Facilitate the Use of Innovative Strategies to Improve Air Quality and Reduce Carbon Footprint of Cities

H.F. ATMAYA, J.J. DORISMOND, J.I. FUENZALIDA NAVARRETE, I. FUQOHA,G. UPRETI,
A. BOUZONVILLE (Supervisor)

Ecole des Mines de Nantes, 4 rue Alfred Kastler, 44307 Nantes Cedex 03, France
Integrated Engineering Project (PM3E – ME3) July 2016, Nantes, France

Introduction

Cities are facing many issues that are prone to affect human health, well-being (Bolunda & Hunhammar, 1999). The use of fossil fuel-based transportation system and increasing settlement of human in cities (with the use of residential or district heating) contribute to the degradation of cities air quality due to considerable emission of sulfur oxide (SOx), nitrogen oxide (NOx), Carbon dioxide (CO2), Carbon monoxide (CO), volatile organic compounds (VOCs), and particulate matter (PM10/2.5) into the atmosphere and the surrounding environment.

Moreover, other factors as the increasing production of energy from fossil fuel due to a higher energy demand, industrial activities, and agriculture have also emitted significant air pollutants and greenhouse gas emissions. Such emissions have worsened the issue of air pollution and carbon footprint in urban areas as well as the global warming climate change and climate change (EPA, 2011). However, despite the fact that government bodies and city planners have made considerable efforts to reduce air pollutant emissions and improve air quality, city dwellers are still exposed to high levels of pollutant concentrations that exceed the limit values standards set by EU/WHO/EPA, and put public health at risk.

Objective and Scope

Objective:

- Identifying existing strategies that are being applied in urban areas to abate air pollution and carbon footprint.
- Assessing the main focus in terms of emission reduction target for the energy sector, transportation, district heating.
- Identifying and synthesizing key qualitative and quantitative parameters (benefits & limits).
- Creating of a tool that can support and facilitate shared-decision making for policy makers and urban planners.

Scope:

For this work we have considered the strategies of 22 green cities in the world, spread over four (4) continents, for which some quantitative and qualitative data are available.

As an innovative nature of this project, it integrates into a simple database the strategies for about 22 cities and also provides some mathematical formula to estimate the level of certain pollutants reduction to achieving air pollution and carbon footprint abatement in urban areas.

Methodology

Literature review: The approach to collect the data is based main in three ways: Online Search Engines - Specific Organizations – European Project - Meeting with Nantes Metropole.

Data interpretation: The columns of this table are: city, country, population of the city, area of the city, strategy name, details of the strategy, timeline, pollutant reduced/targeted, benefits and total cost.

Sensitivity analysis: The next step is to compare the effectiveness and efficiency of all the strategies and select parameters in the averaged values.

Tool Development: The construction can be done, by entering in a chart its values and automatizing the excel sheet.

