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Estimating NUTS3-level CO2-emission rates in Europe.

by
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Abstract

The regional efforts supporting the transformation to a low carbon and resource efficient economy suffers in many regions from a lack of data on the production and use of fossil and other energy within the territory of the region. This paper presents estimates of CO_2-emissions at the NUTS3 level derived from the EDGAR database. The database contains CO_2-emissions that are derived from national emission records and distributed to a 0.1x0.1 degree grid using surrogate variables reflecting population, production, plants, reported point source emissions etc. The derived NUTS3 level emission rates do, however not meet the needs of the regional economic development efforts. First, they only to a limited degree reflect the production and use of fossil fuels, which results in side uncertainties. Second, they do not reflect changes in from fossil to other energy carriers and progress in energy efficincy in any region beyond the changes at the national level. Thus, they are not useful for monitoring progress in these transformations. They do, however, show that even within each country the regions differ widely in their production and use of fossil energy and regional strategies for transformation are.

Acknowledgements

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Scientific disciplines involved

Economics, geography.

Keywords

CO_2-emissions, regions, Europe, statistics.

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Introduction

The regional efforts supporting the transformation to a low carbon and resource efficient economy suffers in many regions from a lack of data on the production and use of fossil and other energy within the territory of the region.

The present research paper is based upon regionalisation of the gridded CO_2 emissions available in the EDGAR database (JRC, 2012) and the point source CO_2-emissions of the E-PRTR (European Environment Agency (EEA), 2013) database.

The EDGAR database is developed by the EU Commission Joint Research Centre and it contains spatially distributed estimates of the GHG-emissions gridded to a 0.1°x0.1° grid. The known emissions data are the national level emissions data used by the IPCC.

The primary data on fossil energy combustion and thus CO2-emissions are not collected or not processed in a way that enables EU-wide statistics on actual CO2-emissions from NUTS2 or NUTS3 regions. Thus, the EDGAR project has developed spatially distributed estimates based on the national level emissions according to a set of surrogate variables or distribution keys.

The surrogate variables (or distribution keys) applied for "gridding" the national data include data on the location of point source emissions, production units in various industrial sectors, population etc. For this reason it will not generate new information to normalise the spatially distributed emissions with population, GDP or similar variables. Many of the surrogate data were not available for 2008 and patterns for earlier years have been applied.

The CO2-emissions used in this study exclude emissions from biomass combustion and burning. This is based on the assumption that these emissions do not contribute to the greenhouse gas emissions if the global uptake of carbon in biomass equals or exceeds the carbon content of emissions from biomass combustion and burning at a global scale.

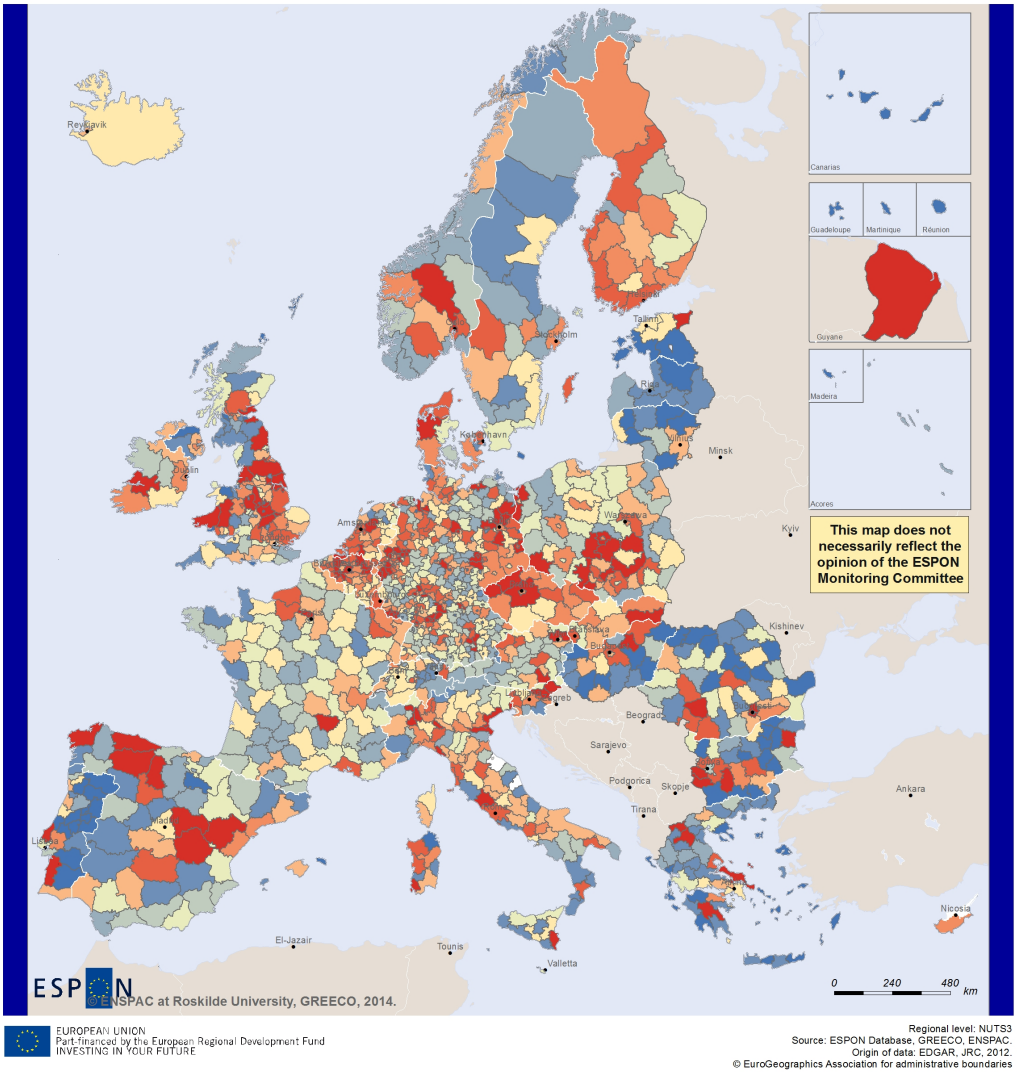
The emissions are divided in three categories: Emissions from production and residential activities, emissions from ground transport and emissions from other transport. This is because ground transport and to an even higher extent sea transport and air transport takes place in other locations than the residence or workplace of its users or beneficiaries.

