SCREENING TECHNIQUE FOR SPECIFYING ROADS WITH HIGH CONCENTRATIONS BY USING REGRESSION EQUATIONS

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Background

The exhaust gas emitted from cars is one of the main causes of air pollutions. The exhausts gas abundantly includes hazardous substances; nitrogen oxide, sulphur oxide, carbon monoxide, suspended particle matter, BTEX (benzene, toluene, ethyl benzene, and xylene), and PAHs (Polycyclic Aromatic Hydrocarbons). Both benzene and benzo[a]pyrene, which is one substance of PAHs, are classified with Group 1 (The agent is carcinogenic to humans) by IARC (International Agency for Research on Cancer).
The high air pollutant concentration occurs locally due to heavy traffic or the geometric structure of buildings and of roads. The limited monitoring network of air pollutions cannot perfectly cover the all of locations with the high concentration. In order to conserve the air quality, it is necessary to know easily where some locations with high concentration are.

Aim

The emission factors of benzene and benzo[a]pyrene to the actual condition including sudden acceleration, quick stop and idling state are estimated by using the portable sampling equipment collecting directly exhaust gas.
The database to estimate the concentration in the roadsides and in the crossroads are created from CFD (Computational Fluid Dynamics) simulations by varying the parameters of building height, road width, wind speed and wind direction.
Using the emission factors obtained from the portable sampling equipment, the database, and the traffic volume, benzene concentration and benzo[a]pyrene concentration at the roadsides and at the crossroads in Osaka City are calculated.

Estimation of Emission Factors

The sampling head is inserted into the muffler of a car and is fixed. The exhaust gas is sampled at the constant flow rate by a pump installed into a car and is collected by the absorber filled up in the sampling tube. The absorbers used are TenaxTA60/80 for collecting BTEX and TenaxTA20/35 for collecting PAHs. Each substance is analyzed by GC-MS (Simazu-QP2010) with Thermal Desorbor (Perkin Elmer- Turbo Matrix ATD).
The number of the sampling gasoline cars and of the sampling diesel cars is 30 and 5, respectively.
The emission factors of gasoline cars are estimated by considering the distribution of manufacture year and the mixing ration of cold start.
The emission factors of diesel cars are estimated to the latest manufacture year because of the regulation that the old diesel cars can't run in Osaka City.

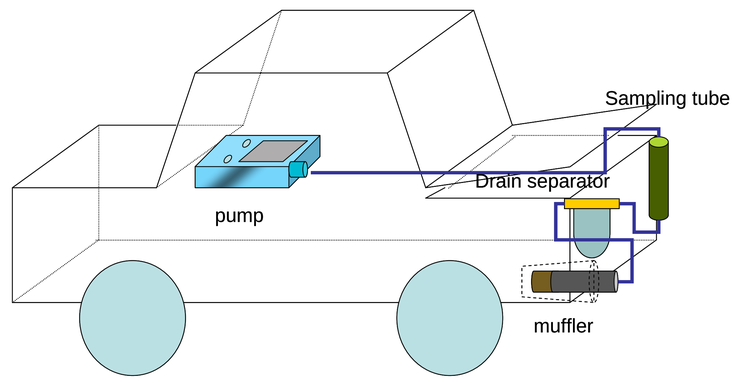


Figure 1. The outline of the portable sampling equipment

Table 1. Emission factor

	gasoline cars	diesel cars
Benzene	4.5mgkm-1	1.2mgkm-1
benzo[a]pyrene_TEQ	660ngkm-1	1700ngkm-1

Numerical Simulation Model

The concentrations in the range of the distance from buildings of 0.5m at the height of 1.5m are calculated from CFD simulations. But the concentrations are irregularly varied by the change of the building height, because the structure of vortexes forming in the canopy is changed due to the building height.
Therefore the database of the concentrations about the parameters; building height, building width, and wind speed is created.

