

June 2023



# The Way Forward on Air Quality Management in Lao PDR: Analysis of Available Air Quality Data and Recommendations on Air Quality Management Measures

# Outline

- 1. Context**
- 2. Assessment of existing Laos air quality data, monitoring equipment, and data management**
- 3. Using an emissions-factor approach to identifying key sources of air pollution in Laos**
- 4. Using satellite products to examine different aspects of air pollution**
- 5. Recommendations on the way forward**

# Context



Laos' comparative advantage is its natural capital, which has fueled rapid growth averaging around 8 percent per annum since 2000. But the country's past natural resource-based growth model is not sustainable in the long run.



The 2022 Yale Environmental Performance Index ranked Lao PDR 149 of 180 countries, and among the lowest countries for air pollution, which is significant as exposure to air pollution lowers cognition and human capital formation

**In Laos, environmental pollution contributed to 10,000 deaths in 2017 (22 percent of all deaths in Laos) and 27 percent of these deaths were from ambient air pollution.** The cost of health effects from ambient air pollution in 2017 amounted to a 3.5 percent equivalent cost of GDP (World Bank, 2021)



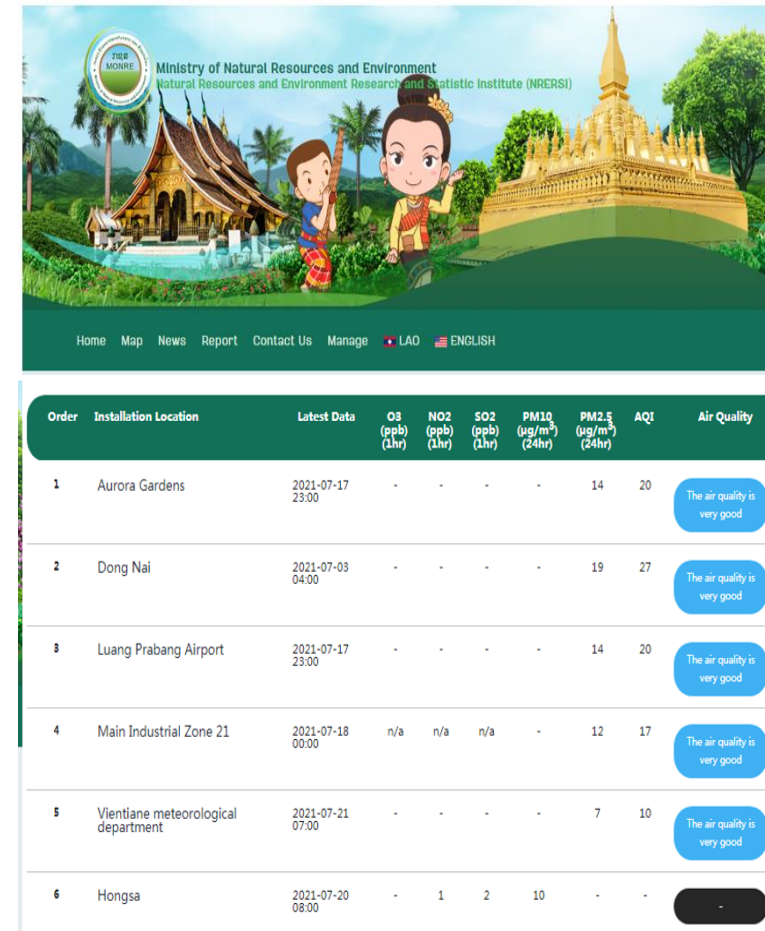
Recognizing the importance of addressing air pollution, the Government of Lao PDR has included relevant priority measures in its 9th National Socio- Economic Development Plan (NSEDP).