Historic changes in CO_2-emissions by regions

The average annual rate of reduction of greenhouse gas emissions in 1990-2000 and 2000-2008 is known for the EU as a whole and for the individual member-states. Primary data on fuel combustion are, however, not collected and processed in a harmonised way across Europe and we don't know the overall emissions at the regional level.

Instead, we have used the "gridded" emission data from the EDGAR database to predict the regional CO_2-emissions from the national emission data just like future developments are "predicted" from past experience. The gridded emissions in the EDGAR database are estimated by distributing the national emission figures according to known spatial distributions of production, population and other economic variables that are known to be associated with the spatial distribution of energy combustion.

The following maps show the emissions from NUTS3 regions that are expected if primary data on fossil fuel consumption or CO_2-emissions were collected and processed following a common standard. The transport related emissions in the EDGAR database are spatially distributed according to transport infrastructure and aviation and maritime transport routes. Consequently, the spatially distributed emissions are not necessarily related to the resident population of the regions and are omitted from the analysis.

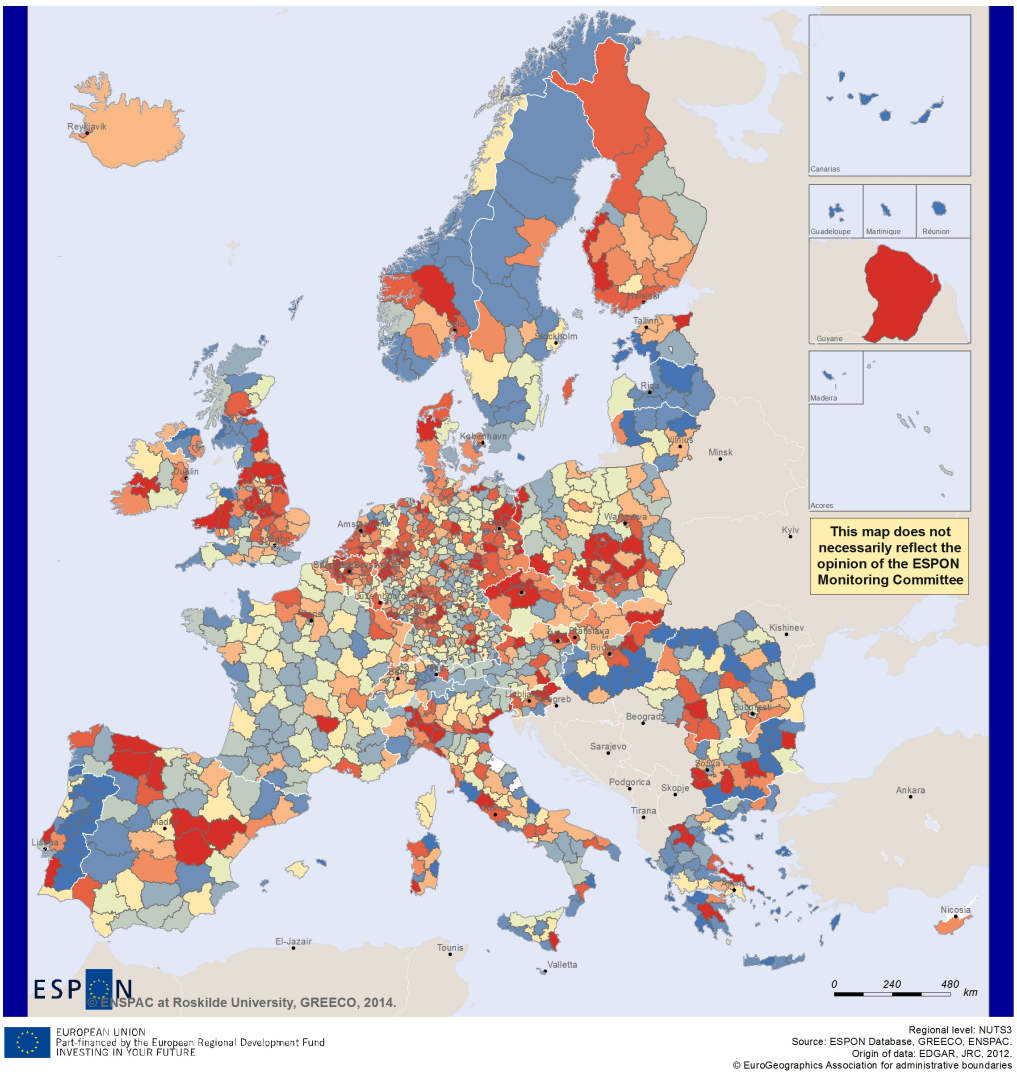


Expected per capita CO2 emissions from fossil fuel combustion excluding all transport in 2000.
Tons CO2 per person. NUTS3 regions in deciles.

0,0 - 1,0	1,8 - 2,1	2,6 - 3,1	4,0 - 5,2	7,9 - 13,2	No data
1,1 - 1,7	2,2 - 2,5	3,2 - 3,9	5,3 - 7,8	13,3 - 238,4	

Map 1. Expected per capita CO_2-emissions from fossil fuel combustion excluding all transport in 2000. Tons per person.

Source: Authors' calculations based on the EDGAR database (JRC, 2012).



Map 2. Expected per capita CO_2-emissions from fossil fuel combustion excluding all transport in 2008. Tons per person.

