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Spatial inventory of GHG emissions from fossil fuels extraction and processing: An uncertainty analysis

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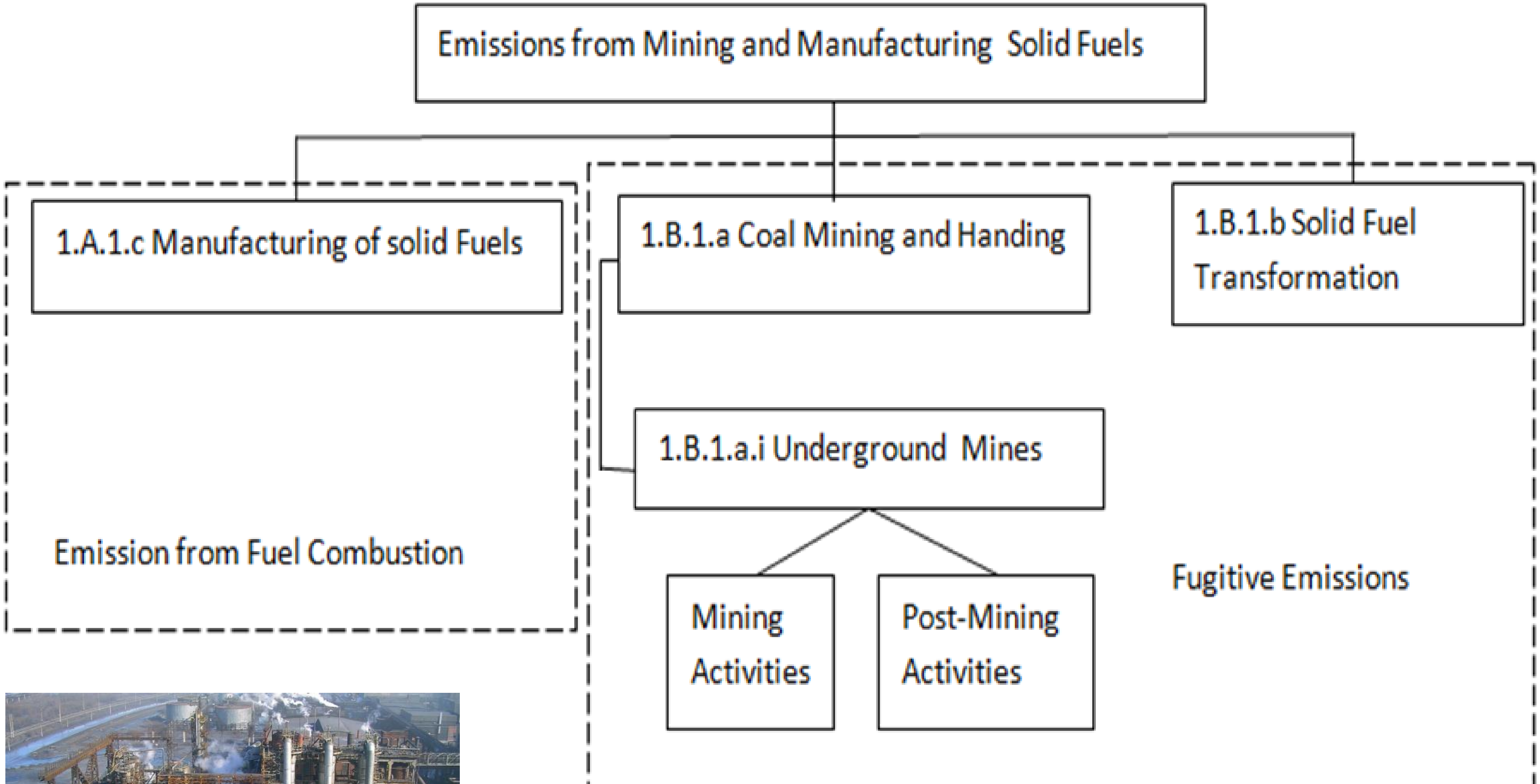
Outline

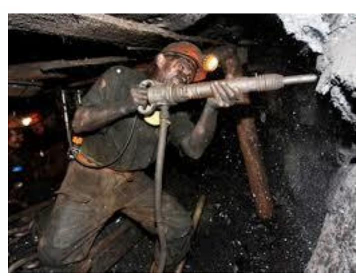
- Introductions
- Methodology
- Inventory results
- An uncertainty analysis

Introductions

CO_2, CH_4, N_2O

Mining and Manufacturing Solid Fuels





Mining and Manufacturing Solid Fuels

Methodology

Statistical data

GUS, BDL

official web sites of associations and enterprises (annual reports, production capacities)

