Supply of project management, air quality information management, behavior change and communication services.

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BTEX monitoring in Kosovo

Draft Final Evaluation

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CONTENTS

Introduction

BTEX

Volatile organic compounds (VOCs) are a broad group of carbonaceous air pollutants of which benzene is one. Benzene is part of mineral oil and is formed when processing it, originates from anthropogenic and natural activities, is still used in industrial processes, is emitted from combustion and diffuses from all types of products including household. The latter type of source causes benzene levels to be higher in the indoor environment. A relevant source of benzene in ambient air is traffic, based on mineral oil.

Exposure to benzene is considered causative of adverse health effects in humans of which haematotoxicity, genotoxicity and carcinogenicity are the most significant. As benzene concentrations in ambient air are at least in the past substantial, benzene is regulated for air quality management purposes at national and supranational levels (Kosovo, European Union and World Health Organization).

Benzene is the lightest of the group of light aromatic compounds that are usually monitored commonly termed BTEX (benzene, toluene, ethylbenzene and xylenes). This xylenes group includes ortho, meta-and para-xylene, of which the last two are summed due to analytical constraints. Although the other compounds of the BTEX group are less harmful than benzene knowledge on the levels of these aromatic compounds provides addition information for confirmation purposes and for a beginning of source apportionment.

Monitoring rationale

Regulating an air pollution substance requires knowledge on the levels in ambient air to such an extent that eventual abatement measures can be developed and their impact on ambient levels be followed. Direct measurement at sufficient number of monitoring sites for sufficient extended periods is a first method of choice. Adequate detailed emission inventory and proper dispersion and atmospheric chemistry models form a good alternative for monitoring by measurement.

The selection of the monitoring methodology for benzene has been addressed in EU directive 2008/50/EC[1], including the reference method, requirements for conformity, and number and siting of monitoring stations based on ambient levels and population size. This selection procedure warrants acquiring information for effective air quality management. The current monitoring campaign is to be evaluated and its comparison with the approach of the EU directive for benzene is considered useful for further planning.

Besides the information to assess the compliance with limit values information on the benzene levels and subsequently the exposure of the population to benzene is to be considered a prerequisite for proper health risk assessment. In that perspective the information on indoor environment exposure and exposure under labour conditions is necessarily complimentary.

[1] DIRECTIVE 2008/50/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 May 2008 on ambient air quality and cleaner air for Europe

As part of the MCC/MFK funded project '*Supply of project management, air quality information management, behavior change and communication services'*, a BTEX monitoring network was operated to assess the ambient levels of benzene and the other light aromatic hydrocarbons. The monitoring activities were planned to cover most of the project period: from January 2020 until July 2021, allowing the analysis and reporting to be completed by the end of project in September 2021. Initially one batch per month was planned for this 19-month period, but due to COVID-19 containment measures, there was a pause in provision of services in the period May-June 2020, therefore the sampling period had to be extended till September 2021. The period with active sampling is covered by the 19 batches initially planned. This evaluation report was planned to be delivered 15 months after the start of the monitoring campaign (covering batches A-O), but later it was agreed to include 2 more batches, therefore batches A-Q are included. The two remaining batches R and S are processed and reported but are left out of this evaluation report.

Objectives of the evaluation

The objective of the evaluation of the monitoring campaign is to describethe monitoring operation, process the obtained analytical results in the context of the requirements set by the air quality management purposes.

Furthermore, the data provides insight into the air pollution situation in Kosovo, which might be used to initiate further investigations.

Monitoring and analysis

Sampling and logistics

The locations for sampling were selected by the staff of KHMI following the guideline to include, when available, the site of the National Air Quality Monitoring System (hereafter AQMS) site, one (heavy) traffic location and one urban, occasionally also with substantial traffic. At some of the towns industrial sites were included. One background location Germi, near Pristina was selected. QA/QC samples included a non-exposed sample at the industrial site (Obiliq, Palaj Stacioni Ajrit), a non-exposed sample kept in the laboratory of KHMI, from where periodic sample-exchange trips were conducted. A batch contained 40 tubes in total. Typically the complete tour required 2 days in the field.

Table 1 lists all these sampling locations and the codes used throughout this report. Figure 1 places the sampling sites on the map along with the locations of the AQMS.

The selected contractor for the BTEX analysis, Gradko International Limited (hereafter Gradko)[2], also provided the tubes for passive sampling. A new batch of tubes was ordered by the NIRAS Pristina office, cleared at customs and delivered at the KHMI laboratory in Pristina.

The fresh samplers were brought to the sampling site where the travel-caps that sealed the tubes from outside air, were changed for exposure caps and the samplers were attached to

[2] Gradko International Limited, St. Martins House, 77 Wales Street, Winchester, Hampshire SO23 0RH, England, UK

special mounting clips placed during the selection trip. The samplers were mounted at least 2 m above ground level, occasionally higher to prevent unauthorized removal of the tubes.

Previously exposed tubes were closed with new caps and brought back to the laboratory. Condition of the tube and exchange date and time were recorded.

The exposed tubes were transported to Gradko, UK for analysis. For the sampling and logistics standard operation procedures were developed. KHMI provided the information on the tube identity, sampling location, start and end date and time to be included in the calculation scheme.

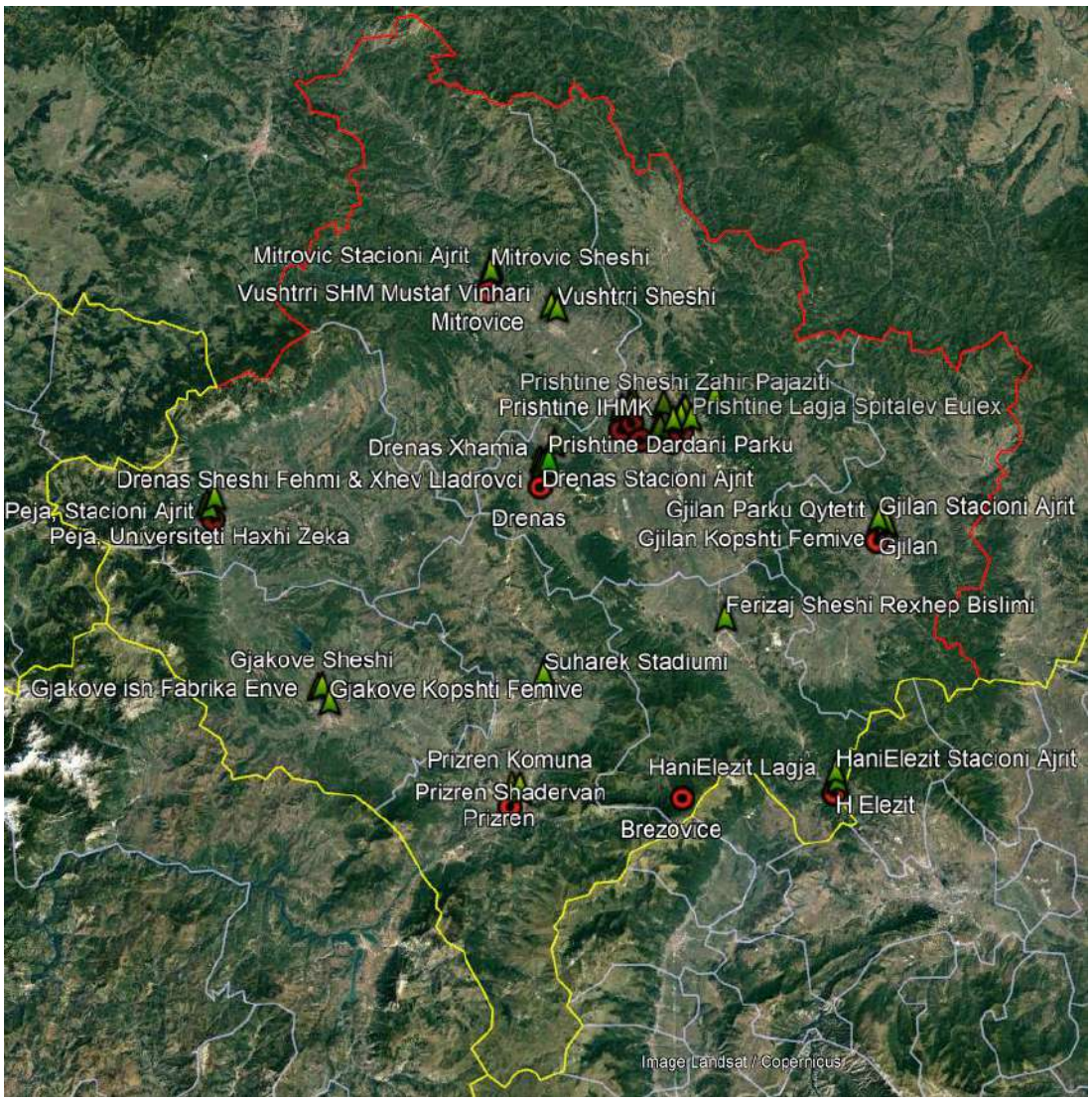


Figure 1: BTEX sampling sites and AQMS locations.

Special care was taken to limit the time between the moment the tubes were coated in the Gradko Laboratory and the analysis in the same laboratory after being exposed in the field. A maximum of 10 weeks was maintained. To ensure complete coverage of this period the moment the tubes were ordered was taken as the start of this period. If indeed the tubes were prepared later the registered period (shelf life) will be shorter.

Table 1: Sampling towns and location.

	Town	Location	Type	Code		Town	Location	Type	Code
1	FushKosove	Afer Semitronix	Traffic	Fush-1	21	Gjakove	ish Fabrika Enve	Traffic Urban	Gjak-1
2	FushKosove	SH.M. Profesional	Urban	Fush-2	22	Gjakove	Kopshti Femive	Traffic Urban	Gjak-2
3	Drenas	SH.M. Halil Bajraktari	Residential/Urban	Dren-1	23	Gjakove	Sheshi	Urban	Gjak-3
4	Drenas	Qikatove	Residential/Urban	Dren-2	24	Prizren	Stacioni Ajrit	Urban	Priz-1
5	Drenas	Xhamia	Urban	Dren-3	25	Prizren	Shadervan	Urban	Priz-2
6	Drenas	Sheshi Fehmi & Xhev Lladrovci	Urban	Dren-4	26	Prizren	Komuna	Urban	Priz-3
7	Drenas	Stacioni Ajrit	Urban	Dren-5	27	Suharek	Stadiumi	Traffic Urban	Suha-1
8	Gjilan	Parku Qytetit	Traffic Urban	Gjil-1	28	Mitrovic	ish Stacioni ajrit Afer ETC	Traffic Urban	Mitr-1
9	Gjilan	Kopshti Femive	Traffic Urban	Gjil-2	29	Mitrovic	Stacioni Ajrit	Urban	Mitr-2
10	Gjilan	Stacioni Ajrit	Urban	Gjil-3	30	Mitrovic	Sheshi	Urban	Mitr-3
11	HaniElezit	Stacioni Ajrit	Urban	Hani-1	31	Vushtrri	SHM Mustaf Vinhari	Urban	Vush-1
12	HaniElezit	Lagja	Residential/Urban	Hani-2	32	Vushtrri	Sheshi	Urban	Vush-2
13	Ferizaj	Sheshi Rexhep Bislimi	Urban	Feri-1	33	Prishtine	Dardani Parku	Urban	Pris-1
14	Obiliq	QKMF	Urban	Obil-1	34	Prishtine	Shkabaj Shtepia Shendetit	Urban	Pris-2
15	Obiliq	Dardhisht Stacioni Ajrit	Urban	Obil-2	35	Prishtine	Lagja Spitalev Eulex	Traffic Urban	Pris-3
16	Obiliq	Palaj Stacioni Ajrit	Industrial	Obil-3	36	Prishtine	Stacioni Ajrit Rilindjes	Traffic Urban	Pris-4
17	Obiliq	Palaj Stacioni Ajrit	Field Blank	Obil-4	37	Prishtine	Sheshi Zahir Pajaziti	Urban	Pris-5
18	Peje	Stacioni Ajrit	Urban	Peje-1	38	Prishtine	Germi	Background	Pris-6
19	Peje	Universiteti Haxhi Zeka	Traffic Urban	Peje-2	39	Prishtine	IHMK	Urban	Pris-7
20	Peje	Sheshi	Urban	Peje-3	40	Prishtine	IHMK Lab	Lab Blank	Pris-8

Sampling periods

In total 17 sampling periods are included in this evaluation. In the period, here indicated as Batch X, no sampling was carried out due to restriction at the analytical laboratory as part of the COVID-19 containment measures. Sampling periods are typically about 4 weeks (28 days), initially the exposure duration varied from 17 – 45 days, all within the specifications of the methodology.

Table 2: Sampling periods, start, end date and duration

Batch	Start Date	End Date	Duration	Age tubes
A	14/01/20	31/01/20	17.0	6.9
B	30/01/20	21/02/20	21.9	6.0
C	19/02/20	18/03/20	28.1	6.0
D	16/03/20	30/04/20	45.3	8.1
X	30/04/20	29/06/20	59.4	
E	29/06/20	29/07/20	30.4	5.1
F	27/07/20	31/08/20	35.5	6.9
G	27/08/20	05/10/20	39.5	8.7
H	30/09/20	03/11/20	34.6	9.9
I	27/10/20	02/12/20	36.1	6.4
J	27/11/20	30/12/20	33.4	6.6
K	28/12/20	28/01/21	31.4	8.0
L	25/01/21	01/03/21	35.5	5.9
M	25/02/21	29/03/21	32.4	5.9
N	25/03/21	29/04/21	35.4	6.1
O	23/04/21	26/05/21	33.6	5.6
P	24/05/21	25/06/21	32.2	6.1
Q	21/06/21	23/07/21	32.0	5.7

The column 'Age tubes (weeks)' indicates the time between the ordering of the tubes, and subsequently the preparation, and the receipt of the tubes for analysis. During this times the tubes were transported to Kosovo, exposed at the sampling sites and returned to the analytical lab. All batches were analysed within 10 weeks.

Analysis

The BTEX monitoring in the framework of the project was to be performed with passive sampling and gaschromatographic analysis with flame-ionization detection (GC/FID analysis). This method is used widely in EU and outside and provides a stable and accurate method.

For this task Gradko International Limited, UK (Gradko), was proposed by NIRAS and accepted by MFK/MCC. This contractor was selected for it has longstanding experience in providing sampling equipment (mounting racks and tubes) and performing analysis for BTEX under certification of the United Kingdom Accreditation Service[3]. The method used is the in-house developed method GLM4.

[3] https://www.ukas.com/wp-content/uploads/schedule_uploads/00002/2187Testing%20Single.pdf; GLM 4 by Thermal Desorption/ FID Gas Chromatography

Performance of sampling and analysis

In total 680 samplers were mounted, of which 22 (3.2%) were lost due to unauthorized removal of the tubes during the exposure period. Given the situation that samplers are placed in clear view as air needs to arrive at the sampler unobstructed, the loss is rather low. When samplers were lost frequently the siting was slightly changed, sometimes with success.

After transport to the Gradko laboratory 10 tubes (1.5%), arrived with loose caps. This condition might have led to compromised results and consequently these results were excluded.

During the analysis 2 tubes were lost due to malfunction of the analytical system. One sample was lost as water had entered the tube during exposure and prevented the analytical system from proper processing the tube. In total 3 tubes (0.4%).

Due to Covid-19 containment measures for a long period no samples could be taken resulting in the loss of two complete batches of samples covering 59 days. The batch for this period is treated as one and is identified as Batch X. This loss is equivalent to 5.5% of the data.

About 89.3% of the samplers provided useful data.

Quality assurance/quality control included blank samples. For each batch one tube was kept at the laboratory of KHMI, one tube was take into the field, mounted but not opened, and for each batch a control tube selected by Grardko, not necessarily from the same batch of prepared tubes, was also analysed.

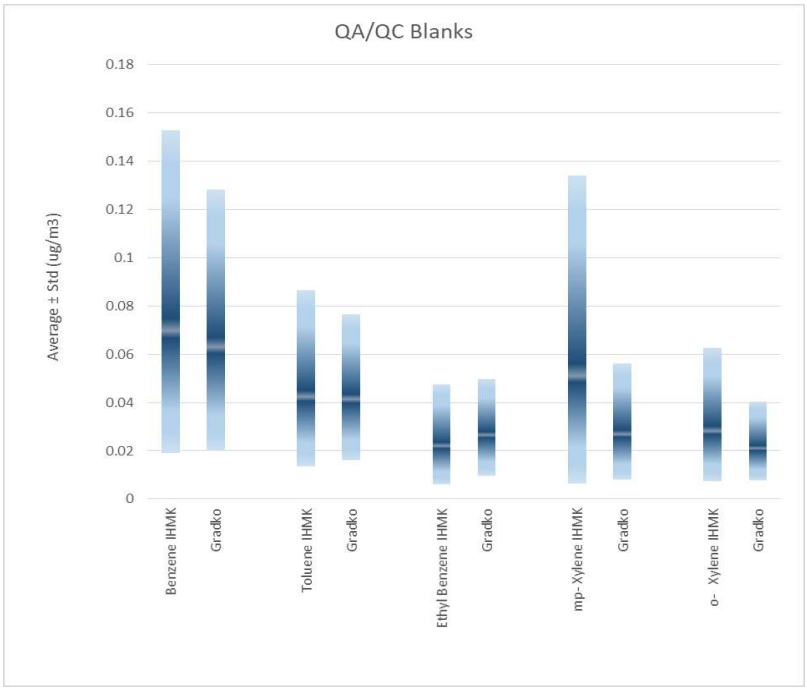


Figure 2: Blank concentrations for field operation and analytical performance. Average concentration assuming 25 m3 sampling volume and range (+/- standard deviation).

