CHAPTER 9

Urban Sprawl and Climate Change: a Statistical Exploration of Cause and Effect, with Policy Options for the EU

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Summary

This study provides a brief evaluation of the relationship between trends in transport emissions and urban land-use. It concludes that the growth of transport emissions is a result of specific urban planning and land use policies (or their absence). These policies can cause an increase in transport emissions even if the population size remains the same and there is no economic growth. This implies that governments need to implement sensible land-use policies. Such policies may not be very visible, but they have a huge impact on transport emissions.

Finally, the study outlines a few possible measures that could control transport emissions by addressing land-use issues. It explores ideas related to benchmarks, mandatory plans and the possibility of using the concept of emissions trading in connection with land-uses causing transport emissions.

Key Words: urban sprawl, land use, climate change, transport GHG emissions

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1. CAUSES IN THE GROWTH OF TRANSPORT EMISSIONS — A STATISTICAL ANALYSIS

In 2005, transport emissions accounted for around 20 percent of all greenhouse gas (GHG) emissions in the EU-25. Road transport is responsible for 93 percent of all transport emissions (excluding international aviation and maritime transport), emitting about 900 million tons of CO_2 in the EU-27 in 2005. This is equal to almost half the amount of emissions covered by the EU Emissions Trading Scheme (ETS). Urban transport accounts for half of these emissions, a volume nearly equivalent to Germany's allowable annual emissions under the EU ETS.

Since 1990 transport emissions have increased by one-fifth in the EU-15, which is the largest increase among all emitting sectors. The trend in both the absolute and relative increase of transport emissions is not expected to change in the future. According to the EEA, by 2010 EU-15 greenhouse gas emissions from transport are projected to increase from the current 126 percent of 1990 levels to 135 percent if only existing policies and measures are used. Even with the recently adopted fleet average limit of 120 g CO_2/km for passenger car emissions, transport emissions would still increase an additional 27 percent over 1990 levels (EEA 2006).

The immediate cause of the phenomenal growth of transport emissions is clear: *a) People are travelling more and more* in general, and especially more on roads. In the EU-25, the number of road-passenger kilometres increased 26 percent between 1990 and 2000, i.e. much higher than the 20 percent increase in GDP in this period (OECD 2007). The number of cars has also increased by 35 percent in this period, approaching an average of 4 cars to 10 people in the EU-15. *b) Demand for the transportation of goods* (responsible for about a third of transport emissions) increased even faster in the same period, with the number of road-freight tonne kilometres growing by 36 percent (ibid.). This strong increase is somewhat mitigated by increased efficiency in fuel use, as CO_2 emissions from road transport have only increased by 18 percent.

The question then arises: what causes the increase in the transportation of passengers and goods? The current paper will look at the development of different general factors in EU Member States for the 10-year period between 1990 and 2000, and will assess their impact on road transport emissions through statistical analysis. Further, the analysis aims to determine a) whether there is a meaningful correlation between a particular indicator and road transport CO_2 emissions; and b) whether it is possible to establish a clear cause-and-effect relationship between this indicator and road transport CO_2 emissions. The analysis will cover population, gross domestic product (GDP) and the size of the area covered by human constructions, including buildings, roads and paved-over lots.

Technological improvements in vehicle efficiency are not considered as they are known to show a gradual and steady increase that is largely uniform in all Member States, and thus are unlikely to have a strong explanatory power (EEA 2009). The analysis will be restricted to road transport, leaving aside aviation, rail transport and shipping, together responsible for about than 30% of transport emissions[1]. Although growing fast, these transport modes are not yet much used in passenger commuting or in retail freight, and the relationship of their emissions to changes in the land area covered by buildings and roads is probably not relevant.

The analysis focuses on the relationship between changes in the above-mentioned variables and changes in road transport emissions for EU Member States where data is available. A simple linear multiple regression analysis is used to determine the correlation between the change in population, gross domestic product and artificial land area and the change in road emissions between 1990 and 2000. The method of analysis assumes that the same relationship holds true for all countries in Europe. The data analysed was expressed in terms of percentage change, so that the effect of the size of the countries would not appear in the analysis. The data used for the analysis is presented below (all graphs in the text are based on this dataset).

The analysis shows that the three variables explain to a considerable degree the variation in the increase in road transport emissions. The R^2 of the linear regression is 85.1%, the adjusted R^2 is 80.6%, and artificial land and per capita GDP variables are significant variables. Results of the analysis are presented in more detail below. If the insignificant population variable is left out of the regression, the R^2 is 84.7.4% and the adjusted R^2 is 82.0%

[1]This figure includes international aviation, and international shipping emissions (source: EEA GHG Data Viewer, www.eea.org).

TABLE 1
Change of Road Transport CO_2 Emissions and Possible Explanatory Variables Between 1990 and 2000 for Selected EU Member States

	Percentage Change Between 1990 and 2000			
Country	**Road transport CO_2 Emissions[1]**	**Artificial Areas[2]**	**Per Capita GDP[3]**	**Population[4]**
Austria	37.92%	3.06%	22.98%	5.08%
Belgium	20.85%	2.78%	*20.32%	2.85%
Denmark	15.77%	4.31%	24.42%	3.86%
France	17.80%	4.84%	16.42%	4.13%
Germany	10.57%	5.80%	18.90%	†2.72%
Greece	25.68%	13.82%	*19.34%	8.21%
Hungary	6.04%	1.51%	†24.20%	-1.57%
Ireland	106.30%	30.67%	*82.99%	8.19%
Italy	17.65%	6.13%	16.58%	0.80%
Netherlands	24.46%	22.42%	28.21%	6.52%
Poland	11.60%	1.44%	*44.09%	0.59%
Portugal	85.20%	38.64%	*29.92%	3.61%
Spain	46.45%	25.14%	*27.69%	3.64%
United Kingdom	6.42%	1.87%	24.83%	2.88%
Total of these countries	**18.59%**	**6.62%**	**26.82%**	**2.86%**

*using OECD's estimate for 1990 per capita GDP value; †using 1991 value instead of 1990

[1]Based on data from OECD and the European Environmental Agency

[2]CORINE Land Cover Database (European Environmental Agency)

[3]Real gross domestic product (expenditure approach), per head, US $, constant exchange rates (source: OECD)

[4](source: OECD)

1.1 Population

As more people travel more and also demand a greater quantity of products to be transported, there is a clear cause-and-effect relationship between road transport CO_2 emissions and population increases. By contrast, it would not make sense to suppose that the population is growing because people and goods are travelling more.