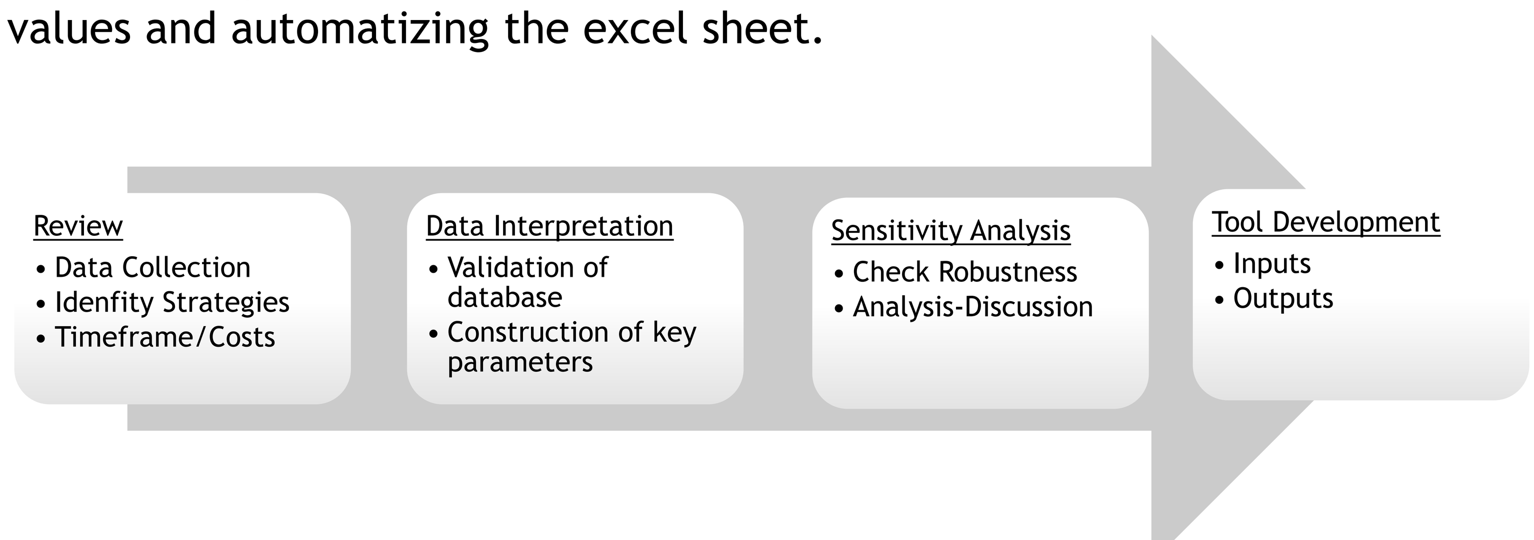

Figure 1. Methodology steps

Results and Discussion

This report analyzed the effectiveness of bicycle, transportation, Urban Access Regulation (UAR), renewable energy, energy efficiency planning, and Urban Green Infrastructure (UGI).

