Basic Training on the Global InMAP Model: A Workshop

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10th – 11th March 2022

Background Quiz

Question 1

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- 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 ×

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

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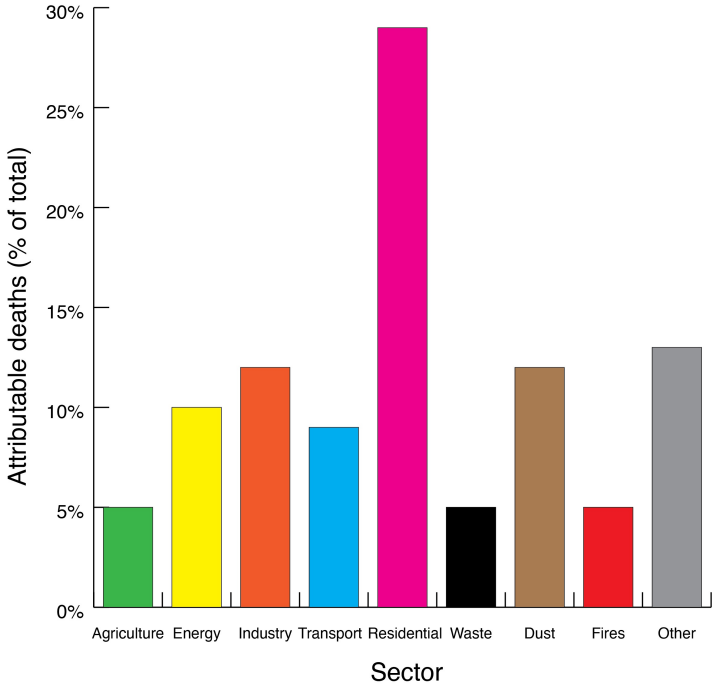


6% from coal and 4% from non-coal energy (McDuffie et al., 2021).