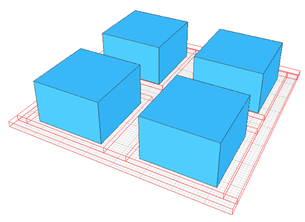


Figure 2. Crossroad model simplified

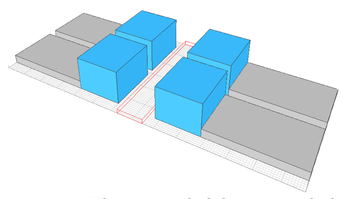


Figure 3. The roadsides model simplified

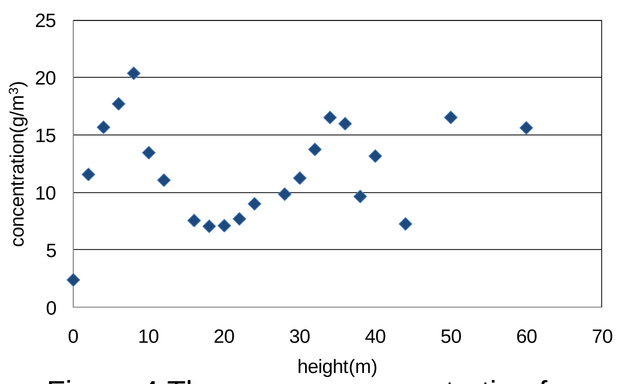
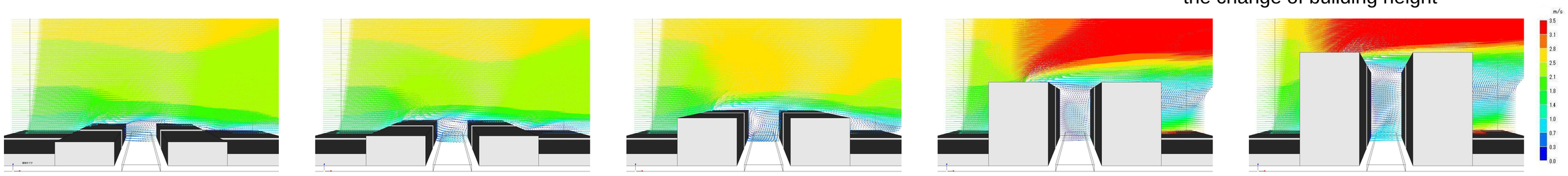


Figure 4.The average concentration for the change of building height



H=8m H=10m H=16m H=28m H=38m

Figure 5. The vertical flows at H=8,10,16,28,38m

Screening Results

Using the emission factors, the database of the concentrations, and the traffic volume, benzo[a]pyrene concentration at the roadsides and at the crossroads in Osaka City are calculated.

