Where does the CO_2 come from?

Introduction

This paper analyses the modelled data for CO_2 emissions produced by the National Atmospheric Emissions Inventory (NAEI) to determine the principal sources of CO_2 in the Pembrokeshire Coast National Park and the surrounding area, and the distribution of those sources.

Method

The data source for this investigation is the mapped atmospheric emissions data published by the NAEI. The NAEI is funded by Defra, The National Assembly for Wales, The Scottish Executive and The Department of Environment, Northern Ireland. The NAEI compiles estimates of emissions to the atmosphere from UK sources such as cars, trucks, power stations and industrial plant. These emissions are estimated to help to find ways of reducing the impact of human activities on the environment and our health.

The data are modelled estimates of emissions of CO_2 for a one kilometre square resolution grid covering the whole of the UK, therefore they provide a high degree of geographic detail and allow analysis of emissions even for small areas such as the Pembrokeshire Coast National Park. The estimates are based on an emissions factor (e.g. the amount of CO_2 produced per tonne of coal), multiplied by the activity rate in the one km^2 grid square (e.g. the amount of activity that involves burning coal). A detailed statement of the method used can be found in the document *NAEI UK Emission Mapping Methodology 2003*[1].

The data are estimates for 2004, published in the inventory year 2004[2]. The data were downloaded from the NAEI website on 8 March 2007 as ArcInfo export grid (E00) files. These were then converted to raster coverages in ArcView 9.1, and the area covering southwest Wales extracted from the complete UK data using ArcView's ExportData function.

The gridded emissions data were used to calculate zonal statistics for the counties of Carmarthenshire, Ceredigion and Pembrokeshire, the Pembrokeshire Coast National Park, the area of Pembrokeshire outside the National Park, and a coastal area surrounding Pembrokeshire (see map 1) using ArcGIS Spatial Analyst. The boundaries for the National Park and the area of Pembrokeshire outside the National Park were generalised from the original detailed datasets by node thinning to a node every 50 metres. The

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[1] Available from http://www.naei.org.uk/report_link.php?report_id=407

[2] The National Atmospheric Emissions Inventory (NAEI) for the United Kingdom presents emissions from 1970 onwards. Each year the time series of emissions is extended by one year. Historic data may also be revised depending on revisions in the:

1. methods used to produce the emission estimates
2. emission factors used (for example, kg of CO2 released per tonne of coal burnt)
3. activity data used (for example, the estimate of distances driven by vehicles on UK roads)

This means that data presented for a certain year in the most current inventory may differ from that presented for the same year in previous editions.

boundary of the coastal area surrounding Pembrokeshire inherits the generalised coastal edge of the National Park and outside National Park areas, and has an arbitrary offshore edge to include the offshore extent of the NAEI data. It should be noted that the 1km grid size means that many grid squares overlap the boundaries of the analysis areas and therefore the zonal statistics will represent, albeit close, approximations to what would be the true modelled estimate for the areas.

Map 1: Analysis zones

The area of each of the zones used in analysis were calculated from boundary files using MapInfo. The total length of roads in each zone were calculated from Ordnance Survey ITN data using MapInfo. The number of households in each zone is that given by the 2001 Census[3] (number of household spaces with residents) as is the number of manufacturing jobs (number of people aged 16-74 employed in manufacturing). These variables are presented in table 1.

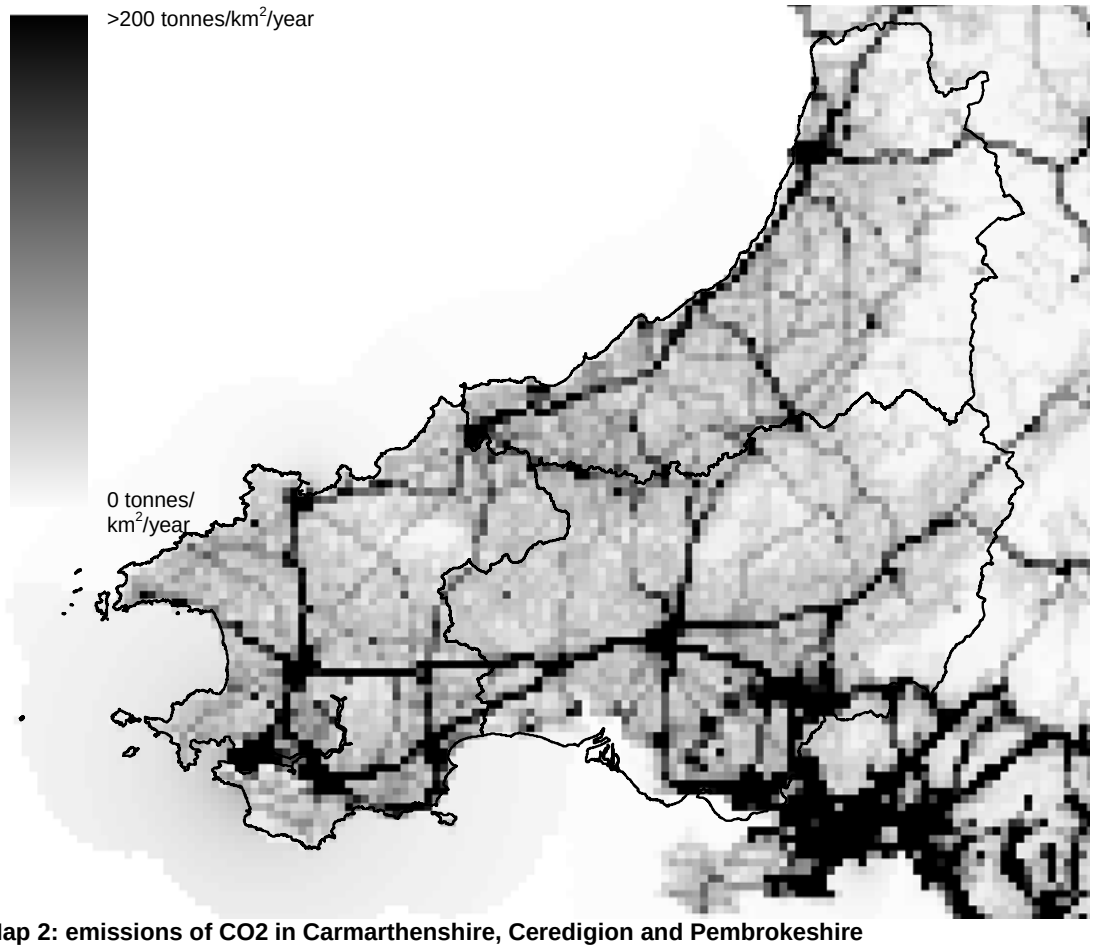
[3] Census 2001: CD supplement to the National report for England and Wales and Key Statistics fo local authorities in England and Wales. February 2004

