WEB BASED SCREENING AIR QUALITY DISPERSION MODEL FOR INDUSTRIAL SITES

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INTRODUCTION

Air pollution, being both an environmental and a social problem, leads to a multitude of adverse effects on the ecosystem, the climate and human health. Due to the **lack of proper planning**, pollutant dispersion have led to numerous deaths and illnesses over the years. In many cases, especially with the **small and medium scale enterprises** (SME), screening models are not used because they are not affordable.
Developing a **user-friendly and easily accessible screening model** to evaluate the impact of emissions released by industries is needed.

OBJECTIVES

- **Transform** an existing Gaussian plume-based screening air quality dispersion model available in XLS format **into a user-friendly web-based** model which is also the end product.
- **Integrate meteorological data** with the aid of a wind rose to create a more dynamic air screening model.

METHODOLOGY

Selection of key parameters → XLS Model → Testing the Model → Transform into Webpage → Testing of Webpage → Comments and data intepretation

Effective Stack Height

$$\Delta H = d\left(\frac{V_s}{u}\right)^{\frac{1}{4}}\left(1+\frac{\Delta T}{T_s}\right)$$

Richardson Number

$$R_i = \frac{g\left[\frac{T(z_1)-T(z_2)}{z_1-z_2}\right]}{T(z_1)\left[\frac{u(z_1)-u(z_2)}{z_1-z_2}\right]^2}$$

Downwind Concentration

$$C(x,y,z) = \frac{Q}{2\pi u \sigma_y \sigma_z}\exp\left(-\frac{y^2}{2{\sigma_y}^2}\right)\left[\exp\left(-\frac{(z-H)^2}{2{\sigma_z}^2}\right)+exp\left(-\frac{(z+H)^2}{2{\sigma_z}^2}\right)\right]$$

Decayed Concentration

$$c(t) = c_0 * \exp\left(-0.693x\frac{t}{t_{1/2}}\right)$$

SENSITIVITY STUDY

Gas emission	5 g/s of PM2.5		
Stack parameter	30 m stack height, 1 m diameter, 15 m/s velocity, 40 C gas temperature		
Stability Class	Neutral for all		
	Scenario		
	Worst	Average	Best
Max value at 500 m	1200 µg/m3	800 µg/m3	600 µg/m3
At 500 m	776 µg/m3/day	552 µg/m3/day	437 µg/m3/day
At 1 km	1024 µg/m3/day	710 µg/m3/day	550 µg/m3/day
At 2 km	599 µg/m3/day	410 µg/m3/day	315 µg/m3/day

PARAMETER'S INFLUENCE

Doubling the gas emission	Simply doubles the final concentration for all scenarios
Doubling the stack height	Tremendously reduces the final concentration
Doubling the stack diameter or exit velocity	Slightly reduces the final concentration
Doubling the gas temperature in °C	The effect on the final concentration can be neglected

WEB INTERFACE

Available at www.bit.ly/webscadim

USER INPUT AREA

I.1. Wind Speed Categories

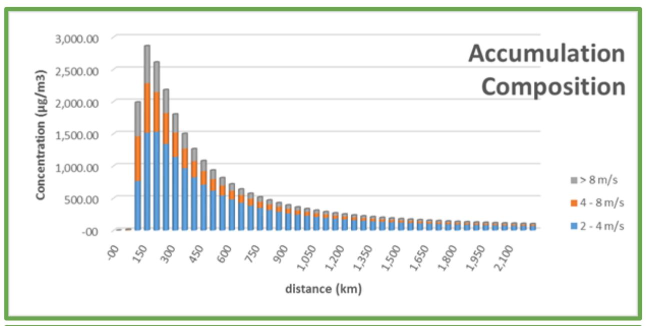
Select 3 different ranges of wind speed for a wind rose data

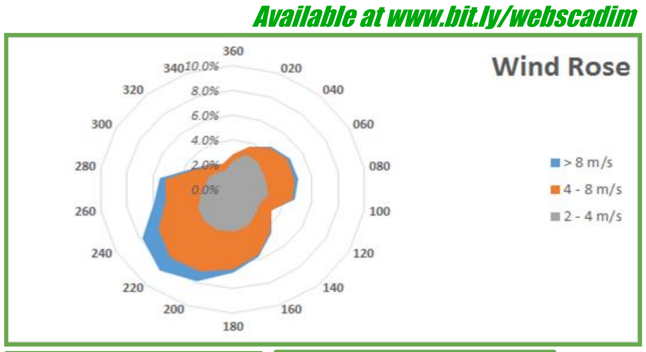
1st	2	-	4	m/s
2nd	4	-	8	m/s
3rd	>	8		m/s

I.2. Input Parameters

Basic gaussian plume model parameter

Observed Pollutant			
Type	PM2.5		Type of Pollutant
EU Yearly Limit	25	[µg/m3]	Average Pollutant Mass Flux
Source Parameter			
Q	5	[g/s]	Pollutant Mass Flux
H	30	[m]	Stack Height
d	1	[m]	Stack diameter
Vs	15	[m/s]	Exit Velocity
Ts	40	[C]	Gas temperature
Tamb	20	[C]	Ambient temperature
Receiver Parameter			
Type	2		1: Degree (#) ; 2: Direction
Dir.	SW	[direction]	Receiver Direction
	225	[degree]	Receiver Direction
x	2	[km]	Receiver Distance
z	1	[m]	Receiver Altitude
Atmospheric Parameter			
Stability Class	E	[class]	Stability Class for 2 - 4 m/s
	D	[class]	Stability Class for 4 - 8 m/s
	D	[class]	Stability Class for > 8 m/s
Scenario	Best	[-]	Calculate based on this scenario





O.3. Annual Accumulation and Average Concentration

Pollution concentration profile along the x downwind distance

Receiver Direction	SW	[direction]
Receiver Distance	2	[km]
Annual Concentration	194.65	[mg/(m3*year)]
Average Daily Concentration	533.30	[µg/(m3*day)]
EU Daily Limitation	25.00	OVER LIMIT
Average 8 Hours Concentration	177.77	[µg/(m3*8h)]

Pollutant		
Name	EU's Yearly Limit	
PM2.5	25	[mmg/m3]
PM10	40	[mmg/m3]
NOx	40	[mmg/m3]
Lead	0.50	[mmg/m3]
Benzene	5	[mmg/m3]
Arsenic	0.006	[mmg/m3]
Cadmium	0.005	[mmg/m3]
Nickel	0.02	[mmg/m3]
PAHs	0.001	[mmg/m3]

Wind Speed	A	B	C	D	E	F
1	X	X				
2	X	X	X		X	X
3	X	X	X	X	X	X
4		X	X	X	X	
5			X	X		
6			X	X		
7				X		
8				X		
9				X		
10				X		

Inputting the necessary parameters on the left give the output of the screening tool with pollutant concentrations plume, wind direction analysis and concentration figures with pollutant limits.

CONCLUSION

The model **successfully integrates four main parameters** which are effective stack height, atmospheric stability classes, dispersion coefficient and take into account several possible atmospheric scenarios.
Considering the critical role of industrial emissions towards air quality, the model developed as part of this project contribute towards **better understanding and control of air quality.** Implementing it as a preliminary screening tool will definitely benefit the industries in the long run.

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