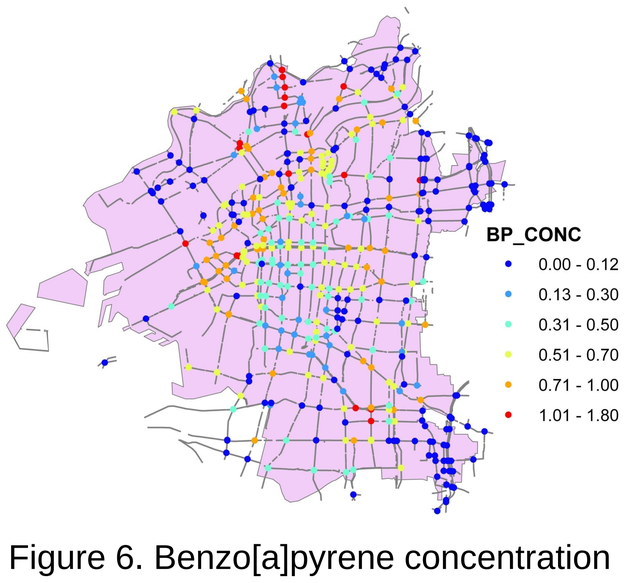


Figure 6. Benzo[a]pyrene concentration at the crossroads

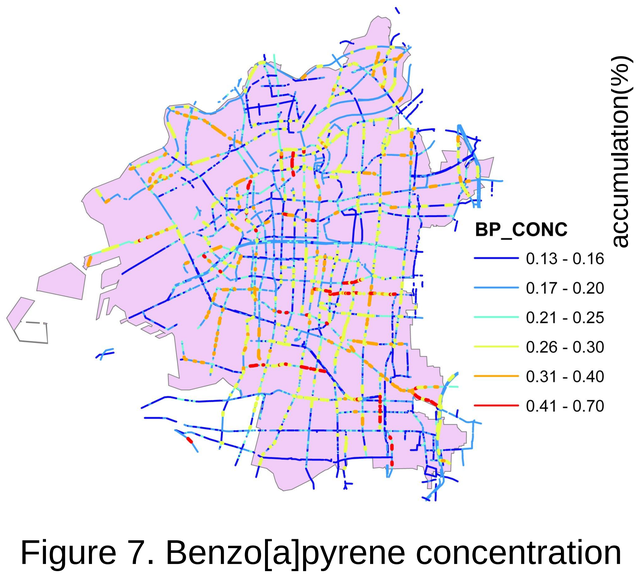


Figure 7. Benzo[a]pyrene concentration at the roadsides

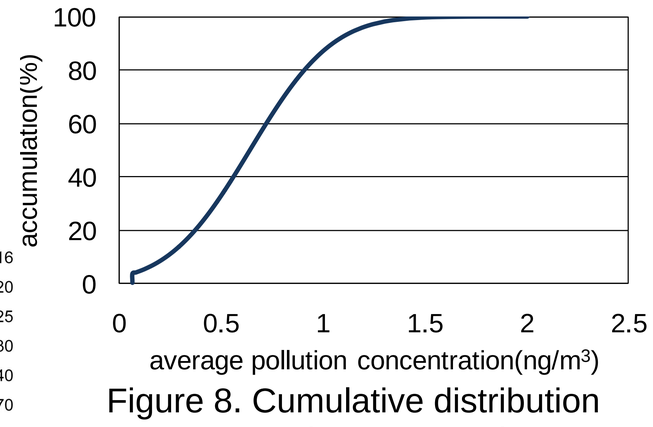


Figure 8. Cumulative distribution at the crossroads

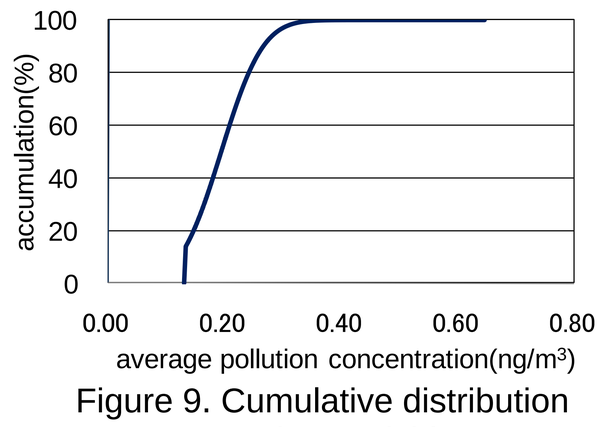


Figure 9. Cumulative distribution at the roadsides

Table 2. Unit risk and Regulation level

	Unit risk	Regulation level
Benzene	5×10^{-5}perμgm^{-3}	2μgm^{-3}
benzo[a]pyrene_TEQ	9×10^{-2}perμgm^{-3}	0.11ngm^{-3}

Atmospheric environmental standard of benzene is 3μgm^{-3} but atmospheric environmental standard of benzo[a]pyrene is not regulated, yet. According to the calculations at the roadsides, benzene concentration at a few locations exceeded atmospheric environmental standard but benzo[a]pyrene concentration at almost locations exceeded 0.11ngm^{-3}. According to the calculations at the crossroads, the average benzene concentration and the average benzo[a]pyrene concentration were 2.2μgm^{-3} and 0.56ngm^{-3}, respectively. These results suggested that atmospheric environmental standard of benzo[a]pyrene should be regulated as soon as possible.