Basic Training on the Global InMAP Model: A Workshop

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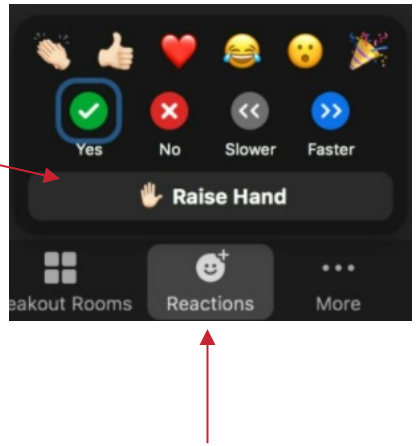
10th–11th March 2022

Zoom Housekeeping

Welcome to our workshop! Here are a few notes about using Zoom:

- You will be **automatically muted** upon joining the webinar.
- To **mute** or **unmute** yourself, use the microphone icon.
- Please **raise your hand** to speak using the “Reactions” icon and **lower your hand** when you are done.
- Use the **chat feature** to add comments and share input.
- If you have **technical issues**, please use the chat feature to message Emily Klos.
- You can adjust your audio through the **audio settings.** If you are having issues, you can also dial-in and listen by phone, which can be found in your registration confirmation email.



Reminder: Please register separately for Day 2 of the workshop (tomorrow). A link to register is in the chat.

Welcome Remarks

Scott Bartos, United States Agency for International Development
Beni Suryadi, ASEAN Centre for Energy

Project Team

Garvin Heath, Strategic Energy Analysis Center, NREL
Vikram Ravi, Strategic Energy Analysis Center, NREL
Jason Hill, Dept. of Bioproducts & Biosystems Engineering, U. Minnesota
Sumil Thakrar, Dept. of Bioproducts & Biosystems Engineering, U. Minnesota

Background Quiz

Question 1

How many excess deaths were associated with air pollution exposure in ASEAN countries in 2019?

- Tens of thousands (~10,000)
- Hundreds of thousands (~100,000)
- Millions (~1,000,000)

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McDuffie et al. (2021) estimate 130,000 – 320,000 excess deaths from ambient $PM_{2.5}$ exposure in ASEAN countries in 2019.

Question 2

Deaths from ambient air pollution are mostly from fine particles ($PM_{2.5}$) followed by ozone. How many times more excess deaths in ASEAN countries were caused by ambient $PM_{2.5}$ than by ozone in 2019?

- Around 5 ×
- Around 10 ×
- Around 50 ×

Question 2

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- Around 10 ×
- **Around 50 ×**

The Global Burden of Disease estimate ~9,000 deaths from ambient ozone exposure, 44 × less than from ambient $PM_{2.5}$.

Question 3

Of the ~300,000 excess deaths associated with ambient $PM_{2.5}$ exposure in ASEAN countries, what percentage are attributable to the power sector?

- Around 10%
- Around 20%
- Around 25%

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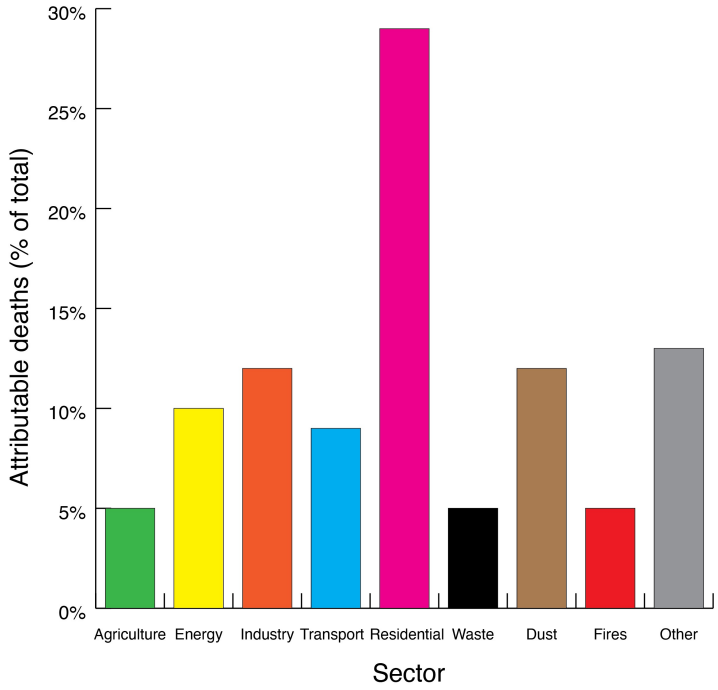


6% from coal and 4% from non-coal energy (McDuffie et al., 2021).