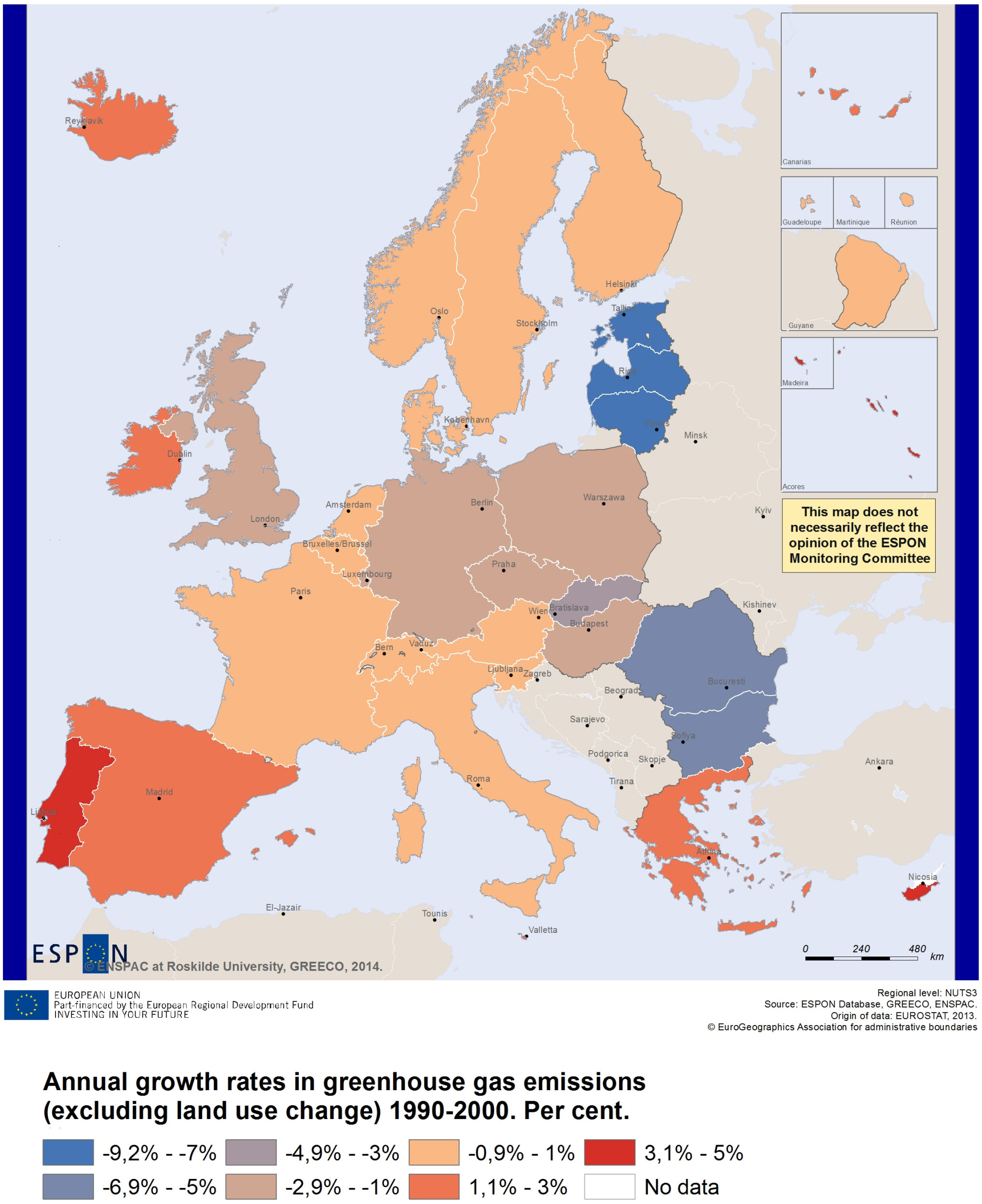
Source: Authors' calculations based on the EDGAR database (JRC, 2012).

Based on the spatial variation in the surrogate variables, the regions must be expected to face very different challenges in the transformation to a low carbon economy. Most countries have regions with both the two lowest (blue colour) and the two highest (red colour) categories.