This includes (i) conducting environmental quality inspections, in particular on air quality (PM<sub>2.5</sub>), establishing a database system and collecting information on sources of pollution; (ii) implementing measures to reduce and prevent bush fire, haze and slash and burn agricultural practices at all hotspots; and (iii) solve air pollution problems

# Lao PDR has started to build the foundation for air quality management (AQM)

- MoNRE is implementing AQM monitoring activities, including cataloguing pollutants and devising sampling procedures, and setting air quality targets.
- MoNRE has installed air quality monitoring equipment to begin building a nationwide air quality monitoring network (currently ten stations, 9 of which were supported by WB LENS 2 project)
- National air quality and emissions standards have been established
- Public disclosure of AQI on NRERI website from monitoring stations



The screenshot shows the website of the Ministry of Natural Resources and Environment (MoNRE) of Laos. The header includes the MoNRE logo and the text 'Ministry of Natural Resources and Environment' and 'Natural Resources and Environment Research and Statistic Institute (NRERI)'. Below the header is a navigation menu with links for Home, Map, News, Report, Contact Us, and Manage, along with language options for LAO and ENGLISH. The main content area displays a table of air quality monitoring stations. The table has columns for Order, Installation Location, Latest Data, O3 (ppb) (1hr), NO2 (ppb) (1hr), SO2 (ppb) (1hr), PM10 (µg/m³) (24hr), PM2.5 (µg/m³) (24hr), AQI, and Air Quality. The data shows that most stations have very good air quality, with one station (Hongsa) having a slightly higher AQI of 10.

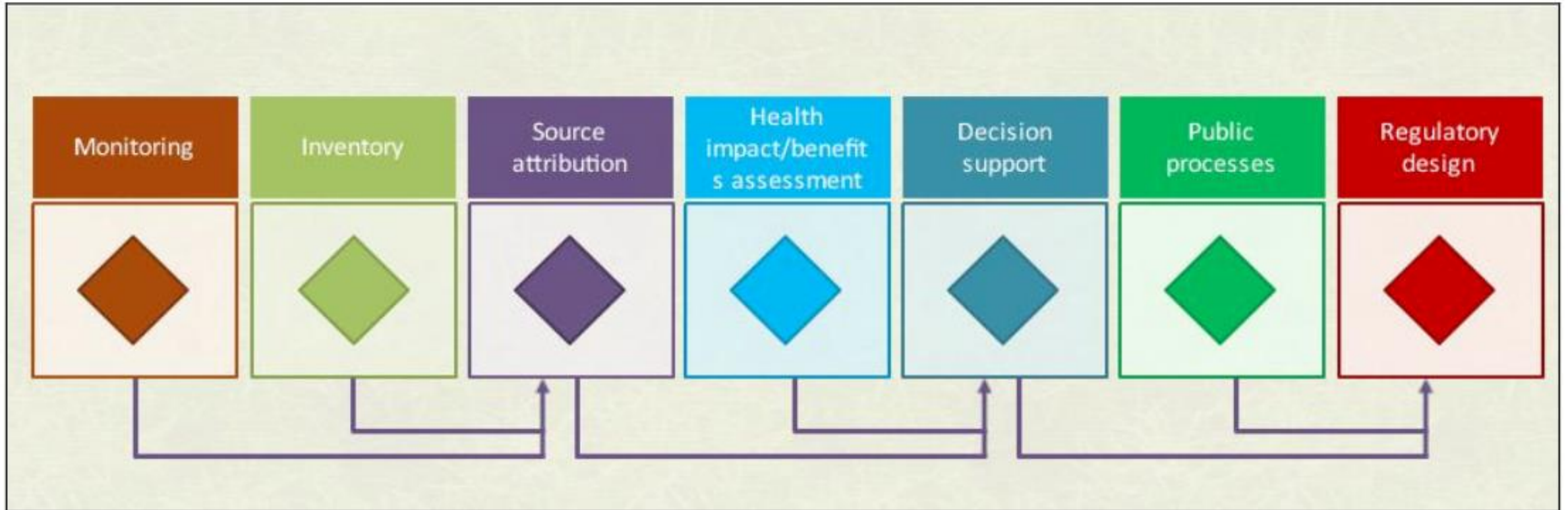
Order	Installation Location	Latest Data	O3 (ppb) (1hr)	NO2 (ppb) (1hr)	SO2 (ppb) (1hr)	PM10 (µg/m³) (24hr)	PM2.5 (µg/m³) (24hr)	AQI	Air Quality
1	Aurora Gardens	2021-07-17 23:00	-	-	-	-	14	20	The air quality is very good.
2	Dong Nai	2021-07-03 04:00	-	-	-	-	19	27	The air quality is very good.
3	Luang Prabang Airport	2021-07-17 23:00	-	-	-	-	14	20	The air quality is very good.
4	Main Industrial Zone 21	2021-07-18 00:00	n/a	n/a	n/a	-	12	17	The air quality is very good.
5	Vientiane meteorological department	2021-07-21 07:00	-	-	-	-	7	10	The air quality is very good.
6	Hongsa	2021-07-20 08:00	-	1	2	10	-	-	-