~10,000 – 40,000 deaths each year

Background Summary

- Long-term exposure to ambient $PM_{2.5}$ is the most important environmental health risk
- Understanding how policies change human health through changes in pollutant emissions is key to alleviating health risks
- Air quality models such as Global InMAP are necessary for this purpose

Workshop Summary

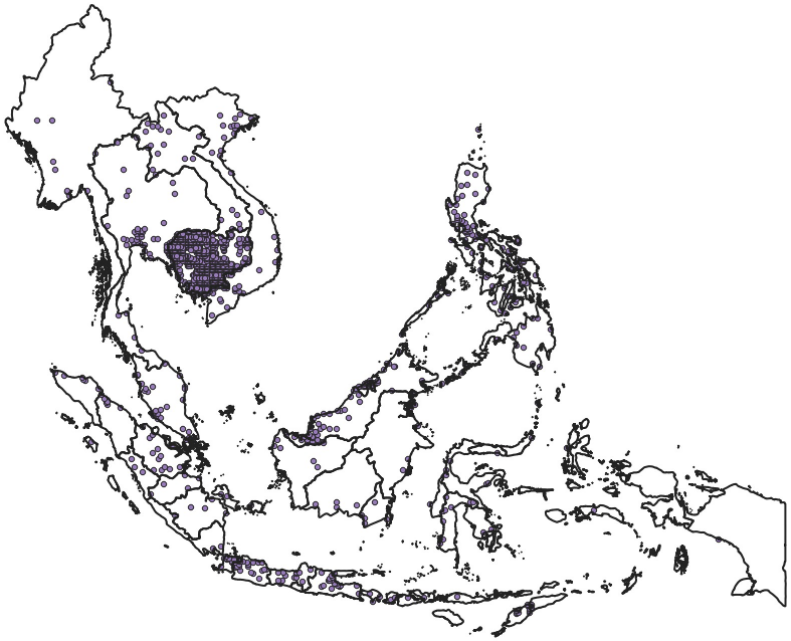
Workshop Overview

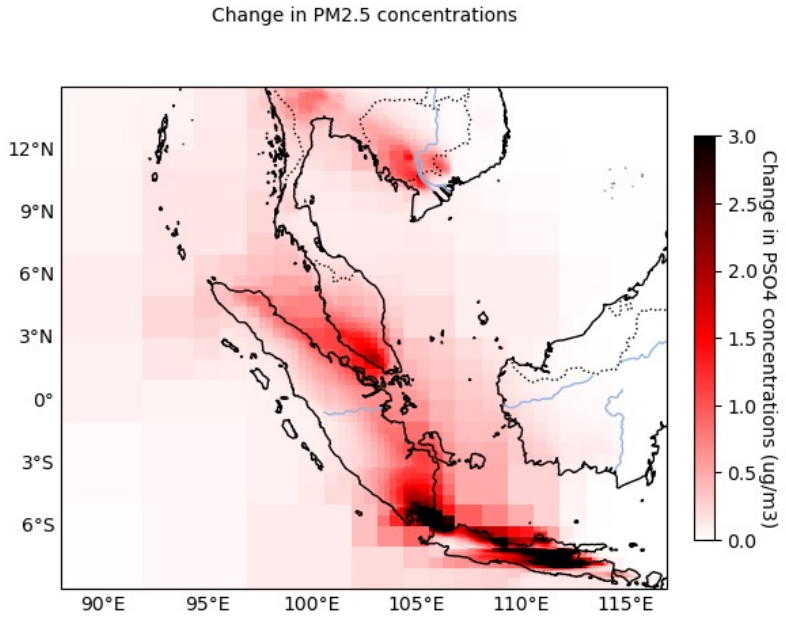
- **Module 1** (10th March): Installing Global InMAP and understanding everything necessary for configuring and running it

- **Module 2** (11th March): Preparing emissions, running Global InMAP, and exploring the model outputs

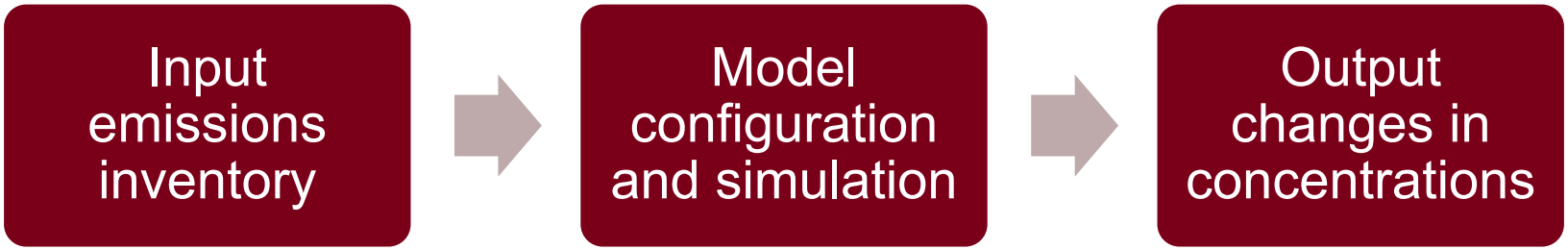
Module 1: Introduction to Global InMAP and model set-up