Except for Batch K no concentrations above the determination limit were found for each of the BTEX compounds in the field blanks. For Batch K 12.4 ng mp-xylene was found in the field blank tube, equivalent to 0.68 ug/m^3, assuming the average sampled volume for that period.

The average results of the blank samples kept at the KHMI laboratory and the blank samples of the analytical laboratory of Gradko show no significant difference and the average values were well below 0.1 ug/m^3 in concentration (see Figure 2). This implies that transport and handling did not cause any faulty concentration addition.

Gradko reports the uncertainty of measurement for the level of confidence of 95% ranging from 16% for benzene to 11% for xylenes. The reporting limit was 5 ng/tube, considered in this evaluation as the determination limit.

Data processing

Analysis results were sent by Gradko to NIRAS for further processing. The results expressed as ng/tube formed the basis for the concentration calculation and so the appropriate spreadsheets of Gradko were used as the input for the calculation by NIRAS[4].

Calculation method

The concentration of a BTEX compound btex is calculated according to

$$Conc_{btex,i} = \frac{Result_{btex,i}}{Volume_{btex,i}} \quad [1]$$

with $Conc_{btex,i}$ the time-averaged concentration of a BTEX compound (benzene, toluene, ethylbenzene, mc-xylene or o-xylene) in µg/m^3 during the sampling period at the sampling location, $Result_{btex,i}$ is the reported amount of the BTEX compound in tube i in ng/tube. The $Volume_{btex,i}$ is calculated according to

$$Volume_{btex,i} = Exposure_i * PSF_{btex,i} \quad [2]$$

with $Exposure_i$ the sampling duration (in min) for tube i and the Passive Sampling Flow (PSF in ml/min) for the BTEX compound btex and tube i, calculated according to:

$$PSF_{btex,i} = \frac{MV}{MW_{btex}} . UR_{btex,i} \quad [3]$$

with $UR_{btex,i}$ the Uptake Rate (in ng.ppm^{-1}.min^{-1}) reported by Gradko for each BTEX compound and each batch, MV the molar volume (25.034 L at 28°C, and 100 kPa, being identical to the conditions used by Gradko) and MW_{btex} the molar mass of each of the BTEX compounds (78.112, 92.139, and 106.168 respectively for benzene (C6H6), toluene (C6H5-CH3) and ethylbenzene and xylenes (C6H4-CH3CH3 / C6H5-CH2CH3)[5].

The calculation of the BTEX concentration is implemented in a spreadsheet used for each batch, referred to as the NIRAS BTEX spreadsheet. The setup is such that easy auditing and modification, if required, is possible as the final results can be traced back to the reports of Gradko and KHMI. Data are used with active links to the NIRAS BTEX spreadsheets.

[4] Gradko also supplied results in ppb units and µg/m3 units, but were not included.

[5] If needed converting the concentration values to the conditions choosen by KHMI, a simple factor needs to be applied.

Imputation – results below determination limit

Values below the detection limit (5 ng/tube) need to be substituted by an estimate that accounts for the distribution of possible values and that satisfy most likely the underlying statistics. If no substitute is used this will act as if the average of the remaining values is included, definitely in most cases not an appropriate procedure as this would erroneously lead to a higher average value.

An often applied imputation method, and for this set the method of choice, is substituting the below-limit-value by the the detection limit value devided by of square root of 2. The substitute for the concentration is then 1/sqrt(2) * 5 ng/tube (= 3.5 ng/tube), divided by the volume of the sample (see the calculation method). This gives approximately 0.14 µg/m^3 as the substitute with some variation due to varying exposure time and so volume.

Imputation – results missing

Missing concentration values due to losing samples limits the accuracy of the calculated statistic, e.g. the period average, and might reduce the information content such as needed to e.g. assess compliance or explore for sources. Although the number of samples lost is somewhat limited (roughly 10%) this loss multiplies if sets of results are to be used. This setback might be overcome by estimating substitutes based on additional information, such as the relation of BTEX with other air pollutants and relation of BTEX levels over time.

All these assumptions are based on the notion that air pollution levels are mainly caused by meteorological conditions in combination with the anthropogenic and natural activities of sources. Sources that might emit a broad range of compounds.

To find a suitable estimate the relation of BTEX and the other air pollutants were included in the imputation effort. The imputation consists of two steps: (i) a seed for the iterative procedure is calculated using ratios of the same BTEX measured at other sites and adjacent time periods. In the next step (ii) these seeds completed the input for the multiple linear regression calculation including PM2.5, NO2 and O3 period average concentration. New values for the seeds were calculated with the obtained regression parameters and formed the substitutes for the earlier seeds. The iteration was halted when the correlation of the measured and calculated values did not improve more than 0.1 %, typically after 3 or 4 iterations. The thus obtained dataset was used for statistical calculations.

The selection of PM2.5, NO2, O3 was guided by the notion that sources potentially emitting BTEX also emit other pollutants such as PM2.5 (emitted by combustion process, including traffic and in particular domestic heating), NO2 (emitted by a number of sources including industry, domestic heating, traffic) and O3 as a good indicator for the atmospheric oxidant state.

Data for the calculation of the air quality parameters were obtained from the datasets of the Open Data Republic of Kosova[6] using hourly averaged values. Daily averaged values were calculated (at least 75% hourly values are available) and averaged over the respective periods.

[6] https://opendata.rks-gov.net/en/dataset?groups%3Dambient

This approach for imputation was only applied to the data of benzene, toluene and mp-xylene. For the other two compounds, ethylbenzene and o-xylene, the frequency of results below-the-determination-limit was too high (approximately 35%) to warrant proper application of this method. These missing values are therefore implicitly replaced by the average of the remaining dataset.

Results

The results for each of the samples are presented in the Annex. For benzene, toluene and mp-xylene including the imputed values. Table 3 summarizes these results.

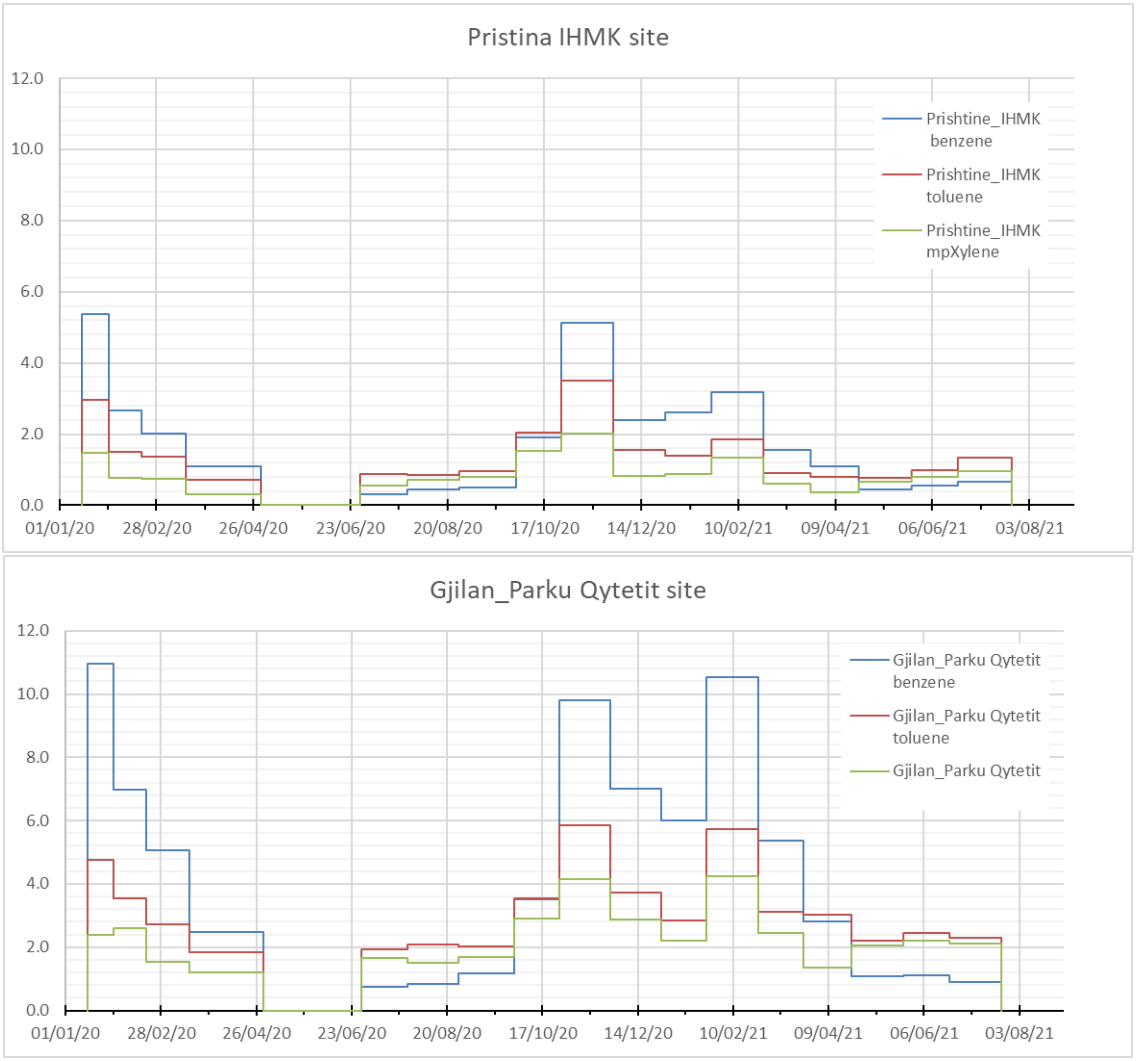
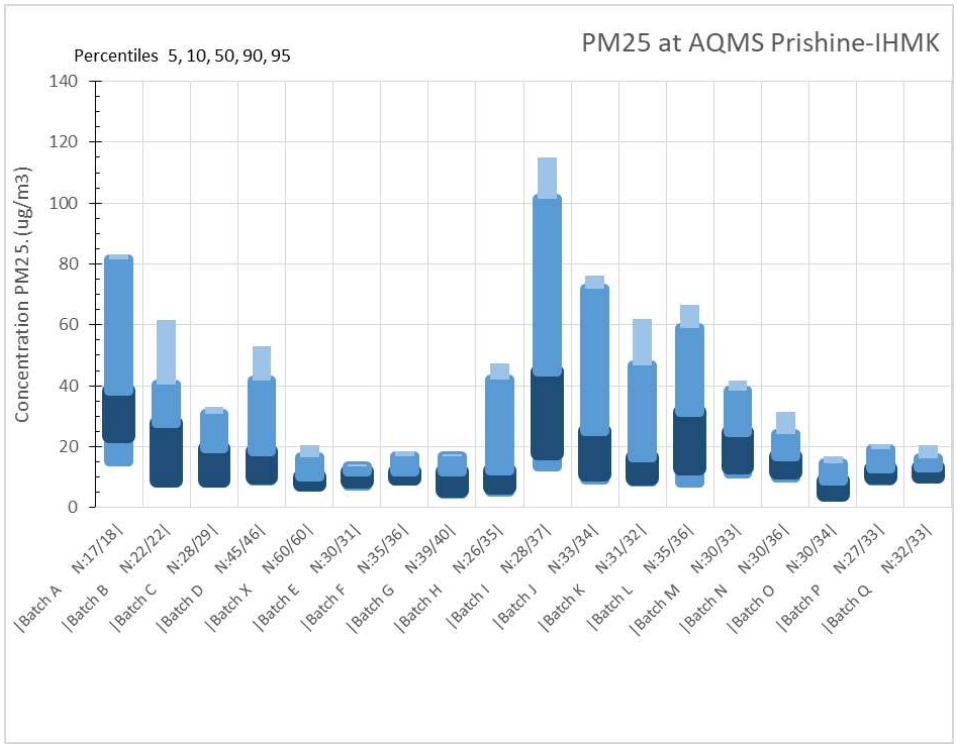


Figure 3: Period-averaged concentration of benzene (blue lines), toluene (red lines) and mp-xylene (green lines) measured at the BTEX stations Pristina (IHMK) and Gjilan (Parku Qytetit). Note that during the period 30/4/2020 – 29/6/2020 no samples were collected.

Figure 3 illustrates the variation over time of the major BTEX compounds, benzene, toluene and mp-xylene for the monitoring stations Pristina IHMK and Gjilan Parku Qytetit The other BTEX compounds, ethylbenzene and o-xylene, usually are present in lower concentrations or even below determination limit (approximately 35%).

During the first four sampling campaigns the levels started high and gradually decrease. This pattern is explained by better dispersion and reduced source activities. In the period March and April COVID-19 containment measures came into force and most likely had an impact on the emissions. Identical time patterns are shown by the PM2.5 concentrations and NO2 concentrations at the AQMS station Pristina IHMK (Figure 4). In September 2020 the

concentrations of BTEX, PM10 and NO2 increase again. In March/April 2021 the levels are lower again to reach levels shown in summer 2020.



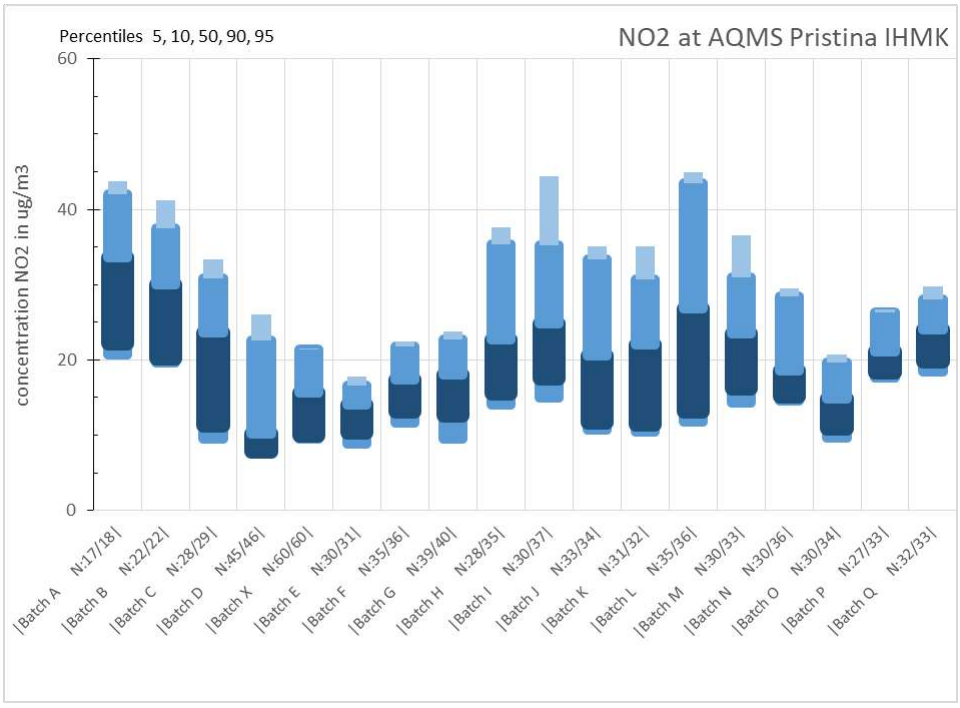


Figure 4: Concentration distribution of PM2.5 and NO2 at the AQMS station Pristina IHMK

Table 3: Summary of concentration values for each of the location over the project (Batch A to Batch Q) as average (minimum and maximum) in ug/m^3.