# Recent high-levels of air pollution emphasize the urgency for further action



- In response to recent high PM 2.5 levels (around 3 times the WHO standard level over a 24 hour period), the Cabinet has ordered urgent action from central and local authorities to tackle air pollution.
- Many schools have been closed in the country as a result
- Air pollution has also impacted domestic tourism with bookings being cancelled and vacations being shortened. Flights to northern Laos have been impacted

# Air Quality Management Planning



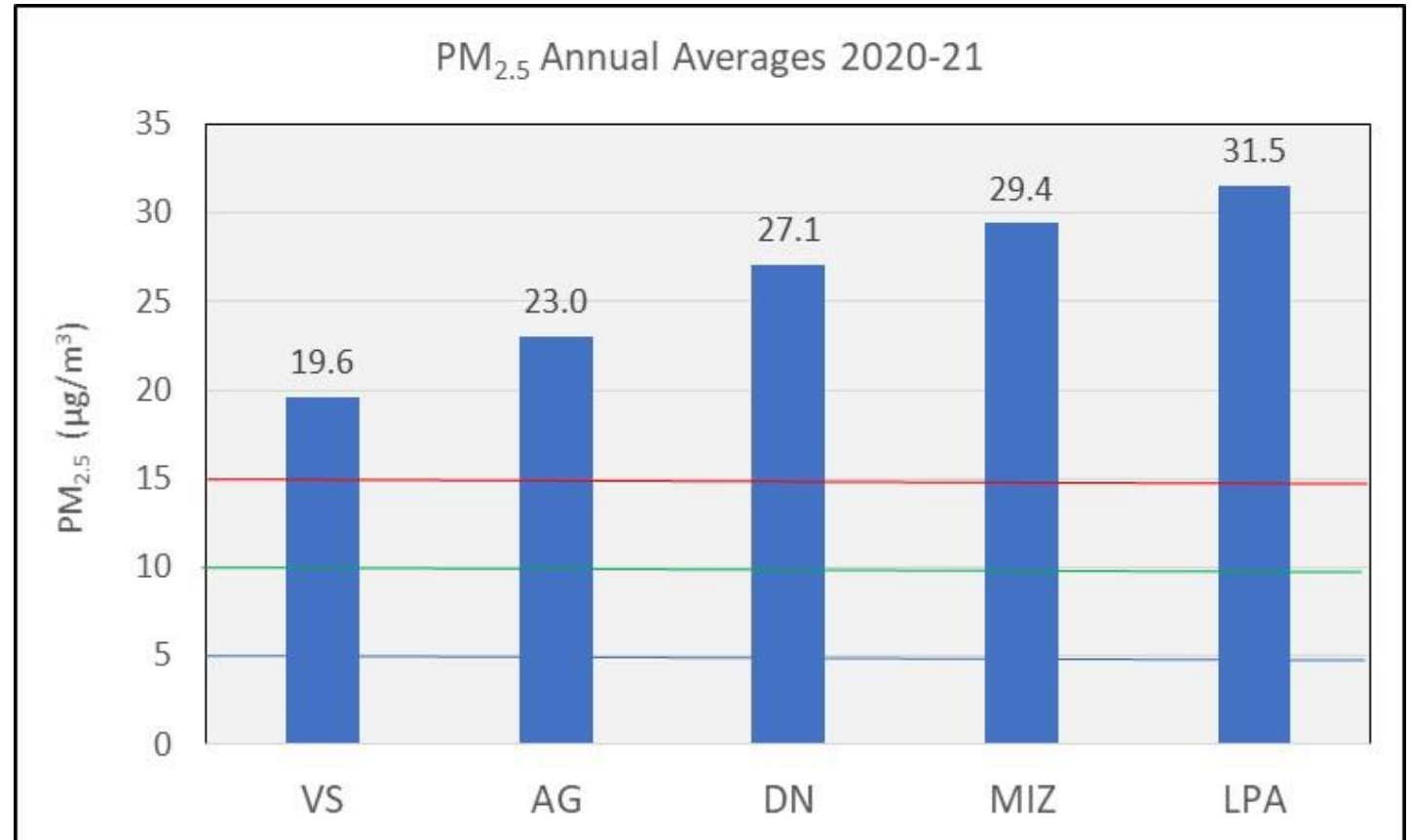
Source: World Bank

# Assessment of existing AQ data, monitoring equipment and data mgmt

Assessment of one year of air quality data (June 2020 – May 2021) from five official air quality monitoring stations, together with additional metadata and meteorological data