- Today, we will:
  - Learn to prepare emissions for input into Global InMAP
  - Learn how to run Global InMAP to estimate changes in pollutant concentrations





Basic Global InMAP workflow



- We will discuss each of these briefly now, including the model configuration in detail
- Tomorrow, we will run through the whole process

Input emissions inventory

- Emissions inputs are in the ESRI Shapefile format:

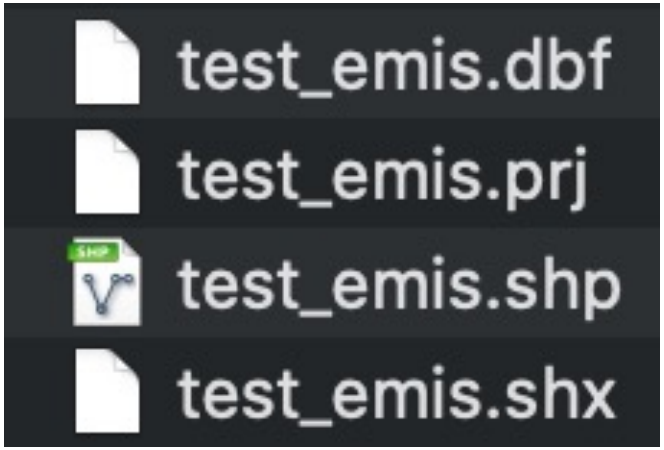
The *.dbf* file stores the feature attributes

The *.prj* file describes the shapefile projection

The *.shp* file describes feature geometry (points, lines, areas)

The *.shx* file describes feature index

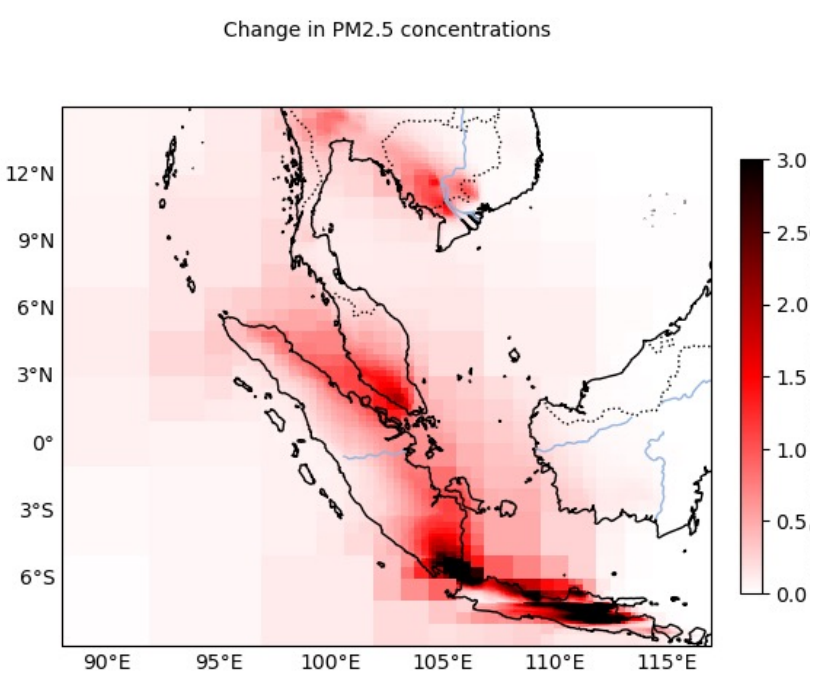
(The *.qml* file describes imaging style)