Project Weighed	Benzene	Toluene	Ethylbenzene	oXylene	mpXylene
Fush-1	2.7 (0.8 - 6.5)	3.9 (1.8 - 7.1)	0.8 (0.4 - 1.9)	1.0 (0.5 - 2.2)	2.7 (1.2 - 6.1)
Fush-2	2.7 (0.4 - 6.8)	2.3 (0.8 - 5.6)	0.4 (0.2 - 1.5)	0.4 (0.2 - 1.6)	1.3 (0.6 - 4.7)
Dren-1	1.5 (0.3 - 3.7)	1.0 (0.5 - 1.9)	0.2 (0.1 - 0.5)	0.2 (0.1 - 0.5)	0.6 (0.4 - 1.4)
Dren-2	1.2 (0.2 - 2.9)	0.7 (0.3 - 1.3)	0.2 (0.1 - 0.3)	0.2 (0.1 - 0.3)	0.3 (0.1 - 0.9)
Dren-3	1.2 (0.3 - 3.0)	0.7 (0.4 - 1.4)	0.2 (0.1 - 0.3)	0.2 (0.1 - 0.7)	0.5 (0.1 - 2.9)
Dren-4	1.7 (0.2 - 4.6)	1.1 (0.4 - 2.1)	0.2 (0.1 - 0.4)	0.2 (0.1 - 0.5)	0.5 (0.3 - 1.4)
Dren-5	1.6 (0.2 - 4.6)	1.0 (0.4 - 2.1)	0.2 (0.1 - 0.4)	0.2 (0.1 - 0.4)	0.5 (0.2 - 1.3)
Gjil-1	3.9 (0.6 - 10.9)	3.0 (1.8 - 5.8)	0.6 (0.4 - 1.3)	0.7 (0.4 - 1.4)	2.1 (1.2 - 4.2)
Gjil-2	2.9 (0.4 - 8.2)	2.1 (1.2 - 4.2)	0.5 (0.2 - 1.1)	0.5 (0.2 - 1.0)	1.6 (0.6 - 3.6)
Gjil-3	3.2 (0.4 - 9.2)	2.0 (1.1 - 4.2)	0.4 (0.2 - 0.9)	0.4 (0.2 - 1.0)	1.3 (0.4 - 2.7)
Hani-1	1.4 (0.3 - 3.5)	0.8 (0.4 - 2.1)	0.2 (0.2 - 0.7)	0.2 (0.2 - 0.4)	0.4 (0.2 - 1.2)
Hani-2	1.5 (0.3 - 3.8)	0.8 (0.4 - 1.6)	0.2 (0.2 - 0.3)	0.2 (0.2 - 0.3)	0.5 (0.3 - 0.9)
Feri-1	2.8 (0.5 - 7.4)	2.5 (1.1 - 5.9)	0.5 (0.3 - 0.9)	0.5 (0.2 - 1.0)	1.5 (0.7 - 3.0)
Obil-1	2.6 (0.7 - 7.0)	1.7 (0.7 - 3.9)	0.3 (0.2 - 0.9)	0.3 (0.1 - 0.7)	1.0 (0.5 - 2.3)
Obil-2	2.0 (0.3 - 6.6)	1.4 (0.6 - 2.9)	0.3 (0.2 - 0.7)	0.3 (0.2 - 0.8)	0.8 (0.5 - 1.6)
Obil-3	1.5 (0.4 - 4.0)	0.9 (0.4 - 2.1)	0.2 (0.1 - 0.5)	0.2 (0.1 - 0.4)	0.6 (0.2 - 1.2)
Peje-1	2.7 (0.5 - 9.6)	1.7 (0.6 - 4.2)	0.3 (0.1 - 0.8)	0.3 (0.1 - 0.8)	0.9 (0.2 - 2.4)
Peje-2	1.4 (0.3 - 4.9)	1.1 (0.6 - 3.0)	0.2 (0.1 - 0.4)	0.2 (0.1 - 0.4)	0.7 (0.3 - 1.4)
Peje-3	2.4 (0.5 - 7.9)	2.0 (0.8 - 3.9)	0.3 (0.2 - 0.7)	0.4 (0.1 - 0.8)	1.1 (0.5 - 2.2)
Gjak-1	2.1 (0.4 - 6.0)	2.5 (0.9 - 6.4)	0.4 (0.2 - 1.1)	0.5 (0.2 - 1.1)	1.5 (0.6 - 3.5)
Gjak-2	2.2 (0.7 - 6.2)	1.8 (0.4 - 7.1)	0.3 (0.2 - 1.1)	0.4 (0.2 - 1.2)	1.0 (0.5 - 3.6)
Gjak-3	2.4 (0.6 - 8.0)	2.2 (1.1 - 4.3)	0.4 (0.2 - 0.9)	0.4 (0.3 - 0.9)	1.1 (0.6 - 2.4)
Priz-1	2.2 (0.4 - 8.7)	2.2 (0.9 - 5.6)	0.3 (0.1 - 1.1)	0.4 (0.2 - 1.1)	1.1 (0.6 - 3.4)
Priz-2	2.1 (0.5 - 8.6)	2.3 (0.9 - 5.2)	0.3 (0.1 - 1.0)	0.4 (0.2 - 1.0)	1.1 (0.5 - 2.8)
Priz-3	2.2 (0.5 - 9.7)	4.3 (1.2 - 9.5)	0.5 (0.3 - 1.4)	0.7 (0.3 - 1.7)	1.9 (0.9 - 5.0)
Suha-1	1.4 (0.3 - 4.5)	1.4 (0.8 - 3.3)	0.2 (0.1 - 0.7)	0.3 (0.1 - 0.8)	0.8 (0.4 - 2.0)
Mitr-1	1.5 (0.1 - 5.2)	1.4 (0.6 - 3.4)	0.2 (0.2 - 0.6)	0.2 (0.2 - 0.6)	0.7 (0.4 - 1.6)
Mitr-2	1.8 (0.1 - 5.0)	1.3 (0.3 - 2.8)	0.2 (0.1 - 0.6)	0.2 (0.1 - 0.6)	0.8 (0.4 - 1.8)
Mitr-3	2.1 (0.5 - 7.2)	1.8 (1.0 - 3.8)	0.3 (0.2 - 0.7)	0.3 (0.2 - 0.7)	1.1 (0.6 - 3.0)
Vush-1	2.0 (0.1 - 6.5)	1.5 (0.7 - 3.3)	0.4 (0.1 - 3.1)	0.4 (0.1 - 3.5)	1.5 (0.5 - 15.6)
Vush-2	2.8 (0.3 - 9.4)	2.3 (0.6 - 5.0)	0.4 (0.2 - 1.0)	0.4 (0.2 - 1.0)	1.2 (0.2 - 3.2)
Pris-1	1.7 (0.4 - 5.3)	1.5 (0.8 - 4.0)	0.3 (0.2 - 0.7)	0.3 (0.2 - 0.7)	0.9 (0.6 - 2.0)
Pris-2	2.0 (0.3 - 6.0)	1.9 (1.0 - 3.3)	0.4 (0.2 - 0.8)	0.4 (0.2 - 1.0)	1.1 (0.8 - 2.8)
Pris-3	1.7 (0.3 - 4.9)	1.6 (0.8 - 4.4)	0.3 (0.2 - 0.7)	0.3 (0.2 - 0.7)	0.9 (0.5 - 1.8)
Pris-4	1.9 (0.5 - 5.0)	1.6 (1.0 - 3.4)	0.3 (0.2 - 0.7)	0.3 (0.2 - 0.7)	1.0 (0.6 - 1.9)
Pris-5	2.1 (0.4 - 6.2)	1.5 (0.8 - 3.0)	0.3 (0.2 - 0.6)	0.3 (0.2 - 0.6)	0.9 (0.6 - 2.3)
Pris-6	0.6 (0.2 - 1.6)	0.5 (0.3 - 1.3)	0.2 (0.2 - 0.9)	0.2 (0.1 - 0.6)	0.4 (0.2 - 1.3)
Pris-7	1.6 (0.3 - 5.4)	1.3 (0.7 - 3.5)	0.3 (0.1 - 0.7)	0.3 (0.1 - 0.7)	0.8 (0.3 - 2.0)

BTEX in towns

Grouped per town the concentration ranges for the project are as given in Table 4. The benzene concentration values range from 1.4-1.6 µg/m^3 for the low level towns, to 1.8-2.2 µg/m^3 for the midlevel towns to 2.4 – 3.3 µg/m^3 for the high-level towns. For toluene and mp-xylene these groups are more or less similar. The concentrations in the high-level towns show some extreme values.

Table 4: BTEX concentration per town (average over 2-6 locations) including extreme values (min – max) in µg/m^3. Weights are the number of days the period/batch lasted.

	Benzene	Toluene	Ethylbenzene	mpXylene	oXylene
FushKosove	2.7 (0.4 - 6.8)	3.1 (0.8 - 7.1)	0.6 (0.2 - 1.9)	2.2 (0.6 - 6.1)	0.7 (0.2 - 2.2)
Drenas	1.4 (0.2 - 4.6)	0.9 (0.3 - 2.1)	0.2 (0.1 - 0.5)	0.6 (0.0 - 2.9)	0.2 (0.1 - 0.7)
Gjilan	3.3 (0.4 - 10.9)	2.4 (1.1 - 5.8)	0.5 (0.2 - 1.3)	1.7 (0.4 - 4.2)	0.5 (0.2 - 1.4)
HaniElezit	1.4 (0.3 - 3.8)	0.8 (0.4 - 2.1)	0.2 (0.2 - 0.7)	0.5 (0.1 - 1.2)	0.2 (0.2 - 0.4)
Ferizaj	2.8 (0.5 - 7.4)	2.5 (1.1 - 5.9)	0.5 (0.3 - 0.9)	1.6 (0.7 - 3.0)	0.5 (0.2 - 1.0)
Obiliq	2.0 (0.3 - 7.0)	1.3 (0.4 - 3.9)	0.3 (0.1 - 0.9)	0.9 (0.2 - 2.3)	0.3 (0.1 - 0.8)
Peje	2.2 (0.3 - 9.6)	1.6 (0.6 - 4.2)	0.3 (0.1 - 0.8)	1.0 (0.2 - 2.4)	0.3 (0.1 - 0.8)
Gjakove	2.2 (0.4 - 8.0)	2.1 (0.4 - 7.1)	0.4 (0.2 - 1.1)	1.3 (0.2 - 3.6)	0.4 (0.2 - 1.2)
Prizren	2.2 (0.4 - 9.7)	2.9 (0.9 - 9.5)	0.4 (0.1 - 1.4)	1.6 (0.5 - 5.0)	0.5 (0.2 - 1.7)
Suharek	1.4 (0.3 - 4.5)	1.4 (0.8 - 3.3)	0.2 (0.1 - 0.7)	0.9 (0.4 - 2.0)	0.3 (0.1 - 0.8)
Mitrovic	1.8 (0.1 - 7.2)	1.5 (0.3 - 3.8)	0.2 (0.1 - 0.7)	1.1 (0.4 - 3.1)	0.3 (0.1 - 0.7)
Vushtrri	2.4 (0.1 - 9.4)	1.9 (0.6 - 5.0)	0.4 (0.1 - 3.1)	1.6 (0.2 - 15.6)	0.4 (0.1 - 3.5)
Pristina	1.9 (0.3 - 6.2)	1.6 (0.7 - 4.4)	0.3 (0.1 - 0.8)	1.1 (0.3 - 2.8)	0.3 (0.1 - 1.0)
Prishtine_Germi	0.6 (0.2 - 1.6)	0.5 (0.3 - 1.3)	0.2 (0.2 - 0.9)	0.4 (0.2 - 1.3)	0.2 (0.1 - 0.6)

BTEX over seasons

The project period covers only roughly 1.5 years. During the period in which a substantial extreme measures modified human and economic activities and hence emissions, possibly in both directions. If the months from March/April 2020 and following are excluded as far as possible the periods/batches D, O, P and Q could represent the summer half year period (140 days), whereas the periods A, B, C and I, J, K the winter half year (170 days) (See Table 5).

During the summer half year the town average benzene levels range from 0.6 to 1.3 µg/m^3, approximately 1.5 to 3 times the background level (0.4 µg/m^3). During the winter period the town average levels range from 2.7 to 6.4 µg/m^3, approximately 2.5 to 6 times the wintertime average level at the background site Pristine Germi. In particular the high maximum levels measured during one monitoring period stand out (up to 11 times the average background level).

Whether this distinction between ‘summer ‘and ‘winter’ is representative for other years cannot be concluded from information presented in this report. More monitoring would be needed to draw such conclusions.

Table 5: BTEX concentration per town (average over 2-6 locations) including extreme values (min – max) in µg/m³ averaged over the 'summer' periods D, O, P and Q. and over 'winter' periods A,B,C and I, J, K. Weights are the number of days the period/batch lasted

'Summer'	Benzene	Toluene	Ethylbenzene	oXylene	mpXylene
FushKosove	1.3 (0.4 - 2.0)	2.6 (1.2 - 6.1)	0.4 (0.2 - 0.9)	0.5 (0.2 - 1.2)	1.7 (0.6 - 3.2)
Drenas	0.7 (0.2 - 1.3)	0.6 (0.3 - 0.8)	0.1 (0.1 - 0.2)	0.1 (0.1 - 0.2)	0.3 (0.1 - 0.6)
Gjilan	1.3 (0.5 - 2.5)	1.6 (1.2 - 2.5)	0.4 (0.2 - 0.7)	0.4 (0.2 - 0.7)	1.3 (0.6 - 2.2)
HaniElezit	0.6 (0.3 - 1.0)	0.5 (0.4 - 0.7)	0.1 (0.2 - 0.2)	0.1 (0.2 - 0.2)	0.3 (0.2 - 0.4)
Ferizaj	1.1 (0.6 - 1.8)	3.2 (1.2 - 5.9)	0.4 (0.3 - 0.4)	0.4 (0.2 - 0.5)	1.2 (0.7 - 1.5)
Obiliq	1.0 (0.4 - 2.3)	0.8 (0.4 - 1.2)	0.2 (0.1 - 0.3)	0.3 (0.1 - 0.8)	0.6 (0.4 - 0.9)
Peje	0.8 (0.4 - 1.6)	1.2 (0.7 - 2.9)	0.2 (0.1 - 0.4)	0.2 (0.1 - 0.5)	0.7 (0.2 - 1.4)
Gjakove	1.0 (0.5 - 1.6)	1.4 (0.7 - 2.0)	0.3 (0.2 - 0.4)	0.4 (0.2 - 1.2)	0.9 (0.5 - 1.5)
Prizren	0.8 (0.5 - 1.5)	2.2 (0.9 - 3.9)	0.3 (0.1 - 0.6)	0.5 (0.2 - 0.8)	1.2 (0.5 - 2.2)
Suharek	0.6 (0.4 - 1.0)	1.0 (0.8 - 1.2)	0.2 (0.1 - 0.3)	0.3 (0.1 - 0.3)	0.8 (0.4 - 1.0)
Mitrovic	0.7 (0.3 - 1.5)	1.1 (0.6 - 1.6)	0.2 (0.1 - 0.4)	0.2 (0.1 - 0.4)	0.7 (0.4 - 1.3)
Vushtrri	1.0 (0.3 - 2.4)	1.1 (0.6 - 1.6)	0.2 (0.1 - 0.4)	0.3 (0.1 - 0.4)	0.8 (0.2 - 1.3)
Pristina	0.9 (0.4 - 1.7)	1.1 (0.7 - 1.8)	0.3 (0.1 - 0.7)	0.3 (0.1 - 0.9)	0.9 (0.3 - 2.5)
Prishtine_Germi	0.4 (0.3 - 0.6)	0.4 (0.4 - 0.5)	0.2 (0.2 - 0.2)	0.2 (0.1 - 0.2)	0.4 (0.2 - 0.6)

'Winter'	Benzene	Toluene	Ethylbenzene	oXylene	mpXylene
FushKosove	4.7 (3.0 - 6.5)	3.7 (2.0 - 5.6)	0.8 (0.4 - 1.5)	0.9 (0.3 - 1.6)	2.6 (1.1 - 4.7)
Drenas	2.7 (1.3 - 4.6)	1.3 (0.5 - 2.1)	0.2 (0.2 - 0.5)	0.2 (0.2 - 0.4)	0.7 (0.2 - 1.4)
Gjilan	6.4 (3.2 - 10.9)	3.3 (1.1 - 5.8)	0.7 (0.2 - 1.2)	0.7 (0.2 - 1.4)	2.2 (0.4 - 4.1)
HaniElezit	2.8 (1.7 - 3.8)	1.4 (0.7 - 2.1)	0.3 (0.2 - 0.7)	0.3 (0.2 - 0.4)	0.7 (0.3 - 1.2)
Ferizaj	5.4 (4.0 - 7.4)	3.1 (2.2 - 4.7)	0.7 (0.5 - 0.9)	0.7 (0.5 - 1.0)	2.2 (1.3 - 3.0)
Obiliq	3.8 (1.9 - 7.0)	2.1 (1.0 - 3.9)	0.4 (0.2 - 0.9)	0.4 (0.2 - 0.7)	1.2 (0.6 - 2.3)
Peje	4.7 (1.7 - 9.6)	2.6 (0.9 - 4.2)	0.4 (0.2 - 0.8)	0.4 (0.2 - 0.8)	1.4 (0.6 - 2.4)
Gjakove	4.4 (2.1 - 8.0)	3.2 (1.3 - 7.1)	0.6 (0.2 - 1.1)	0.6 (0.2 - 1.2)	1.9 (0.6 - 3.6)
Prizren	4.8 (0.5 - 9.7)	4.0 (1.2 - 9.5)	0.7 (0.3 - 1.4)	0.8 (0.3 - 1.7)	2.2 (0.8 - 5.0)
Suharek	2.7 (1.9 - 4.5)	2.0 (1.1 - 3.3)	0.4 (0.2 - 0.7)	0.4 (0.2 - 0.8)	1.1 (0.6 - 2.0)
Mitrovic	3.7 (1.6 - 7.2)	2.4 (1.1 - 3.8)	0.3 (0.2 - 0.7)	0.4 (0.2 - 0.7)	1.5 (0.6 - 3.1)
Vushtrri	4.9 (2.6 - 9.4)	2.9 (1.6 - 5.0)	0.8 (0.4 - 3.1)	0.8 (0.3 - 3.5)	3.0 (1.1 - 15.6)
Pristina	3.7 (2.0 - 6.2)	2.2 (1.1 - 4.4)	0.4 (0.2 - 0.7)	0.4 (0.2 - 0.7)	1.2 (0.7 - 2.0)
Prishtine_Germi	1.0 (0.5 - 1.6)	0.6 (0.3 - 1.0)	0.2 (0.2 - 0.5)	0.2 (0.2 - 0.5)	0.3 (0.2 - 0.6)

Discussion

Compliance with limit values

A first objective for monitoring BTEX is to examine whether the conditions comply with limit values set by the Kosovo government. Limit values for benzene listed in the guidelines are 5 µg/m^3 annual average (Kosovo Air Quality Law and EU Directive). As a target values 1 µg/m^3 is published.