Monitored annual average PM<sub>2.5</sub> concentrations exceeded national and international air quality standards significantly (4-6 x WHO guidelines)

The Luang Prabang Airport station, located about 200 km north of the capital, recorded the highest mean PM<sub>2.5</sub> concentrations



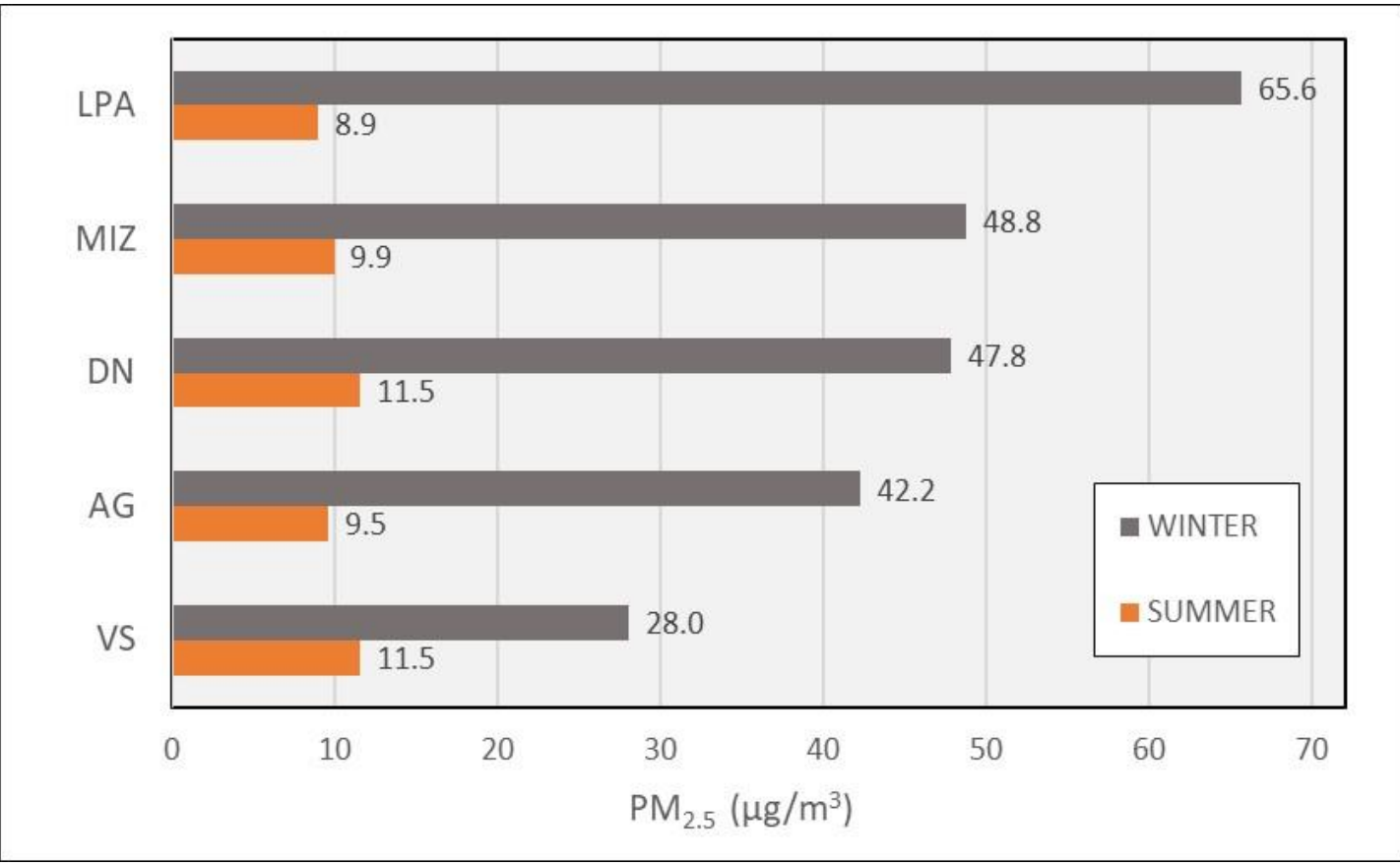
Annual average PM<sub>2.5</sub> concentration values at the five AQ stations in 2020-21. The horizontal red line indicates the annual mean Lao PDR PM<sub>2.5</sub> air quality standard of 15 µg m<sup>-3</sup>. The green line indicates the WHO-2005 PM<sub>2.5</sub> air quality guideline of 10 µg m<sup>-3</sup>. The blue line indicates the recently revised WHO-2021 PM<sub>2.5</sub> air quality guideline of 5 µg m<sup>-3</sup>.