Emission factors

NIR

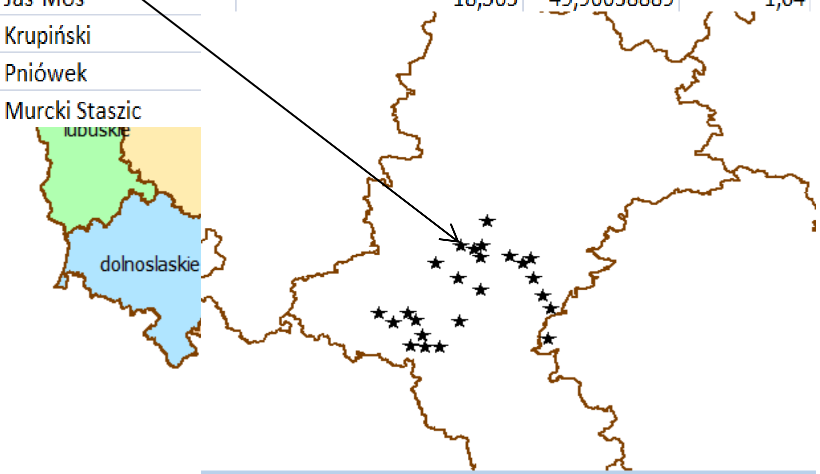
Digital maps

Administrative maps

Map of GHG emissions sources

Geographic coordinates

	X	Y	mln.t
KWK Borynia	18,61388889	50,00055556	1,96
KWK Zofiówka	18,62361111	49,96577778	1,72
KWK Budryk	18,76444444	50,17821667	2,94
KWK Jas-Mos	18,565	49,96638889	1,64
KWK Krupiński			
KWK Pniówek			
KWK Murcki Staszic			



	A	B
1	Name of mine	Capacity of the mine
2	KWK M	2,875156
3	KWK M	
4	KWK W	
5	Oddział	

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CTIVITY DAT	IMPLIED EMISSION FACTORS	
	Amount of fuel produced	CH_4 (1)	CO_2
	(Mt)	(kg/t)	
1. B. 1. a. Coal Mining and Handling	125,71		
i. Underground Mines (4)	69,19	4,91	NE
Mining Activities		4,55	NE
Post-Mining Activities		0,36	NE

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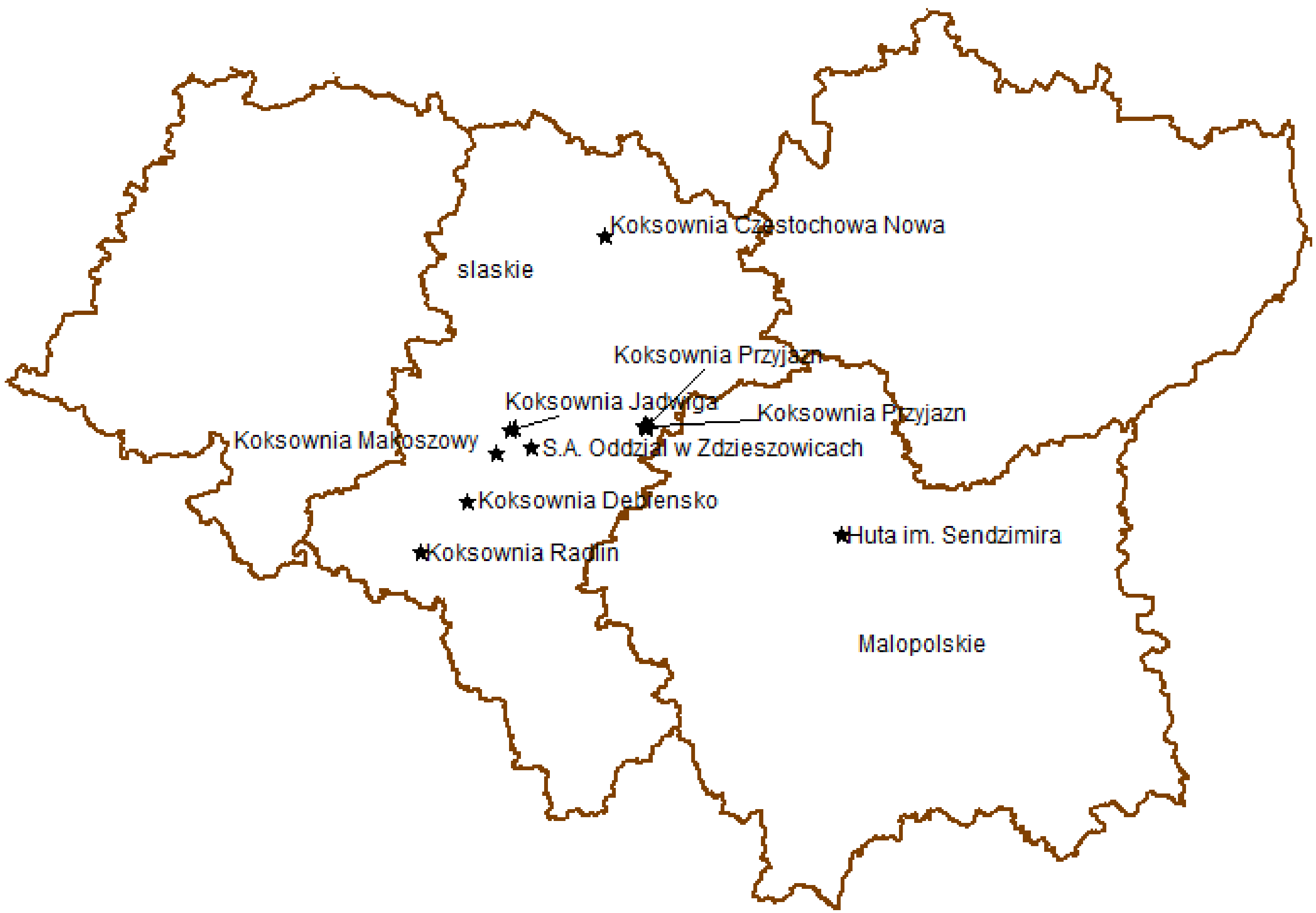
Mining and Manufacturing Solid Fuels