WHO states that due to the carcinogenicity of benzene no values are recommended as a safe level. WHO uses values for risk assessment of 1.7 and 0.17 µg/m^3 associated with excess lifetime risk of 1/100.000 and 1/1.000.000 respectively[7].

At all monitoring sites the concentrations are below the limit values and except for the background site above the target value of 1 µg/m^3. This is also the case if the 'winter' and 'summer' values are averaged.

WHO still expects a risk when people are exposed to the levels currently measured; the excess lifetime risk of 1/100.000.

Compliance with assessment thresholds

Although not in force, holding the results against EU regulations[8] might be of interest for future planning of monitoring activities. In this respect the assessment thresholds are relevant. A lower assessment threshold is defined as 40% of the limit value, for benzene this comes to 2 µg/m^3. An upper assessment threshold is defined as 70% of the limit value, for benzene this comes to 3.5 µg/m^3.

For assessing the air pollutants levels both measurements and modelling in combination with appropriate emission inventories can be used. Three conditions can be defined:

a. Levels are above the upper assessment threshold:

   To assess the benzene annual average level fixed measurements are required, using certified methodology and at a number of sites indicated by the population for which the assessment describes the potential exposure.

b. Levels are between lower and upper assessment threshold:

   Both fixed measurements and model calculations can be applied where the number of sites might be reduced as model calculations supplement measurement

c. Levels are below lower assessment threshold:

   Model calculations based on adequate emission inventories are stated sufficient to assess the benzene levels. Model calibration might require some measurements.

The minimum number of sampling points in this respect is given in the mentioned directive[8], Annex V and shown in Table 6.

[7] World Health Organization. Regional Office for Europe. (2000). Air quality guidelines for Europe: second edition. World Health Organization. Regional Office for Europe. https://apps.who.int/iris/handle/10665/107335

[8] DIRECTIVE 2008/50/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 May 2008 on ambient air quality and cleaner air for Europe

Table 6: Minimum number of sampling points for fixed measurement when fix measurements are the only source of information to assess compliance with limit values for the protection of human health and alert thresholds in zones and agglomerations. (copied from AQ directive 2008/50/EC)

1. *Diffuse sources*

Population of agglomeration or zone (thousands)	If maximum concentrations exceed the upper assessment threshold (1)		If maximum concentrations are between the upper and lower assessment thresholds	
	Pollutants except PM	PM (2) (sum of PM_{10} and $PM_{2,5}$)	Pollutants except PM	PM (2) (sum of PM_{10} and $PM_{2,5}$)
0-249	1	2	1	1
250-499	2	3	1	2
500-749	2	3	1	2
750-999	3	4	1	2

The results of the current monitoring campaign

The levels of benzene are between the upper and lower assessment threshold (most right condition mentioned in Table 6) hence it can be concluded that fix measurements are required for some years at least. The siting of the fix measurements depends on the population of each agglomeration or zone, which needs to be defined according to the Directive.

When applying these EU recommendations/requirements of the Directive 2008/50/EC to the future setup of the BTEX monitoring and assuming each town as an agglomeration or zone the number of sites for fixed monitoring for each town, would be one or two (Pristina).

The number of the current monitoring campaign ismore than sufficient for the future set-up. The larger number in the current setup provides the required redundancy needed when measuring the air pollutant for the first time.

Source investigation

Benzene is emitted by a number of sources; traffic and other combustion processes using fuel containing benzene, processes involving solvents that contain benzene (industry, paints, cleaning) or that produce benzene in chemical procedures (e.g. cement industry). Smoking is often mentioned a source of benzene and other BTEX compounds but that only holds for the indoor environment. For most urban areas with no heavy industry in the neighborhood traffic is the major source for benzene. Certainly benzene is the most relevant of the BTEX from a health perspective, the other compounds provide information on the possible sources and the conditions under which benzene is emitted and converted in the atmospheric chemical processes. The toluene/benzene ratio is quite indicative. Toluene is a major light VOC aromatic hydrocarbon in fuel, is measured as part of BTEX and is more reactive in the air than benzene where it is oxidized or reacts with NO2. The ratio toluene/benzene (T/B) will change over time (toluene disappears faster than benzene) and is not largely affected by the dispersion processes. The atmospheric processes are mainly driven by sunlight and are relatively slow compared to dispersion. All this leads to the expectation that the measured ratio T/B reflects the ratio of the source(s) when levels are still relatively high and possibly fresh. And so if the mix of source contributions remain the same also the ratio remain the same, only changing slightly due to the faster removal of toluene compared to that of benzene.

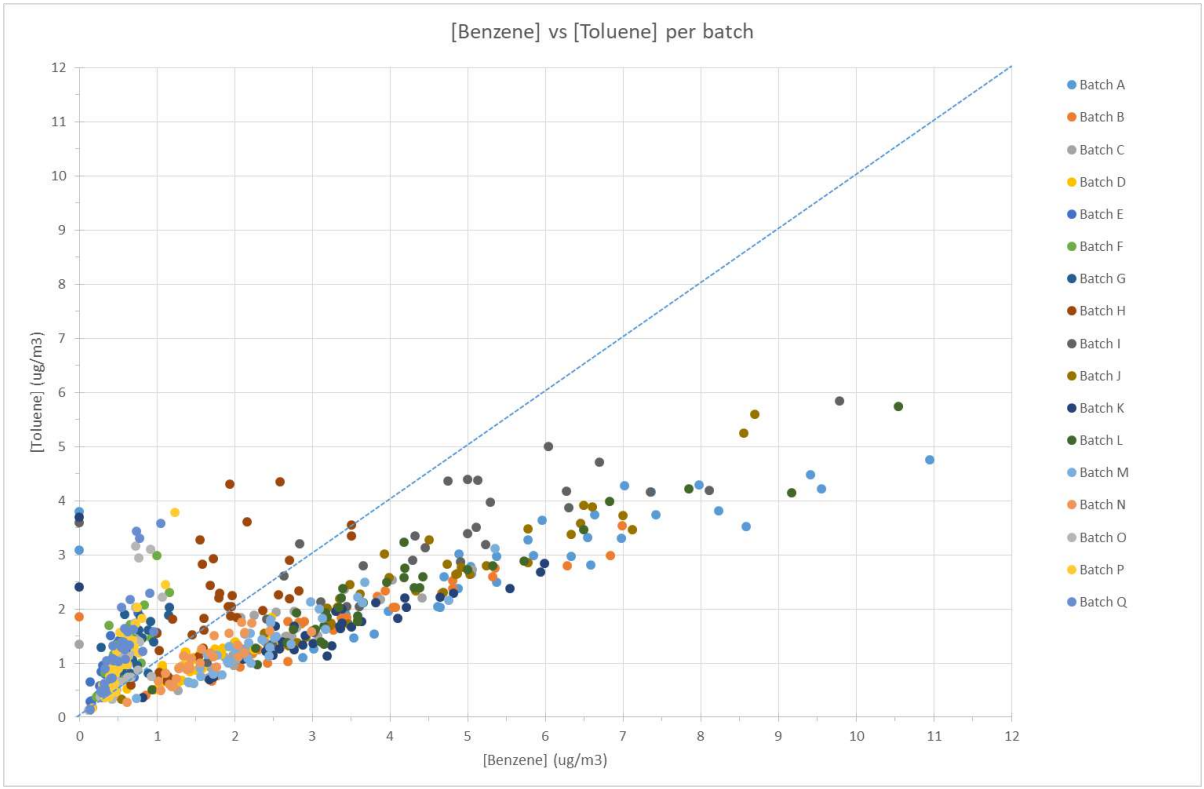


Figure 5: Benzene vs toluene concentrations of all samples per batch. The dotted line represents the 1:1 ratio

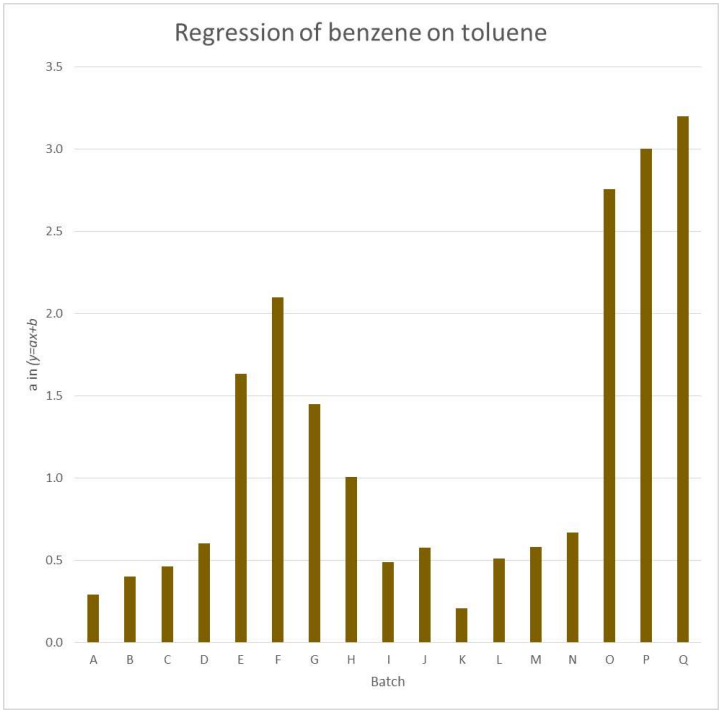


*Figure 6 Regression of benzene on toluene. Regression factor (a) in [toluene] = a *[benzene] + offset ternaire plot of benzene, toluene and mp-xylene for the Drenas sites*

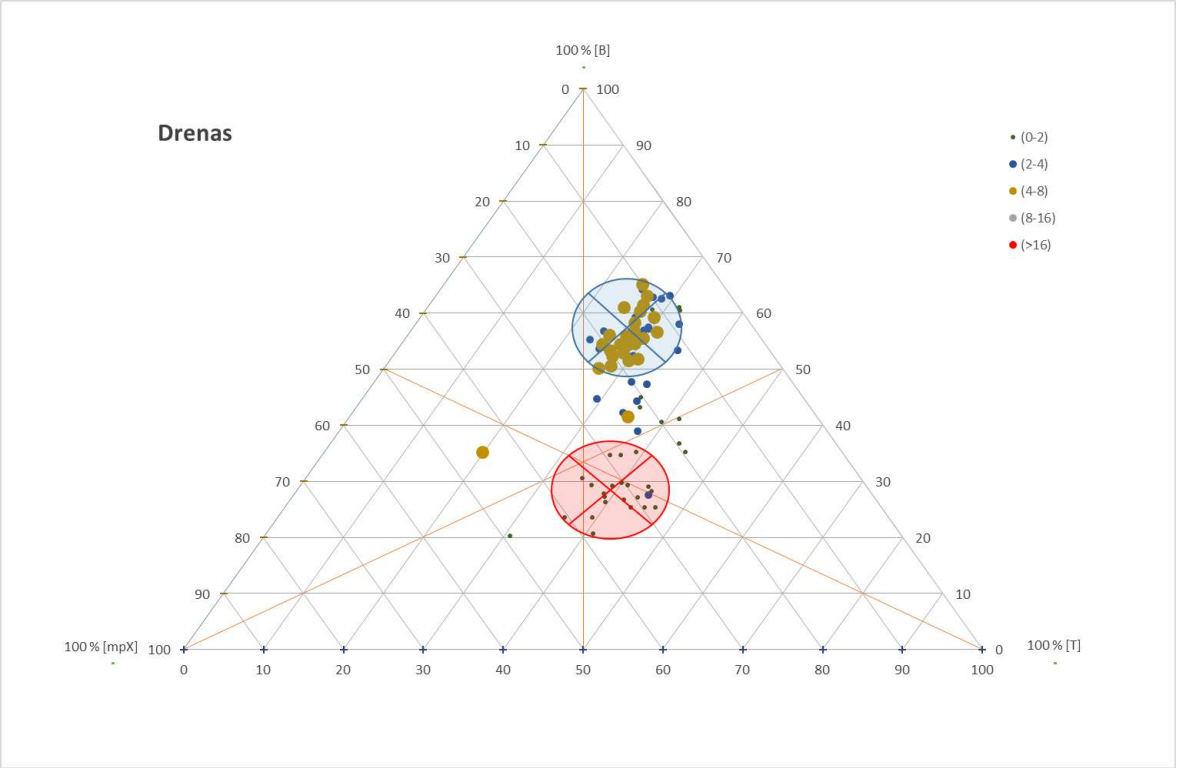


Figure 7: Ternary plot of the benzene, toluene and mp-xylene content of all the samples collected at the Drenas locations. Group by the total concentration of BTEX (see text).

Many investigations published in the literature [9] indicate a ratio of toluene: benzene as 3:1 in urban areas. During the project the levels of BTEX changed as well as the ratio toluene/benzene (T/B) (see Figure 5 and Figure 6. High T/B ratios coincide with low BTEX levels.

High BTEX levels and low T/B ratios occur especially during the 'winter' months. The ternary plot of the samples of the Drenas locations in Figure 7 (N=5) shows the composition of benzene:toluene:mp-xylene of the samples (N=85) grouped by the sum of the concentrations.(5 categories; 0-2; 2-4;4-8;8-16;>16 µg/m^3). The graphs shows that the centroid of the first and last set of samples is B:T:mpX = 57:27:16 with relatively high

[9] E.g.

Bozena Zabiegała, Magdalena Urbanowicz, Krystyna Szymanska, and Jacek Namiesnik , Application of Passive Sampling Technique for Monitoring of BTEX Concentration in Urban Air: Field Comparison of Different Types of Passive Samplers Journal of Chromatographic Science, Vol. 48, March 2010

Martino Amodioa, Gianluigi de Gennaroa,b, Annalisa Marzoccab, Livia Trizioa,b, Maria Tutinob, Monitoring of volatile organic compounds in the cities of the metropolitan area of Bari (Italy). Procedia Environmental Sciences 4 (2011) 126–133

Lokman Hakan Tecer, Sermin Tagel, Osman Ulukaya and Merve Ficici. Spatial Distribution of BTEX and Inorganic Pollutants during Summer Season in Yalova, Turkey. Ecol Chem Eng S. 2017;2 4(4):565-581

concentration sums and a centroid of B:T:mpX=28:39:33 for the low concentration samples. The plot shows clearly that the change of the composition is mainly due to changing benzene content (centroid moves along the benzene center line).

All this information is not in line with a higher removal rate of toluene compared to that of benzene. This observation however would indicate another source than traffic, or more accurately stated: traffic fueled with other than ‘common’ petrol and diesel. It must be mentioned here that benzene levels in petrol in most countries have been lowered substantially resulting in lower ambient benzene levels in many countries. Whether the composition of fuel used in Kosovo has a higher benzene content than petrol used in many other countries or whether an unknown source is active is in need of further investigation.

Conclusion

Operation of the monitoring campaign

The planning, execution and evaluation of the monitoring has become a part of the project's routine and has run with the foreseen frequency. The three involved organizations NIRAS, KHMI and Gradko have established a well-defined transfer of samplers, results and evaluation of those results. The current routine also warrants early-warnings for possible issues because of the checks the NIRAS office has taken and this prevents administration errors.

The operation has seen some samples being lost during the various steps of the field work, transport and analysis. The latter is beyond control of NIRAS and KHMI and is very limited. Also losing tubes because people take them away is not to be avoided. The remedy of changing the siting of the tubes, given the constraints, has possibly reduced somewhat the loss. Transport losses were mostly avoided once noticed. And of course, the loss of samples due to COVID-19 containment measures was unavoidable.

In conclusion it can be stated that the operation was successful and that the experience of KHMI and the insights gathered with the BTEX monitoring will form a basis for future assessment of VOC and in particular BTEX and benzene.

Quality of the results

The quality of the results is expressed by analytical QA/QC parameters: results of blank field samples, KHMI lab samples and analytical control samples. The results show that the sampling and analysis produce high quality results with no contamination in any of the monitoring steps. The quality of the analysis is adequate and is guaranteed with the certified methodology of Gradko.