# Assessment of existing AQ data, monitoring equipment and data mgmt

The pollution levels during the dry months of January – March were significantly higher than during the wet months of June – August.

Roughly 20% of particulate matter data were missing or corrupted pointing to need for QA/QC of monitoring

Usable gaseous concentration data were available only from the main industrial zone station and the Hongsa private station at the lignite fired power plant, but completeness was even lower.



The mean 24-hour average PM2.5 values (µg m-3) over three months of the winter and summer at each of the five AQM stations

# Using an emissions-factor approach to identifying key sources of air pollution

- An emissions factor approach was tested to estimate sources of non-point source pollution, including agricultural activities and land-use change, as well as potential sources of point source pollution
- Applying emissions factors to estimated activity levels allows the rapid estimation of important pollution sources without large additional data requirements. It can serve as an initial basis towards comprehensive and up-to-date methods of estimating pollution loads and developing an emissions inventory

## Important caveats:

- The estimates generated to demonstrate this approach include emissions from burning agricultural residues, emissions from land clearance, and point source air pollution emissions from the cement sector and Hong Sa lignite fired power plant. **Key sources such as transport and open burning of solid waste are also likely to be important contributors to air pollution although data was not available at the time of this study to enable a preliminary analysis of these sources.**
- This approach would not yet be able to clearly identify the most significant sources unless there is a comprehensive set of activity data and emission factors for all sectors. There is also a degree of uncertainty around these estimates, relating to both the appropriateness of emissions factors, the accuracy of activity data and the extent to which pollution control equipment is installed and in use

# Non-point source pollution

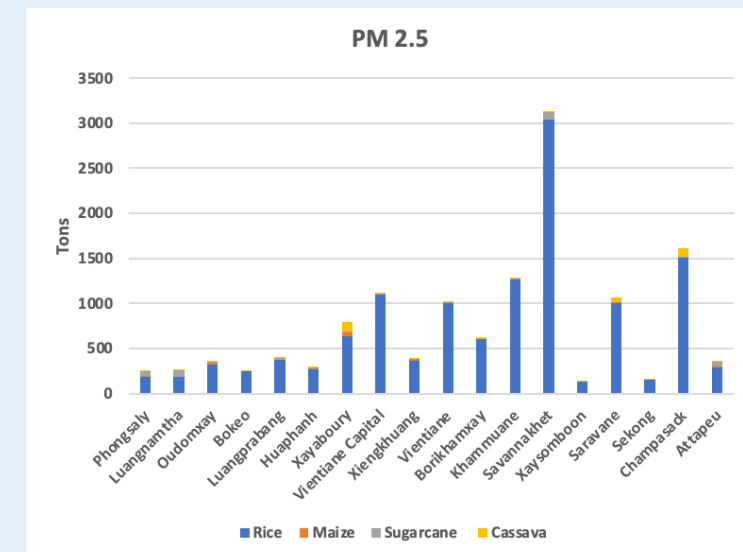
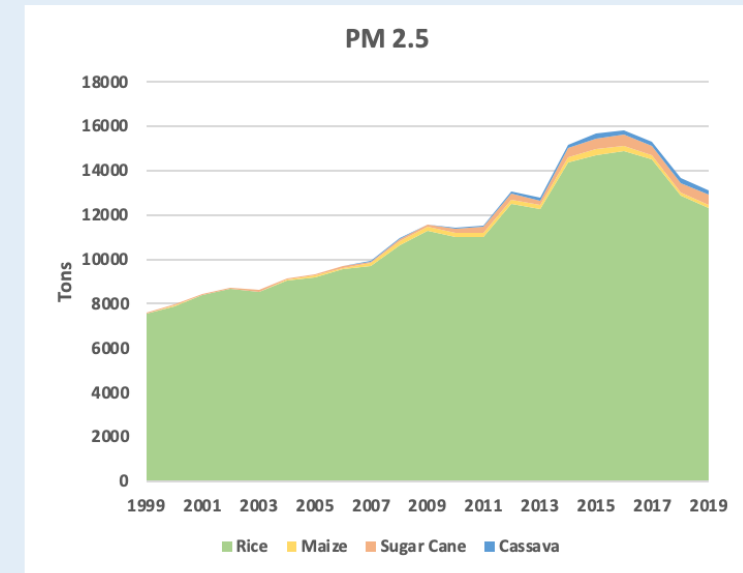
Recognizing that these estimates need to be verified and complemented with other important source sectors, seasonal open burning of biomass appears to be a large source of air pollution from particulate matter