Zone	Area (km^2)	Total length of roads	Number of households	Number of manufacturing jobs
Pembrokeshire county	1,650	2,678	48,176	4,835
Pembrokeshire Coast National Park	609	775	9,862	854
Pembrokeshire outside the National Park	1,040	1,905	38,314	3,981
Carmarthenshire county	2,439	4,171	73,112	9,213
Ceredigion county	1,806	2,254	30,972	2,332

Table 1: characteristics of analysis zones

Results

Maps 2 shows the distribution of total CO_2 emissions from all sources, other than point sources, in southwest Wales.



Map 2: emissions of CO2 in Carmarthenshire, Ceredigion and Pembrokeshire

Chart 1 shows the CO_2 emissions from all sectors, excluding point sources, per square kilometre of the analysis zone. Chart 2 shows the percentage contribution of each principal sector in each analysis zone.

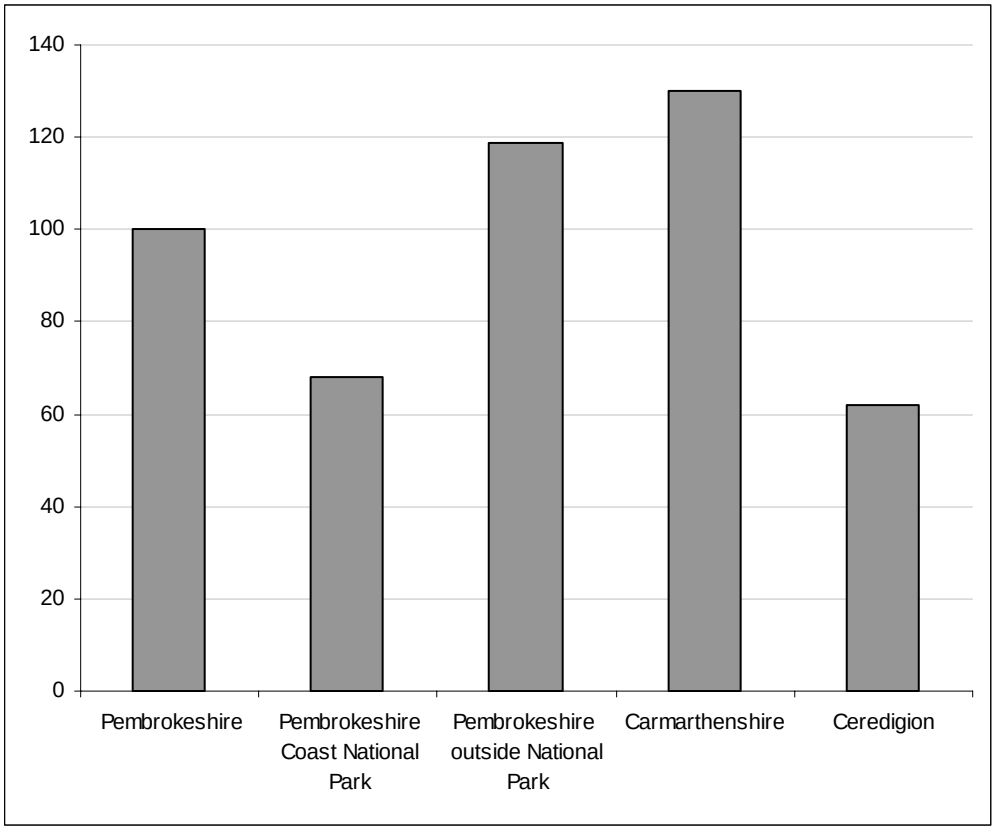


Chart 1: total emissions, excluding point sources, tonnes of carbon per km^2

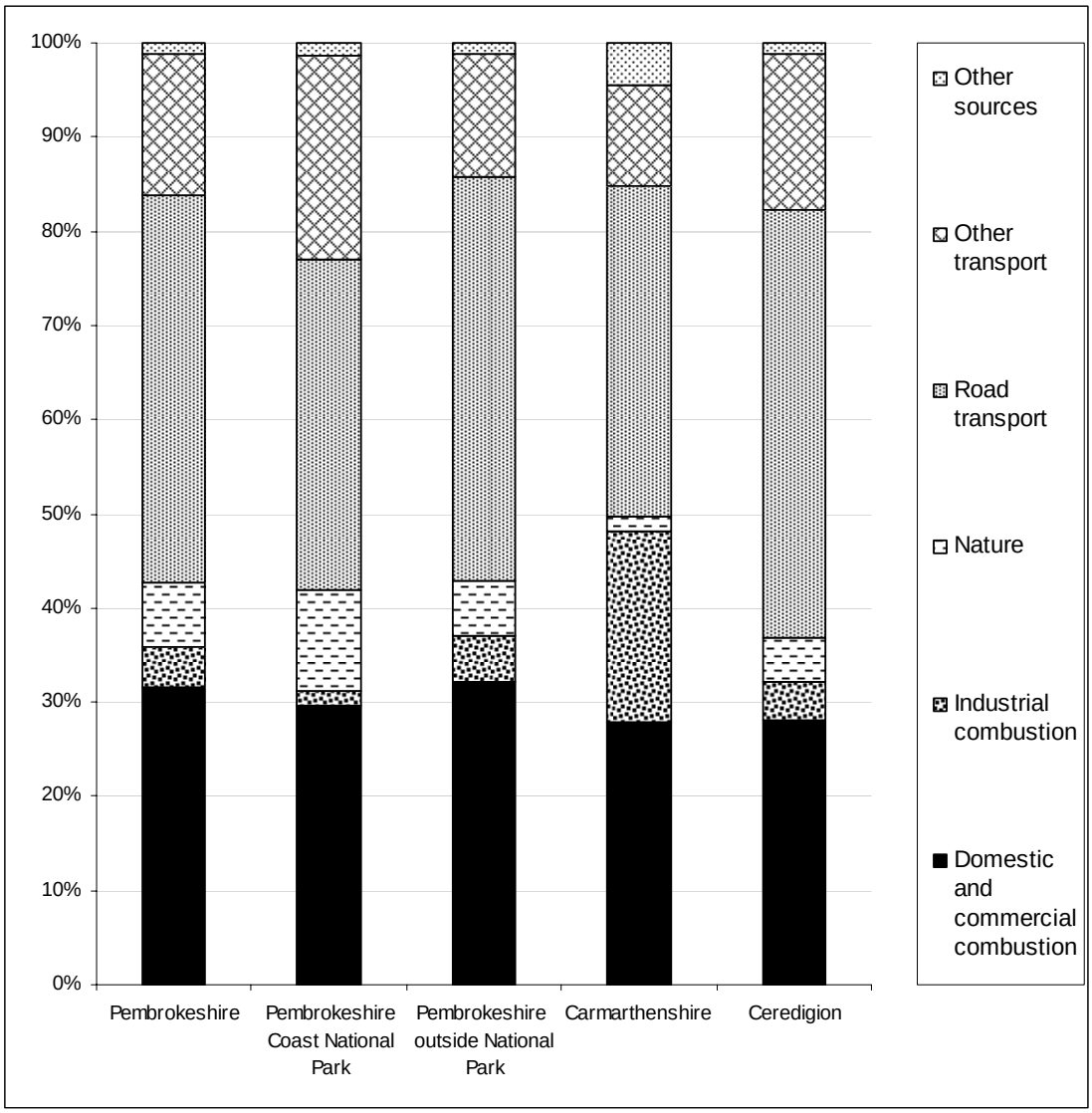


Chart 2: percentage contribution from emission sectors

The main contributing sectors for CO_2 in the National Park are domestic and commercial combustion; industrial combustion; nature; road transport; and other forms of transport. These are now considered in turn. Care should be taken in the interpretation of the maps as the shading scale is not consistent across the maps, it has been selected to show the variation within the map for each sector, not that between the sectors.

Domestic and commercial combustion

This sector covers the atmospheric emission produce by combustion in domestic, commercial, institutional and agricultural boilers or generators, for heat or local electricity production. It does not include emissions from centrally generated electricity. Emissions of CO_2 from domestic and commercial combustion per household are shown for each of the analysis zones in chart 3. The distribution of domestic and commercial CO_2 emissions in Pembrokeshire is shown in map 3.

