Comparative results of environmental aspects obtained by Micro and Mesoscopic approach for urban road networks

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TU1102: Autonomic Road Transport Support Systems

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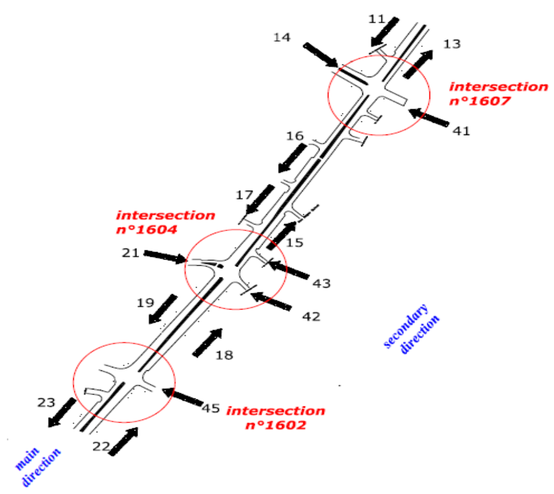
For some decades the air quality has received, both locally and globally, more and more attention from the scientific community and local authorities. It is well known that one of the major causes of pollution are vehicle emissions, and that they are closely related with driving style. According to studies that define vehicular emissions, it has been found that they contain a wide variety of pollutants, principally carbon monoxide and dioxide (CO and CO2), oxides of nitrogen (NOX), particulate matter (PM10) and hydrocarbons (HC) or volatile organic compounds (VOC), which have a major long-term impact on air quality.

This work describes the correlation between the traffic phenomena of road networks and the percentages of the major pollutants made by vehicle emissions.
Results are based on real time data from a road network in France where mesoscopic approach offers insights on the use of ITS systems, such as the intelligent traffic lights or Urban Traffic Control (UTC) systems, which are useful to road management policy in terms of pollution decrease.
The use of a mathematical model allows the creation of measurement scales of the environmental risk considering signalized and un-signalized intersections on the road network.



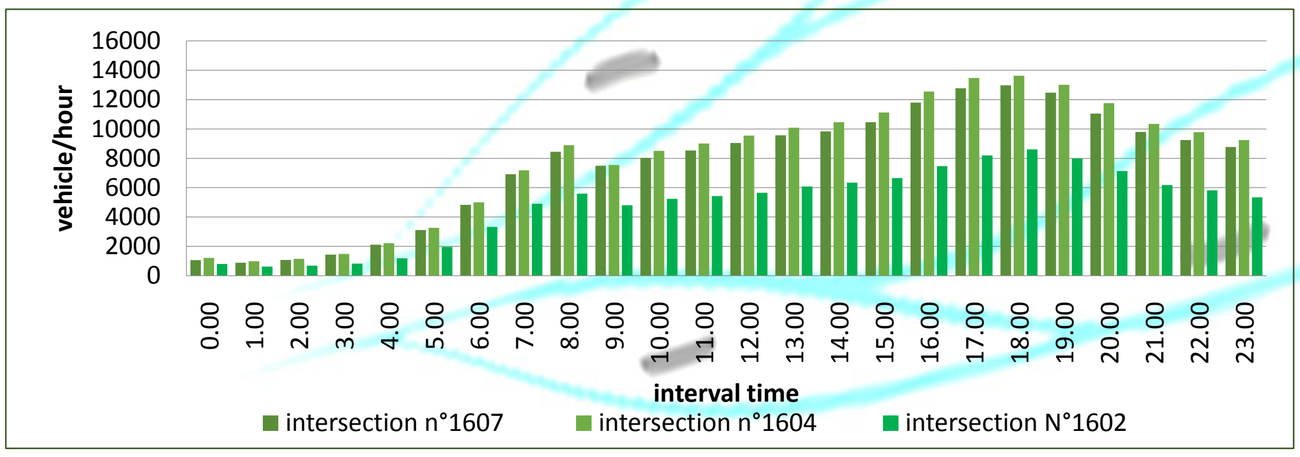
Le Bourget road network: real time traffic data acquisition