The overall population figures are fairly stable in Europe. Between 1990 and 2000, the population of the EU-25 has increased by less than 3 percent. The variation among countries is modest, with Ireland and Greece showing an 8.2 percent increase and Hungary a 1.5 percent decrease over the period.

FIGURE 1
Comparison of Road Transport CO_2 Emissions Increase and Population Increase Between 1990 and 2000

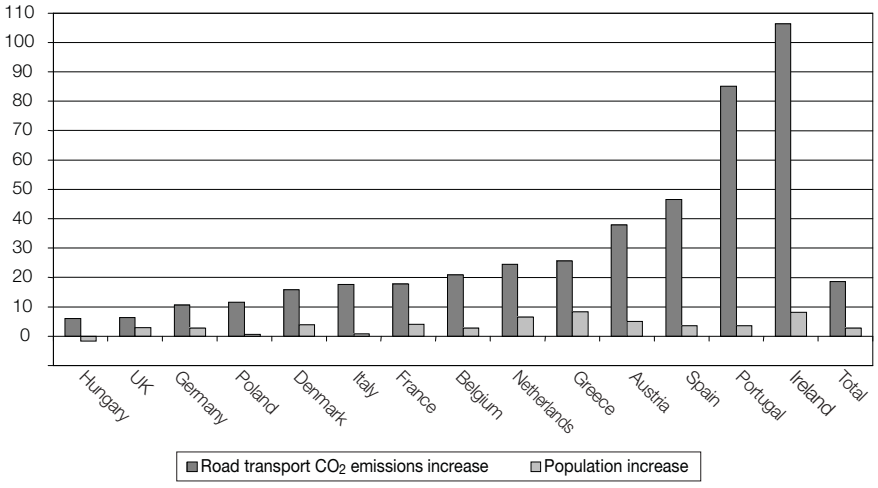


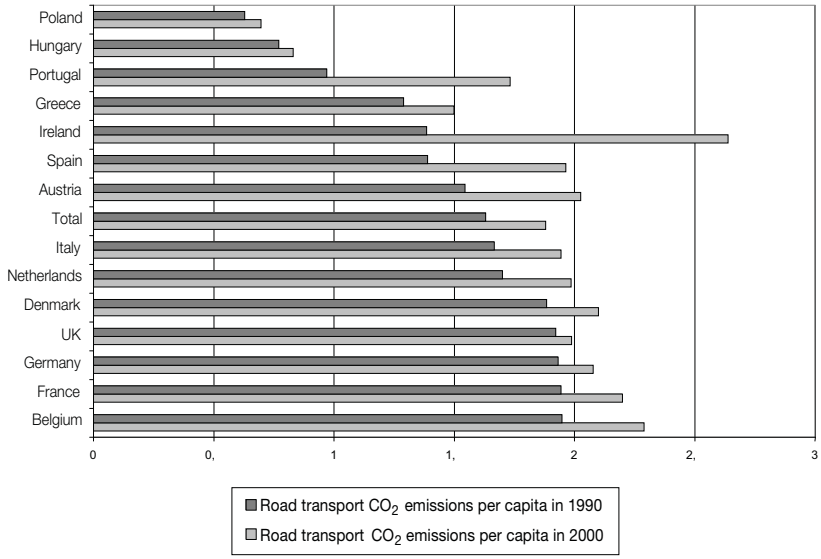
Figure 1 compares the growth of transport CO_2 emissions with population growth in selected countries. In some countries (e.g. Ireland), a higher than average population growth took place simultaneously with a strong increase of road transport-related emissions. For example, both Greece and Ireland experienced population increases of over 8 percent, but the growth of transport emissions in Greece was one-quarter of the growth seen in Ireland. At the same time, countries like Portugal and Spain have experienced an explosion in transport emissions while population increase remained slightly over the average[2]. It is also clear from multiple regression analysis that population growth in itself cannot explain the increase in transport emissions. According to the analysis, the growth of population does not contribute significantly to explaining the variance of the growth of CO_2 emissions. A multiple regression analysis of the relationship between road transport CO_2 emissions and population growth, per capita GDP growth, and increase of artificial areas yielded a t-value of 0.48 for population growth, and a p-value of 0.63.

The lack of a strong relationship between population and road transport

[2]It should be noted however that while Spain and Portugal did not experience significant overall population growth, there is a very strong urbanisation trend in these countries, i.e. people are moving to the big cities. (See: page 15, EEA Report no 10/2006). This movement in itself does not inevitably lead to increasing transport emissions — it does so probably because new urban areas are built in a sprawling, transport-intensive fashion.

CO_2 emissions is quite remarkable, as it means that roughly the same number of people are able to both travel more and consume more goods, which results in more transport emissions than before. While worrying with respect to future emissions, the lack of such a strong relationship might be viewed positively, as it could mean that it is possible to reduce transport-related CO_2 emissions without limiting the number of people.