Plausibility of the results

The plausibility of the data for the batches is strengthened by the consistency of results at the various locations and as is seen in previous and next samples. The comparable pattern seen in other simultaneous air pollution data contributes to the plausibility.

Special attention is given to the ratio of the benzene and toluene concentrations at most of the sites. Exploring the data revealed the consistency of this ratio although it is different from what would be expected. The variation over time of this ratio suggests an important unknown source or unknown composition of fuel of known sources. The consistency of the ratio and given the nature of the analytical methodology makes an analytical error unlikely.

Results of the monitoring – annual average benzene

The period averaged concentrations of benzene at the various sites show that the levels in Kosovo are below the guideline limits but above the target value set by the EU and WHO

This assessment of the BTEX-air quality is for the situation that emissions might have been lower than 'normal' due to the special condition created by the COVID-19 containment measures. When activity levels return to 'normal' these values might be higher and possibly beyond the limit values.

Levels in relation with monitoring set-up

The current information on levels might be evaluated in the light of assessment threshold defined by the EU to develop future monitoring plans. The current setup of the BTEX monitoring is certainly sufficient according to the EU guidelines for this. Future design might include model calculations provided sufficient accurate emission inventories are available.

Recommendations

Operation of the monitoring

The setup of the monitoring is sufficient to acquire data on BTEX and in particular on benzene for the first set of year giving insight in the levels and behavior of benzene in the Kosovo situation. This setup might be continued in the same design and prepared for reduction once levels tend to lower. Passive sampling technology is labor intensive but cheap in technology (no pumps and electricity supply, no need of protection against vandalism or even monitors and housing thereof) and could remain the methodology of choice.

The analytical part of the exercise, now taken care of by Gradko, requires instrumentation that might be present in the KHMI laboratories. Thermal desorption followed by flame ionization detection is a well-known technique used for many years in many laboratories, If benzene is an air quality issue also in other compartments (indoor air, near petrol stations etc.) this might be considered.

Source apportionment

The indication of an abnormal condition with respect to the sources of benzene (or toluene) might be reason for further investigation of the composition of fuels or a widespread source of benzene other than traffic. Most likely source information and emission patterns might be available in the Kosovo data warehouse and guide the investigation.

Further evaluation of the benzene level information

The results of this monitoring exercise might be considered as indication for the level of exposure of the Kosovo people to benzene from ambient sources. Indoor environment might be impacted by indoor sources (e.g. smoking, cleaning products) as well causing indoor benzene levels even higher. Levels indoor will be at least the outdoor levels as ambient air is the source of ‘fresh’ air for the indoor environment.

Future BTEX monitoring

Developing policy measured requires trend analysis over a number of years. The current data set describes a little short of two year measurement, more might be required. To come to an effective setup the policy framework in which the future results will be used needs to be outlined clearly. Current practice laid down in Directives for EU or information of USA EPA provided in the Ambient Monitoring Technology Information Center (AMTIC) will be of great help.

Annex I

Digital Data

All data is available in digital form as the NIRAS spreadsheet for each batch.

ANNEX Table 1: Benzene concentrations of all samples for each batch A – Q in µg/m3. Including imputation results. Part I.Note that values for Batch X are obtained by imputation.

Benzene		Batch	A	B	C	D	X	E	F	G	H	I	J	K	L	M	N	O	P	Q
		start	14.1.20	30.1.20	19.2.20	16.3.20	30.4.20	29.6.20	27.7.20	27.8.20	30.9.20	27.10.20	27.11.20	28.12.20	25.1.21	25.2.21	25.3.21	23.4.21	24.5.21	21.6.21
		end	31.1.20	21.2.20	18.3.20	30.4.20	29.6.20	29.7.20	31.8.20	5.10.20	3.11.20	2.12.20	30.12.20	28.1.21	1.3.21	29.3.21	29.4.21	26.5.21	25.6.21	23.7.21
Code	All	N/Dur	17	22	28	45	59	30	35	40	35	36	33	31	35	32	35	34	32	32
Fush-1	2.9	18	5.7	4.3	3.0	1.7	1.6	0.8	1.0	1.3	3.7	4.7	6.5	4.2	5.5	3.1	2.2	1.2	1.2	1.0
Fush-2	2.9	18	6.3	4.8	3.4	2.0	0.9	0.4	0.6	0.7	3.5	5.2	5.5	3.6	6.8	3.7	2.0	0.7	1.8	0.4
Dren-1	1.6	18	3.4	2.3	2.0	1.3	0.3	0.3	0.4	0.5	1.7	3.7	3.0	2.5	3.2	1.9	1.0	0.4	0.4	0.3
Dren-2	1.3	18	2.9	1.7	1.4	1.0	0.4	0.2	0.4	0.5	1.6	2.5	2.7	1.7	2.3	1.4	1.1	0.4	0.3	0.3
Dren-3	1.3	18	3.0	1.8	1.3	1.0	0.4	0.3	0.4	0.5	1.5	2.4	2.8	1.7	2.3	1.5	1.2	0.4	0.4	0.3
Dren-4	1.8	18	4.6	2.6	2.0	1.3	0.4	0.4	0.5	0.6	2.4	3.4	3.6	2.9	3.6	1.9	0.9	0.2	0.8	0.8
Dren-5	1.8	18	4.6	2.1	2.0	1.3	0.2	0.4	0.5	0.5	1.1	4.2	3.5	2.8	3.7	2.2	1.2	0.4	0.4	0.4
Gjil-1	4.3	18	10.9	7.0	5.1	2.5	0.6	0.8	0.8	1.2	3.5	9.8	7.0	6.0	10.5	5.4	2.8	1.1	1.1	0.9
Gjil-2	3.2	18	8.2	5.4	3.9	1.8	0.4	0.4	0.5	0.8	2.6	7.4	4.8	5.9	7.9	3.6	2.4	0.8	0.6	0.6
Gjil-3	3.5	18	8.6	6.8	4.4	2.5	0.4	0.5	0.5	0.8	2.8	8.1	5.8	3.2	9.2	4.8	3.0	0.8	0.7	0.5
Hani-1	1.5	18	3.5	2.4	1.7	1.0	0.5	0.3	0.3	0.4	1.0	3.1	3.2	3.0	3.1	1.7	1.2	0.5	0.3	0.3
Hani-2	1.6	18	3.8	2.7	1.7	1.0	0.6	0.3	0.3	0.5	1.0	3.0	2.9	3.3	3.1	1.8	1.4	0.4	0.4	0.3
Feri-1	3.1	18	7.4	5.3	4.0	1.8	1.8	0.5	0.6	0.9	2.7	6.7	4.7	4.6	6.5	3.1	2.2	0.9	0.6	0.7
Obil-1	2.8	18	7.0	4.0	2.7	2.3	0.8	0.7	0.8	1.2	2.7	6.3	5.0	3.5	5.0	3.2	2.1	0.9	1.0	0.8
Obil-2	2.2	18	6.6	3.2	2.5	1.5	0.3	0.4	0.5	0.7	2.0	4.9	4.3	2.6	4.4	2.7	1.8	0.5	0.5	0.6
Obil-3	1.6	18	4.0	2.5	1.9	1.3	0.6	0.4	0.6	0.9	1.1	3.6	3.2	2.4	2.7	1.6	1.2	0.4	0.5	0.4
Peje-1	3.0	18	9.6	4.8	3.1	1.6	0.7	0.5	0.5	0.7	1.9	6.3	7.1	5.5	5.7	2.2	2.0	0.8	0.6	0.5
Peje-2	1.6	18	4.9	2.2	1.7	1.1	0.5	0.3	0.4	0.5	1.0	2.4	3.9	2.6	3.0	1.4	1.3	0.5	0.4	0.5
Peje-3	2.7	18	7.9	4.7	2.8	1.4	0.6	0.5	0.7	0.7	1.7	7.2	6.5	3.8	4.4	1.9	1.7	0.8	0.6	0.7

ANNEX Table 2: Benzene concentrations of all samples for each batch A – Q in µg/m³. Including imputation results. Part II. Note that values for Batch X are obtained by imputation.

Benzene		Batch	A	B	C	D	X	E	F	G	H	I	J	K	L	M	N	O	P	Q
		start	14.1.20	30.1.20	19.2.20	16.3.20	30.4.20	29.6.20	27.7.20	27.8.20	30.9.20	27.10.20	27.11.20	28.12.20	25.1.21	25.2.21	25.3.21	23.4.21	24.5.21	21.6.21
		end	31.1.20	21.2.20	18.3.20	30.4.20	29.6.20	29.7.20	31.8.20	5.10.20	3.11.20	2.12.20	30.12.20	28.1.21	1.3.21	29.3.21	29.4.21	26.5.21	25.6.21	23.7.21
Code	All	N/Dur	17	22	28	45	59	30	35	40	35	36	33	31	35	32	35	34	32	32
Gjak-1	2.3	18	6.0	2.9	2.1	1.4	0.4	0.7	0.7	0.6	1.9	5.1	5.8	2.7	3.6	3.6	1.5	0.7	0.7	0.5
Gjak-2	2.4	18	5.4	2.6	2.1	1.4	0.8	1.8	1.6	1.0	1.6	6.2	5.2	3.3	3.2	2.5	1.7	0.7	0.8	1.0
Gjak-3	2.7	18	8.0	3.9	2.8	1.6	1.2	1.0	0.9	0.8	2.2	4.3	6.6	4.0	4.2	3.0	1.9	0.6	0.8	0.7
Priz-1	2.4	18	7.4	2.9	2.5	1.3	0.4	0.4	0.5	0.7	1.6	5.1	8.7	3.3	3.4	2.5	1.6	0.5	0.5	0.5
Priz-2	2.4	18	6.6	2.7	2.3	1.1	0.7	0.5	0.7	0.8	1.7	5.0	8.6	3.4	2.9	2.5	1.1	0.7	0.7	0.8
Priz-3	2.5	18	7.0	3.2	3.0	1.5	0.6	0.6	0.7	0.7	1.6	5.0	9.7	0.5	3.7	2.6	1.8	0.7	0.5	0.6
Suha-1	1.5	18	2.0	2.2	1.9	1.0	0.8	0.3	0.5	0.6	1.0	2.6	4.5	2.5	2.8	1.6	1.0	0.5	0.5	0.4
Mitr-1	1.7	18	5.2	2.4	1.6	1.1	0.4	0.1	0.3	0.5	1.2	2.8	4.0	2.8	2.8	1.8	1.3	0.6	0.3	0.3
Mitr-2	2.0	18	5.0	3.2	2.2	1.3	0.5	0.1	0.3	0.6	1.5	3.7	4.7	4.1	3.6	2.0	1.6	0.6	0.4	0.3
Mitr-3	2.3	18	7.2	3.8	2.1	1.5	0.8	0.5	0.8	0.9	1.8	4.3	4.9	4.2	4.2	2.3	1.2	0.5	0.5	0.6
Vush-1	2.2	18	6.5	3.3	2.6	1.6	0.1	0.3	0.4	0.6	1.6	4.4	4.9	3.6	5.2	2.4	1.4	0.6	0.5	0.4
Vush-2	3.1	18	9.4	6.3	3.1	2.4	0.5	0.6	1.2	1.2	2.6	6.0	6.3	4.8	5.3	3.1	2.1	0.7	0.3	0.6
Pris-1	1.9	18	5.1	3.4	2.0	1.4	0.4	0.4	0.5	0.6	2.0	5.3	3.2	2.1	3.3	2.0	1.4	0.5	0.5	0.4
Pris-2	2.1	18	5.8	2.9	2.1	1.7	0.5	0.3	0.4	0.6	1.6	6.0	3.6	2.8	4.0	2.2	2.1	0.6	0.5	1.1
Pris-3	1.9	18	4.9	2.8	2.0	1.4	0.5	0.3	0.4	0.5	1.8	4.7	3.5	2.9	3.4	2.2	1.3	0.5	0.5	0.4
Pris-4	2.1	18	4.7	3.4	2.4	1.5	0.6	0.5	0.6	0.7	2.0	5.0	3.3	3.4	4.2	2.5	1.4	0.6	0.6	0.6
Pris-5	2.3	18	5.8	4.1	2.7	1.7	0.5	0.4	0.6	0.7	2.0	6.2	3.3	3.4	4.3	2.5	1.7	0.6	0.7	0.6
Pris-6	0.6	18	1.2	0.9	0.8	0.6	0.4	0.2	0.2	0.3	0.7	1.6	0.5	0.8	0.9	0.7	0.6	0.3	0.3	0.3
Pris-7	1.8	18	5.4	2.7	2.0	1.1	0.3	0.3	0.4	0.5	1.9	5.1	2.4	2.6	3.2	1.6	1.1	0.5	0.6	0.6

ANNEX Table 3: Toluene concentrations of all samples for each batch A – Q in µg/m³. Including imputation results. Part I. Note that values for Batch X are obtained by imputation.

Toluene		Batch	A	B	C	D	X	E	F	G	H	I	J	K	L	M	N	O	P	Q
		start	14.1.20	30.1.20	19.2.20	16.3.20	30.4.20	29.6.20	27.7.20	27.8.20	30.9.20	27.10.20	27.11.20	28.12.20	25.1.21	25.2.21	25.3.21	23.4.21	24.5.21	21.6.21
		end	31.1.20	21.2.20	18.3.20	30.4.20	29.6.20	29.7.20	31.8.20	5.10.20	3.11.20	2.12.20	30.12.20	28.1.21	1.3.21	29.3.21	29.4.21	26.5.21	25.6.21	23.7.21
Code	All	N/Dur	17	22	28	45	59	30	35	40	35	36	33	31	35	32	35	34	32	32
Fush-1	4.0	18	4.7	4.3	3.6	1.8	3.4	2.6	3.0	3.6	7.1	5.5	3.6	2.0	5.9	3.9	3.0	6.1	3.8	3.6
Fush-2	2.3	18	3.0	2.5	2.4	1.4	1.8	0.8	1.3	1.1	3.4	3.2	5.6	3.7	4.0	2.5	1.3	1.2	1.8	1.3
Dren-1	1.0	18	1.9	1.2	1.1	0.7	0.6	0.5	0.7	0.7	1.2	1.9	1.6	1.2	1.7	1.0	0.7	0.5	0.6	0.6
Dren-2	0.7	18	1.1	0.7	0.6	0.5	0.5	0.4	0.4	0.5	1.3	1.3	1.3	0.7	1.0	0.6	0.5	0.3	0.4	0.5
Dren-3	0.7	18	1.3	0.8	0.5	0.5	0.4	0.4	0.4	0.5	1.1	1.3	1.4	0.7	1.3	0.6	0.6	0.4	0.4	0.5
Dren-4	1.1	18	2.1	1.3	1.0	0.7	0.6	0.6	0.8	1.0	2.0	2.1	1.8	1.3	1.9	1.0	0.7	0.4	0.8	0.7
Dren-5	1.0	18	2.0	0.9	1.0	0.7	0.4	0.6	0.7	0.9	0.7	1.7	1.7	1.2	2.1	1.0	0.7	0.5	0.6	0.7
Gjil-1	3.1	18	4.8	3.5	2.7	1.8	1.9	1.9	2.1	2.0	3.5	5.8	3.7	2.8	5.7	3.1	3.0	2.2	2.5	2.3
Gjil-2	2.2	18	3.8	2.8	2.2	1.3	1.2	1.5	1.3	1.4	2.3	4.2	2.6	2.7	4.2	2.1	1.6	1.4	1.5	1.4
Gjil-3	2.1	18	3.5	3.0	2.2	1.4	1.2	1.2	1.3	1.5	2.3	4.2	2.9	1.1	4.1	2.2	1.6	1.2	1.4	1.4
Hani-1	0.9	18	1.5	1.0	0.8	0.7	0.4	0.6	0.4	0.5	0.8	2.1	1.7	1.4	1.4	0.8	0.6	0.5	0.4	0.4
Hani-2	0.9	18	1.5	1.0	0.7	0.7	0.5	0.6	0.5	0.5	0.7	1.6	1.5	1.3	1.3	0.8	0.9	0.4	0.5	0.5
Feri-1	2.7	18	3.7	2.6	2.5	1.2	1.1	1.2	1.5	1.6	2.9	4.7	2.8	2.2	3.5	2.0	1.7	3.1	5.9	3.4
Obil-1	1.7	18	3.3	2.0	1.5	1.2	1.0	0.7	1.0	1.2	2.2	3.9	2.6	1.7	2.7	1.6	1.2	0.8	1.1	1.2
Obil-2	1.4	18	2.8	1.8	1.3	0.9	0.8	0.6	0.8	0.8	1.8	2.9	2.3	1.6	2.4	1.4	0.9	0.7	0.9	1.1
Obil-3	1.0	18	2.0	1.3	1.0	0.7	0.6	0.5	0.7	0.8	0.7	2.1	1.7	1.2	1.4	0.8	0.6	0.4	0.5	0.7
Peje-1	1.8	18	4.2	2.4	1.5	0.9	0.6	0.9	1.0	1.0	1.9	4.2	3.5	2.4	2.9	1.1	1.1	0.9	1.1	1.3
Peje-2	1.2	18	2.4	1.2	0.9	0.7	0.6	0.8	0.9	0.9	1.2	1.8	3.0	1.3	1.6	0.9	0.9	0.8	0.8	1.0
Peje-3	2.1	18	3.7	2.3	1.7	0.8	0.9	1.3	1.7	1.6	2.4	3.6	3.9	2.1	2.6	1.3	1.5	2.9	1.6	2.2

ANNEX Table 4: Toluene concentrations of all samples for each batch A – Q in µg/m³. Including imputation results. Part II. Note that values for Batch X are obtained by imputation.

