

SUPPORTING MATERIAL

Compilation of a GIS based high spatially and temporally resolved emission inventory for the greater Istanbul area

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Table S1. Annual fuel consumption in the GIA

Fuel type	Residential	Industrial/Energy
Coal (in kt)	1 000	1 402
NG (in million m ³)	2 828	3 196
Fuel oil (in kt)	-	1 082
LPG (in million m ³)	-	0.47

Table S2. Emission factors^a used for the quantification of residential and industrial combustion emissions. Inside the parenthesis the quality rating of the emission factor is provided^b (where available)

Fuel type	CO	NO _x	SO _x ^c	NM VOC	PM ₁₀ /PM _{2.5}
Residential					
Coal (kg/t) ^d	46.4	2.3	13.61 S	1.9	4 / 4
Natural gas (kg/million m ³)	640 (B)	1 504 (B)	9.6 (A)	51.2 (B)	121.6 (B) / 121.6 (B)
Industrial/Energy					
Coal (kg/t)	0.125 (C)	3.15 ^e (C)	15 S (C)	0.02 (C)	0.9 A ^f (E) / 0.26 A ^f (E)
Fuel oil (kg/10 ³ L) ^g	0.6 (A)	LB: 5.64 ^h (B) SB No4: 2.4 (A) SB No6: 6.6 (A)	No4: 18.68 S (A) No6: 19.52 S (A)	No4: 0.024 (A) No6: 0.091 (A)	No4: 0.723 (D) / 0.471 (D) No6: 1.45 (D) / 0.942 (D)
Natural gas (kg/million m ³)	1344 (B)	LB: 3040 ⁱ (A) SB: 1600 ⁱ (B)	9.6 (A)	51.2 (B)	121.6 (B) / 121.6 (B)
LPG (kg/10 ³ L)	0.384 (E)	2.28 (E)	0.012 S (E)	0.036 (E)	0.072 (E) / 0.072 (E)

^a All emission factors derive from USEPA (1995).

^b Quality rating: A - Excellent, B - Above average, C - Average, D - Below average and E - Poor. Additional information can be found at <http://www.epa.gov/ttn/chieff/efpac>.

^c S is the sulfur content of the fuel in% wt.

^d Uncontrolled.

^e emission factor for Dry Bottom Wall Fired Boilers - Uncontrolled (post-NSPS).

^f emission factor for uncontrolled Wall Fired Boilers, A is the ash content of fuel.

^g For combustion in industries No4 fuel oil was used, normal firing. For the energy sector No6 heavy fuel oil was used.

^h LB: Large boilers (>100 Million Btu/hr), SB: Small boilers (<100 Million Btu/hr).

ⁱ emission factor for Large Wall Fired Boilers - Uncontrolled (post-NSPS).

Table S3. Annual vessel traffic in the Bosphorus crossing and the Ambarli port

Vessel type	Bosphorus crossing ^a	Ambarli port ^b
Tankers	9 324	2 239
General cargo	34 705	1 305
Containers	2 727	1 725
LPG	800	-
RoRo	439	155
Bulk Carriers	5 144	-
Passenger	1 702	-
Other	1 765	177
Total	56 606	5 601

^a data for 2007 (UMA 2007). Number represents the passing vessels through the crossing.

^b data for 2005 (Kılıç 2006). Number represents the vessels visited the port of Ambarli.

Table S4. Emission factors (in g/t of fuel) used for the quantification of cargo shipping emissions

Engines type	CO	NO _x	SO _x ^a	NH ₃	NMVOC	PM ₁₀ /PM _{2.5}
Cruising mode^b						
Slow speed	2 545	87 136	46 000 S	27	1 525	6 667
Medium speed	5 063	61 657	46 000 S	29	919	2 326
High speed	5 116	58 857	46 000 S	14	930	2 326
Hotelling mode^c						
Slow speed	99 000	35 000	20 000 S	-	23 100	1 200
Medium speed	99 000	23 000	20 000 S	-	23 100	1 200
High speed	120 000	28 000	20 000 S	-	28 900	1 500
Maneuvering mode^b						
Slow speed	4 627	63 372	46 000 S	25	2 773	12 121
Medium speed	9 206	44 841	46 000 S	26	1 671	4 228
High speed	9 302	42 805	46 000 S	13	1 691	4 228

^a Sulfur content of fuel (wt%) was taken equal to 2.3 (Cooper and Gustafsson 2004).

^b Emission factors for cruising and maneuvering modes from Cooper and Gustafsson (2004). Uncertainty ranges of the emission factors are given therein.

^c Emission factors from Trozzi and Vaccaro (1998).