~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

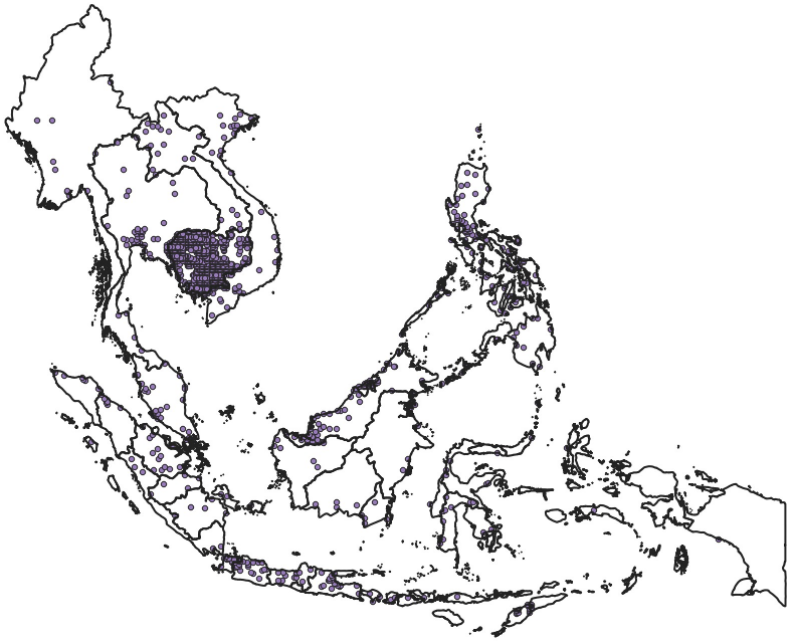
Workshop Overview

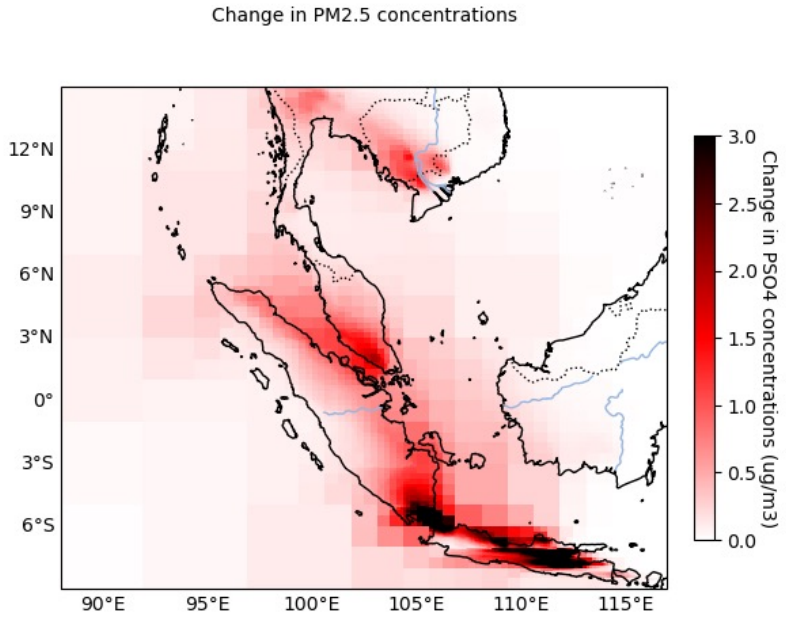
- **Module 1** (10th March): Installing Global InMAP and understanding everything necessary for configuring and running it

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

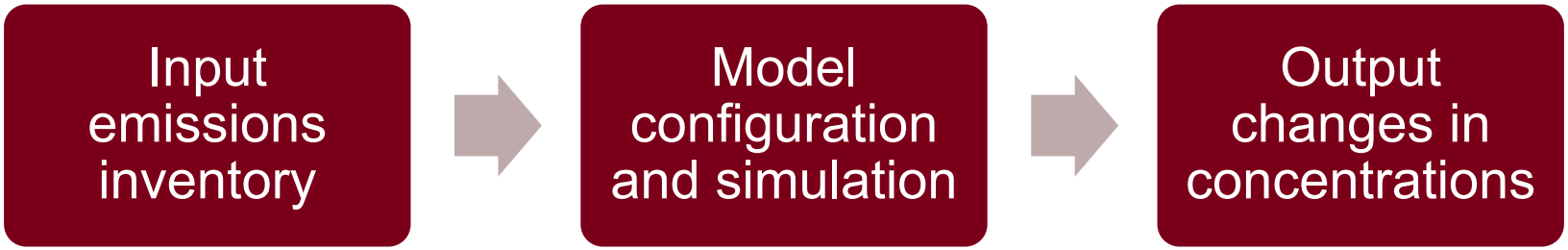
Module 1: Introduction to Global InMAP and model set-up

- 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:

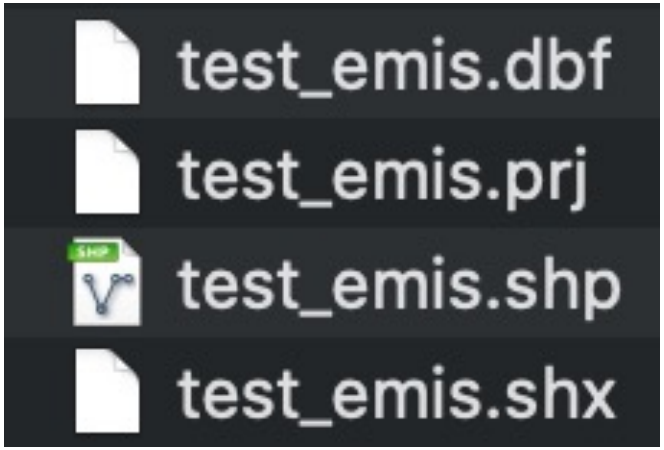
The *.dbf* file stores the feature attributes