Map 3 and map 4 show the compound annual growth rates of expected GHG emissions in European countries in the 1990s and in the 2000s until 2008.

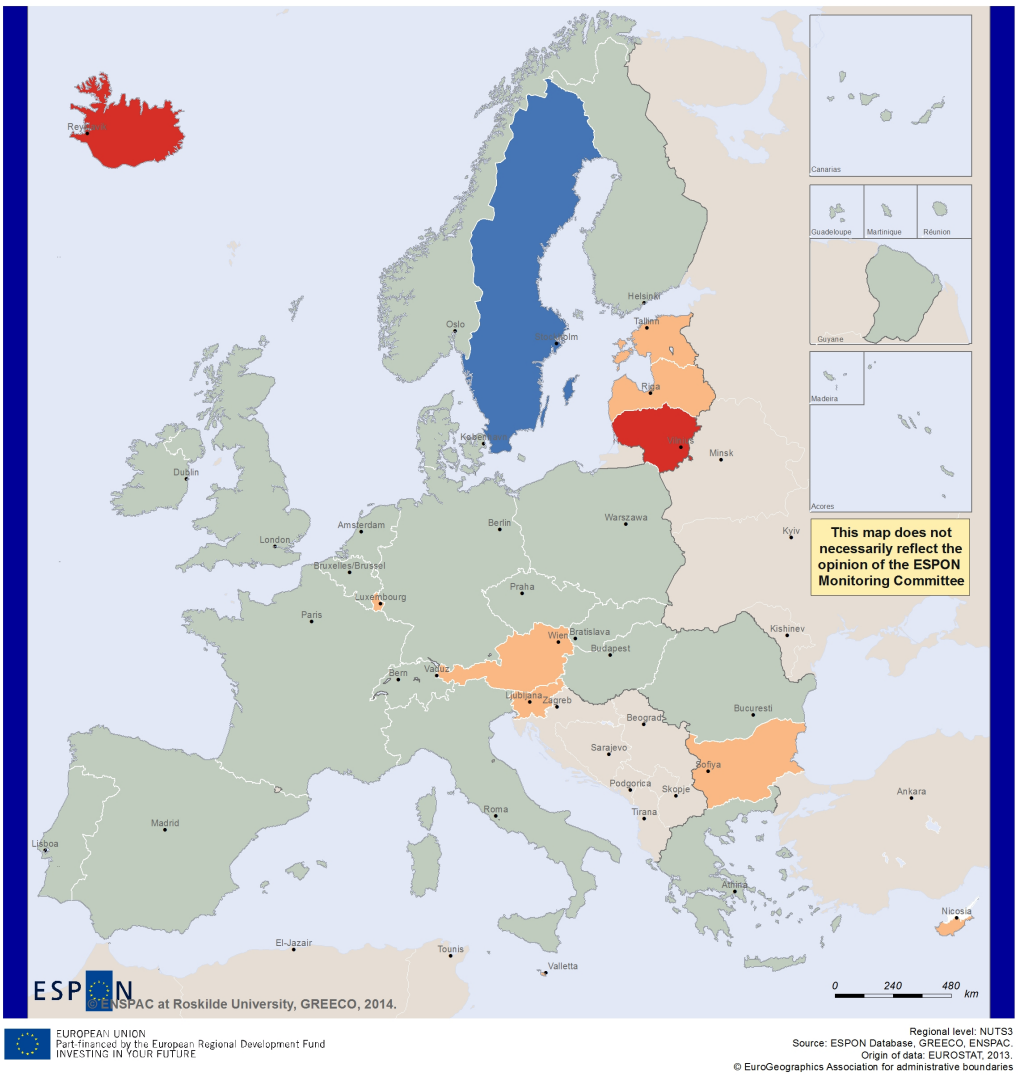
In the 1990s, the emissions declined dramatically in the countries of the former eastern block following the collapse of the fossil fuel intensive industry of these economies. At the same

