

Department of Irrigation and Drainage

Malaysia Civil Defence Force (APM)

Public Works Department (JKR)

Floods / Flash Floods



Landslides



Sink Holes



Front-End Graphics Server



Backend Database Server and Data Processing Engine

Meteorological



Atmospheric Hazards



Supplementary Studies / System



How can short-term forecasts of atmospheric hazards be produced?

- Urban and regional-scale numerical models used to predict atmospheric hazards

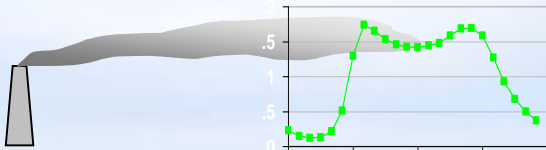
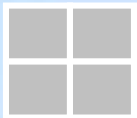
FORECAST DATA INPUTS*

Meteorological data, boundary conditions



FINE-SCALE HISTORICAL DATA INPUTS**

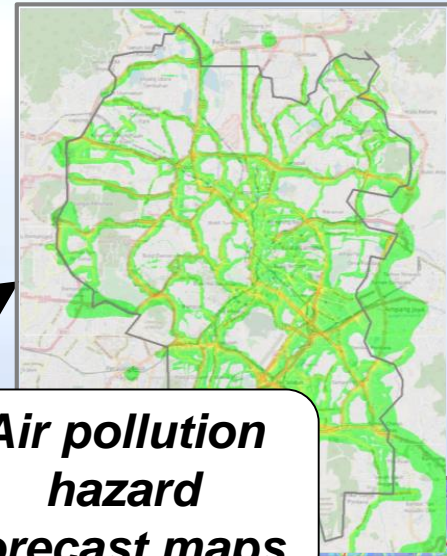
Traffic flows and other emissions / activity data



NUMERICAL MODEL

CERC UKM PAKARUNDING

UKMP modelling using ADMS-Urban: Kuala Lumpur (1 hour)



Air pollution hazard forecast maps



CERC modelling using ADMS-Urban: London (annual mean)

*Forecast data inputs are usually from another model e.g. regional scale

**Representative data inputs can be derived from historical data if near-real-time data unavailable

Near-real-time urban heat forecasts

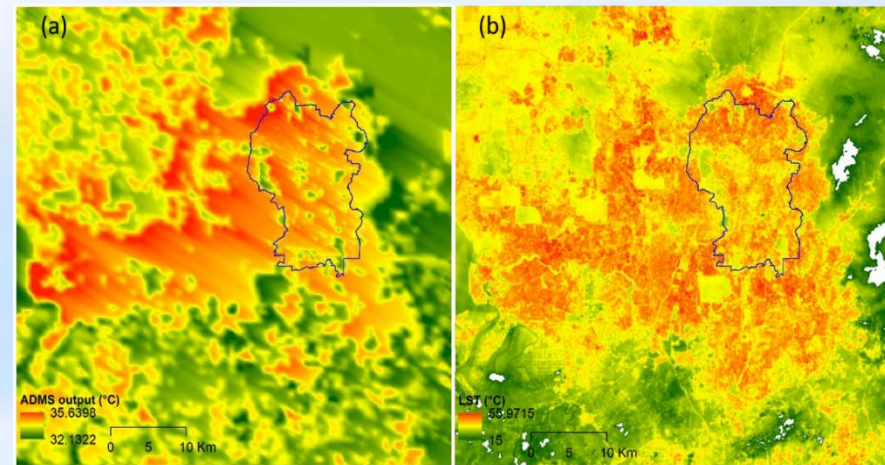


Why forecast urban heat?

- Extreme temperatures have health impact
 - Both heatwaves and cold weather
- Urban fabric and morphology produces local and city scale variations in climate
- Local and city scale variations in climate influence air quality
 - Pollutant dispersion is affected, chemical reaction rates are temperature dependent