Emissions from open burning of agricultural residues were estimated for the major crops - rice, maize, sugar cane and cassava. This air pollution is dominated by particulates (PM<sub>10</sub> and PM<sub>2.5</sub>).

Estimated emissions from the burning of agricultural residue have shown a declining trend since reaching a peak in 2016. This reflects a decline in crop production figures for the crops considered here since 2016

The use of fire to clear land as part of shifting cultivation and the more general clearance of forest and scrub land are also likely important sources of seasonal air pollution from the open burning of biomass in Lao PDR

The rate of forest clearing increased during 2018 to 2020, reflected in increasing air pollution from this source. The amount of forest biomass burnt increased very significantly from over 90,000 tons in 2018 to over 250,000 tons in 2020

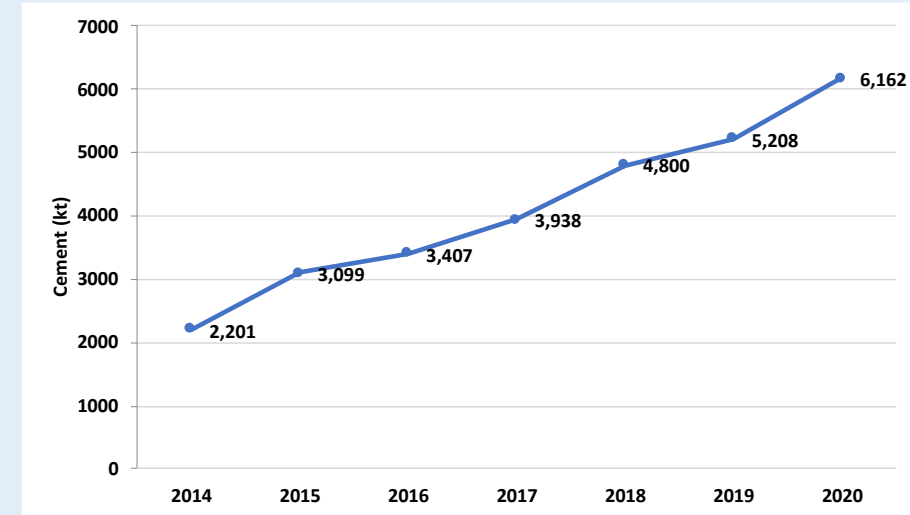


# Point source pollution

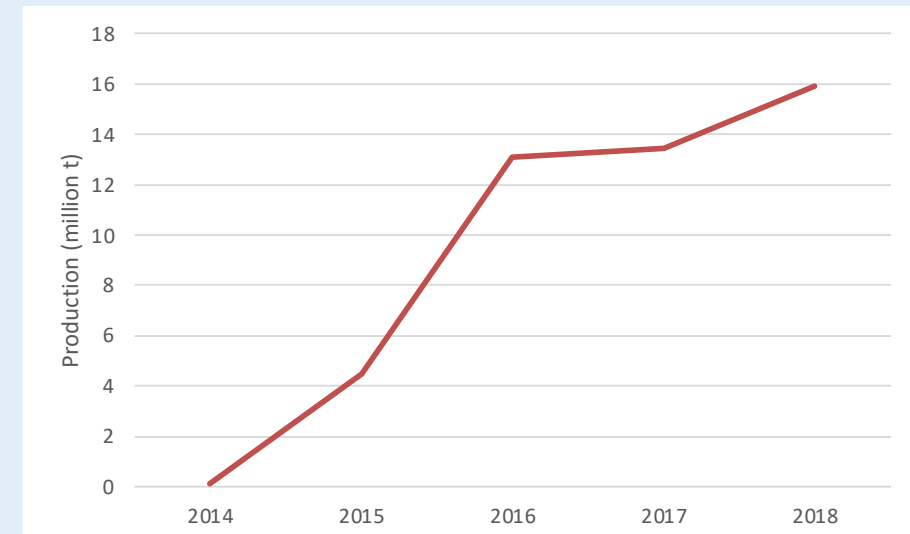
Over the past decade, emissions from the cement sector have increased significantly. Estimated emissions in 2019 from production of 6.2 million tons of cement are 16,000 tons of SO<sub>2</sub>, 5,400 tons of PM<sub>10</sub>, 6,300 tons of NO<sub>x</sub> and almost 2 million tons of CO<sub>2</sub>

The estimated emissions from the Hong Sa Thermal power plant are also very significant. Estimated annual emissions of particulate matter is 32,526 tons

National cement production 2014-2020 (kt)



Lignite production 2014-2018 (million t)



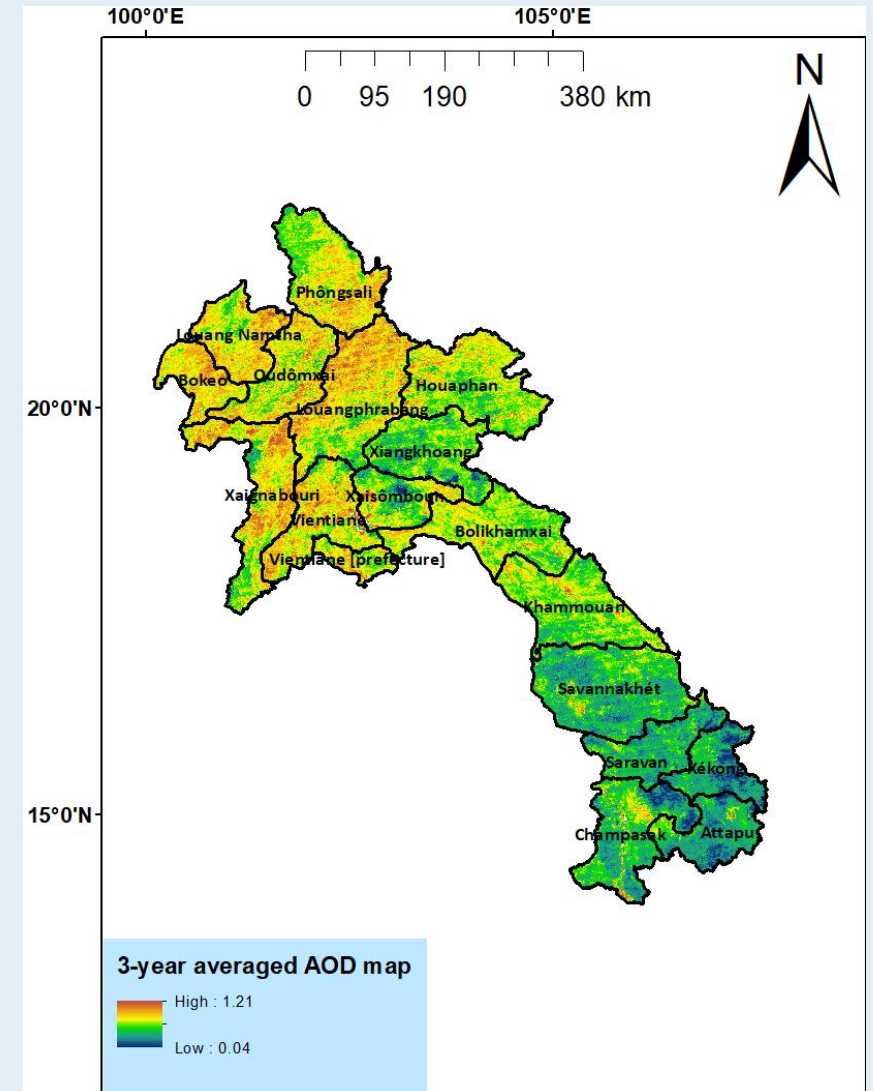
# Using satellite products to examine different aspects of air pollution