time a rapid economic growth in some economies such as Spain and Portugal led to high rates of emission growth. The emissions of the remaining EU countries grew at rates close to 0.



Map 3. Greenhouse gas emission growth in EEA countries. Reported change 1990-2000. Per cent per year.

Source: EUROSTAT (EC, 2013).

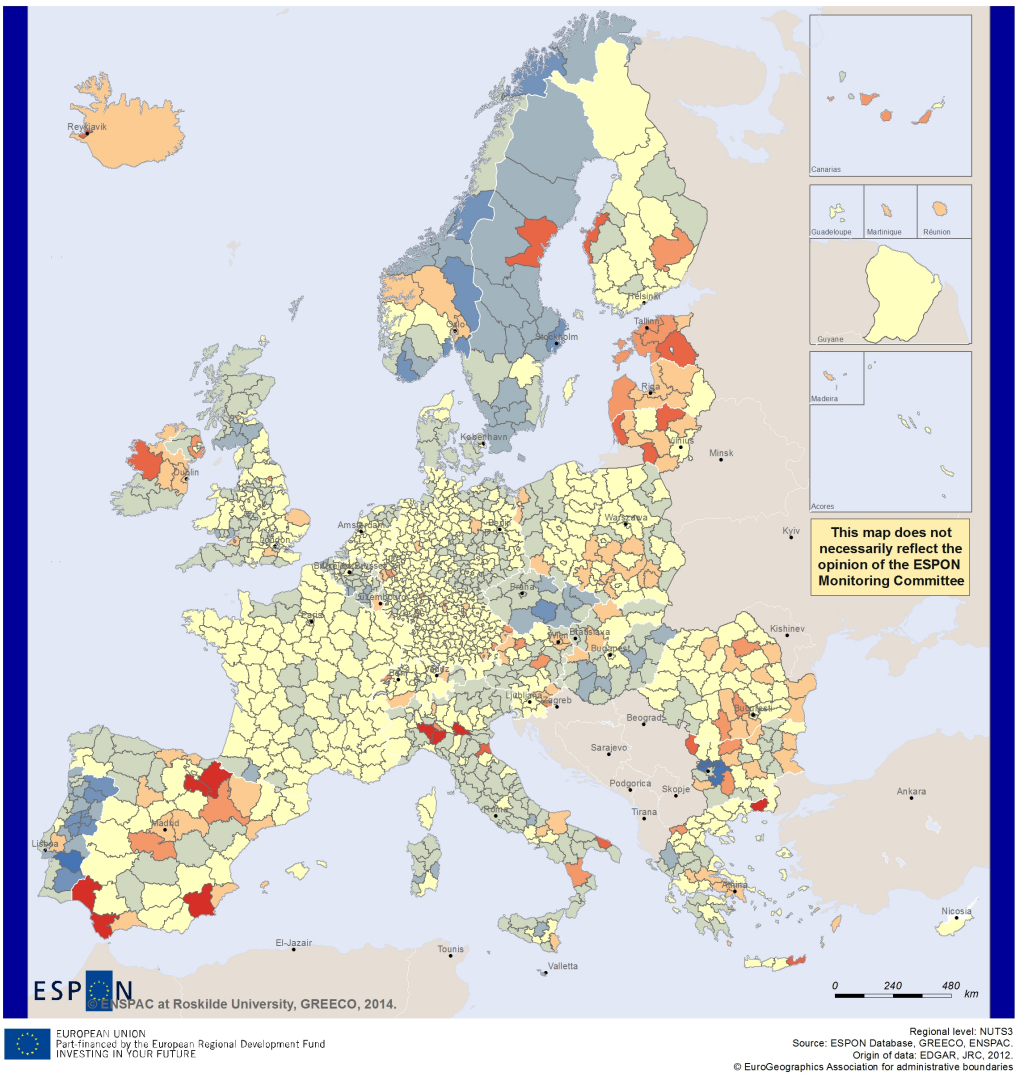