Toluene		Batch	A	B	C	D	X	E	F	G	H	I	J	K	L	M	N	O	P	Q
		start	14.1.20	30.1.20	19.2.20	16.3.20	30.4.20	29.6.20	27.7.20	27.8.20	30.9.20	27.10.20	27.11.20	28.12.20	25.1.21	25.2.21	25.3.21	23.4.21	24.5.21	21.6.21
		end	31.1.20	21.2.20	18.3.20	30.4.20	29.6.20	29.7.20	31.8.20	5.10.20	3.11.20	2.12.20	30.12.20	28.1.21	1.3.21	29.3.21	29.4.21	26.5.21	25.6.21	23.7.21
Code	All	N/Dur	17	22	28	45	59	30	35	40	35	36	33	31	35	32	35	34	32	32
Gjak-1	2.6	18	3.6	2.4	1.8	1.2	0.9	1.1	1.4	1.3	4.3	5.4	3.5	3.3	6.4	2.2	1.7	1.7	1.7	2.0
Gjak-2	1.8	18	2.5	1.3	1.3	1.1	0.4	1.9	1.5	1.4	1.6	7.1	2.8	1.7	1.9	1.5	1.2	0.7	1.2	1.6
Gjak-3	2.3	18	4.3	2.3	2.0	1.3	1.7	1.6	1.5	1.9	3.6	2.9	3.9	3.2	3.2	2.1	1.6	1.1	1.8	1.6
Priz-1	2.2	18	4.2	1.8	1.9	0.9	1.9	1.1	1.1	1.3	2.8	4.4	5.6	2.0	2.2	1.7	1.3	1.2	3.8	1.4
Priz-2	2.4	18	3.7	1.8	1.9	0.9	2.0	1.4	1.4	1.6	2.9	4.4	5.2	2.0	2.3	1.8	1.7	2.0	2.0	3.3
Priz-3	4.3	18	4.3	3.6	5.1	1.8	4.9	4.9	3.2	5.5	6.3	6.2	9.5	1.2	3.7	2.8	3.5	3.2	3.6	3.9
Suha-1	1.4	18	1.6	1.3	1.1	0.8	0.8	0.9	1.1	1.1	1.6	2.6	3.3	1.7	1.6	1.2	1.6	1.1	1.2	1.1
Mitr-1	1.5	18	3.4	1.9	1.1	1.0	0.8	0.7	0.9	1.1	1.8	3.2	2.6	1.9	1.9	1.1	1.1	1.1	0.6	0.9
Mitr-2	1.4	18	2.8	1.7	1.3	1.0	0.8	0.3	0.8	1.0	1.5	2.8	2.3	1.8	1.8	1.1	1.0	1.0	0.9	1.0
Mitr-3	1.9	18	3.8	2.2	1.5	1.5	1.4	1.2	1.5	1.8	2.2	3.4	2.8	2.2	2.8	1.4	1.2	1.0	1.0	1.6
Vush-1	1.6	18	3.3	1.6	2.7	1.2	0.9	0.8	1.0	1.2	1.8	3.1	2.7	1.8	2.0	1.1	0.9	0.7	0.8	1.1
Vush-2	2.4	18	4.5	2.8	2.1	1.5	1.5	1.2	2.3	1.9	4.3	5.0	3.4	2.3	2.8	1.8	1.6	1.4	0.6	1.6
Pris-1	1.5	18	2.7	1.8	1.1	1.1	1.0	0.8	1.1	1.5	2.2	4.0	2.0	1.1	2.0	1.2	1.0	1.0	0.9	1.0
Pris-2	1.9	18	3.3	1.7	1.5	1.3	1.6	1.0	1.7	1.9	3.3	2.9	2.3	1.7	2.5	1.6	1.8	1.6	1.6	1.8
Pris-3	1.6	18	3.0	1.8	1.3	1.2	1.0	0.9	1.2	1.1	2.3	4.4	2.5	1.5	2.4	1.4	0.9	0.8	0.9	1.1
Pris-4	1.7	18	2.6	1.8	1.4	1.1	1.2	1.4	1.2	1.4	2.0	3.4	2.0	1.7	2.6	1.5	1.1	1.0	1.0	1.4
Pris-5	1.6	18	3.0	2.0	1.5	1.1	1.1	0.8	1.2	1.2	1.8	2.9	2.2	1.6	2.4	1.3	1.1	1.2	1.3	1.2
Pris-6	0.5	18	0.7	0.4	0.5	0.5	0.5	0.3	0.4	1.3	0.6	1.0	0.3	0.4	0.5	0.3	0.3	0.4	0.4	0.5
Pris-7	1.4	18	3.0	1.5	1.4	0.7	0.8	0.9	0.8	1.0	2.0	3.5	1.6	1.4	1.9	0.9	0.8	0.8	1.0	1.3

*ANNEX Table 5: Ethylbenzene concentrations of all samples for each batch A – Q in µg/m³. Part I. Note that **no** values for Batch X or instances of missing values (mv) are obtained by imputation due to low levels of ethylbenzene.*

Ethylbenzene		Batch	A	B	C	D	X	E	F	G	H	I	J	K	L	M	N	O	P	Q
		start	14.1.20	30.1.20	19.2.20	16.3.20	30.4.20	29.6.20	27.7.20	27.8.20	30.9.20	27.10.20	27.11.20	28.12.20	25.1.21	25.2.21	25.3.21	23.4.21	24.5.21	21.6.21
		end	31.1.20	21.2.20	18.3.20	30.4.20	29.6.20	29.7.20	31.8.20	5.10.20	3.11.20	2.12.20	30.12.20	28.1.21	1.3.21	29.3.21	29.4.21	26.5.21	25.6.21	23.7.21
Code	All	N/Dur	17	22	28	45	59	30	35	40	35	36	33	31	35	32	35	34	32	32
Fush-1	0.9	17	1.0	0.9	0.8	0.4		0.5	0.6	0.8	1.9	1.3	0.6	0.4	1.5	1.0	0.8	0.8	0.9	0.9
Fush-2	0.5	16	0.5	0.4	0.4	0.3		0.2	0.3	0.2	0.7	0.7	1.5	0.9	0.7	0.5	0.3	0.2	mv	0.2
Dren-1	0.2	15	0.5	0.3	0.2	0.1		0.2	0.2	0.1	mv	mv	0.3	0.2	0.4	0.2	0.2	0.2	0.2	0.2
Dren-2	0.2	17	0.3	0.3	0.2	0.1		0.2	0.2	0.1	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Dren-3	0.2	17	0.3	0.3	0.2	0.1		0.2	0.2	0.1	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Dren-4	0.3	13	0.3	0.3	0.2	0.1		0.2	0.2	0.2	0.4	0.4	0.4	0.3	0.4	0.2	mv	mv	mv	mv
Dren-5	0.2	16	0.3	0.3	0.2	0.1		0.2	0.2	0.1	0.2	mv	0.4	0.2	0.4	0.2	0.2	0.2	0.2	0.2
Gjil-1	0.7	17	1.0	0.9	0.6	0.4		0.4	0.4	0.5	0.8	1.2	0.8	0.6	1.3	0.7	0.5	0.6	0.7	0.6
Gjil-2	0.6	17	0.8	0.9	0.5	0.2		0.3	0.3	0.4	0.6	1.1	0.6	0.6	1.1	0.5	0.4	0.3	0.4	0.4
Gjil-3	0.4	17	0.6	0.6	0.4	0.3		0.3	0.3	0.3	0.4	0.9	0.5	0.2	0.8	0.4	0.3	0.3	0.4	0.2
Hani-1	0.2	16	0.3	0.3	0.2	mv		0.2	0.2	0.2	0.2	0.7	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Hani-2	0.2	16	0.3	0.3	0.2	mv		0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Feri-1	0.5	17	0.8	0.6	0.6	0.3		0.3	0.4	0.4	0.6	0.9	0.6	0.5	0.7	0.4	0.4	0.4	0.4	0.4
Obil-1	0.4	17	0.6	0.4	0.4	0.3		0.2	0.2	0.3	0.5	0.9	0.6	0.4	0.6	0.3	0.2	0.2	0.3	0.3
Obil-2	0.3	16	0.5	0.5	0.2	0.2		0.2	0.2	0.2	0.4	0.7	0.5	mv	0.6	0.3	0.2	0.2	0.2	0.3
Obil-3	0.2	17	0.3	0.3	0.2	0.1		0.2	0.2	0.2	0.2	0.5	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.2
Peje-1	0.4	17	0.8	0.5	0.3	0.1		0.2	0.2	0.2	0.2	0.8	0.7	0.5	0.6	0.2	0.2	0.2	0.2	0.2
Peje-2	0.2	17	0.4	0.3	0.2	0.1		0.2	0.2	0.1	0.2	0.4	0.4	0.2	0.3	0.2	0.2	0.2	0.2	0.3
Peje-3	0.4	15	mv	0.5	0.3	0.2		0.3	0.3	0.4	0.5	mv	0.7	0.4	0.5	0.3	0.3	0.3	0.4	0.4

*ANNEX Table 6: Ethylbenzene concentrations of all samples for each batch A – Q in µg/m³. Part II. Note that **no** values for Batch X or instances of missing values (mv) are obtained by imputation due to low levels of ethylbenzene.*

Ethylbenzene		Batch	A	B	C	D	X	E	F	G	H	I	J	K	L	M	N	O	P	Q
		start	14.1.20	30.1.20	19.2.20	16.3.20	30.4.20	29.6.20	27.7.20	27.8.20	30.9.20	27.10.20	27.11.20	28.12.20	25.1.21	25.2.21	25.3.21	23.4.21	24.5.21	21.6.21
		end	31.1.20	21.2.20	18.3.20	30.4.20	29.6.20	29.7.20	31.8.20	5.10.20	3.11.20	2.12.20	30.12.20	28.1.21	1.3.21	29.3.21	29.4.21	26.5.21	25.6.21	23.7.21
Code	All	N/Dur	17	22	28	45	59	30	35	40	35	36	33	31	35	32	35	34	32	32
Gjak-1	0.5	17	0.7	0.5	0.3	0.2		0.3	0.3	0.3	0.9	1.1	0.7	0.8	0.7	0.4	0.4	0.3	0.4	0.4
Gjak-2	0.4	16	0.4	0.3	0.2	0.2		0.6	0.5	0.3	0.2	1.1	0.5	0.3	0.4	0.2	0.5	0.2	0.3	mv
Gjak-3	0.5	16	0.9	0.5	0.4	0.2		0.4	0.3	0.4	0.6	0.5	0.8	mv	0.6	0.4	0.3	0.2	0.4	0.4
Priz-1	0.4	17	0.8	0.3	0.4	0.1		0.2	0.2	0.3	0.4	0.9	1.1	0.4	0.4	0.3	0.3	0.2	0.3	0.2
Priz-2	0.4	15	0.7	0.3	0.3	0.1		0.2	0.3	0.4	0.5	0.8	1.0	0.4	mv	0.3	mv	0.4	0.4	0.6
Priz-3	0.6	17	0.8	0.5	0.6	0.3		0.4	0.4	0.5	0.6	0.9	1.4	0.3	0.6	0.4	0.5	0.5	0.5	0.6
Suha-1	0.3	16	mv	0.3	0.2	0.1		0.2	0.2	0.3	0.2	0.5	0.7	0.4	0.3	0.2	0.3	0.2	0.3	0.2
Mitr-1	0.3	13	mv	mv	mv	0.2		0.2	0.2	0.2	0.4	0.6	0.5	mv	0.5	0.2	0.3	0.2	0.2	0.2
Mitr-2	0.3	17	0.5	0.3	0.2	0.1		0.2	0.2	0.2	0.3	0.6	0.3	0.4	0.4	0.2	0.2	0.2	0.2	0.2
Mitr-3	0.4	13	mv	0.5	mv	0.3		0.2	0.3	0.4	0.5	0.7	0.6	0.5	0.6	0.3	mv	mv	0.2	0.4
Vush-1	0.5	16	0.5	0.4	3.1	0.1		0.2	0.2	0.3	0.4	0.7	0.5	0.4	mv	0.2	0.2	0.2	0.2	0.2
Vush-2	0.5	16	0.8	0.5	mv	0.3		0.2	0.4	0.4	0.6	1.0	0.7	0.4	0.5	0.4	0.3	0.4	0.2	0.4
Pris-1	0.3	17	0.5	0.4	0.2	0.3		0.2	0.2	0.2	0.4	0.7	0.4	0.2	0.4	0.2	0.2	0.2	0.2	0.3
Pris-2	0.4	15	0.5	0.3	0.2	0.3		0.4	0.6	0.6	0.8	mv	0.5	0.3	0.6	0.4	0.3	0.4	0.7	mv
Pris-3	0.3	17	0.5	0.3	0.2	0.3		0.2	0.3	0.2	0.4	0.7	0.4	0.3	0.5	0.2	0.2	0.2	0.2	0.2
Pris-4	0.3	17	0.5	0.3	0.2	0.3		0.2	0.3	0.3	0.4	0.7	0.4	0.4	0.5	0.3	0.2	0.2	0.3	0.3
Pris-5	0.4	15	0.5	0.4	0.2	0.3		0.2	0.3	0.3	mv	mv	0.4	0.4	0.4	0.3	0.2	0.6	0.4	0.3
Pris-6	0.3	16	0.5	0.3	mv	0.2		0.2	0.2	0.9	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Pris-7	0.3	17	0.5	0.2	0.2	0.1		0.2	0.2	0.2	0.4	0.7	0.3	0.3	0.4	0.2	0.2	0.2	0.2	0.3

ANNEX Table 7: mp-Xylene concentrations of all samples for each batch A – Q in µg/m³. Including imputation results. Part I. Note that values for Batch X are obtained by imputation.

mpXylene		Batch	A	B	C	D	X	E	F	G	H	I	J	K	L	M	N	O	P	Q
		start	14.1.20	30.1.20	19.2.20	16.3.20	30.4.20	29.6.20	27.7.20	27.8.20	30.9.20	27.10.20	27.11.20	28.12.20	25.1.21	25.2.21	25.3.21	23.4.21	24.5.21	21.6.21
		end	31.1.20	21.2.20	18.3.20	30.4.20	29.6.20	29.7.20	31.8.20	5.10.20	3.11.20	2.12.20	30.12.20	28.1.21	1.3.21	29.3.21	29.4.21	26.5.21	25.6.21	23.7.21
Code	All	N/Dur	17	22	28	45	59	30	35	40	35	36	33	31	35	32	35	34	32	32
Fush-1	2.9	18	3.2	3.1	2.8	1.2	1.6	2.1	2.2	2.6	6.1	4.3	1.9	1.4	5.1	3.6	2.6	2.9	2.9	3.2
Fush-2	1.5	18	1.3	1.1	1.1	0.6	0.7	0.7	1.0	0.7	1.9	1.8	4.7	3.2	2.4	1.5	0.9	1.0	1.0	1.1
Dren-1	0.7	18	1.4	0.8	0.7	0.4	0.4	0.8	0.5	0.6	0.7	1.2	0.9	0.9	1.4	0.5	0.6	0.4	0.5	0.6
Dren-2	0.4	18	0.4	0.3	0.2	0.1	0.3	0.4	0.2	0.4	0.9	0.5	0.8	0.6	0.4	0.2	0.2	0.2	0.2	0.4
Dren-3	0.5	18	0.5	0.3	0.2	0.1	0.0	0.3	0.4	0.4	0.6	0.6	0.8	0.7	2.9	0.2	0.5	0.2	0.2	0.3
Dren-4	0.7	18	1.0	0.5	0.5	0.3	0.4	0.5	0.5	0.6	1.3	1.1	1.2	0.7	1.4	0.5	0.5	0.3	0.5	0.4
Dren-5	0.6	18	0.9	0.4	0.5	0.3	0.3	0.6	0.6	0.5	0.2	1.0	1.3	0.9	1.3	0.5	0.2	0.3	0.5	0.5
Gjil-1	2.3	18	2.4	2.6	1.5	1.2	1.4	1.7	1.5	1.7	2.9	4.1	2.9	2.2	4.2	2.5	1.3	2.1	2.2	2.1
Gjil-2	1.7	18	2.2	2.5	1.4	0.6	0.9	1.3	1.1	1.4	2.0	3.3	2.2	1.6	3.6	1.6	1.3	1.1	1.4	1.3
Gjil-3	1.4	18	2.0	1.8	1.4	0.7	0.9	1.2	1.0	1.2	1.2	2.7	1.9	0.4	2.7	1.5	1.1	1.0	1.2	1.1
Hani-1	0.5	18	0.7	0.4	0.4	0.2	0.1	0.2	0.2	0.3	0.6	1.2	0.9	0.7	1.1	0.5	0.5	0.3	0.2	0.4
Hani-2	0.5	18	0.7	0.3	0.3	0.4	0.3	0.7	0.4	0.4	0.5	0.8	0.8	0.9	0.8	0.7	0.5	0.4	0.3	0.4
Feri-1	1.6	18	2.2	1.3	2.1	0.7	1.3	1.1	1.3	1.3	1.9	3.0	1.9	2.1	2.3	1.3	1.3	1.4	1.4	1.5
Obil-1	1.1	18	1.5	1.1	0.8	0.6	0.8	0.6	0.7	1.0	1.5	2.3	1.7	1.2	1.9	0.9	0.9	0.5	0.8	0.8
Obil-2	0.9	18	1.3	1.2	0.7	0.5	0.7	0.6	0.6	0.6	1.3	1.6	1.6	1.0	1.5	0.8	0.7	0.5	0.7	0.9
Obil-3	0.6	18	0.9	0.6	0.6	0.4	0.6	0.5	0.5	0.8	0.6	1.2	1.2	0.6	1.0	0.6	0.2	0.5	0.4	0.4
Peje-1	1.0	18	2.1	1.4	0.9	0.2	0.3	0.7	0.6	0.7	0.7	2.4	2.1	1.3	1.9	0.5	0.7	0.6	0.7	0.8
Peje-2	0.8	18	1.2	0.6	0.6	0.3	0.7	1.4	0.8	0.6	0.7	0.9	1.1	0.9	1.2	0.4	0.4	0.5	0.5	1.1
Peje-3	1.4	18	1.9	1.6	1.2	0.5	0.9	1.2	1.4	1.3	1.8	2.0	2.2	1.6	1.9	0.9	1.3	1.1	1.2	1.4