Methodology



),34072
0
),33239
),16028
;0,0375
),79908
),27514

Map of coke plants in Poland

Mining and Manufacturing Solid Fuels

GHG emissions calculation

$$E^{g}_{coal,}(\xi_n) = E^{gl}_{coal,m}(\xi_n) + E^{gl}_{coal,p}(\xi_n),$$

$$E^{gl}_{coal,m}(\xi_n) = \frac{A^{\Sigma}_{coal} \cdot P_{coal}(\xi_n)}{\sum_{j=1}^{N} P_{coal}(\xi_j)} \cdot K^{gl}_{coal,m},$$

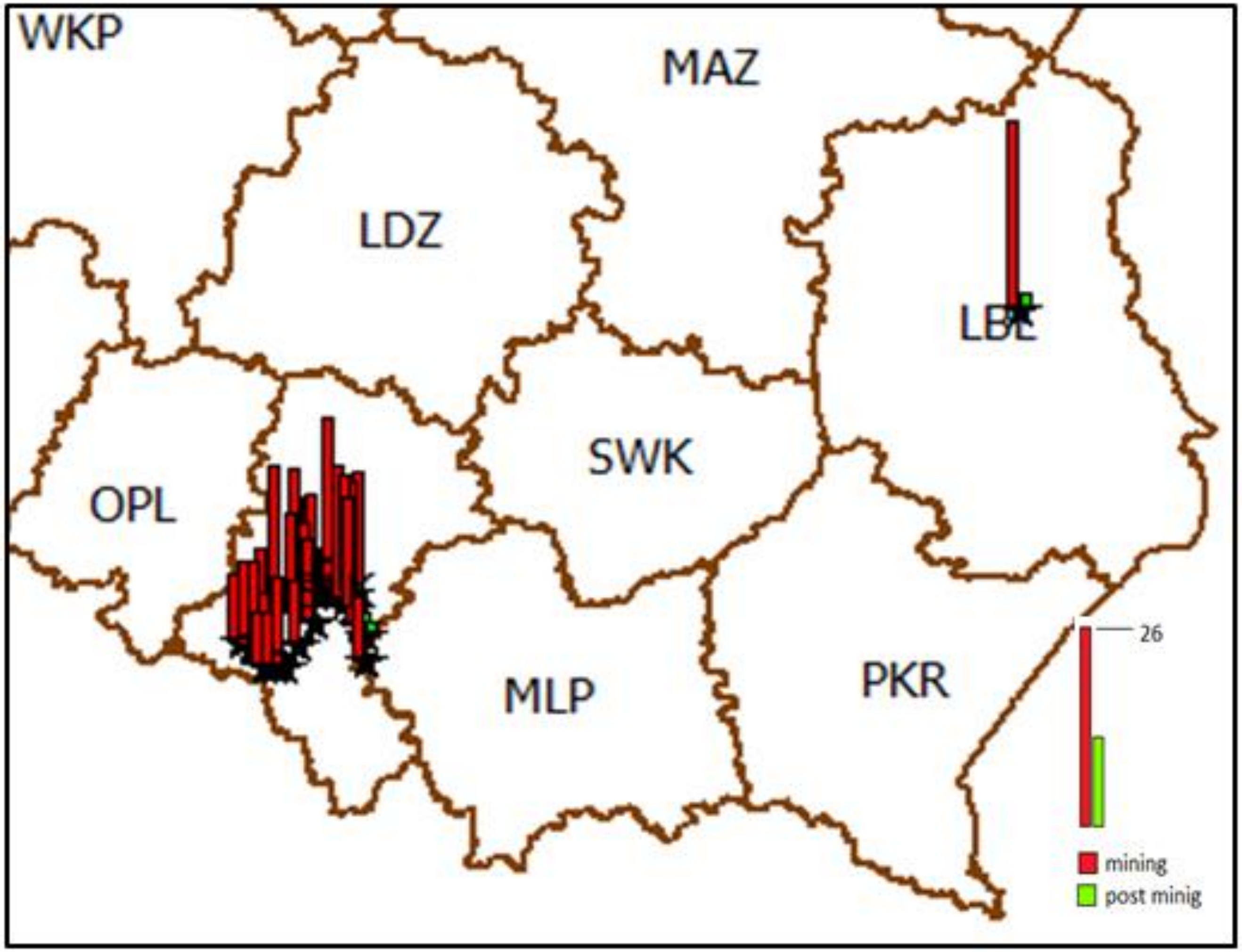
$$E^{gl}_{coal,p}(\xi_n) = \frac{A^{\Sigma}_{coal} \cdot P_{coal}(\xi_n)}{\sum_{j=1}^{N} P_{coal}(\xi_j)} \cdot K^{gl}_{coal,p},$$

$$E^{g,f}_{coke}(\eta_k) = D^{f}_{stat,coke} \cdot K^{f}_{coke}(\eta_k) \cdot K^{g,f}_{em,coke}(\eta_k), \qquad K^{f}_{coke}(\eta_k) = \frac{C(\eta_k)}{\sum_i C(\eta_i)},$$

$$E^{\Sigma}_{coalInd} = \sum_{g \in G} \left\{ W_g \left[\sum_{f \in F} \sum_{\eta_k} E^{g,f}_{coke}(\eta_k) + \sum_{\eta_k} E^{g}_{coke}(\eta_k) + \sum_{\xi_n} E^{g}_{coal}(\xi_n) \right] \right\},$$