Map 4. Greenhouse gas emission growth in EEA countries. Reported change 2000-2008. Percent per year.

Source: EUROSTAT (EC, 2013).

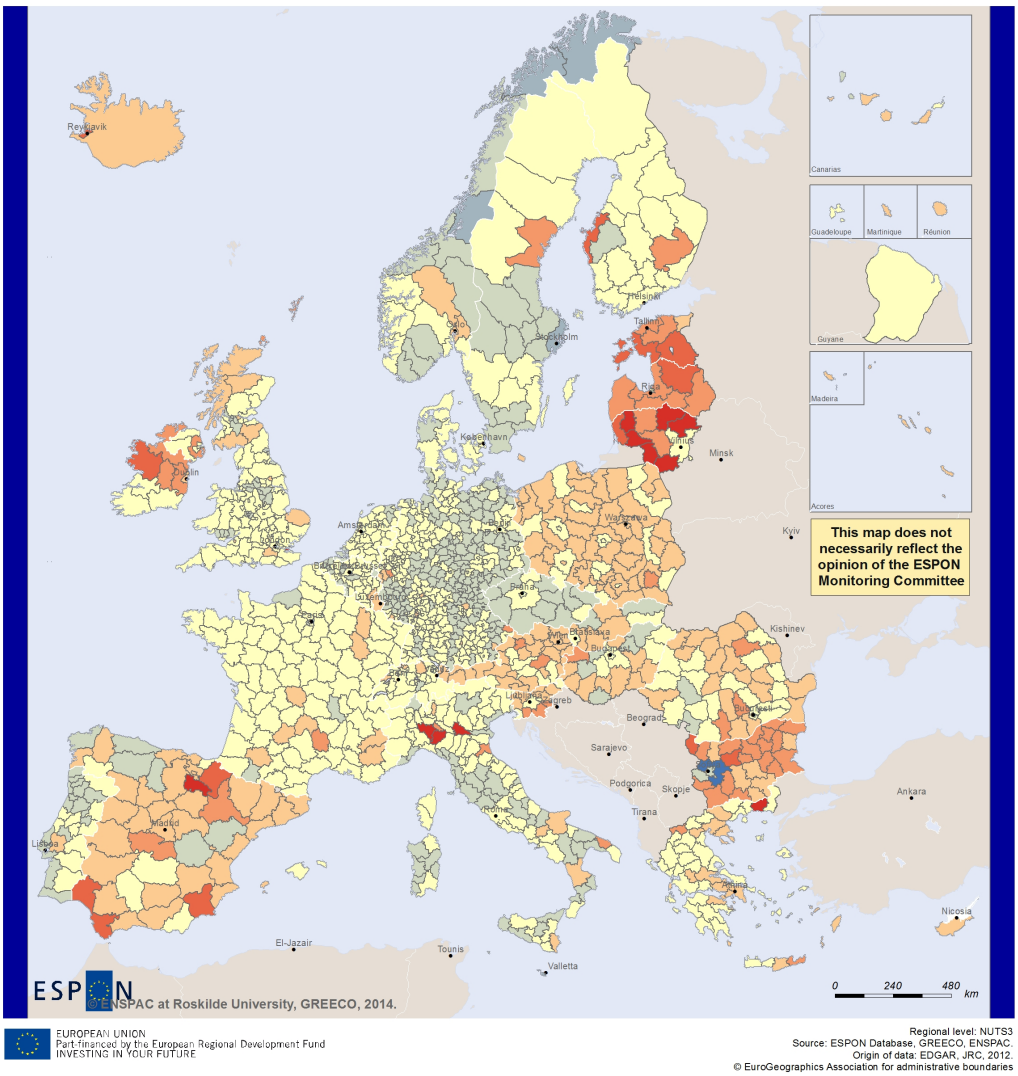
Map 4 also shows that despite high growth rates across Europe until 2008, the annual change of GHG emissions remained within the interval between +1% and -1% per year in most countries.