ANNEX Table 8: mp-Xylene concentrations of all samples for each batch A – Q in µg/m³. Including imputation results. Part II. Note that values for Batch X are obtained by imputation.

mpXylene		Batch	A	B	C	D	X	E	F	G	H	I	J	K	L	M	N	O	P	Q
		start	14.1.20	30.1.20	19.2.20	16.3.20	30.4.20	29.6.20	27.7.20	27.8.20	30.9.20	27.10.20	27.11.20	28.12.20	25.1.21	25.2.21	25.3.21	23.4.21	24.5.21	21.6.21
		end	31.1.20	21.2.20	18.3.20	30.4.20	29.6.20	29.7.20	31.8.20	5.10.20	3.11.20	2.12.20	30.12.20	28.1.21	1.3.21	29.3.21	29.4.21	26.5.21	25.6.21	23.7.21
Code	All	N/Dur	17	22	28	45	59	30	35	40	35	36	33	31	35	32	35	34	32	32
Gjak-1	1.6	18	1.8	1.3	1.1	0.6	1.0	1.0	1.0	1.1	3.2	3.5	2.0	3.1	2.2	1.2	1.2	1.1	1.2	1.2
Gjak-2	1.0	18	1.2	0.6	0.7	0.5	0.2	0.9	1.0	0.9	1.4	3.6	1.4	1.2	1.2	0.6	0.7	0.5	0.8	1.5
Gjak-3	1.4	18	2.4	1.3	1.2	0.6	1.0	1.0	0.9	1.3	2.1	1.8	2.1	1.7	1.7	1.3	0.8	0.8	1.3	1.3
Priz-1	1.3	18	2.3	1.0	1.4	0.9	0.9	0.6	0.7	0.8	1.4	2.8	3.4	1.4	1.2	1.0	0.8	1.0	0.7	0.9
Priz-2	1.4	18	1.9	0.8	1.0	0.5	1.4	0.8	1.1	1.2	1.9	2.6	2.8	1.3	1.3	1.0	1.0	1.4	1.2	1.9
Priz-3	2.1	18	2.0	1.7	2.2	0.9	2.3	1.9	1.6	2.3	2.7	2.8	5.0	1.7	2.2	1.5	1.7	1.7	1.7	2.2
Suha-1	0.9	18	0.9	0.6	0.6	0.4	0.6	0.7	0.8	0.9	1.0	1.3	2.0	1.0	0.9	0.6	0.8	0.9	0.9	1.0
Mitr-1	1.0	18	2.1	1.1	0.7	0.5	0.7	0.5	0.8	0.8	1.2	1.6	1.5	1.3	1.5	0.8	0.6	0.9	0.4	0.7
Mitr-2	0.8	18	1.2	1.0	0.6	0.4	0.7	0.5	0.9	0.7	1.2	1.8	0.7	1.6	1.0	0.6	0.8	0.7	0.4	0.7
Mitr-3	1.5	18	3.1	1.4	1.3	0.7	1.2	0.9	1.0	1.4	1.6	2.0	1.7	2.6	3.0	1.2	1.0	0.9	0.6	1.3
Vush-1	2.0	18	1.6	1.4	15.6	0.5	1.5	0.6	0.8	0.9	1.3	2.1	1.7	1.1	2.6	0.6	0.8	0.7	0.6	0.9
Vush-2	1.4	18	2.4	1.4	1.3	0.8	0.9	0.8	1.3	1.5	2.2	3.2	1.9	1.5	1.8	1.0	1.0	1.3	0.2	1.3
Pris-1	1.0	18	1.3	1.2	0.7	0.6	0.7	0.6	0.7	0.8	1.5	2.0	1.2	0.8	1.3	0.8	0.6	0.7	0.7	1.1
Pris-2	1.4	18	1.4	0.8	0.9	0.8	1.6	1.1	1.6	1.6	2.8	0.8	1.2	0.8	1.8	0.9	0.9	1.6	2.5	1.7
Pris-3	1.0	18	1.5	1.1	0.8	0.6	0.8	0.7	0.9	0.9	1.4	1.8	1.2	1.0	1.5	1.1	0.5	0.6	0.7	0.9
Pris-4	1.1	18	1.3	0.9	0.9	0.6	0.9	0.9	0.9	1.1	1.4	1.9	1.1	1.2	1.6	1.2	0.6	0.9	1.0	1.1
Pris-5	1.1	18	1.3	0.9	0.7	0.6	1.1	0.6	1.5	1.2	1.3	1.3	1.2	1.1	1.7	0.6	0.6	2.3	1.0	0.9
Pris-6	0.4	18	0.5	0.3	0.3	0.2	0.5	0.2	0.3	1.3	0.7	0.6	0.2	0.2	0.4	0.3	0.2	0.6	0.3	0.6
Pris-7	0.9	18	1.5	0.8	0.7	0.3	0.6	0.5	0.7	0.8	1.5	2.0	0.8	0.9	1.3	0.6	0.4	0.7	0.8	1.0

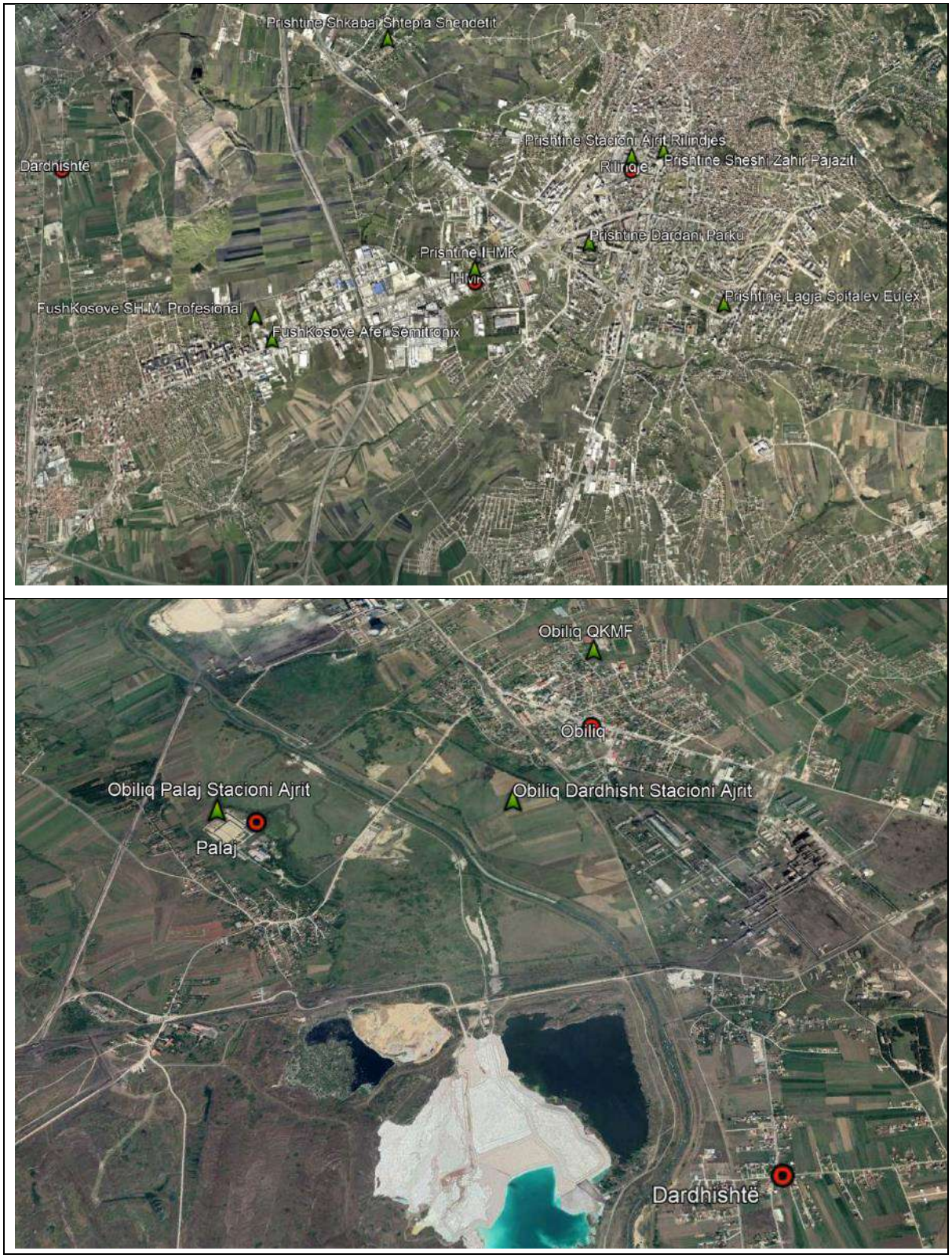
*ANNEX Table 9: o-Xylene concentrations of all samples for each batch A – Q in µg/m³. Including imputation results. Part I. Note that **no** values for Batch X or instances of missing values (mv) are obtained by imputation due to low levels of o-xylene.*

o-Xylene		Batch	A	B	C	D	X	E	F	G	H	I	J	K	L	M	N	O	P	Q
		start	14.1.20	30.1.20	19.2.20	16.3.20	30.4.20	29.6.20	27.7.20	27.8.20	30.9.20	27.10.20	27.11.20	28.12.20	25.1.21	25.2.21	25.3.21	23.4.21	24.5.21	21.6.21
		end	31.1.20	21.2.20	18.3.20	30.4.20	29.6.20	29.7.20	31.8.20	5.10.20	3.11.20	2.12.20	30.12.20	28.1.21	1.3.21	29.3.21	29.4.21	26.5.21	25.6.21	23.7.21
Code	All	N/Dur	17	22	28	45	59	30	35	40	35	36	33	31	35	32	35	34	32	32
Fush-1	1.1	17	1.3	1.2	1.1	0.5		0.8	0.9	1.0	2.2	1.6	0.7	0.5	1.7	1.3	1.0	1.1	1.1	1.2
Fush-2	0.5	16	0.4	0.3	0.4	0.2		0.2	0.4	0.3	0.7	0.6	1.6	1.2	0.7	0.5	0.2	0.3	mv	0.3
Dren-1	0.2	15	0.4	0.3	0.2	0.1		0.2	0.2	0.2	mv	mv	0.3	0.3	0.5	0.2	0.2	0.2	0.2	0.2
Dren-2	0.2	17	0.3	0.3	0.2	0.1		0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Dren-3	0.2	17	0.3	0.3	0.2	0.1		0.2	0.2	0.1	0.2	0.2	0.2	0.3	0.7	0.2	0.2	0.2	0.2	0.2
Dren-4	0.3	13	0.3	0.3	0.2	0.1		0.2	0.2	0.1	0.5	0.4	0.4	0.3	0.3	0.2	mv	mv	mv	mv
Dren-5	0.2	16	0.3	0.3	0.2	0.1		0.2	0.2	0.1	0.2	mv	0.4	0.2	0.4	0.2	0.2	0.2	0.2	0.2
Gjil-1	0.8	17	0.9	0.7	0.5	0.4		0.6	0.6	0.6	1.0	1.4	1.0	0.7	1.3	0.8	0.5	0.7	0.7	0.7
Gjil-2	0.5	17	0.7	0.7	0.4	0.2		0.3	0.4	0.4	0.6	1.0	0.7	0.6	1.0	0.5	0.4	0.4	0.5	0.5
Gjil-3	0.5	17	0.6	0.5	0.5	0.2		0.4	0.4	0.4	0.5	1.0	0.6	0.2	0.8	0.5	0.4	0.4	0.4	0.4
Hani-1	0.2	16	0.3	0.3	0.2	mv		0.2	0.2	0.2	0.2	0.4	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.2
Hani-2	0.2	16	0.3	0.3	0.2	mv		0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Feri-1	0.5	17	0.7	0.5	0.7	0.2		0.4	0.5	0.4	0.7	1.0	0.7	0.6	0.8	0.4	0.4	0.4	0.4	0.5
Obil-1	0.3	17	0.5	0.3	0.2	0.1		0.2	0.3	0.3	0.5	0.7	0.6	0.4	0.6	0.3	0.2	0.2	0.3	0.3
Obil-2	0.3	16	0.3	0.4	0.2	0.8		0.2	0.2	0.2	0.4	0.5	0.5	mv	0.4	0.3	0.2	0.2	0.2	0.3
Obil-3	0.2	17	0.3	0.3	0.2	0.1		0.2	0.2	0.2	0.2	0.4	0.4	0.2	0.3	0.2	0.2	0.2	0.2	0.2
Peje-1	0.3	17	0.8	0.4	0.2	0.1		0.2	0.2	0.2	0.2	0.8	0.7	0.4	0.6	0.2	0.2	0.2	0.3	0.2
Peje-2	0.3	17	0.4	0.3	0.2	0.1		0.3	0.2	0.2	0.2	0.3	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.3
Peje-3	0.5	15	mv	0.5	0.4	0.1		0.4	0.5	0.5	0.6	mv	0.8	0.5	0.6	0.3	0.4	0.4	0.4	0.5