Mining and Manufacturing Solid Fuels

Inventory results



Fugitive emissions of CH_4 from Coal mining (th. t., Poland, 2010)

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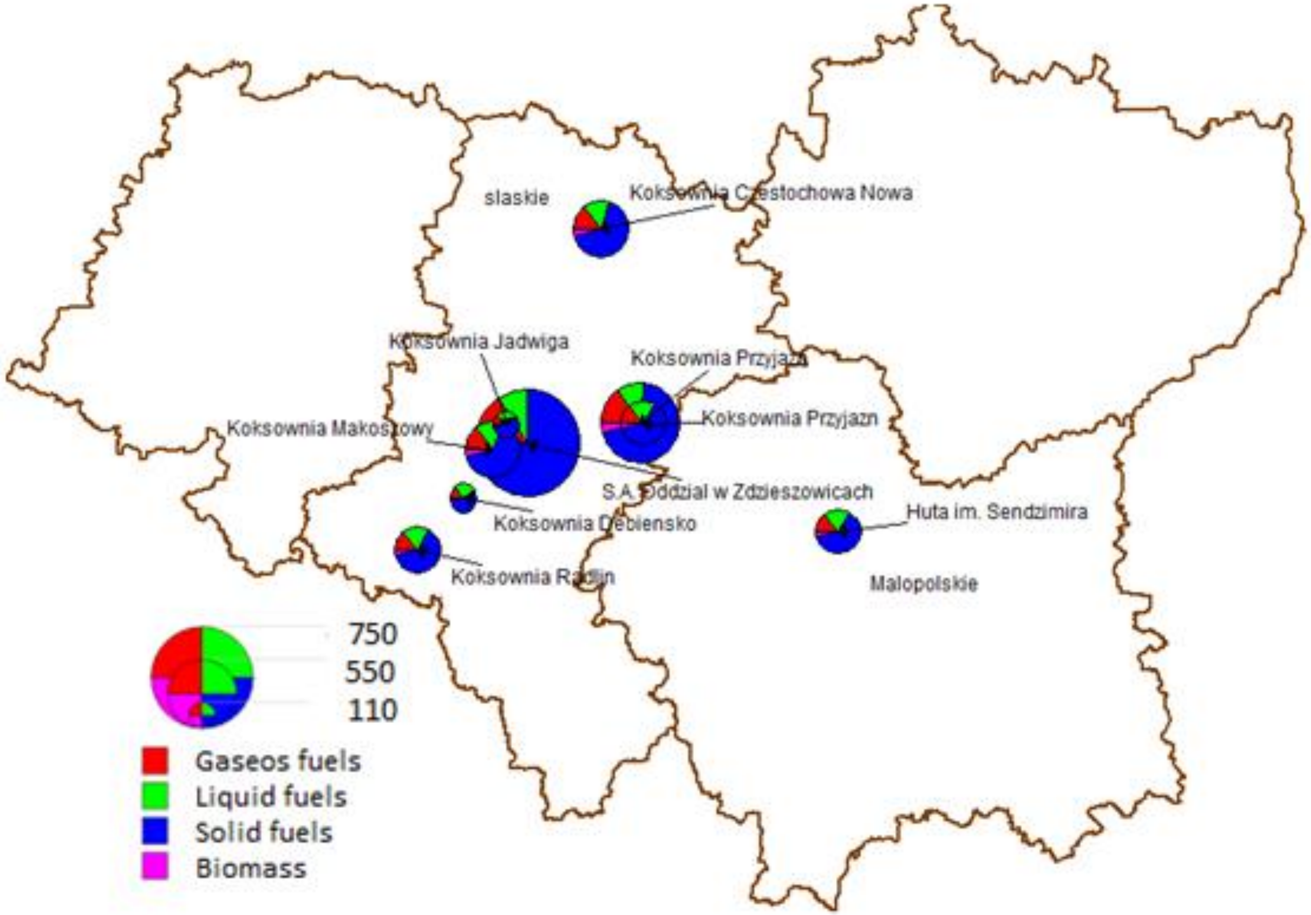
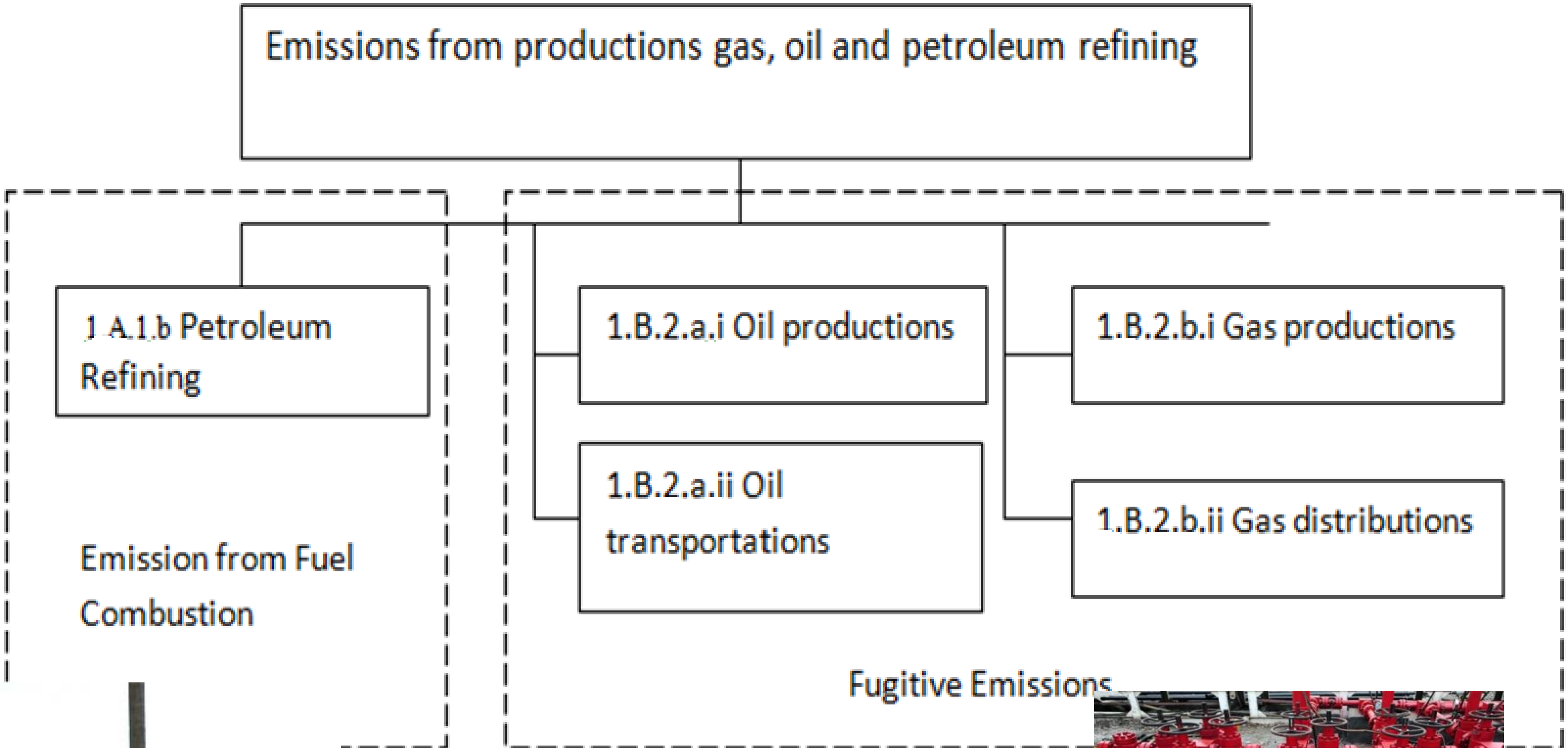
Mining and Manufacturing Solid Fuels