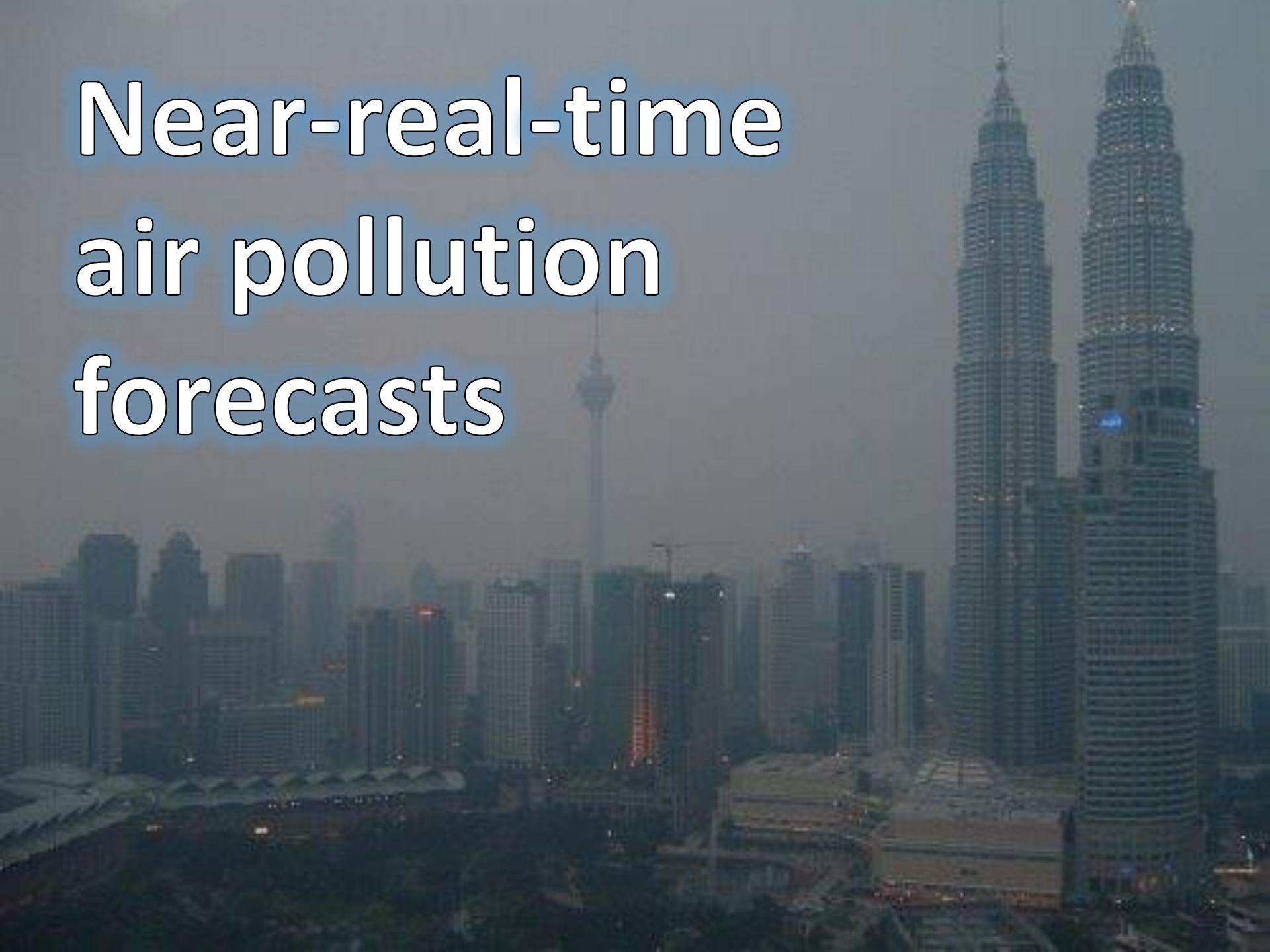
Presenting urban heat forecasts

- Temperatures are well understood by the general public and decision-makers
 - Use appropriate units for the audience ($^{\circ}\text{C}$, $^{\circ}\text{F}$)
 - Consider using 'feels like' temperature (wind speed, humidity)
- Threshold values
- Colour-shaded maps



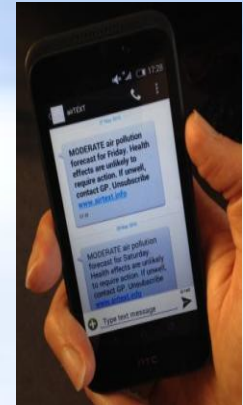
(a) ADMS-Urban modelled air temperatures and (b) derived Land Surface Temperatures for the Greater Kuala Lumpur region. Wang et al., *Geoscience Letters*