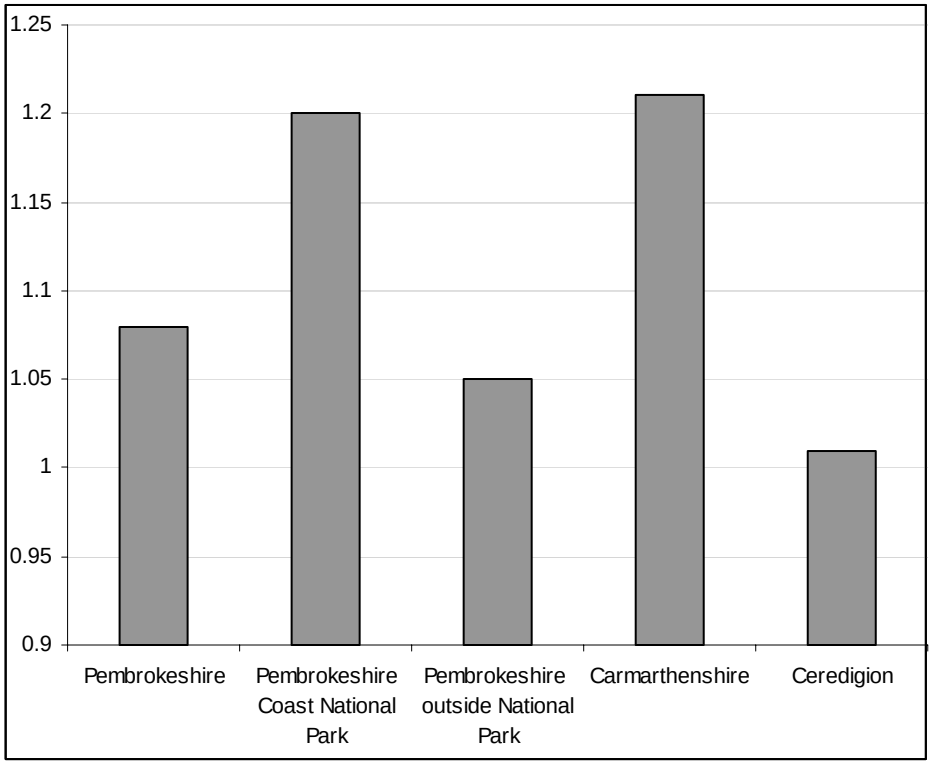
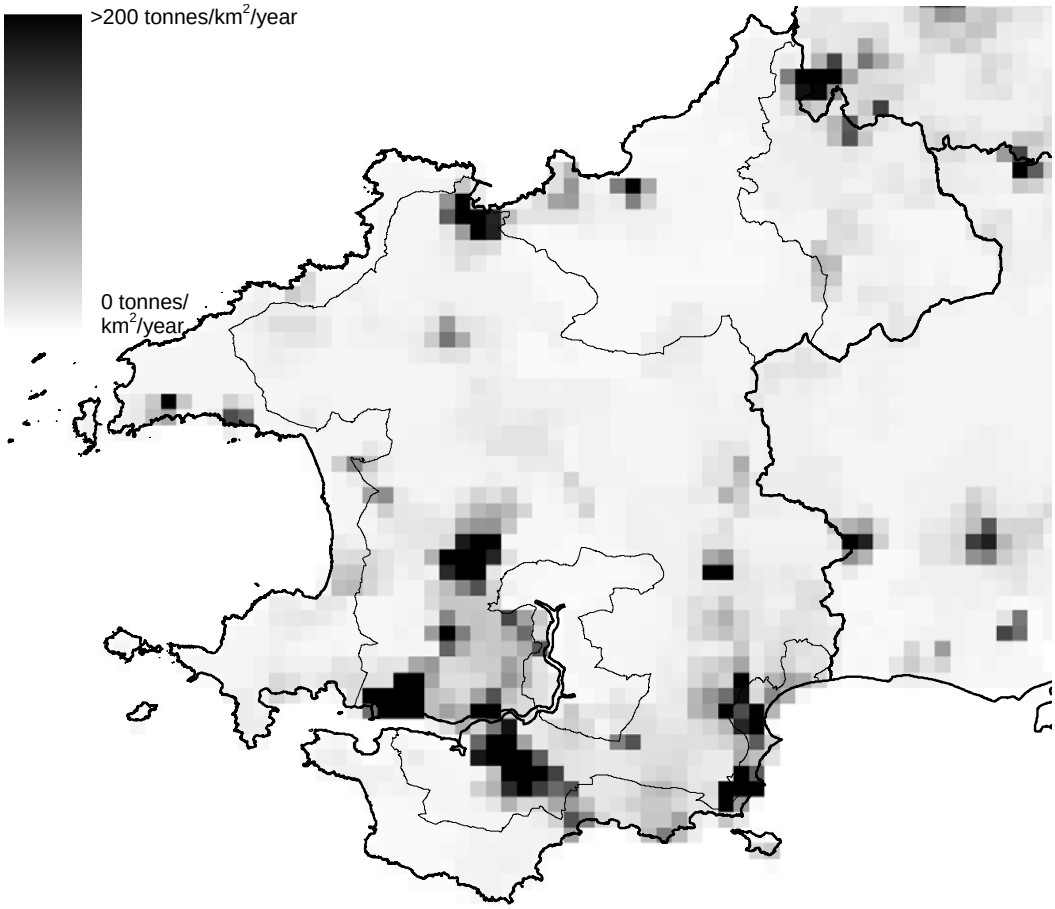


Chart 3: emissions of CO_2 from domestic and commercial combustion, tonnes of carbon per resident household



Map 3: the distribution of CO_2 emissions from domestic and commercial combustion in Pembrokeshire

As might be expected map 3 shows that domestic and commercial combustion CO_2 emissions match the settlement pattern in Pembrokeshire (population density is an input into the model for this emissions source). Chart shows relatively high rates of emission per resident household in the National Park, reasons for this may be the high numbers of second/ holiday homes, or the amount of tourist accommodation.

Industrial combustion

This sector includes emissions due to local combustion for heating and electricity in industrial premises and combustion during manufacturing processes. The amount of CO_2 emitted per person employed in manufacturing at the 2001 Census is shown in chart 4, the distribution of emissions from industrial combustion is shown in map 4.