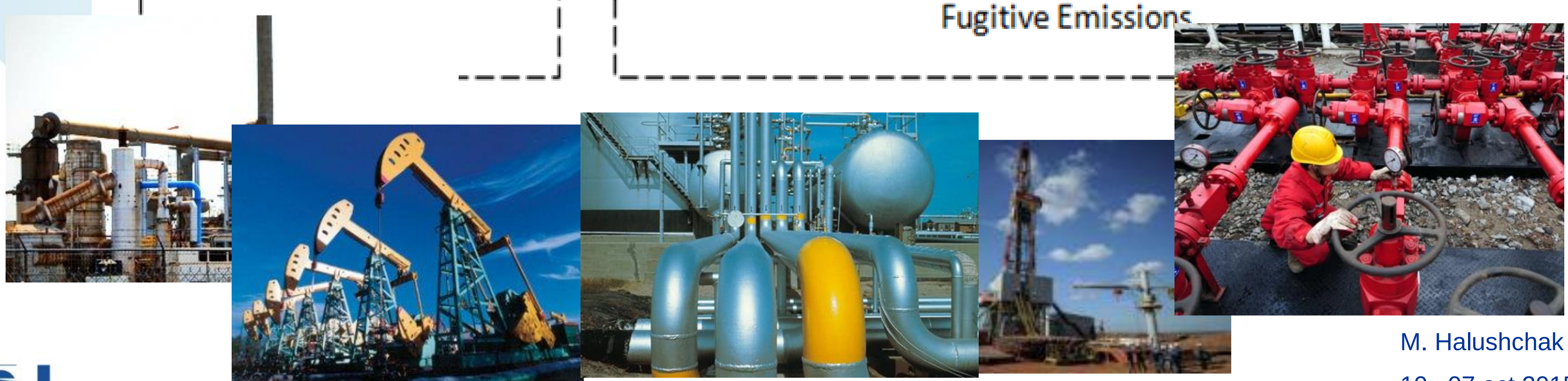
Inventory results



Structure of GHG emissions from burning coal, oil, natural gas and biomass by type of fuel for separate coke plants (th. t.,CO_2-equivalent, Poland, 2010)