The *.prj* file describes the shapefile projection

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

The *.shx* file describes feature index

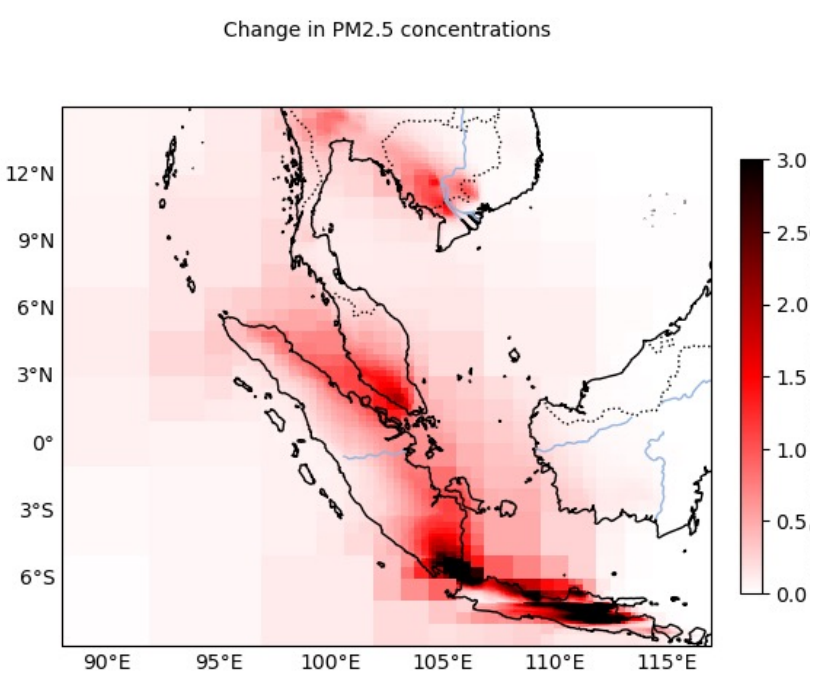
(The *.qml* file describes imaging style)

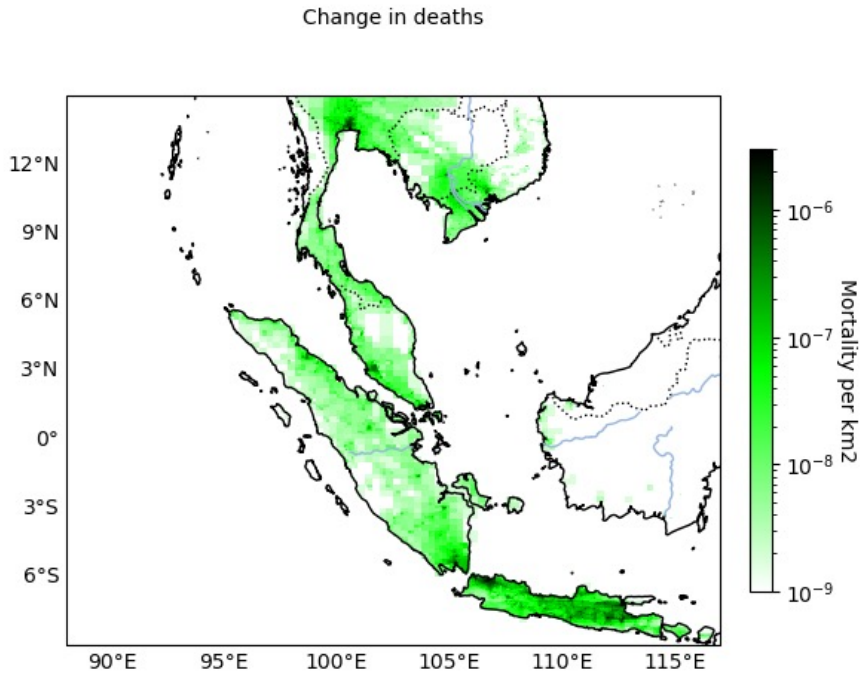


- The inputs are in units of ton/year, kg/year, or µg/s
- For each primary pollutant ($PM_{2.5}$, SO_x, NO_x, NMVOC, and NH_3) there is 1 attribute
- There are also attributes for stack parameters (height, diameter, temperature, velocity) of elevated emissions

Output changes in concentrations

- Global InMAP results are saves 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 (e.g., Notepad is good, Microsoft Word is not good)

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' and 'kg/year'.
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