Near-real-time air pollution forecasts



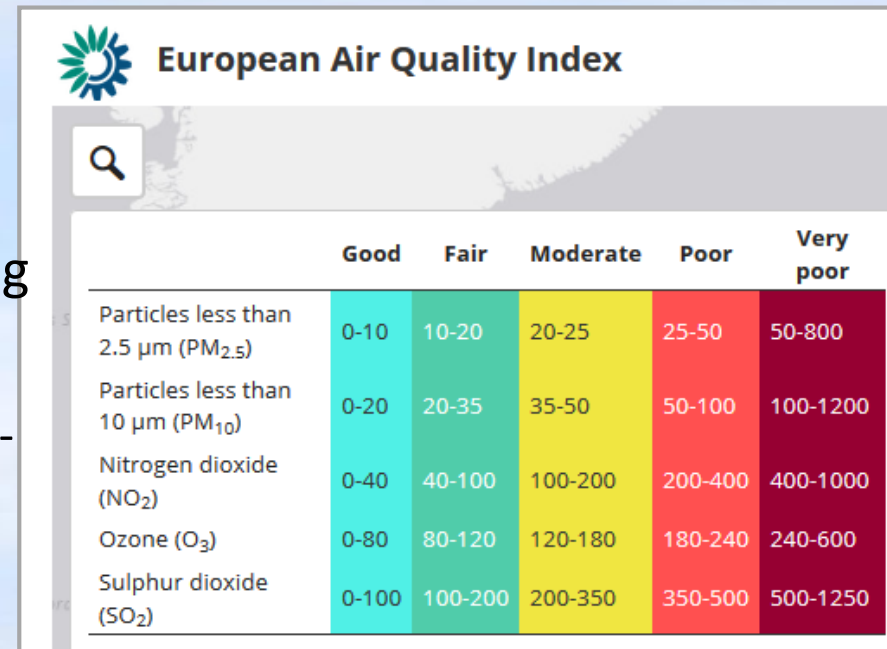
Why forecast local air pollution?

- Impact of air pollution episodes
 - Population suffers health impacts. Particularly those with heart or lung conditions or other breathing problems.
- Measurements alone cannot give advance warning
- Advance warning enables action
 - Enable decision makers to alleviate forecast episodes. E.g. reduce road traffic, provide more public transport.
 - Enable the public to reduce their personal exposure by avoiding areas of higher pollution.



Presenting forecasts of air quality

- **Challenge:** typically the general public and government decision makers do not understand concentrations or have knowledge of different pollutants
- **Solution:** Air Quality Indices. Communicate air quality levels for one day across several pollutants. May use
 - A single number from a defined range, e.g. 1-500
 - A band, e.g. “Moderate”
 - Supporting information
 - Colours
- Considerations when choosing concentration values and averaging times for an air quality index
 - Air Quality Standards
 - Evidence on health effects of short-term exposure
 - Typical air quality levels



The screenshot shows the European Air Quality Index (AQI) website. It features a search bar and a table with five columns representing quality levels: Good (light blue), Fair (teal), Moderate (yellow), Poor (red), and Very poor (dark red). The table lists concentration ranges for five pollutants: Particles less than 2.5 µm (PM_{2.5}), Particles less than 10 µm (PM₁₀), Nitrogen dioxide (NO₂), Ozone (O₃), and Sulphur dioxide (SO₂).

	Good	Fair	Moderate	Poor	Very poor
Particles less than 2.5 µm (PM _{2.5})	0-10	10-20	20-25	25-50	50-800
Particles less than 10 µm (PM ₁₀)	0-20	20-35	35-50	50-100	100-1200
Nitrogen dioxide (NO ₂)	0-40	40-100	100-200	200-400	400-1000
Ozone (O ₃)	0-80	80-120	120-180	180-240	240-600
Sulphur dioxide (SO ₂)	0-100	100-200	200-350	350-500	500-1250

Air Pollutant Index of Malaysia

API Value	Band	Advice
Below 50	GOOD	Low pollution without any bad effect on health
51 – 100	MODERATE	Moderate pollution that does not pose any bad effect on health
101 – 200	UNHEALTHY	Worsen the health condition of high risk people who is the people with heart and lung complications
201 – 300	VERY UNHEALTHY	Worsen the health condition and low tolerance of physical exercises to people with heart and lung complications. Affect public health
Above 300	HAZARDOUS	Hazardous to high risk people and public health

http://apims.doe.gov.my/public_v2/faq.html

- The Air Pollutant Index system of Malaysia closely follows that of the US EPA
- The concentration breakpoints are linked to the Malaysian Air Quality Standards