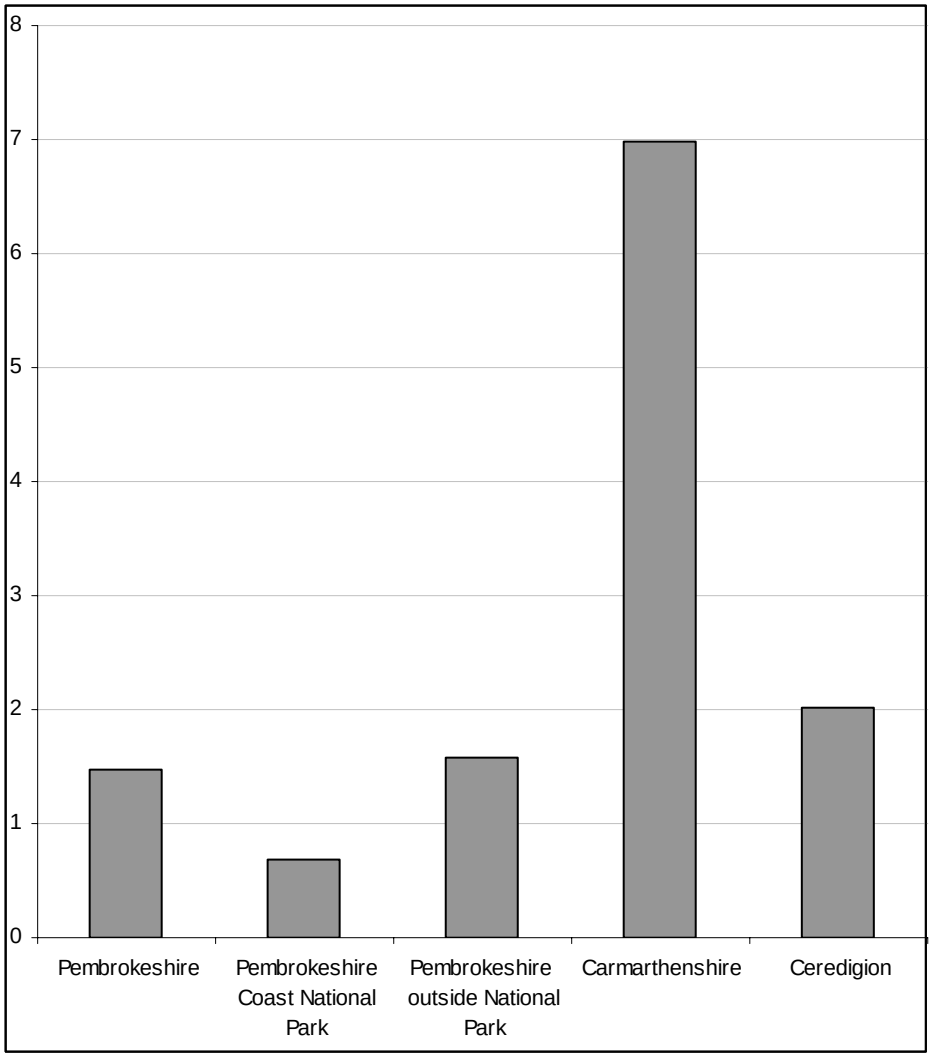
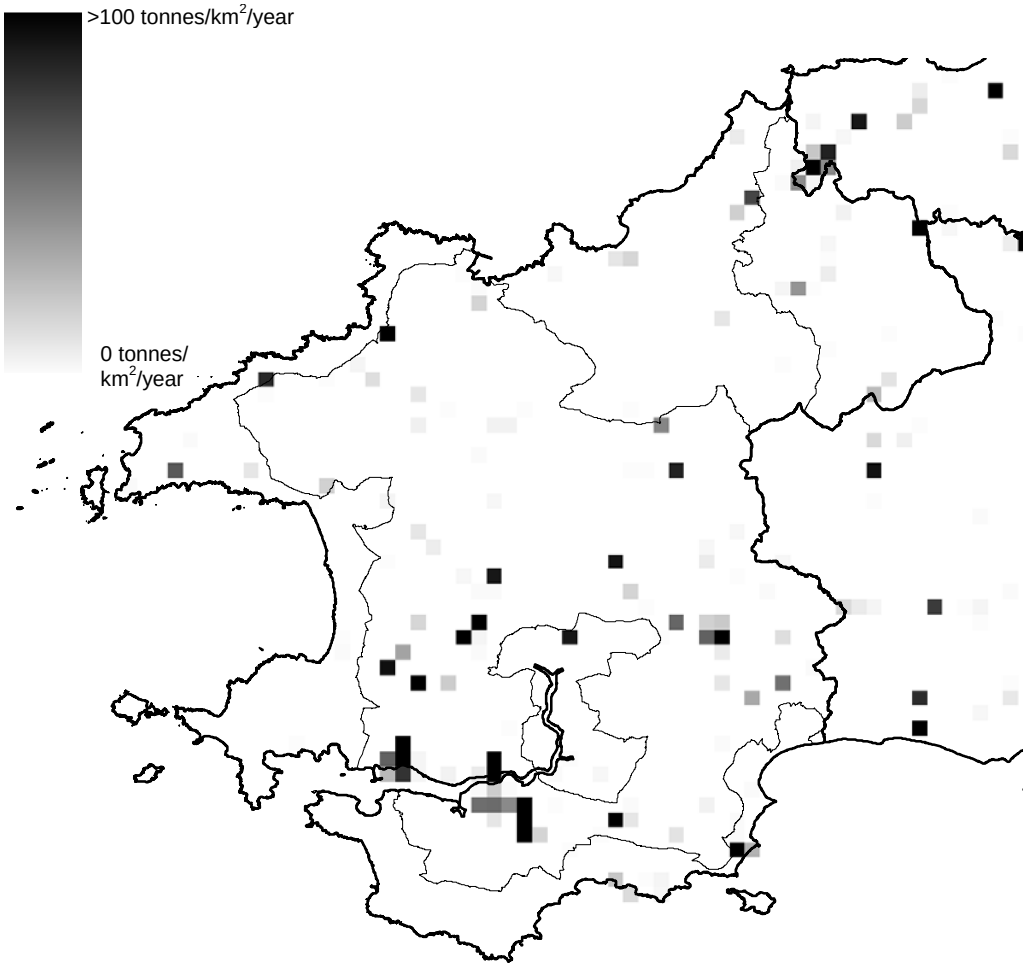


Chart 4: emissions of CO_2 from industrial combustion, tonnes of carbon per person employed in manufacturing



Map 4: the distribution of CO_2 emissions from industrial combustion in Pembrokeshire

Nature

This sector covers the emissions from different types of natural and semi-natural land cover. It also includes the emissions resulting from landuse/cover changes such as deforestation. Chart 5 shows natural emissions per km^2 for each analysis zone and map 5 shows the distribution of natural emissions.

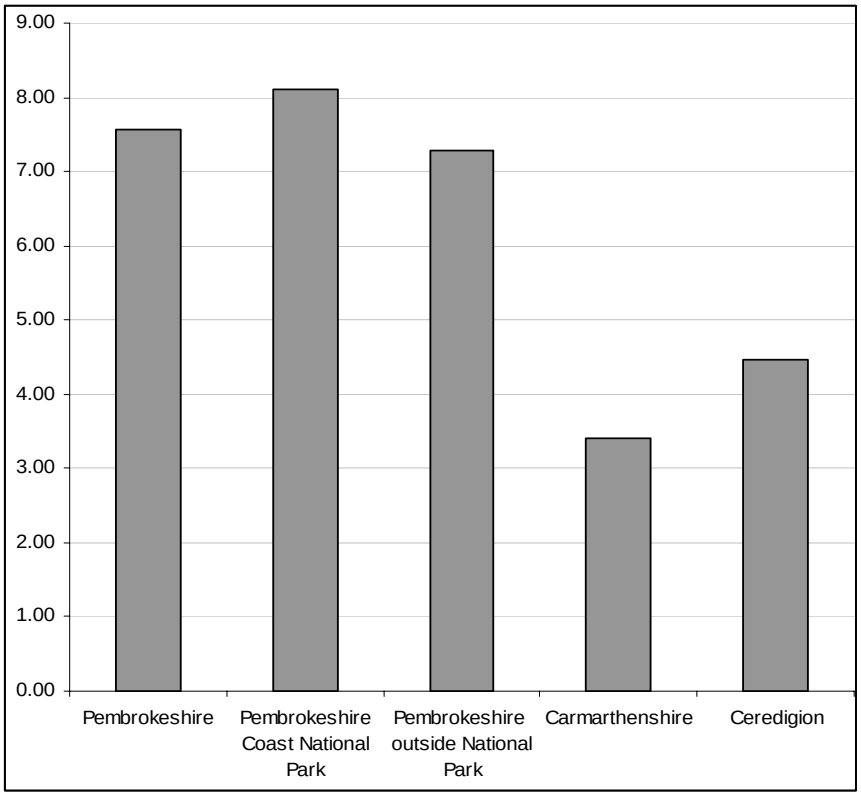
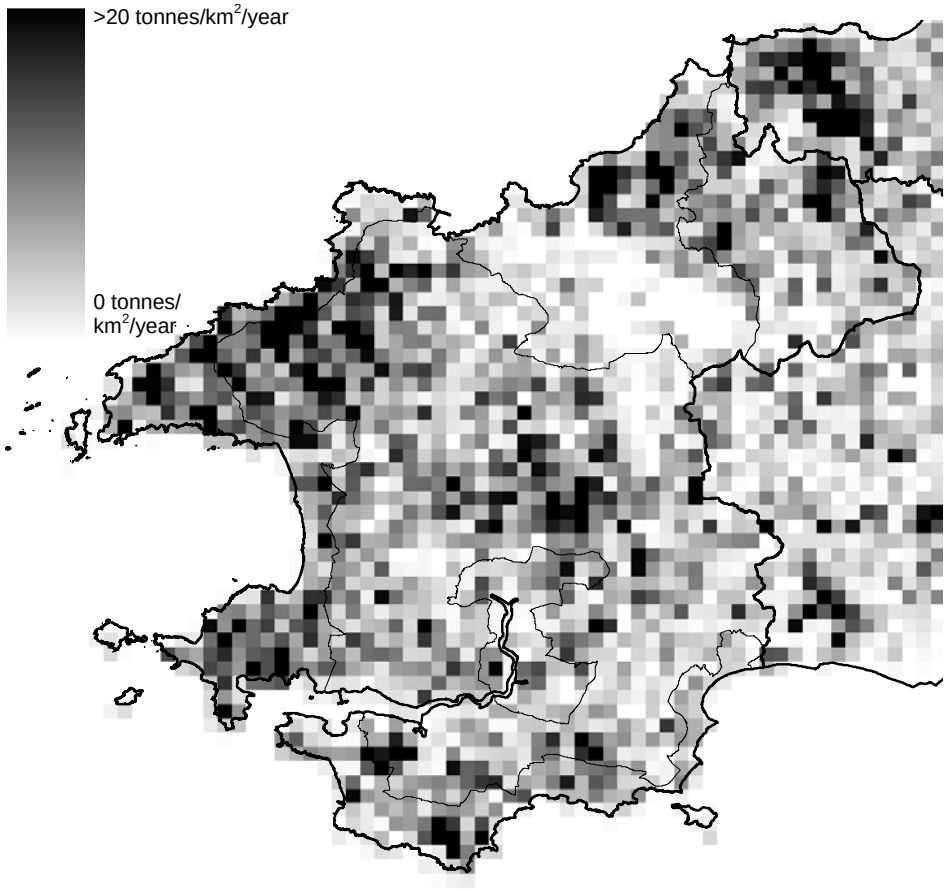


Chart 5: mean emissions of CO_2 from natural sources, tonnes of carbon per km^2 grid cell containing data (the Pembrokeshire Coast National Park, Carmarthenshire and Ceredigion analysis zones each have a significant number of cells will no data)



Map 5: the distribution of CO_2 emissions from natural sources in Pembrokeshire (n.b. many of the cells covering the high ground of Mynydd Preseli and Carningli contain no data)

Road transport

This sector covers all road transportation, including passenger cars and motorcycles and goods vehicles. Chart 6 shows the road transport emissions per kilometre of road, map 6 shows the distribution of road transport emissions.