The spatial predictions from the EDGAR database are regionalised to the NUTS3 level. Based on these estimates the predicted change in the 1990s and the 2000s are shown in map 5.



Map 5. Expected regional pattern in annual change in CO_2-emissions from fossil fuel combustion excluding transport. 2000-08. Per cent.

Sources: Authors' calculations based on the EDGAR database (JRC, 2012).



Map 6. Expected regional pattern in annual change in CO_2-emissions from fossil fuel combustion excluding maritime and air transport, but including ground transport. 2000-08. Per cent.

Sources: Authors' calculations based on the EDGAR database (JRC, 2012).

Map 5 and map 6 show how the emission growth rates of map 3 and map 4 could be expected to unfold by NUTS3 regions. The EDGAR-project gridding of national emission figures were based on regional economic statistics and transport route and road network statistics. The gridded data have been aggregated to the NUTS3 territorial level.

In the 1990s GHG emissions were reduced in Germany and the United Kingdom and what became the new member-states. In Spain, Portugal, Greece, Ireland, Iceland, Cyprus and Malta

they were increasing, whereas in the rest of the countries the rate of change were between 1% and -1% cf map 4. In 2000-08 the changes were less significant in either direction.

The gridding methodology, however, ignores the changes caused by more general shifts in industrial structure and energy sources by region. Thus the changes in emissions expected according to the methodology applied by the EDGAR project are quite similar in all or most NUTS3 regions within the same country.

As shown in map 5 different regions within the same country can be expected to differ by changes in emissions. It is because some regions are growth regions and some are regions in decline. In some regions energy intensive plants are retired, whereas in other regions they are established. These changes are reflected in the surrogate variables.

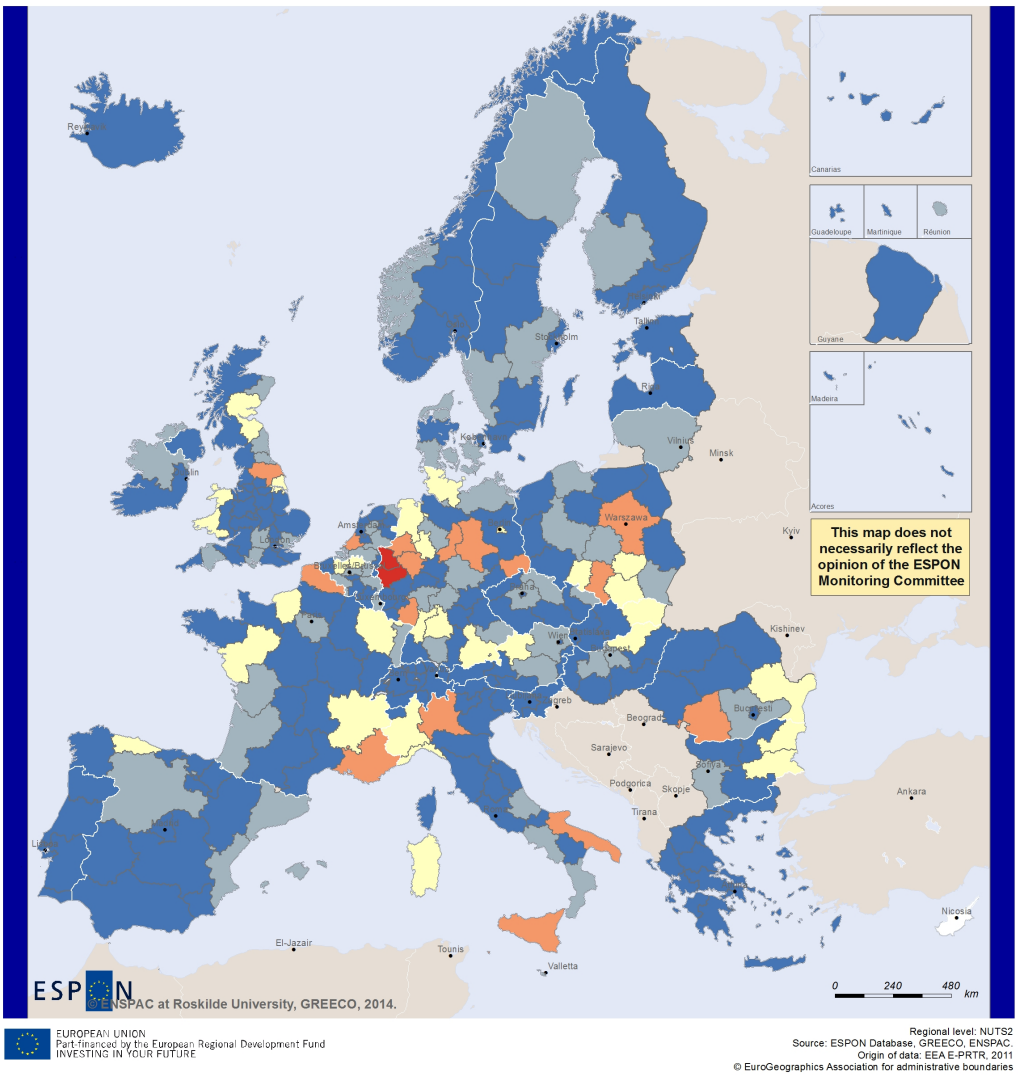
It is, however, important to note that the regional patterns of emissions are not observed or based on actual fossil energy combustion but only the emissions one would *expect* to find *if* these data were collected and processed. Consequently, the data are of little use for monitoring, performance measuring or even target setting. A region can only reduce these emission data relative to those at the national level by inducing its citizens and firms to migrate to other regions.