*ANNEX Table 10: o-Xylene concentrations of all samples for each batch A – Q in µg/m³. Including imputation results. Part II. Note that **no** values for Batch X or instances of missing values (mv) are obtained by imputation due to low levels of o-xylene.*

oXylene		Batch	A	B	C	D	X	E	F	G	H	I	J	K	L	M	N	O	P	Q
		start	14.1.20	30.1.20	19.2.20	16.3.20	30.4.20	29.6.20	27.7.20	27.8.20	30.9.20	27.10.20	27.11.20	28.12.20	25.1.21	25.2.21	25.3.21	23.4.21	24.5.21	21.6.21
		end	31.1.20	21.2.20	18.3.20	30.4.20	29.6.20	29.7.20	31.8.20	5.10.20	3.11.20	2.12.20	30.12.20	28.1.21	1.3.21	29.3.21	29.4.21	26.5.21	25.6.21	23.7.21
Code	All	N/Dur	17	22	28	45	59	30	35	40	35	36	33	31	35	32	35	34	32	32
Gjak-1	0.6	17	0.7	0.4	0.4	0.2		0.3	0.3	0.4	1.0	1.1	0.8	1.1	0.8	0.4	0.4	0.4	0.4	0.4
Gjak-2	0.4	17	0.4	0.3	0.2	0.2		0.4	0.4	0.3	0.4	1.2	0.6	0.4	0.4	0.2	0.3	0.2	0.3	1.2
Gjak-3	0.5	16	0.9	0.5	0.4	0.3		0.4	0.4	0.5	0.8	0.6	0.8	mv	0.6	0.5	0.3	0.3	0.5	0.4
Priz-1	0.5	17	0.8	0.3	0.5	0.8		0.2	0.2	0.3	0.5	0.9	1.1	0.5	0.4	0.3	0.2	0.2	0.2	0.3
Priz-2	0.5	15	0.7	0.3	0.3	0.2		0.3	0.4	0.5	0.7	1.0	1.0	0.4	mv	0.4	mv	0.5	0.5	0.7
Priz-3	0.7	17	0.8	0.6	0.8	0.3		0.7	0.6	0.8	1.0	1.0	1.7	0.6	0.8	0.6	0.6	0.6	0.6	0.7
Suha-1	0.3	16	mv	0.3	0.2	0.1		0.2	0.3	0.3	0.4	0.5	0.8	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Mitr-1	0.3	13	mv	mv	mv	0.2		0.2	0.2	0.3	0.4	0.6	0.6	mv	0.5	0.2	0.2	0.3	0.2	0.2
Mitr-2	0.3	17	0.5	0.3	0.2	0.1		0.2	0.3	0.2	0.3	0.6	0.3	0.4	0.3	0.2	0.2	0.2	0.2	0.2
Mitr-3	0.5	13	mv	0.4	mv	0.2		0.3	0.4	0.5	0.6	0.7	0.6	0.5	0.7	0.3	mv	mv	0.2	0.4
Vush-1	0.5	16	0.5	0.3	3.5	0.1		0.2	0.2	0.3	0.4	0.7	0.6	0.4	mv	0.2	0.2	0.2	0.2	0.3
Vush-2	0.5	16	0.8	0.4	mv	0.3		0.3	0.4	0.5	0.6	1.0	0.6	0.5	0.5	0.4	0.3	0.4	0.2	0.4
Pris-1	0.3	17	0.5	0.3	0.2	0.2		0.2	0.2	0.2	0.5	0.7	0.4	0.2	0.4	0.2	0.2	0.2	0.2	0.3
Pris-2	0.5	15	0.3	0.3	0.2	0.3		0.5	0.6	0.6	1.0	mv	0.4	0.3	0.5	0.3	0.2	0.5	0.9	mv
Pris-3	0.3	17	0.5	0.3	0.2	0.2		0.2	0.3	0.3	0.5	0.7	0.5	0.3	0.5	0.3	0.2	0.2	0.2	0.3
Pris-4	0.4	17	0.5	0.3	0.2	0.3		0.3	0.3	0.4	0.6	0.7	0.4	0.4	0.6	0.3	0.2	0.3	0.3	0.4
Pris-5	0.3	15	0.5	0.3	0.2	0.2		0.2	0.4	0.3	mv	mv	0.4	0.3	0.5	0.2	0.2	0.6	0.4	0.3
Pris-6	0.2	16	0.5	0.3	mv	0.1		0.2	0.2	0.4	0.6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Pris-7	0.3	17	0.5	0.2	0.2	0.1		0.2	0.2	0.2	0.5	0.7	0.3	0.3	0.4	0.2	0.2	0.2	0.2	0.3

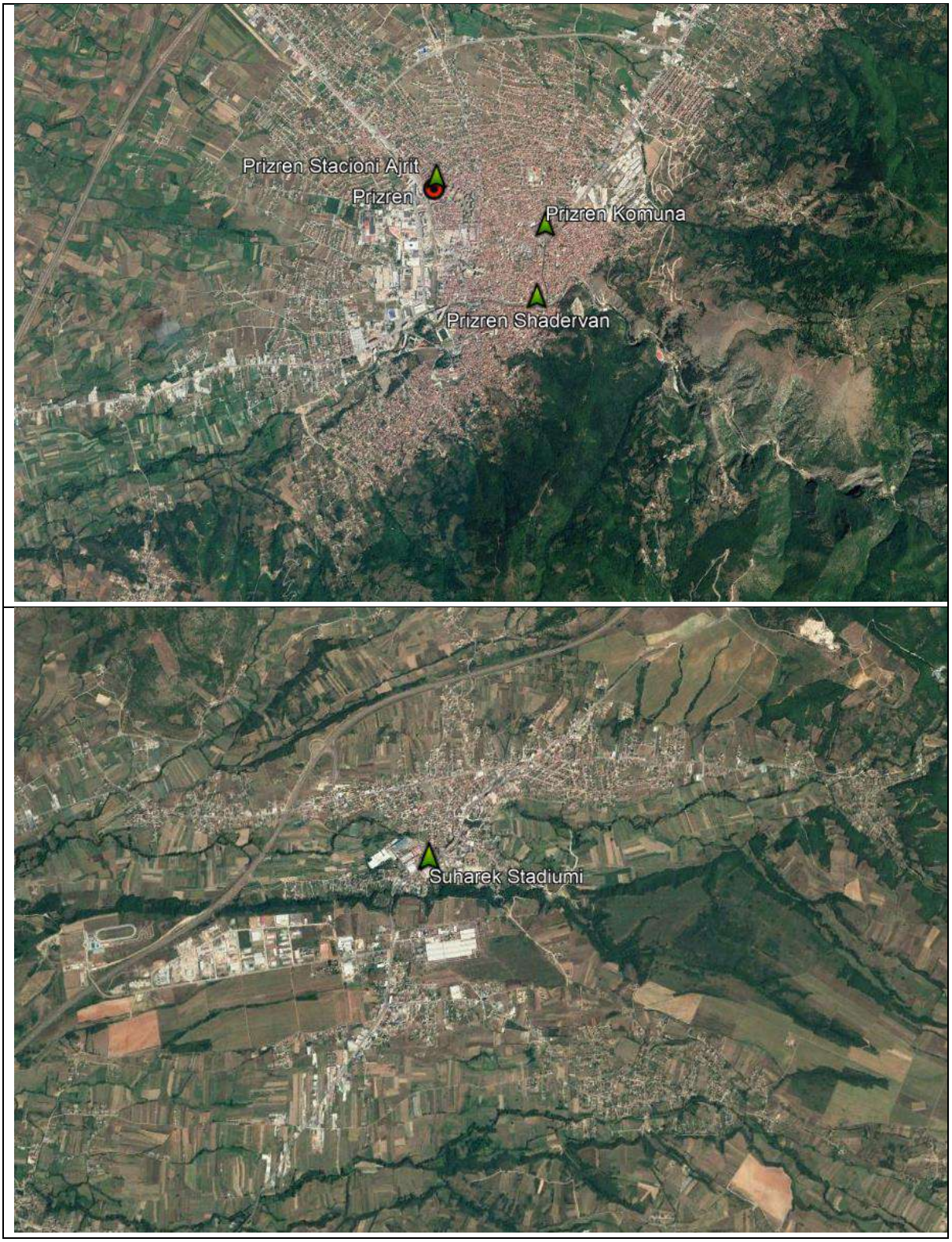
Locations in the towns.



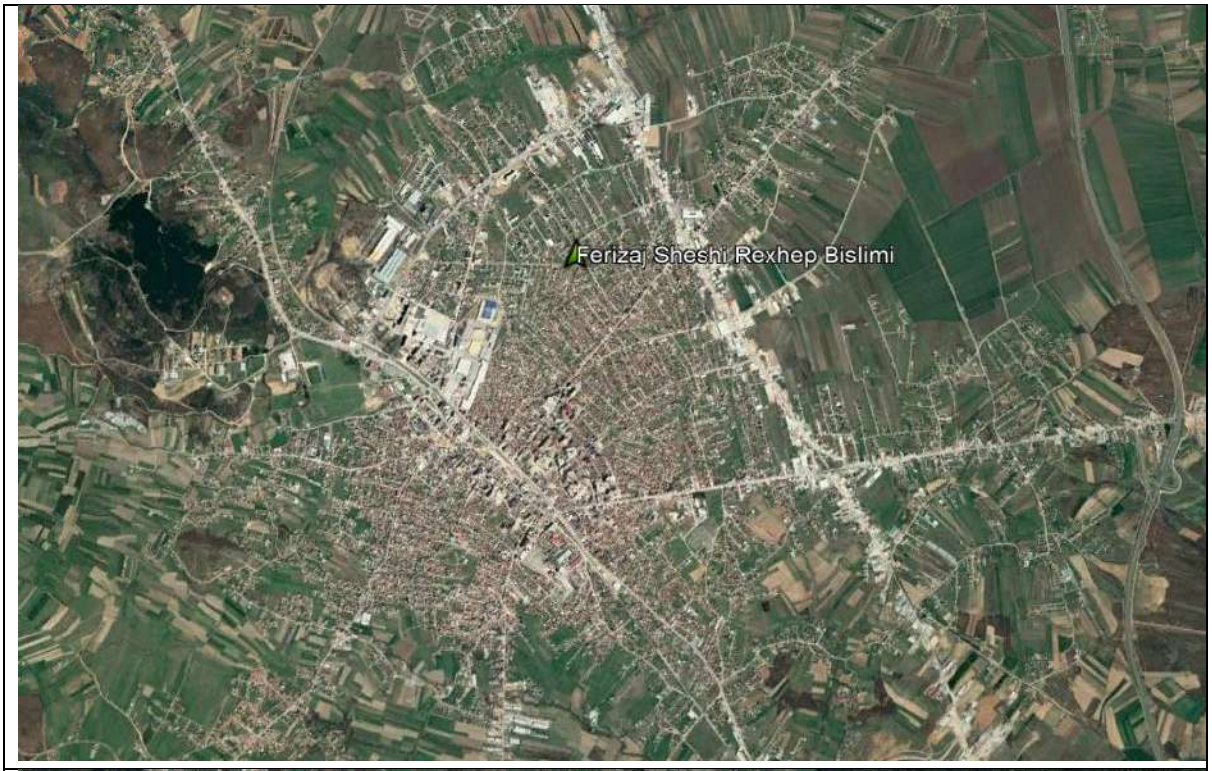
BTEX Location 1: *Location in Pristina and FushKosove (upper part) and locations in Obiliq (lower part) (green triangles) and AQMS sites (red/black dot) (source Google Earth)*

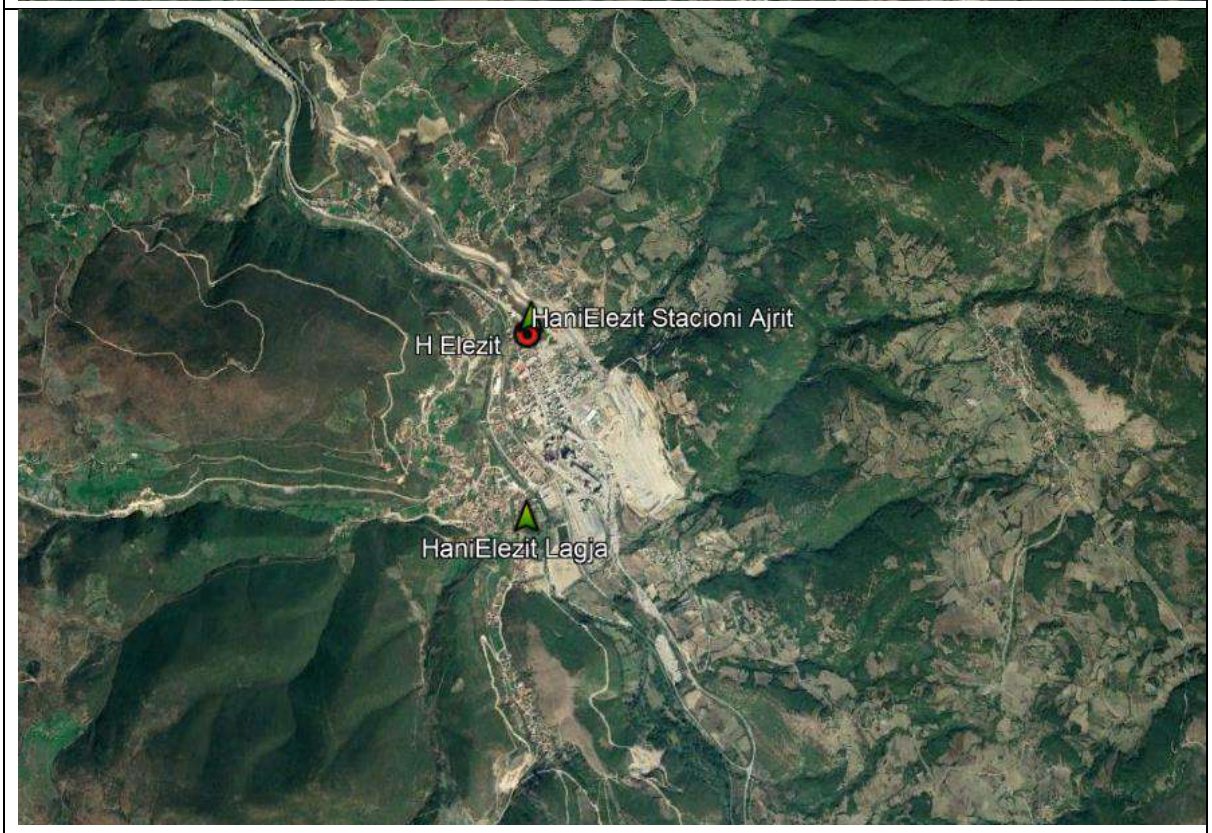
BTEX Location 2: *Location in Vushtrri (upper part) and locations in Mitrovice (lower part) (green triangles) and AQMS sites (red/black dot). (Source Google Earth)*

BTEX Location 3: *Locations in Peja (upper part) and locations in Gjakove (lower part) (green triangles). (Source Google Earth)*

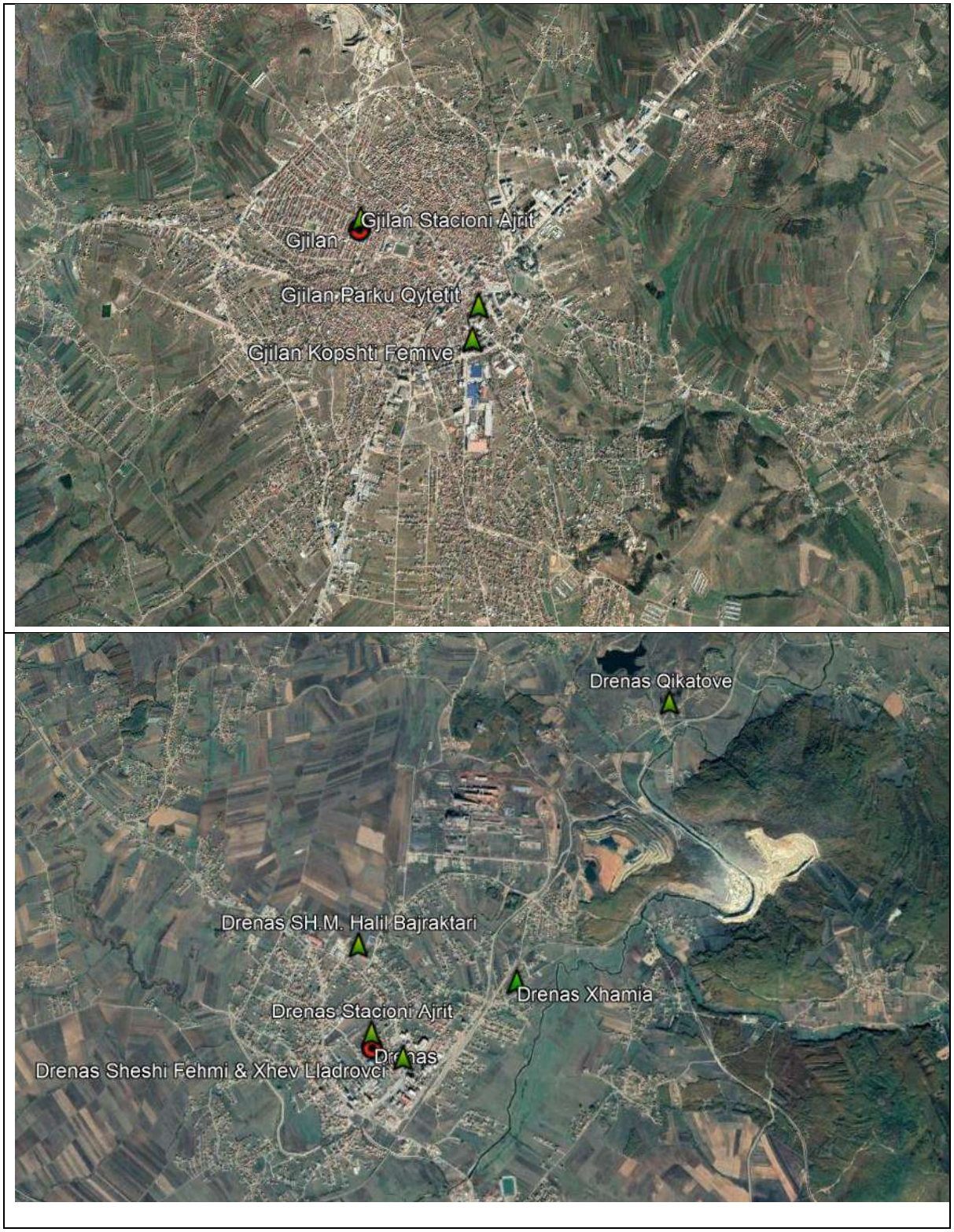


BTEX Location 4: *Locations in Prizren (upper part) and location in Suharek (lower part) (green triangles) and AQMS sites (red/black dot). (Source Google Earth)*





BTEX Location 5: *Location in Ferizaj (upper part) and locations in Han I Elezit (lower part) (green triangles) and AQMS sites (red/black dot). (Source Google Earth)*



BTEX Location 6: *Locations in Gjilan (upper part) and locations in Drenas (lower part) (green triangles) and AQMS sites (red/black dot). (Source Google Earth)*