FIGURE 2
Road Transport CO_2 Emissions Per Capita in 1990 and in 2000 (tons)



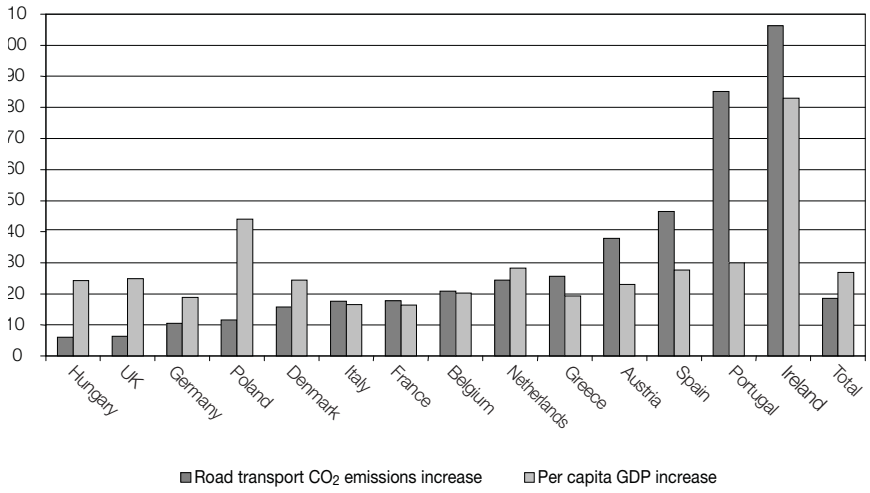
1.2 Gross Domestic Product

It is a general public assumption that the volume of transport and thus road-transport CO_2 emissions are related to GDP, i.e. the richer a country is, the more transport would take place. However, the cause-and-effect relationship between the two is not straightforward. It is sensible to suppose that people are becoming wealthier and, therefore, travel more and buy goods with a greater value (acquired through more transport). It is equally sensible to suppose that more transportation of goods and people induces a productive economy and generates more

GDP.[3] Therefore, GDP-growth and the growth of transport emissions are not necessarily in a one-way cause-and-effect relationship, but rather, may influence each other.

In the EU as a whole, transport-related CO_2-emissions have grown in tandem with per capita GDP. This statement masks great differences among Member States as to what extent GDP growth was coupled with growth in transport emissions. In some Member States the link is strong, whereas in others, it is almost non-existent. Figure 3 compares the growth of per capita GDP with the growth of road transport-related CO_2 emissions. As shown, some Member States have experienced high per capita GDP growth coupled with high growth in road transport-related CO_2 emissions (Ireland), but other Member States had enormous growth in road transport-related CO_2 emissions while per capita GDP growth was only slightly above average (Portugal, Spain). Finally, some countries attained an average per capita GDP growth with relatively little increase in road transport-related CO_2 emissions (UK, Poland, Germany).

FIGURE 3
Comparison of Road Transport CO_2 Emissions Increase and GDP Increase Between 1990 and 2000



[3]The fact that a growth in transport infrastructure investment induces economic growth has been supported by early works by e.g. Aschauer (1989), but recently several authors have refuted this claim. Crescenzi and Rodriguez-Pose (2008) have conducted an analysis of data for European countries which shows that although good infrastructure endowment is a precondition for high economic performance, additional investment in infrastructure is disconnected from economic performance.

The multiple regression analysis showed that per capita GDP contributes little to explaining the growth of CO_2 emissions. A multiple-style regression analysis of the relationship between road transport CO_2 emissions and population growth/ per capita GDP growth/ Increase of artificial areas yielded a t-value of 2.7 for per capita GDP growth, with a p-value of 0.02. If the insignificant population variable is left out of the analysis, the t-value is 2.9 and the p-value is 0.01. The coefficient of the variable is 0.6, which means that a 1% rise in per capita GDP produces less than 1% rise in transport CO_2 emissions.

This shows that road transport emissions are linked to economic growth only to some extent. If the cause and effect relationship shows that transport is a precondition of economic growth, one might conclude that the only way to limit growth of road transport emissions is to limit economic growth, which would be very difficult for any elected government to sell. A further analysis of transport-related CO_2 emissions and economic growth may reveal that some stages and types of economic growth do correlate with rising emissions while others not.

In wealthy countries where the motorway network is already built, with little space for new roads and high levels of car ownership[4], further economic growth may not necessarily be linked to greater transport volumes (UK, Sweden), and transport emissions could increase slowly over a high base level. In countries where the motorway network is in the process of being built and many people cross the wealth threshold necessary to buy a car, economic growth may be accompanied by a massive increase in transport emissions from a lower base level[5] (Portugal, Ireland). Such detailed analysis is beyond the possibilities of the present paper, however.

1.3 Increase in Areas Covered by Buildings

If population growth and economic growth cannot explain growth in transport emissions, other causes can be considered. Transport emissions increase because there is a greater quantity of passenger-kilometres and freight tonne-kilometres. The increase in these values could be a result of more passengers and goods travelling between the same destinations or of the same amount of passengers and goods travelling between destinations that are further apart from each other.

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[4]For a comparison of GDP levels and the number of vehicles, see European Environmental Agency, *Indicator fact sheet* TERM 2002 32 AC — Size of the vehicle fleet, page 7. (http://themes.eea.europa.eu/Sectors_and_activities/transport/indicators/technology/TERM32,2002/TERM_2002_32_AC_Size_of_the_vehicle_fleet.pdf)

[5]This hypothesis seems to be borne out by the fact that the land used for road networks has indeed increased by over 300 percent between 1990 and 2000 both in Portugal and Ireland, while the average increase in the EU-25 was only 21 percent (EEA Corine Land Cover Database). In this period, Ireland had much higher than average economic growth, while Portugal's growth was only average.

For both goods and people, most journeys either connect two urban areas or connect two destinations within the same urban area. No reliable statistical data is available on how much of road transport CO_2 emissions is generated in urban areas. According to the EC's Green Paper on Urban Transport,6 "Urban traffic is responsible for 40% of CO_2 emissions … arising from road transport."

It would require a very complex analysis to fully map the long-term evolution of trip-lengths and destinations for all passengers and goods. In the following, this complexity will be minimized by assuming that the increase in road transport emissions can be explained by the increase in urban areas. An increase in urban areas increases individual trip lengths, and as most newly urbanised areas are fully car-dependent with no public transport, these areas would have to lead to increased road transport emissions. This assumption is well grounded in the findings of researchers (see e.g. Camagni et al. 2002).

While this approach does not fully explain the increase in emissions that occur in interurban transport, (i.e. about 50 percent of road transport emissions), it could provide a strong explanation for the increase of emissions within urban areas, i.e. for the other half of the emissions, because of the clear cause-and-effect relationship between destinations and transport emissions. As people and goods rarely travel to an empty field in the hope that one day they will find a house, a shopping mall or a factory there, the establishment of a destination (and the road leading to it) *always* precedes the journeys that cause the CO_2 emissions. Indeed, Southworth (2001) considers the building of new roads and buildings to be a primary reason for the growth in road transport.

For analysing the increase in urban areas, the CORINE Land Cover Database was used, which uses satellite imaging to calculate the number of hectares covered with a particular land-use type. CORINE uses about twenty different land-use classes, covering different types of natural areas (forests, agriculture, wetlands, etc.) and artificial areas (continuous and discontinuous urban fabric, commercial areas, transport infrastructure areas, etc.). Data is available for 1990 and 2000 for the EU-27, except Sweden, Finland, Cyprus and Malta. To measure the increase of urban areas, CORINE's composite land-use class of artificial areas is used. This composite includes all buildings and all transport infrastructure (with the latter being overwhelmingly roads), and in this paper this group will be referred to as "artificial areas".

An EEA report[7] provides a detailed analysis of the urbanisation and sprawl trends in Europe for the 1990-2000 period. According to the report, most European regions are sprawling (i.e. urban areas are expanding much more than population growth), as new housing and commercial development is almost

[6] COM(2007) 551 final, Green Paper: Towards a new culture for urban mobility, Brussels, 25.9.2007, p. 3.

[7] Urban sprawl in Europe, the ignored challenge, EEA Report No 10/2006

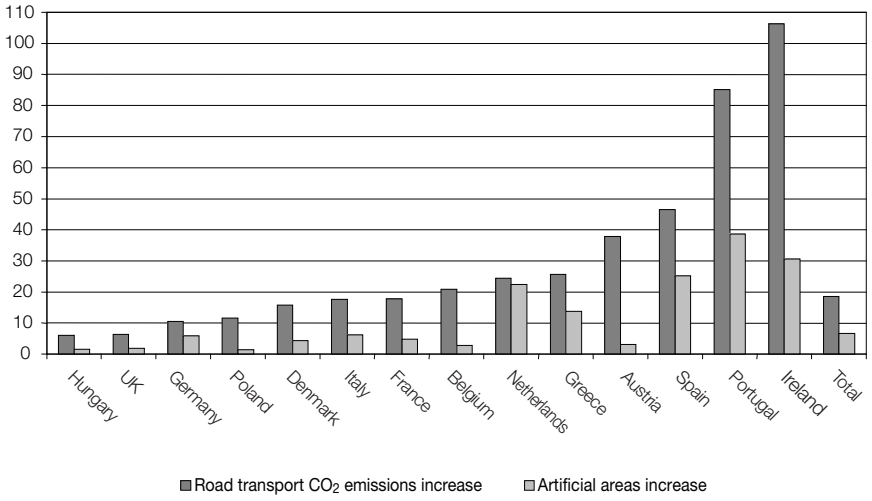
exclusively suburban and car-centric. As these areas are usually not new cities, but rather outlying appendages to existing urban areas, the inhabitants continue to use the same city centres, but reach them from further away. With the new areas usually not planned around public transport and too sparsely populated to be able to support effective public transport, the passenger car remains as the sole feasible mode of transportation. The area gobbled up by European cities between 1990 and 2000 is equivalent to the entire area of Luxembourg. The advance of artificial areas is alarmingly fast in Spain and Ireland, while the process is only beginning in the new Member States. A very important finding of the report is that sprawl is not a natural phenomenon; it can be effectively controlled with the appropriate government policies. Indeed, a study by Cameron, Lyons and Kenworthy (2004) concluded that *"a number of cities in Europe (e.g. Munich and Stockholm) and Asia (e.g. Hong Kong and Singapore) have shown that clear policy initiatives can contain the growth of urban private motorised mobility" and "in other cities such as Stockholm, the control of urban sprawl … appears to have been pivotal in reducing the growth of car use, despite strong growth in affluence and car ownership."*

The question is whether the expansion of artificial areas (in short, sprawl) can be considered as a driver of transport emissions growth. The multiple regression analysis which was conducted on the change in road transport emissions between 1990 and 2000 also included the change in the land covered by artificial areas as an explanatory variable. The result is that the relationship between the growth of artificial areas and the growth of transport CO_2 emissions is very strong, much stronger than for the other examined factors (i.e. population growth and per capita GDP growth). A multiple-style regression analysis of the relationship between road transport CO_2 emissions and population growth/ per capita GDP growth/ increase of artificial areas yielded a t-value of 4.2 for increase of artificial areas, with a p-value of 0.002. If the insignificant population variable is left out of the analysis, the t-value is 5 and the p-value is 0.0004. The coefficient of the variable is 1.6, which means that a 1% rise in artificial areas produces a greater than 1% rise in transport CO_2 emissions.

This result is in line with several studies that have found a strong link between the density and form of urban development and the amount of private car transport that the development entails (Newman and Kenworthy 1999; Handy 2005). In a particular example, Muñiz and Galindo (2005) reached a similar conclusion in their study of Barcelona when they stated that "*measures of urban form typically used (net population density and accessibility) have a greater capacity to explain municipal ecological footprints variability than other factors, such as average municipal family income and the job ratio, which leads the authors to conclude that urban form exercises a clear effect on the ecological footprint of transport.*"

Figure 4 provides a percentage comparison between the increase of artificial land and road transport emissions, as was done earlier for population and per capita GDP. The rate of sprawl experienced by individual Member States is widely divergent. It has barely started in the new Member States, while reaching dramatic proportions in Spain, Portugal and Italy. However, where sprawl is strong (e.g. artificial areas have increased by more than 5 percent from 1990 to 2000), a significant increase in road transport emissions is also found (with the exception of the Netherlands). Similarly, the increase in road transport emissions was the lowest in the countries experiencing the least degree of sprawl.

FIGURE 4
Comparison of Road Transport CO_2 Emissions Increase and Artificial Areas Increase Between 1990 and 2000



1.4 Summary

The strong correlation between increases in artificial land area and transport-related CO_2 emissions indicates that policies limiting the increase of artificial land could be effective in limiting the increase of CO_2 emissions in transport. Policies limiting land use will not necessarily restrict economic growth, for growth is not correlated to increasing the quantities of artificial land.

Sprawl is not an inevitable consequence of economic growth, but rather a result of specific government policies. The economy of the Netherlands and Portugal increased at about the same rate between 1990 and 2000, but Portugal

saw both its urban area and transport CO_2 emissions grow at triple the rate of the Netherlands. This difference can probably be best explained by different land-use policies. Another example is the UK, which had strong economic growth in this period but only limited expansion of artificial areas, probably due to its vigorous policies against sprawl. According to Couch and Karecha (2006): "*urban sprawl in Britain is brought under strong planning control and this has been particularly effective in the large northern conurbations such as Liverpool*." As the newly urbanised areas are a primary cause of increasing transport CO_2-emissions, the current insouciance of EU policies towards increasing sprawl is a dangerous position that threatens to undermine the achievements of other climate policies.

The CO_2 emission effects of unmitigated sprawl are already clearly visible in the Mediterranean Member States. For example, although under the EU burden sharing agreement Spain is allowed to increase its total greenhouse gas emissions by 15 percent compared to 1990 levels by 2008-2012 , in 2005 its total emissions stood at 50 percent over the base year. Though emissions from all sectors are growing, transport emissions have almost doubled in Spain and have increased their share in total emissions. The picture is similar in Portugal, Ireland, Greece and Italy. The Member States most affected by sprawl are among those that are furthest away from meeting their Kyoto Protocol reduction targets.[8] All these countries will now have to spend huge amounts of money on buying credits to comply with their Kyoto target. Their transport emissions, engendered by growing affluence that allows more and more people to have cars, coupled with a lack of urban planning, will be very costly to reduce.

For better or worse, Central Europe always tried to follow the development patterns of Western Europe. This seems to be the case in transport development too. Greenhouse gas emissions from transport in the new Member States have increased by 28 percent between 1990 and 2004[9], which is higher than the average increase in the EU-15. As these countries have already fulfilled their Kyoto targets, no outside pressure will limit the growth of transport CO_2 emissions in these countries until after 2012. Due to the lack of roads and money for cars, sprawl was not strong in the land use patterns of the 1990-2000 period in these countries. However, as they are in the process of passing the wealth threshold which enables nearly everyone to buy a car[10], it is expected that transport emissions and sprawl will explode in the same way as they did in the Mediterranean. With no EU-policies against sprawl, the deluge of structural and cohesion funds (a

[8] EEA 9/2006, p. 20.

[9] EEA 9/2006, p. 23.

[10] The threshold appears to be being passed in these years. Car sales in Central and Eastern Europe have increased by 13.4% between 2006 and 2007, with several countries showing growth over 25%. http://www.jato.com/Documents/PRESS%20RELEASES/Central%20and%20Eastern%20European%20car%20market%20continues%20significant%20growth%2025.9.2007.pdf

large portion of which is spent on new roads) will only exacerbate this process. According to an EEA report: "*The new Member States seem to be repeating the experience of Ireland, Portugal and Spain. Starting from a relatively low transport level, all these countries experienced strong growth in transport and its greenhouse gas emissions due to high economic growth.*"[11]

In order to prevent the further deterioration of the situation in the Mediterranean and to try to set new Member States on a more sustainable course of growth, the EU should get into the business of regulating city development and urban planning. The possible policy options are outlined in the next chapter.

2 WHAT COULD THE EU DO TO LIMIT THE GROWTH OF GREENHOUSE GAS EMISSIONS FROM TRANSPORT?

2.1 Current Policies on Reducing Transport Emissions

Existing and planned specific EU-level policies aim primarily at increasing the CO_2-efficiency of existing traffic volumes. Both the Directive 2003/30/EC on biofuels and the planned target of 120 g CO_2/km for new passenger cars by 2012[12] would bring substantial savings in transport-related CO2 emissions, but will only slow their growth and not stop the increase. The average carbon dioxide emissions of new passenger cars were reduced from 186 g CO2/km in 1995 to 163 g CO_2/km in 2004, representing a reduction of about 12 percent.[13] However, in the same period, 21 percent more cars were sold, more than offsetting the emission reductions due to increased CO_2-efficiency.[14] As nothing indicates that the trend towards a growing automobile fleet (and a parallel increase in the growth of artificial land[15]) would stop in the future, a similar offsetting of the planned policies can be expected.

The EU's Green Transport package of July 2008[16] makes an important step by providing a common framework for Member States' policies on charging for road usage by heavy lorries, and crucially, allowing the introduction of environmental

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[11] EEA 9/2006, p. 23.

[12] Commission Communication - Review of the Community Strategy to reduce CO2 emissions from passenger cars and light-commercial vehicles (7.2.2007, COM(2007)19 final)

[13] COM(2007)19 final, Impact Assessment, pp. 7, 32.

[14] EEA 9/2006, p. 47.

[15] Not surprisingly, there is a discernible correlation between the increase of the number of passenger cars and the increase of the artificial land area. In statistical terms: R^2(indicating the strength of the relationship) = 0.7 (1 means a perfect correlation, 0 means no correlation); P-value (indicating statistical significance) = 0.00000840912 (i.e. there is a 0.0008% likelihood that the correlation is "false")

[16] For a summary of the documents in the package, see: http://ec.europa.eu/transport/greening/index_en.htm

costs in the charges, something that was not possible previously. However, as the Communication[17] in the package states, "*Private transport is not covered because of subsidiarity*". In other words, the EU does not consider itself legally empowered to introduce road charging for passenger cars, a policy that could have dramatic effects on sprawl and its related emissions.

Outside actual legislation, the notion that unsustainable land-use patterns are a main cause of the increase in transport emissions does appear in policy documents, though without offering policies to address the problem. The EU's Thematic Strategy on the Urban Environment[18] (Thematic Strategy) does at one point say that "*Avoiding urban sprawl through high density and mixed-use settlement patterns offers environmental advantages regarding land use, transport and heating contributing to less resource use per capita.*[19]", but it never quite makes the link between land-use decisions and climate change. [20]

A very useful result of the Commission's work on the Thematic Strategy is the development of guidance on Sustainable Urban Transport Plans[21], which provides a wealth of information on what local governments can do to reduce CO_2 emissions from transport if they have the resources to address the issue. The Annex of the guidance[22] provides detailed policy options in the areas of land use and transport planning co-ordination, traffic calming, fostering cycling and walking, promoting public transport, road pricing, and parking management.

The Green Paper on Urban Transport is a document that is up to date with the latest thinking on the environmental impacts of car-traffic and identifies sensible policies to promote the use of public transport, cycling and walking. In particular, it recognises that *"The trends towards suburbanisation and urban sprawl lead to low-density, spatially segregated land use. The resulting dispersal of home, work and leisure facilities results in increase transport demand. The lower densities in peripheral areas make it difficult to offer collective transport solutions of a sufficient quality to attract substantial amounts of users.*[23]" In other words, sprawl cannot be "fixed" by investment in public transport; it is an inherently climate-unfriendly mode of urban development, which cannot be eliminated by better transport policies. The problem of sprawl requires better land-use policies. However, the Green Paper on Urban Transport does not go beyond asking the question: "How can better coordination between urban and interurban transport and land use planning be achieved?[24]"

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[17] COM(2008) 433 final, Communication from the Commission to the European Parliament and the Council on Greening Transport, Brussels, 8.7.2008

[18] COM (2005)718 final, Communication from the Commission to the European Parliament and the Council on a Thematic Strategy on the Urban Environment; Brussels, 11.1.6.

[19] COM (2005)718 final, p.10.

[20] COM (2005)718 final, p. 5.

[21] http://ec.europa.eu/environment/urban/pdf/transport/2007_sutp_prepdoc.pdf

[22] http://ec.europa.eu/environment/urban/pdf/transport/2007_sutp_annex.pdf

[23] COM(2007) 551 final, p.15.

[24] COM(2007) 551 final, p.16.

2.2 Possible Future Policies

From a policy development point of view, realising that sprawl is a main driver of the growth of transport emissions allows policymakers to do something beyond legislating CO_2 efficiency improvements that do not reduce the volume of traffic or hoping that modest increases in fuel tax would reduce emissions without causing public outrage first.

The growth of urban areas (at steady population levels) is not a desirable public good, but rather an undesirable consequence of ever greater fossil fuel-based mobility. Governments seek to limit sprawl, though with varying success. In the EU, as the Thematic Strategy states *"Most cities are confronted with a common core set of environmental problems such as poor air quality, high levels of traffic and congestion, high levels of ambient noise, poor-quality built environment, derelict land, greenhouse gas emissions, urban sprawl, generation of waste and waste-water.* [25]"

If greenhouse gas abatement policies are aimed at limiting sprawl, they can be expected to face less opposition than policies that directly limit car use or raise fuel costs. Unlike in the case of a road that people are not allowed or cannot afford to use, nobody complains about a situation where people do not need to travel to fulfil some need or other. Another advantage of concentrating on land-use policies is that the building of cities is already a densely regulated field, albeit the current objectives of regulations do not always include limits to greenhouse gas emissions.

The EU has significant limitations in developing policies on urban planning. Land-use policies are currently widely regarded as falling into national, regional or local competence, even though the climate change effects of urban planning do not justify this. Article 175 of the EC Treaty explicitly states that *"measures affecting town and country planning and land use"* require unanimity. These provisions also appear in Article III-234 of the Constitution; however, internal market-related harmonisation measures will be exempt from such unanimity requirements. Tax policies are in principle possible to adopt on an EU level, but they require unanimity. The EU's unsuccessful efforts in the 1990's to introduce a meaningful EU carbon tax suggest that fighting sprawl with EU-level taxes (either on fuels, vehicles or land-use types) is not possible in the foreseeable future[26], even though taxes could be very effective for this purpose.

As it is properly recognised by the Thematic Strategy, many European cities were successful in developing policies to halt sprawl and to limit the growth of transport CO_2 emissions. (Witness, for example, the outstanding success of the policies of Dutch cities to limit the growth of transport emissions compared to

[25] COM(2005) 718 final, p.3.

[26] For a short account of the EU's attempts to introduce a carbon tax, see Padilla and Roca (2004)

increase of land area in Figure 4.) However, as these policies are often locally initiated, only the vanguard of regional and local governments can implement them, while the majority of cities abandon themselves to the centrifugal forces of car-based urban development because of a lack of resources and/or expertise. Without central, EU-level requirements to address the problem of sprawl, most cities will only recognise it when it is too late. Bearing in mind the impending explosion of transport CO_2 emissions in the new Member States, the EC should not rely on the wisdom of local governments to recognise the need to fight against sprawl, but should rather focus on extending sustainable urban development practices through binding measures.

While there is a need for general EU-level policies in the field, it is very important to recognise the diversity of the myriad planning decisions that subsidiarity rightly places in the hands of local governments. Even so, EU policies could still be devised to avoid micro-management and concentrate on areas where it is possible to set up general guidelines that can be followed under all circumstances.

Following are a set of ideas on the types of instruments that the EU could develop with the purpose of reducing transport CO_2 emission through encouraging more sustainable land use patterns. The measures presented below were selected according to the following criteria: a) they are legal under the EC Treaty; b) they can be adopted on an EU-level without unanimity; c) they are not voluntary actions, but applicable for all. Ideas related to improving public transport are not included here as such measures are addressed in detail in the Green Paper.

2.2.1 Benchmarks, Targets and Minimum-Standards

Though urban planning needs to take account of diversity of urban areas, if the objective is to reduce CO_2 emissions, it is possible to develop overall objectives which could then be established as recommended benchmarks, future targets or mandatory minimum standards. The most straightforward would be a **public transport access requirement**, whereby Member States would be required to ensure that buildings have access to a certain level of public transport[27].

Though a public transport access requirement policy does not directly regulate urban development, the only way for Member States to realise such an obligation is (in addition to investing in public transport) through urban planning measures, in particular in requiring higher settlement densities. A public transport access

[27] A similar policy exists in the Netherlands since the early 1990s, known as the "ABC location policy", which differentiates between areas according to their accessibility by public transport. Businesses which attract a large number of customers can only be located at places with good public transport access. (http://international.vrom.nl/docs/internationaal/engelsesamenvattingnr.pdf)
Another comparable policy is the so-called "concurrency" policy in Florida and the US state of Washington, which requires local governments to only allow new urban development if certain public services (including e.g. public transport but also roads) is made available "concurrent with the impacts of such a development." (Southworth 2001; Steiner 1999)

obligation could stop the process of building low-density suburban areas where public transport is unable to compete with cars. As a minimum, the policy could extend to new apartments, larger workplaces and commercial establishments; it could then be extended to various categories of existing buildings. Similarly to recycling and renewables, the requirement could also be formulated in percentages to be reached within a timeframe[28]. A first step in this direction would be to include information on the level of public transport accessibility into all buildings' Energy Performance Certificates.

As a remnant of an age with different preoccupations, many cities have minimum parking-space requirements for new buildings. This policy is intended to make sure that relatively wealthy car-owners are also able to move into these buildings thus increasing the local tax base, but it invariably has the consequence of increased congestion. Therefore, instead of minimum requirements, targets for **maximum parking space requirements** should be established, depending on the level of public transport available[29]. Such a policy would reduce CO_2 emissions, reduce congestion and free up space for other uses. (Of course, this policy works only if the area is served by public transport or is accessible on foot and bicycle.)

Another possible benchmark is the designation of **peri-urban green areas** that could eventually form an effective urban growth boundary around large cities. Most large agglomerations have already expanded well beyond the administrative limits of the original city. Thus the frontier of sprawl is in suburban municipalities. While the central government of an agglomeration usually sees sprawl as problematic, many suburban municipalities welcome and foster sprawl on their territories because new development can increases the tax base. . A potential tool against this process would be to require Member States to designate no-development areas around large cities that would form a barrier towards sprawl and direct further development into existing transport corridors[30] and areas that are well served by public transport. Thus, such a policy is effectively the inverse of a public transport access requirement, in making areas not served by public transport off-limits to development. Unoccupied areas around cities are often agricultural areas that would not merit protection on the basis of their environmental value. Once such protected areas are established, they could also

[28] In its effects, such a percentage target could be compared to the UK target of building at least 60% of new housing on brownfields (i.e. previously developed land), which typically have better transport services than greenfields. (Couch and Karecha 2006)

[29] The Dutch "ABC" location policy is again a good example of this, as it maximises the amount of parking space that can be provided for each location type. E.g. in an "A" location the ratio of total area to parking area must not exceed 1:125.

[30] An example of this is the "Finger Plan" in Copenhagen, where development is restricted to the five "fingers" reaching out from the city. The fingers follow railway lines, and between the fingers, there are green areas. (see e.g.: http://www.geogr.ku.dk/dkgs/image/pub_pdf/artikler/2006_2/02.pdf)

serve the purpose of providing accessible green areas to people living in the city (which is necessary if they live at density levels that are high enough to maintain public transport.) According to Anas and Pines (2008), if charging for road usage is not possible, urban growth boundaries are effective second-best measures to limit sprawl.

2.2.2 Development of Mandatory Sustainable Urban Transport Plans

Short of targets and benchmarks, the public and authorities can consider the climate-change impacts of their development policies through a requirement to draw up plans and strategies on sustainable urban development.

A very important recommendation of the Thematic Strategy is for cities to develop **Sustainable Urban Transport Plans**. This is already an obligation in France and the UK, and other Member States are considering its introduction. According to the Thematic Strategy, "*Transport planning should take account of safety and security, access to goods and services, air pollution, noise, greenhouse gas emissions and energy consumption, land use, cover passenger and freight transportation and all modes of transport*.[31]" The guidance provided by the Commission on developing Sustainable Urban Transport Plans[32] is very useful for local governments who are already looking for solutions to the problems of urban land-use and transportation. However, without a specific obligation to draw up such a plan, many municipalities will not find the time and the money to prioritise urban transport and land-use planning. This is particularly true in those cities (particularly in new Member States) where these problems may not yet be endemic and the progress of car-based development could still be checked.

Transport planning by housing developers could be useful even if not coupled with a public transport access obligation. The Green Paper mentions in passing the possibility that "*developers could be encouraged to prepare a site-specific mobility plan as part of the procedure for obtaining planning permission.*[33]" In many countries, home buyers and local authorities alike tend to neglect the transport aspects of new housing developments. As the problem is similar to buyers' neglect or ignorance of their building's energy use, the solution could be to expand building energy performance certificates with information on the quality of transport services available at the building (and an estimate of the CO_2 emissions caused by the trips to the building.)

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[31] COM (2005) 718 final, p.5.

[32] See footnotes 26 and 27 for links

[33] COM(2007) 551 final, p.7.

2.2.3 Emissions-Trading for Land Uses That Cause Transport Emissions (e.g. parking)

It is worth considering whether the transport emissions could not be limited through involving the land-use forms that cause emissions into an emissions trading scheme. Emissions trading would be superior to benchmarks or plans as it would be able to set a cap on transport emissions without prescribing the policies that should be used to achieve it.

Airplanes and ships are managed by commercial enterprises in fleets, where operators have many opportunities to increase carbon efficiency on a fleet level through better organization, and upgrades. By contrast, passenger cars are usually operated by private persons, who have little scope to improve the efficiency of their cars after the purchase. In the face of high carbon prices, the only immediately available emission-reduction option would be to reduce the amount of driving (on the longer term, the purchase of a more efficient vehicle or moving to a place with better transport options would also be possible.) Having only one short term option would probably make participants feel very constrained, thus reducing the acceptability of the scheme.

Emissions trading-induced increases in the cost of air travel may be countered with flying less or buying goods with lower transport costs. This is illustrated with the greater price-sensitivity of air transport compared to road or rail transport, as demonstrated in a meta-analysis by Kremers et al. Road transport thus appears to be a more essential service and/or one with fewer alternatives, than air transport. If people are less likely to give up road transport in the face of higher costs, many people will have no other choice but to pay more. This is both a social question and an issue of political acceptability.

To date, the inclusion of road transport into existing emissions trading schemes has not been possible for several reasons: a) the enormous number of transport vehicles make the management, verification and enforcement of a scheme involving individual car operators very costly; b) passenger cars are usually operated by private persons, who have little scope to improve the efficiency of their cars after the purchase. Thus, faced with high carbon prices, their only significant short-term emission-reduction option would be to reduce the amount of driving. Having only one option would probably make participants feel very constrained, thus reducing the acceptability of the scheme. Also, Incentives to drive less or to buy more efficient cars are much easier created through fiscal measures.

In order to make emissions trading a valid concept for transport emissions, a set of operators that are less numerous and can actively influence the CO_2-efficiency of the overall transport system is needed. For this, not only direct, but also indirect emitters need to be considered. Such indirect emitters could be the owners of houses or other buildings, but they are just as numerous as car operators, so the

system would not be much simpler. A much more appropriate set of operators are the providers of parking spaces, private or public, or on a higher level of aggregation, municipal governments. According to Southworth (2001): "*Parking control policies, through either higher parking rates or restrictions on spaces available, offer considerable leverage through which to alter travel patterns.*"

Currently, free parking in out-of-town workplaces and shopping centres is one of the infrastructural bases of the present unsustainable trend of urban sprawl. As the Green Paper on Urban Mobility says: "*Providing more parking spaces may, in the long term encourage car transport, in particular if they are free of charge.*[34]" The amount of parking space is a significant limiting factor on the volume of transport, but it is often provided by private entities with no government control, thereby inducing further traffic and overloading the road network. The mechanism works in reverse as well, cars stop going to places where it is not possible to park. Therefore, controlling parking could effectively be used to control transport CO_2 emissions. Of course, such parking policies should always bear in mind that a total lack of access by car can result in the abandonment of an area, if the same amenities are freely available in other areas where cars can go.

A **trading scheme to reduce transport emissions involving parking place-providers** would work as follows:

i) The government would establish a total cap on the amount of transport emissions for a given period. A quantity of allowances equal to this cap would be distributed free of charge to entities or by auction.

ii) Entities responsible for a large number of parking (large offices, shopping centres, municipalities, etc) would be required to report the number of parking spaces provided, and they would be obliged to surrender a certain amount of allowances for each parking space.

iii) The amount of allowances to be surrendered per parking space would be set by the government in advance on the basis of average vehicle emissions, average trip lengths and average parking space occupancy rates. This figure should not be changed very often, and changes would need a long lead-time.

iv) As the surrender obligation for parking spaces is placed on the parking provider, the parking provider would need to obtain the allowances first, either through the free allocation or through a purchase in an auction or from another participant. The cost of an allowance (and thus, indirectly, the cost of providing a parking space) would depend on the level of scarcity, i.e. the size of transport emissions compared to the cap. Parking providers would have to decide whether to i) limit the amount of parking; ii) pass on the cost of purchasing allowances to their clients in the form of parking fees; or iii) to absorb these costs. Of course, the more parking is created, the greater the

[34] COM (2007) 551 final, p.6.

need for allowances and the higher their price would be, eventually forcing many parking providers to pass on the costs of parking.

It is important to realise that because parking spaces function in groups (i.e. one car needs a parking space at home, at the office and at the shopping centre to be able to operate) it is not necessary to introduce the system everywhere at the same time. The system would bring benefits even if first limited to large commercial establishments and offices (though questions of equity would arise as to whether it is fair to place the entire burden on a subset of parking space providers.) A great advantage of emissions trading for parking spaces is that there is no international competition and costs may be passed on to the consumer freely.

Beyond simply ensuring that the cap for transport emissions is not overstepped, and realising the polluter pays principle, such a scheme would have long term structural impacts. It would eliminate the cost-advantages of car-only locations, which are in fact free riding on publicly funded road infrastructure and take business away from more centrally located facilities which lack unlimited free parking. In the next step, if the accessibility by car of workplaces and shopping decreases, suburban living becomes more difficult, thereby inducing people to live in more sustainable locations.

A great political advantage of an emissions trading scheme for parking spaces is that it would not directly limit mobility by increasing the price of cars or the price of fuel, measures which would be very unpopular if implemented at a level which has a real effect on CO_2 emissions. The car fetish would be left untouched, and high parking prices would develop "automatically", without direct government involvement.

3. CONCLUSIONS

The statistical analysis shows that wherever sprawl occurs in the EU, it results in a strong increase of transport-related CO_2 emissions. Sprawl, measured in the increase of the areas covered by buildings and roads, is a stronger cause of increased road transport emissions than other possible causes, such as the growth of per capita GDP or population growth.

This conclusion is very relevant for the EU's climate policy. Unlike other sources of greenhouse gas emissions, emissions from transport are growing steadily. Current EU policies aimed at transport emissions try to increase the CO_2-efficiency of cars, but they are not enough to stop the growth of emissions. If sprawl is significantly correlated to increasing transport emissions, then the EU needs to adopt policies that try to limit sprawl. Several policy options are described in this paper, including a public transport access obligation, mandatory sustainable transport plans, and emissions trading for parking.

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