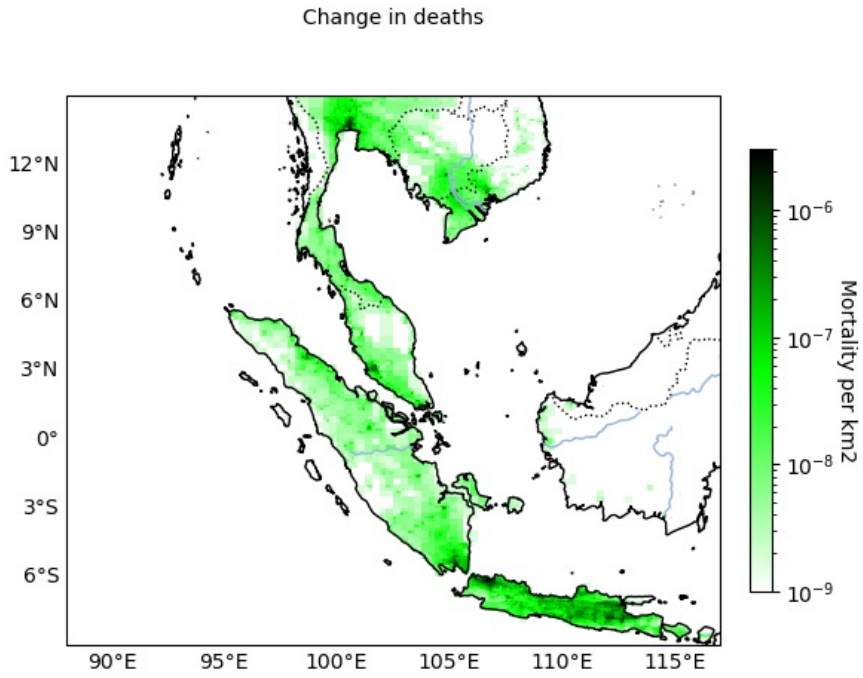


- The inputs are in units of ton/year, kg/year, or µg/s
- For each primary pollutant ($PM_{2.5}$, SO_x, NO_x, NMVOC, and NH_3) there is 1 attribute
- There are also attributes for stack parameters (height, diameter, temperature, velocity) of elevated emissions

Output changes in concentrations

- Global InMAP results are saved as an ESRI Shapefile
- The results give annual average changes in $PM_{2.5}$ concentrations across space
- Also: speciated $PM_{2.5}$ concentrations and mortality





Model configuration and simulation

- The basic command we will be running is the following:

```
inmap run steady -s --config=sampleConfig.toml
```


"inmap" calls the executable. In this workshop, we will download a release of InMAP, so it will be called something like "inmap-v1.9.5-darwin-amd64"

"run steady -s" tells InMAP to run in a mode where the grid is already saved out in a *.gob* file specified in the configuration. This is faster for our purposes.

"sampleConfig.toml" is the path to the configuration file that describes the Global InMAP set-up, including the emissions input files, and the grid.

Installing Global InMAP on your local machine

First download a copy of the input data:

1. https://github.com/SumilThakr/asean_workshop
2. https://z.umn.edu/asean

Then, install the latest release for your machine:

3. https://github.com/spatialmodel/inmap/releases

Overview of the configuration file

sampleConfig.toml

Please use a text editor that does not use Rich Text Formatting

Windows: Notepad, WordPad, Notepad++

Mac OS: TextEdit, Emacs, Vim

The Configuration File

- The configuration file is in the TOML format, and tells Global InMAP everything it needs to know to run your simulation
- We will be looking at *sampleConfig.toml* and talking about 5 main parameters in turn:
  - *VariableGridData:* The path to the computational grid.
  - *EmissionsShapefiles:* The path to the emission inputs.
  - *EmissionUnits:* The units of the emissions.
  - *OutputFile:* The path to where InMAP results go.
  - *OutputVariables:* The desired attributes for the InMAP results.

VariableGridData

```
5 # VariableGridData is the path to the location of the variable-resolution gridded
6 # InMAP data, or the location where it should be created if it doesn't already
7 # exist. The path can include environment variables.
8 VariableGridData = "test_grid.gob"
```

EmissionsShapefiles

```
10 EmissionsShapefiles = [
11     "./test_emis.shp"
12 ]
```

EmissionUnits

```
14 # EmissionUnits gives the units that the input emissions are in.
15 # Acceptable values are 'tons/year', 'kg/year', or 'ug/s'.
16 EmissionUnits = "tons/year"
```

OutputFile

```
20 # OutputFile specifies the path to the desired output shapefile location. It can
21 # include environment variables.
22 OutputFile = "inmap_test_results.shp"
```

OutputVariables

```
57 # OutputVariables specifies which model variables should be included in the
58 # output file. Each output variable is defined by the desired name and an
59 # expression that can be used to calculate it
60 # (in the form VariableName = "Expression"). These expressions can utilize
61 # variables built into the model, user-defined variables, and functions.
62 # Available functions include:
63 # 'exp(x)' which applies the exponetional function e^x.
64 # 'log(x)' which applies the natural logarithm function log(e).
65 # 'log10(x)' which applies the base-10 logarithm function log10(e).
66 # Note: Environment variables can be used in both variable names and expressions.
67 [OutputVariables]
68 TotalPM25 = "PrimaryPM25 + pNH4 + pSO4 + pNO3 + SOA"
69 TotalPop = "TotalPop"
70 AllCause = "AllCause"
71 PSO4 = "pSO4"
72 PNO3 = "pNO3"
73 PNH4 = "pNH4"
74 SOA = "SOA"
75 SOx = "SOx"
76 NH3 = "NH3"
77 NOx = "NOx"
78 BasePM25 = "BaselineTotalPM25"
```

Time for Questions