Comparing index schemes

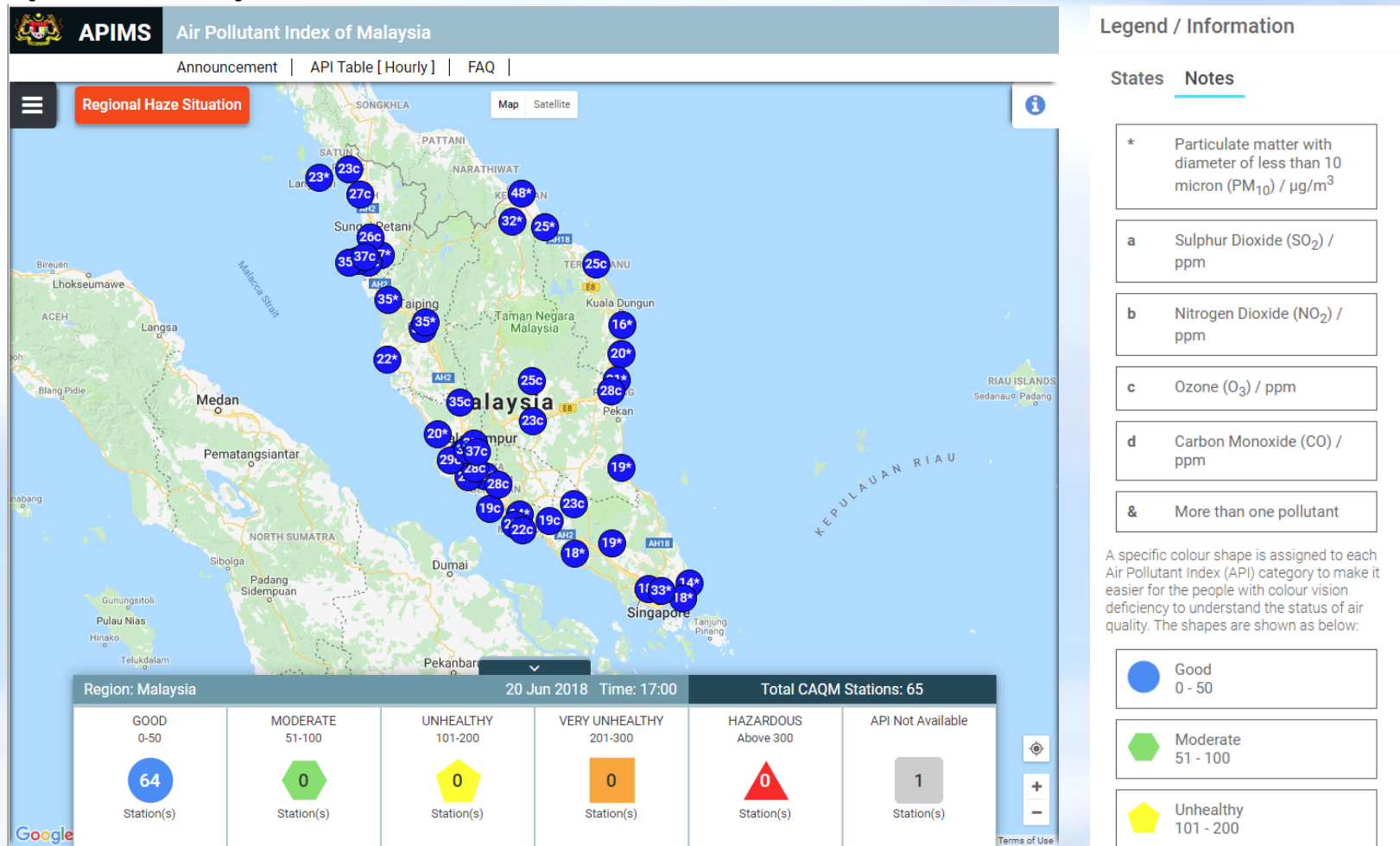
Index	Pollutants and averaging times					
	PM2.5	PM10	NO2	O3	SO2	CO
Malaysian Air Pollutant Index	N/A	24-hr	1-hr	1-hr	24-hr	8-hr
US EPA Air Quality Index	24-hr	24-hr	1-hr	1-hr / 8-hr	1-hr / 24-hr	8-hr
UK Daily Air Quality Index	24-hr	24-hr	1-hr	8-hr	15-min	N/A
European Air Quality Index	24-hr	24-hr	1-hr	1-hour	1-hour	N/A