Productions gas, oil and petroleum refining





Productions gas, oil and petroleum refining

Methodology

Input data

Statistical data

GUS, BDL
official web sites of associations and enterprises (annual reports, production capacities)

Emission factors

NIR

Digital maps

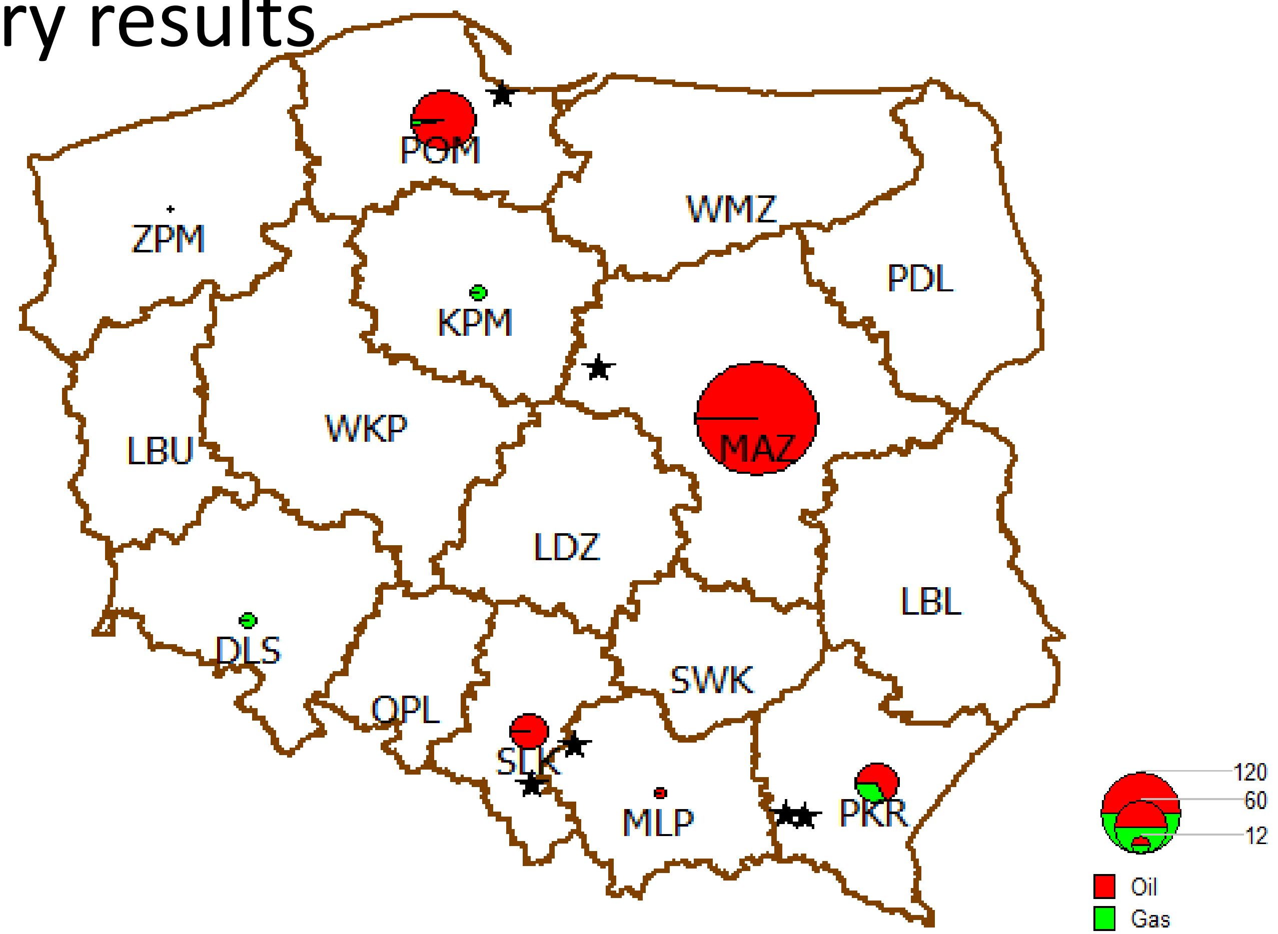
map of administrative division
geographic coordinates

map of GHG emissions sources

2		X	Y
3	PMG Daszewa	15,88255	54,08326
4	KPMG Mogilno	17,96643	52,65876
5	PMGBonlkowo	21,45943	49,72118
6	PMG Wierzchowice	15,9512	51,62753
			,72107
			,12235

Productions gas, oil and petroleum refining

Inventory results



GHG emissions from productions gas and refining
(Gg., CO_2-eq., Poland, 2010)