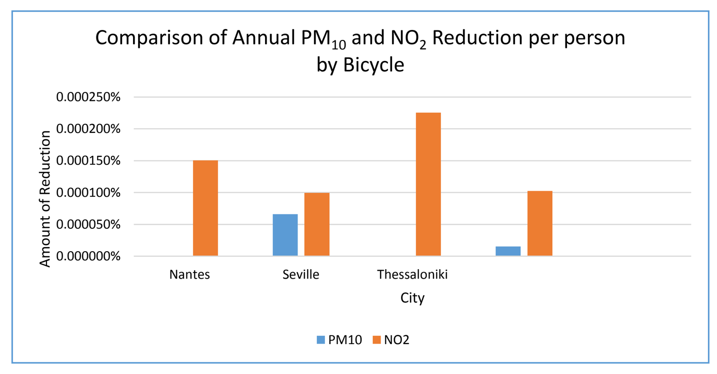

Figure 2. Reduction of PM_{10} and NO_2 by bicycle

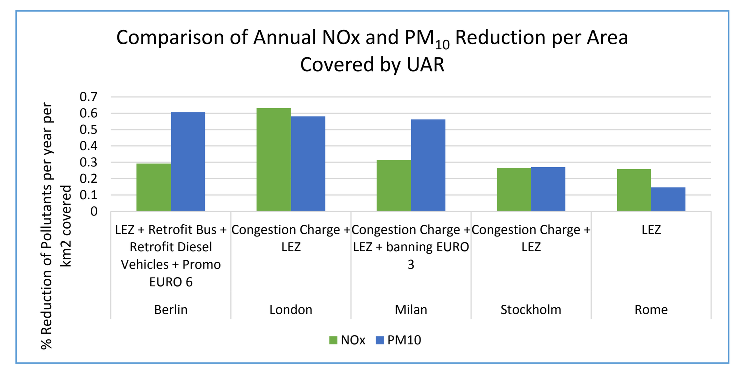

Figure 3. Reduction of NOx and PM_{10} by UAR

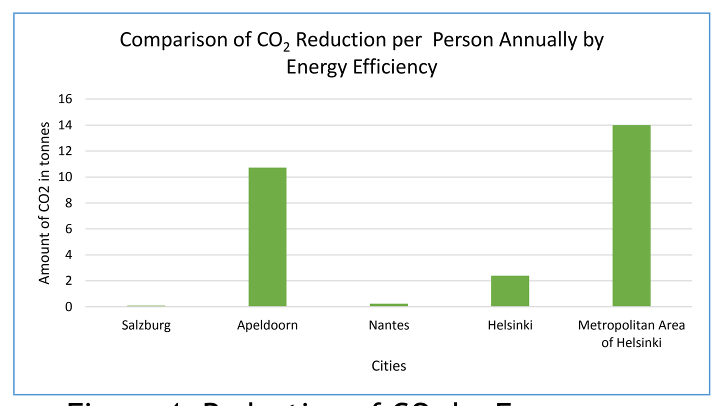

Figure 4. Reduction of CO_2 by Energy Efficiency Planning

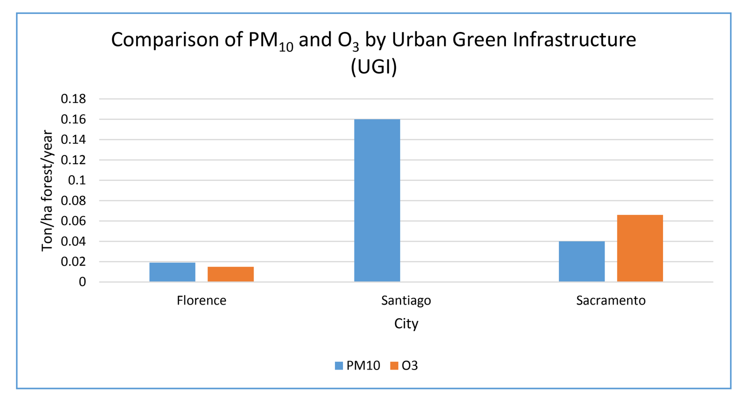

Figure 5 : Reduction of PM_{10} and CO_2 by UGI

Each strategy implemented have reduced PM_{10}, NO_x, O_3, and CO_2 effectively. For an instance, bicycle reduces PM_{10} and NO_x and decreases car mode share. Seville's bicycle share scheme has the highest reduction percentage of PM10 for 0.000066% PM_{10} /person/year.
By taking the highest value or average percentage reduction of each strategy, the key parameters for designing the tool can be seen as follow:

Table 1. Key parameter of each strategy

Strategies12	Parameter	Value
Bicycle	% PM_{10}/person/year	0.000066 %
	% NO_2/person/year	0.000103 %
Transportation	Cannot make average different approaches	
Urban Access Regulation	%NO_x/area covered/year	0.40%
	%PM_{10} /area covered/year	0.47%
Urban Green Infrastructure	Ton O_3/ha of forest/year	0.066
	Ton PM_{10}/ha of forest/year	0.16
Renewables Energy	-	
Efficient Planning	Total CO_2/person/year	13.99

Table 2.The scope of the developing tool

Range of Values			
Input	Min	Max	Average
Total Population	100000	10000000	3500000
Area Covered for UAR	5	35	28
Area of Forest (ha)	25000	100000	44290
Timeframe	2	15	8

Urban city planners can input their data of total population, area covered and area of forest as seen in **table 2**. It will give the result shows automatically in the **table 3** for each strategy.

Table 3. The developing tools

TOOL		
Inputs		
Total Population		hab
Area Covered for UAR		km2 for UAR
Area of Forest		km2 of forest
Benefits		
Bicycle	0	% PM_{10} reduced per year
	0	% NO_2 reduced per year
Urban Acess Regulation	0	% NO_x reduced per year
	0	% PM_{10} reduced per year
Urban Green Infrastructure	0	Total O_3
	0	Total PM_{10}
Efficient Planning	0	Total CO_2

Conclusions

- By way of conclusion, several strategies were assessing and comment in detail; these strategies also were quantified with key parameters, which helped to construct the urban planner tool. The urban planner tool shows:
- Bicycle strategy is substantial in average for over 100000 users for PM10 and 10000 for NO. Regarding urban access regulation covering areas in average over than 10 km can be determinant for these two pollutants.
- In Urban green infrastructure and efficient planning only total amount of pollutant can be calculated therefore city planners will need the initial amount of concentration in order to have the percentage reduction.
- Transportation and renewable energy were not considered into the tool because both strategies showed variability and different approaches. City planner should review the examples of Copenhagen for this scheme.

Bibliography

Bolunda, P., & Hunhammar, S. (1999). Ecosystem services in urban areas. *ELSEVIER, Ecological Economics*, Pages 293-301.
https://www3.epa.gov/airquality/airtrends/2011/report/climatechange.pdf
European Comission. (n.d.).
European Commission. (2013). Retrieved April 2016, from http://www.europarl.europa.eu/EPRS/EPRS-Briefing-565910-Reducing-air-pollution-v3-FINAL.pdf