- Malaysian API and US-EPA AQI are linked to the respective air quality standards
- The UK DAQI is based on evidence of health impacts of short-term exposure
- The European AQI aims to reconcile evidence of health impacts, air quality standards, and also ensure there is some day-to-day variation in the AQI

Existing air quality platforms



Malaysian DOE platform for air quality measurements



London 'airTEXT' platform

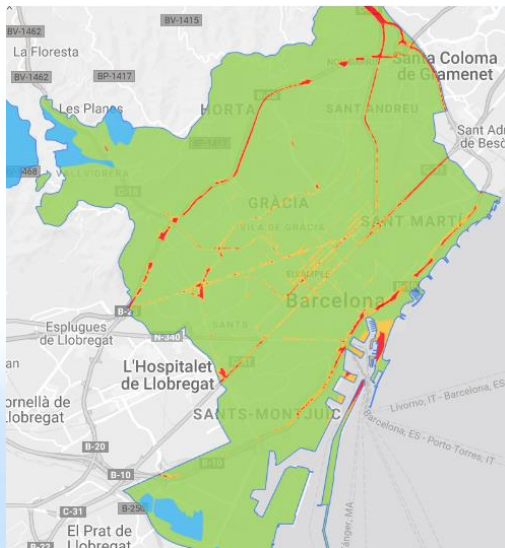


- System covers all of London
- Created and operated by CERC
- Over 10,000 subscribers
- Street level (~10m) pollution contours posted to web
- Alerts sent by email, text message or voice message
- Phone app
- Uses ADMS-Urban
- Forecast for three days
- Produced for the Mayor of London
- www.airtext.info



Other air quality platforms

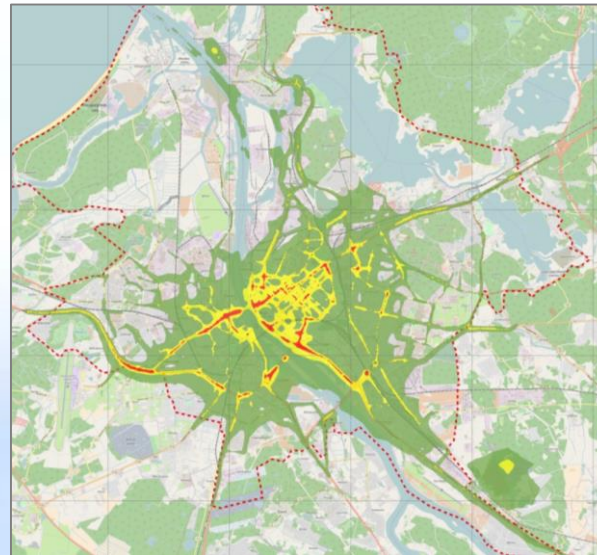
Barcelona, Spain



<https://ajuntament.barcelona.cat/qualitativaire/en/>

- Uses ADMS-Urban
- High resolution maps
- Email alerts

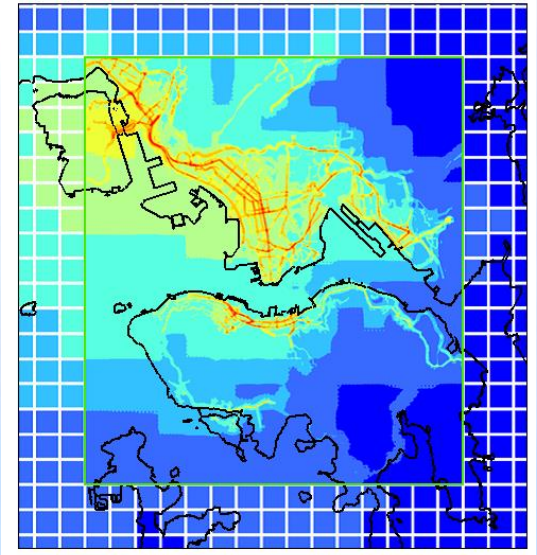
Riga, Latvia



www.rigaairtext.lv

- Uses ADMS-Urban
- High resolution maps
- Email and SMS alerts
- Phone app

Hong Kong, China



<http://praise.ust.hk>

- Uses ADMS-Urban
- High resolution maps
- Alerts
- Phone app
- *Under development*

Thank you

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