To the extent that emission growth actually follows production growth as assumed in generating the EDGAR database, it is important to distinguish between emission reductions that take place alongside with economic development and reductions that follow from economic recession. The latter are not necessarily durable, that is, the emission reduction may be reversed as the economy reassumes growth.

Regionalised ETS CO_2-emissions

The E-PRTR database includes reported CO_2-emissions for large point sources since 2005 (incomplete compared to national reporting). The large point source emissions of CO_2 are regulated by the EU emission trading system (ETS). In principle, it includes all plants with a fossil fuel boiler with a capacity of more than 20MW in. Their emissions are reported to the E-PRTR database of the European Environmental Agency (EEA).

Based on these data, it is possible to study the regional distribution of these large point source emissions.



Map 7. Share of ETS CO_2-emissions by NUTS2 region, 2011. Per cent.

Source: Author's calculations based on the EEA E-PRTR database (European Environment Agency (EEA), 2013).

The emissions of CO_2 from the large point sources regulated by the ETS are not evenly distributed across the European map. Some regions have the potentials of becoming global leaders of the transformation of large point source econosphere whereas other regions only have diffuse sources. 18.5% of the reported point source emissions in 2011 came from the three regions, Düsseldorf (DE), Cologne (DE) and Puglia (IT) (the darkest blue on map 7). Another 16.6% were emitted from the 7 regions Münster and Arnsberg (DE), Slaskie and Mazowieckie (PL), Zuid-Holland (NL), Lombardia (IT) and North Yorkshire (UK) (the slightly lighter shade of blue on map 7). Another 13.6% were reported from the 8 regions of Sicily (IT), Dresden, Braunschweig, Rheinhessen-Pfalz and Sachsen-Anhalt (DE), Nord - Pas-de-

Calais and Provence-Alpes-Côte d'Azur (FR) and Sud-Vest Oltenia (RO) (the still lighter shade of blue on map 7).

Almost half of the point source emissions from the ETS area in 2011 came from fossil fuel combustion in these 18 regions. The local governments of the 18 regions do not control the solutions to the problem of transformation. They are mainly controlled by the EU and national governments. The challenge of transformation to a green economy, however, is markedly different to these regions than to regions with no point sources.

Final remarks

The spatial distribution of non-transport emissions from the EDGAR database is based on surrogate variables that to varying degrees can be expected to reflect fossil fuel use. The resulting predictions of NUTS3 level emission rates are consequently subject to wide uncertainties and should be interpreted with caution. In particular, they are unable to reflect the performance of individual regions beyond the national trend in the transformation towards a low carbon economy. Such changes are not reflected in the spatial distribution of the surrogate variables.

The available spatially distributed emissions data do, however, indicate the wide differences between the per capita emissions of the regions. The regions face very different challenges even within the same countries. National and local governments as well as regional policy institutions are engaged in securing progress in the economic and social dimensions alongside with the transformation to a low carbon and resource efficient economy. These efforts would gain significantly from a credible statistical basis on the production and use of fossil fuels – and thus the CO_2-emissions - at regional or municipal levels.

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