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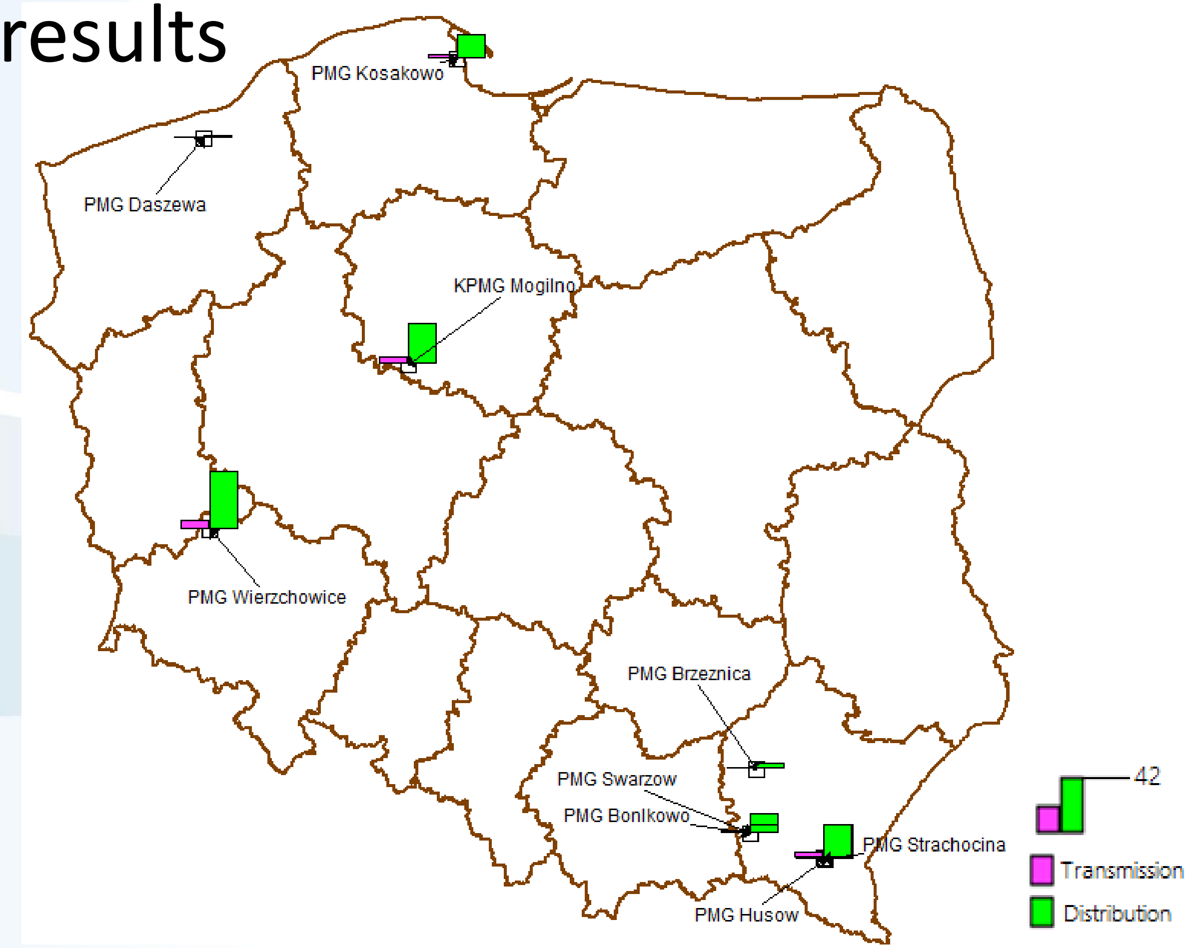
Productions gas, oil and petroleum refining

Inventory results



CH_4 fugitive emissions from transmission and distribution of natural gas, (Gg., CO_2-eq., Poland, 2010)

An uncertainty analysis

The results of modelling GHG emissions and their uncertainties for separate coke plants

Name of coke plant	CO_2 emissions,t; uncertainty, %	CH_4 emissions, t; uncertainty, %	N_2O emissions, t; uncertainty, %	Total emissions, t; uncertainty, %
Coke plant Przyjaźń	464,408.5	2,756.6	603.8	466,722.0
	±3.6	-37.3..+49.3	-45.4..+68.1	-3.6..+3.7
Coke plant Jadwiga	50,018.4	968.5	65.0	50,154.675
	±3.6	-37.3..+49.3	-45.4..+68.1	-3.6..+3.7
Coke plant Dębieńsko	53,585.6	1,037.7	69.8	54,731.6
	±3,6	-37.3..+49.3	-45.4..+68.1	-3.6..+3.7
Coke plant Radlin	133,964.0	2,594.2	174.2	136,328.9
	±3.6	-37.3..+49.3	-45.4..+68.1	-3.6..+3.7
Coke plant Przyjaźń	133,964.0	2,594.2	174.2	136,328.9
	±3.6	-37.3..+49.3	-45.4..+68.1	-3.6..+3.7
Coke plant Częstochowa Nowa	232,204.2	4,496.6	301.9	236,936.8
	±3.6	-37.3..+49.3	-45.4..+68.1	-3.6..+3.7
Coke plant Makoszowy	206,434.0	4,150.7	268.4	210,996.3
	±3.6	-37.3..+49.3	-45.4..+68.1	-3.6..+3.7
S.A. Oddział w Zdzieszowicach	722,518.0	1,4527.5	939.5	724,486.3
	±3.6	-37.3..+49.3	-45.4..+68.1	-3.6..+3.7
Ironworks im. Sendzimira	137,623.0	2,767.1	178.9	139,997.9
	±3.6	-37.3..+49.3	-45.4..+68.1	-3.6..+3.7

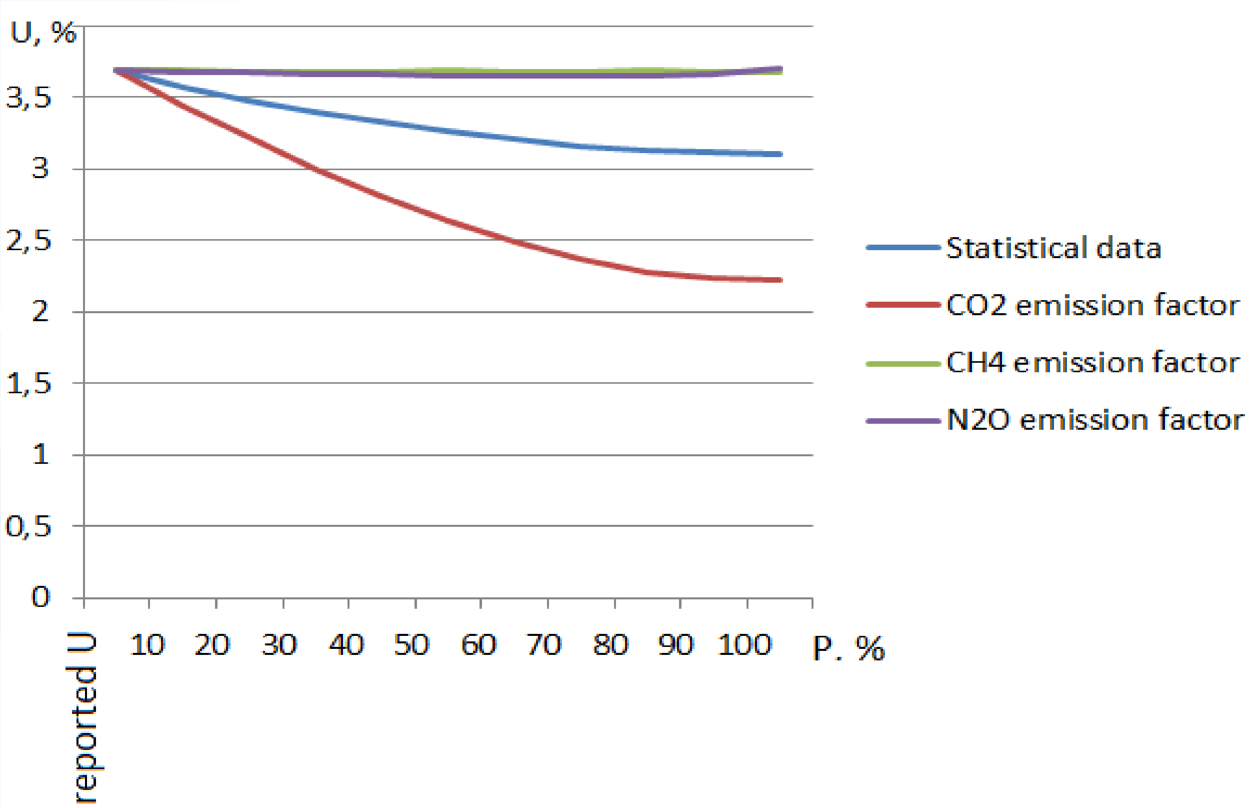
An uncertainty analysis

The results of modelling GHG emissions and their uncertainties for the main coal mines

Name of coal mine	Volumes of coal extraction; 10^3 tons/year	CH_4 emission factor; t_{CO2}/t	CH_4 fugitive emissions, Gg	Uncertainty, %
KWK Murcki Staszic	3.875	4.90	18.977	48
KWK Mysłowice-Wesoła	3.229	4.91	19.029	48.
KWK Wujek	4.982	4.91	24.466	48
Oddział KWK Jankowice	2.759	4.91	13.547	48
Oddział KWK Knurów-Szczygłowice	3.792	4.91	18.622	48
Oddział KWK Sośnica-Makoszowy	3.285	4.91	16.13	48
Oddział KWK Ziemowit	4.097	4.91	19.912	48
Oddział KWK Piast	4.613	4.87	22.423	48
KWK Wieczorek	3.405	4.9	16.548	48
KWK Bogdanka	5.351	4.91	26.011	48

An uncertainty analysis

Sensitivity analysis



Dependence of total uncertainty of GHG inventory from burning coal in the coke plants of Poland (U) from decreasing uncertainty of input data into P percent (Monte Carlo simulations).

Conclusions

- Spatial inventory of GHG emissions from mining and manufacturing solid fuels;
- Spatial inventory of GHG emissions from productions gas, oil and petroleum refining;
- An uncertainty analysis of emission for investigated area.

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