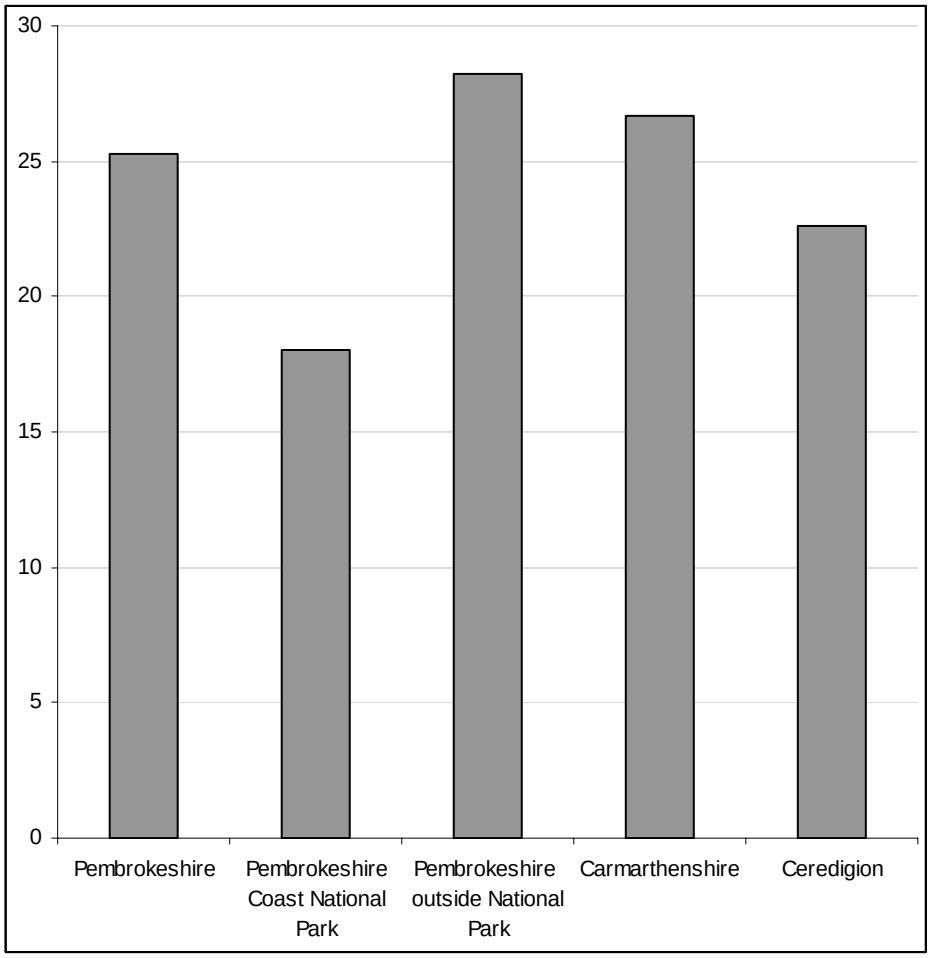
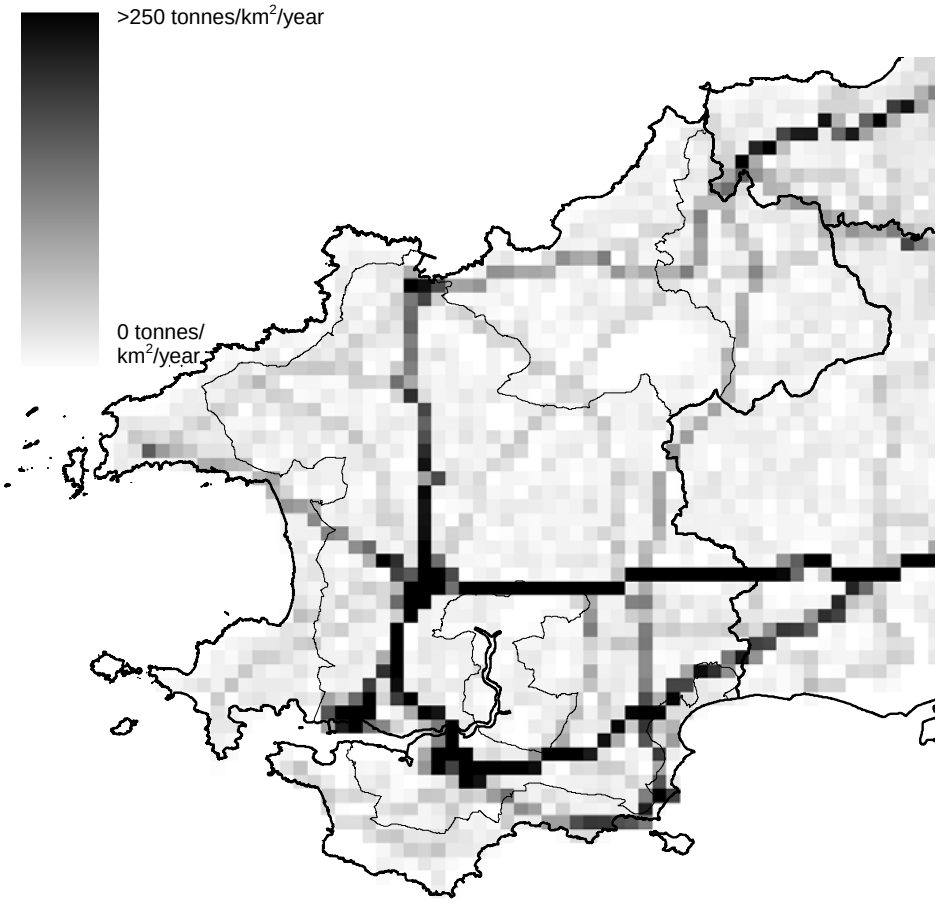


Chart 6: emissions of CO_2 from road transport, tonnes of carbon per kilometre of road



Map 6: the distribution of CO_2 emissions from road transport in Pembrokeshire

Other transport / the offshore area

This sector includes emissions from aviation, railways, shipping, military off-road transport and mobile machinery. Chart 7 shows emissions from other transport per km^2, map 7 shows the distribution of other transport emissions.

