Spatial inventory of greenhouse gas emissions in the residential sector: a case-study for Poland and Ukraine

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Introduction

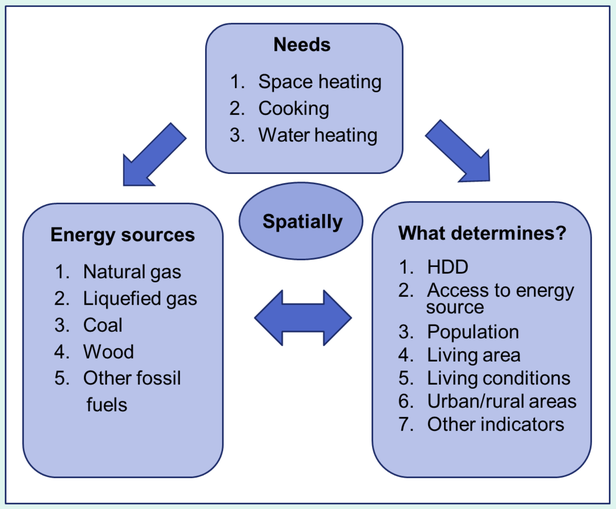
Residential sector has a great potential for greenhouse gas (GHG) emissions reduction comparing to other sectors, especially in developing countries. In order to assess the potential for energy efficiency improvement in this sector the easy-to-use tool for spatial-distributed GHG emissions inventory is needed.

Methodology

The proposed approach of emission inventory of GHG gases in residential sector consists of:

(1) dividing investigated area for elementary objects of specified size;
(2) assessment of energy demand for every elementary object;
(3) disaggregation of burned fossil fuels from regional level to the level of elementary objects;
(4) performing inventory of GHG emissions for every elementary object.

Based on conducted numerical experiments the geo-referenced databases and digital maps of GHG emissions in Poland, as an example of EU Member State, and Ukraine, as an example of non-EU Member State, are obtained.

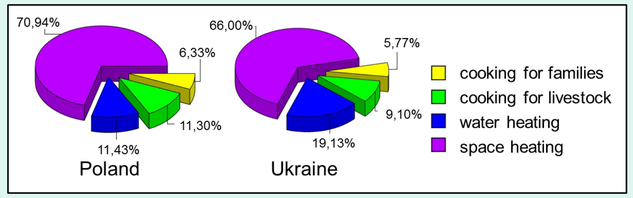


Energy assessment

Energy demand in the residential sector can be estimated as sum of energy needs for cooking, water and space heating:

$$Q = Q_h + Q_c + Q_w ,$$

where Q_h – annual energy demand for space heating,
Q_c – annual energy demand for cooking,
Q_w – annual energy demand for water heating.



Energy demand for cooking, water and space heating (Poland, Ukraine, 2010)

Fossil fuel disaggregation

Statistical data about fossil fuels consumption of households as small consumers for most countries are available only on country or regional level. Therefore to obtain the information about amount of fossil fuel burned at the level of elementary object the data about consumed fossil fuels was disaggregated.

The amount of consumed i fossil fuel in n elementary object can be calculated by the formula:

$$M_{i,n} = M_{i,R} \cdot F^{n}_{i,type},\ n = \overline{1,N}$$

where $M_{i,R}$ – amount of consumed i fossil fuel in R region,
n – number of elementary object (city, town, village),
N – total number of elementary objects,
$type \in \{Urb, Rur\}$ – affiliation of elementary object to urban/rural area,
$R \in \tilde{R}$ – set of administrative territorial units,
$F^{n}_{i,type}$ – disaggregation coefficient.

GHG emission calculation

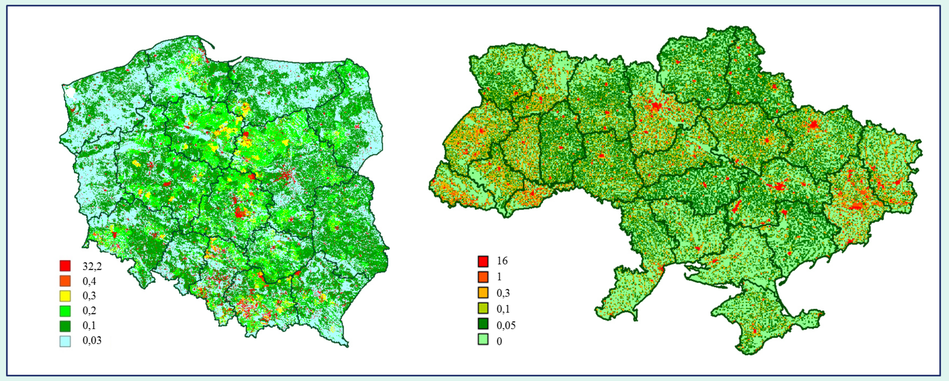
The emission of G greenhouse gas from burning i fossil fuel in n elementary object can be calculated using the formula:

$$E^{G}_{i,n} = M_{i,n} \cdot EF^{G}_{i,n},\ n = \overline{1,N}$$

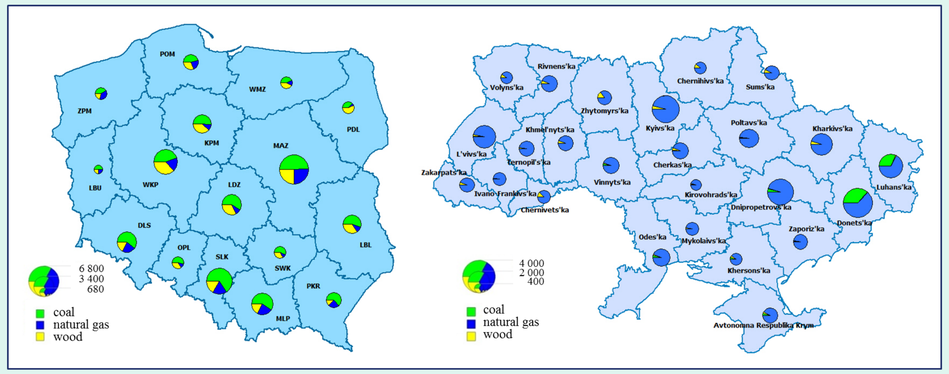
where $EF^{G}_{i,n}$ – emission factor of G greenhouse gas.

Inventory results

Due to the analysis of obtained results the major GHG emission sources for selected regions are identified. Analysis of emission processes is conducted for elementary areas 2 km x 2 km in size.



Specific GHG emissions in residential sector (mln kg/sq.km., CO_2-eq., Poland, Ukraine, 2010)



Structure of GHG emissions by type of fossil fuel for administrative regions (mln kg, CO_2-eq., 2010)

Conclusions

As the developed approach is flexible based on the available input data, it may be implemented in other countries. The practical importance of the developed spatial-based approach and GIS-based software consists in its usefulness for analyzing, optimization and planning the environmental protection measures.

Acknowledgements

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