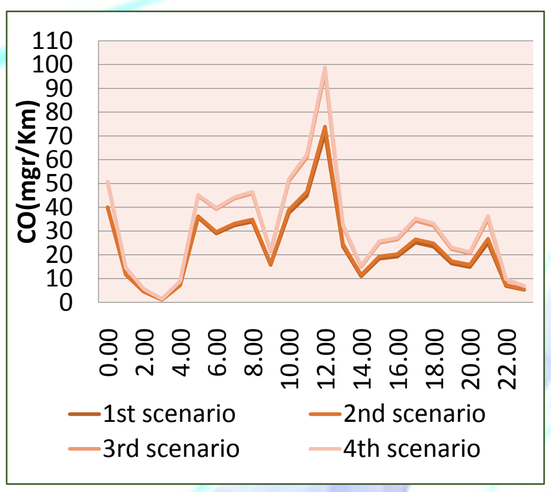
Input data
Traffic data flow
Speed of vehicles (km/h)
Congested and uncongested condition analysis
Geometrical road parameters
Traffic light cycle
Mix of vehicle (heavy,light….)
Selection of pollutant emissions (CO,Nox,PM10…)

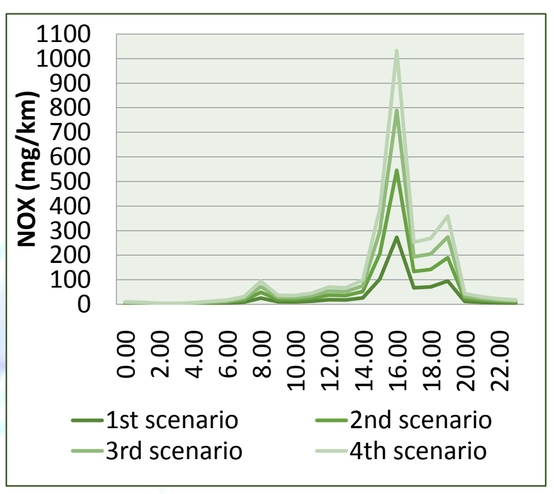
Microscopic approach
EnViver tool

Mesoscopic approach
Gori et al. equation (1)

data output
Comparison of results in terms of CO,NOX and PM10 concentration (chancing traffic light cycle)







The explained methodologies is applied to:

- **24 hours of dynamic traffic simulation** (from 00:00 am to 11:00 pm);
- **2 different case study on satured/unsatured network** (average link values for each time interval or dividing each link between congested and uncongested conditions)
- **2 pollutants concentration extimated and compared** (CO, NOx) for different case study and microsimulation results too
- **2 types of emission functions for congested and uncongested system**
- **4 different scenarios** with different traffic light cycles set considering increase/decrease of total traffic light (84 and 94 sec) and green interval time too

1st scenario			2nd scenario		
84 sec	**main**	**secondary**	**84 sec**	**main**	**secondary**
green time (sec)	40	30	green time (sec)	49	39
yellow time (sec)	5	5	yellow time (sec)	5	5
red time (sec)	39	49	red time (sec)	39	49
3rd scenario			**4th scenario**		
94ec	**main**	**secondary**	**94ec**	**main**	**secondary**
green time (sec)	45	35	green time (sec)	55	25
yellow time (sec)	5	5	yellow time (sec)	5	5
red time (sec)	44	54	red time (sec)	34	64

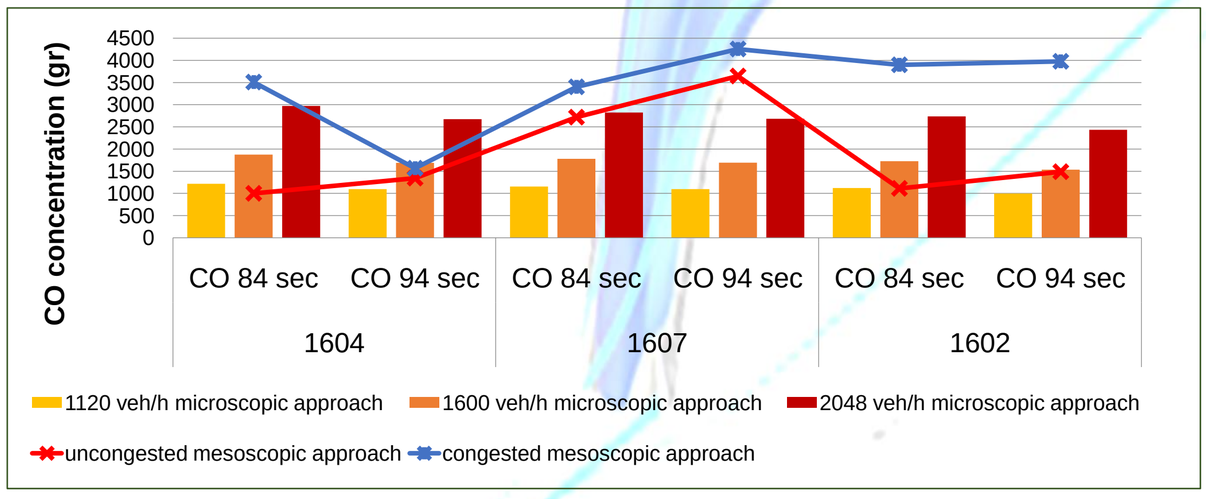
The emission estimation for a link k approaching a signalized intersection in the time slice T can be evaluated as follows:

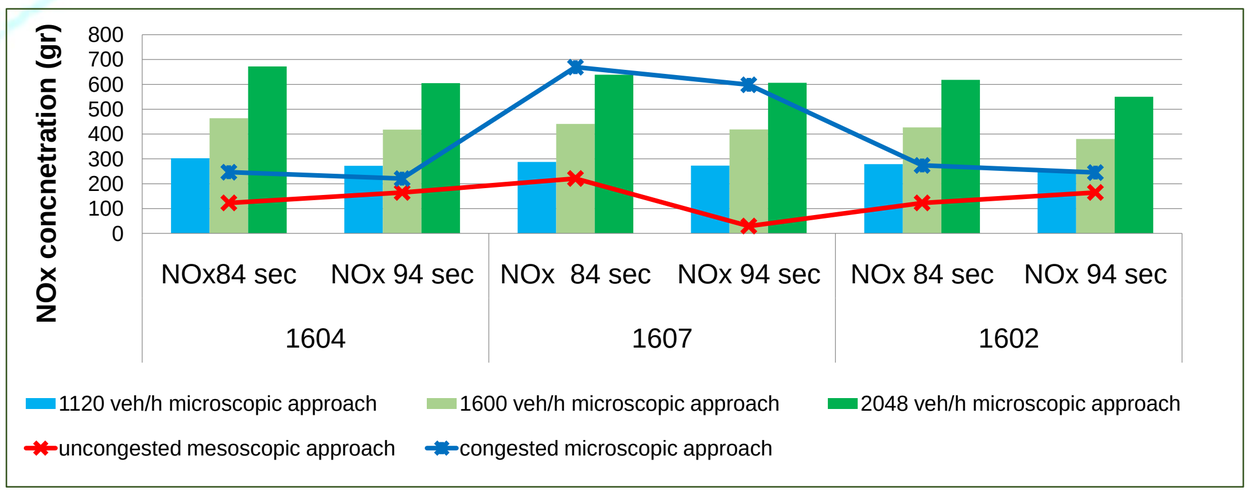
$$ETk=(qTk*La+Qnv*LB+Qnv*LC)*ea+(Qns*LB)*eb+(Qns*LC)*ec \quad (1)$$

where:

Traffic volume	**qTk**	average hourly volume [veh/h] on link k at time T;
	Qnv	total hourly volume [veh/h] on link k that cross the intersection without any deceleration (i.e. vehicles not penalized by the traffic control): it is computed as the vehicles per cycle not subject to stop and go phases (qnv) multiplied for the number of cycles C during the considered time slice T (T/C);
	Qns	total hourly volume [veh/h] subject to stop and go phases on link k : it is computed as the vehicles per cycle subject to stop and go phases (qns) multiplied by the number of cycles during the considered time slice (T/C);
Emission parameters	**ea**	calibrated specific emission function to be adopted in LA
	eb	calibrated specific emission function to be adopted in LB;
	ec	calibrated specific emission function to be adopted in LC.

The environmental impacts related to signalized intersection are tested comparing micro and mesoscopic approach and ,also , analyzing possible scenarios that lead to decrease of vehicular emissions referring to Le Bourget area on French Region of Seine-Saint Denis. Specific emission factors for the acceleration and the queue phases have been estimated at mesoscopic level starting from the microscopic approach by ENVIVER tool. In particular pollutant concentration were compared ,changing four different traffic light cycle with two phases (especially increasing or decreasing red time). It also shows the capacity of the model to test different off-line and on-line traffic strategies in order to work both on emission and congestion problems.





The application involved also the analysis of simulate the impact of adopted strategies to reduce emissions such as the optimization of signalized intersection (phases, cycle length and offset), the optimization of a system of one-way street and the changes of the vehicle fleet composition. The use of a mathematical model allows the creation of measurement scales of the environmental risk (and specific maps) considering urban road network in according with European and local Legislation benchmarking.

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