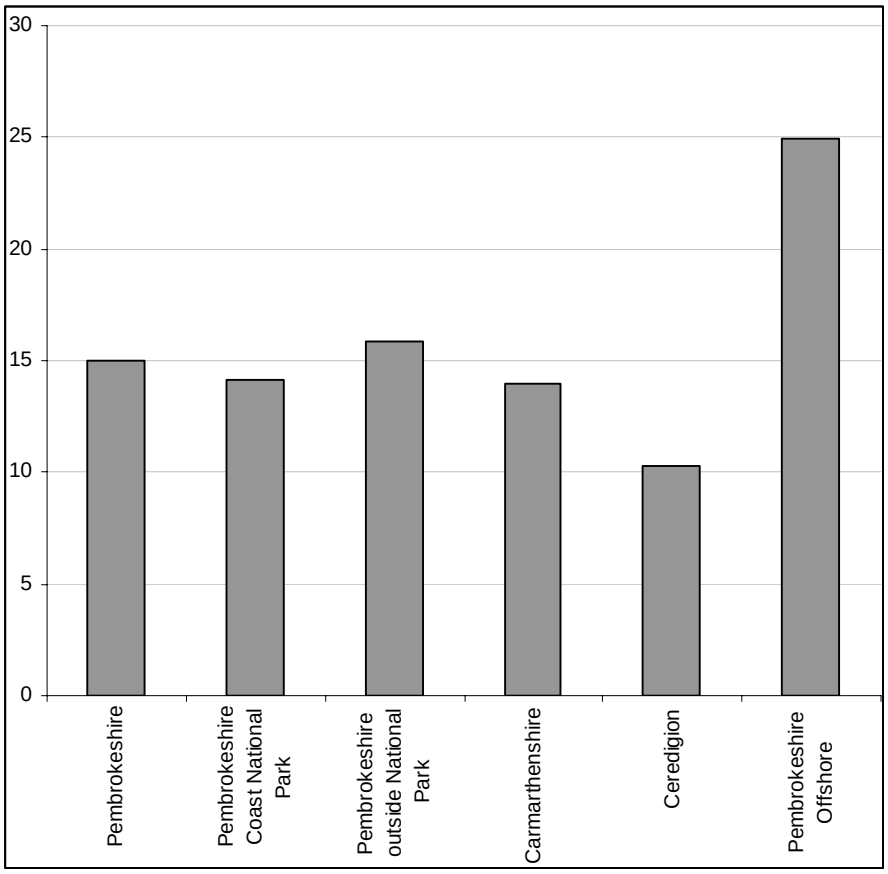
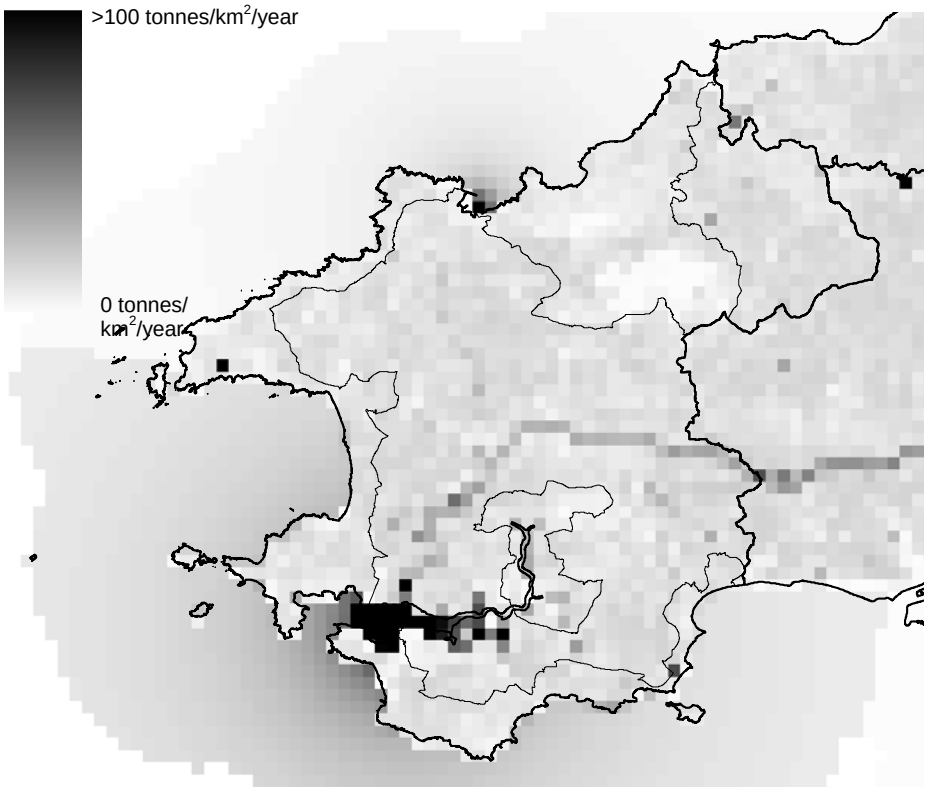


Chart 7: emissions of CO_2 from other transport, tonnes of carbon per km^2



Map 7: the distribution of CO_2 emissions from other transport sources in Pembrokeshire and offshore

Point sources

There are two point sources of CO_2 in Pembrokeshire included in the NEAI data. They are the oil refinery at Robeston West near Milford Haven, emitting an estimated 308,253 tonnes of Carbon in the form of CO_2 annually, and the refinery at Rhoscrowther near Pembroke, emitting an estimated 180,982 tonnes. The location of these points is shown on map 8. These point sources represent large emissions sources, to put them in context, the total emissions of CO_2 for Pembrokeshire excluding these point sources amounts to around 165,000 tonnes of Carbon.

Map 8: point sources of CO_2

Discussion & conclusions

In the Pembrokeshire Coast National Park, as in Pembrokeshire as a whole, the dominant sources of CO_2 are road transport and combustion in domestic and commercial premises. Other forms of transport and natural sources are also significant in the National Park. The relatively high emissions from other transport sources offshore is likely to be due to shipping activity around Milford Haven and indicates the importance of shipping as a source of CO_2. Though the two refinery point sources emit about four times the amount of CO_2 as all sources in the rest of Pembrokeshire, it should be remembered that these facilities provide fuel and other petrochemical products for national

consumption and therefore their contribution of CO_2 should be viewed in this context.

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