Satellite Aerosol Optical Depth (AOD) products were used to examine different aspects of air pollution in Lao PDR, focusing on PM<sub>2.5</sub> including the relationship between satellite AOD and ground PM<sub>2.5</sub>, spatial and seasonal variation and transboundary transport of pollution. **AOD satellite images correlate with ground PM<sub>2.5</sub> observations in Lao PDR**

AOD values as an indicator of PM<sub>2.5</sub> emissions show that higher PM air pollution is observed in the northern region than in the southern region of Lao PDR, particularly in the provinces of Luang Prabang, Sayaboury, BoKeo, Luang Namtha, Oudomxay and Vientiane

Air pollution tends to increase in the first months of the year from February to May, especially in March and April

Transboundary air pollution from Myanmar and Thailand to Northern Laos and from Laos to Northern Vietnam tends to occur during March and April, when winds in the bordering area between Eastern Myanmar, Northern Thailand and Northern Laos have Southwest direction. Requires further research.



# Recommendations on the way forward

Building on the technical analyses, the studies offered a number of detailed recommendations to improve air quality management in Lao PDR

The priority actions identified are foundational next steps for building Lao PDR's air pollution management framework

## Strengthen air quality monitoring

- Calibrate and compare the FPM-377C monitor alongside a standard BAM instrument for a few days
- Calibrate all AQM instruments at regular intervals and check the data regularly, preferably daily, to identify any malfunctions that may be occurring
- Upgrade the existing AQM stations by installing additional equipment to effectively monitor other parameters beside PM<sub>2.5</sub> (ie NO<sub>x</sub>, SO<sub>x</sub>, O<sub>3</sub>, and CO)

## Capacity building

- Emission source monitoring (focusing on provincial level and specific sources);
- Data storing, managing, processing and reporting for decision making;
- O&M of AQM equipment and stations (focusing on provincial level network)

## Improving air quality data management and information system

- Carry out frequent validations of AQM data, including identifying erroneous or invalid data
- Develop a well-structured database within MONRE to receive, store, and manage emission monitoring data of point sources

## Building an emission inventory with coefficients and real field data

- Extend the database of emissions coefficients to cover all emissions types and sector
- Obtain more detailed activity data

## Regulatory and institutional strengthening

- Complete and formalize the National Pollution Control Strategy and Action Plan

## Air pollution reduction measures

- Identify sources with high exceedance levels of PM<sub>2.5</sub> through a PM<sub>2.5</sub> source apportionment study

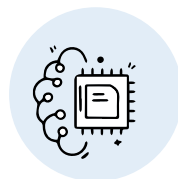


# AQM measures to be supported by EWMP

Focus of support will be on AQ monitoring network enhancement (to be led by NRERI) which would build on the existing 10-site Air Quality Monitoring Stations (AQMS) in place but would include resources to improve the completeness and reliability of the network and work to understand exposure to air pollution where no monitoring exists. This includes support across the following:



**Establish SOPs and QA/QC protocols for AQMS** and implement capacity building trainings for national/local gov staff. **Calibrate/repair and upgrade existing stations** to ensure reliability of operation, data collection and storage.



**Conduct limited deployment of low-cost sensors** in provinces that currently have no AQMS and **to enable use of global remote sensing products** to estimate human exposure to PM<sub>2.5</sub> with reduced uncertainty



**Foundational support for the development of a Lao National Emissions Inventory.**



**Enhance disclosure of information on PM<sub>2.5</sub> to public** by enhancing the robustness of MONRE's existing Air Quality Index (AQI) website by developing and linking to a smart-phone application.

# Additional priority next steps

- Conduct source apportionment analysis in Vientiane to robustly determine which sectors are primary contributors to air pollution
- Analyses/deep dives of AQ interventions in priority sectors (e.g., biomass-based sources -> agriculture, forestry) and support design of cost-effective interventions
- Improve reporting on AQ progress through “State of the air” annual reporting
- Regional exchange



# THANK YOU



Studies were conducted by:



Funding from:

