

## Oslo Conference on Climate Change and Urban Design.c.e.u. 2008

### URBAN CHANGING PATTERNS AND GREENHOUSE GAS EMISSIONS. AN ANALYSIS FROM A REGIONAL PERSPECTIVE. SPAIN 1990-2000

Marian Simón Rojo. m.simon@surcosurbanos.es

Architect and PhD Candidate. Universidad Politécnica de Madrid, Spain

This paper explores how urban and territorial changing patterns relate to greenhouse gas emissions. Our research analyses the connection between artificial surfaces expansion, urban and territorial changing patterns and greenhouse gas emissions. Spanish data are compared at a regional level, using 1990 and 2000 figures in order to reveal emerging patterns.

According to spatial and statistical analysis there has been a radical shift in urban patterns almost everywhere and has been particularly acute in smaller cities. The shift from traditional compact city to scattered suburban areas, and the development of transport infrastructures leads to a significant increase in car travel lengths.

Gas emissions increases are not offset by additional sink capacity. To the contrary sinks are actually shrinking. A key side effect of the widespread urbanization is the destruction of carbon sinks. Urban sprawl has been largely made at the expense of “Forest and seminatural areas”.

Given these trends, technological advance will not suffice to meet emission reduction targets. Policies based on a smarter urban and territorial perspective will be required. When applied, these policies should take into account local and regional differences.

## 1 INTRODUCTION. TRANSPORT EMISSION FAR OFF TARGET

Climate change is a matter of great public interest and is one of the top issues in the political agenda. Targets have been set, inventories, assesment tools and prediction models have been developed. Within this frame limits to greenhouse gas (GHG) emissions have been set, though cutting emissions do not improve as quickly as intended, especially those from the transport sector.

Transport sector in the area of EU Member States the transport<sup>1</sup> was responsible for 21 % of total GHG emissions in 2001. And they increased by 21 % between 1990 and 2000. (EEA, 2003)

---

<sup>1</sup> Excluding international transport.

Spain is performing worse than many other EU States. By 2008-2012 Spain agreed to increase 15% on 1990 emissions levels. According to National Inventory Reports, this limit has been already largely exceeded. By 2000 Spanish GHG emissions were 52,3% bigger than the 1990 baseline, and 59,8% by 2006. As in many other countries transportation is the fastest-growing source of GHGs, with an increase of 86,9% between 1990 and 2006.

If future targets for GHG emissions reductions are to be achieved, the role of transport should not be overlooked and specific targets should be set.

## **2 URBAN EXPANSION AND TRANSPORT INCREASING DEMAND**

Relevant studies underline that there is a narrow relationship between urban form and transport, and therefore GHG emissions. Scale is decisive, what happens when the scope of analysis is enlarged? Results might vary considerably if, instead of cities and metropolitan areas, a whole region is taken into consideration. GHG inventories are reported at national level. Within global national statistics bad performing areas might be shadowed or balanced with other better ones. Regions stand between metropolitan and national scales and they are assuming a growing protagonism. It may be worth noting that some Spanish regions are in fact larger than many European countries.

The study aims to analyze changes in urban and territorial patterns at regional level. Traditionally urban sprawl and development of infrastructures have been identified as two main drivers of growing transport demand. Can a connection be established between those factors and GHG emissions at regional level?.

### **2.1 LAND COVER. SOIL MATTERS**

Urban sprawl is defined as *“unplanned incremental urban development, characterized by a low density mix of land uses on the urban fringe”* (EEA 2006). According to European Environment Agency (EEA) more than a quarter of the European Union's territory is directly affected by urban uses. It has turned to be a matter of great concern in the UE.

Soil is a vital asset, without it, life would not be possible. Soil supports vegetation, provides nourishment for plants and animals, and it also filters water, replenishing the groundwater supplies. It is a non-renewable resource. But land is diverted away from natural ecosystems for urban areas and other human uses. Natural heritage is destroyed, not only in the urbanized areas, but also in those surroundings that, under the urban and infrastructures influence, are degraded. Urbanization exerts considerable pressure on the environment, it erodes soil and changes vegetation cover, surface moisture availability, wetness and radiant surface temperature. Land cover transformation affects also to radiation, sensible heat and greenhouse gases emissions. All these impacts together are a prime contributor to climate change.

Also note that in addition to these impacts Spain is under a major threat of desertification. According to CIDE (Centro de Investigaciones sobre Desertificación, Research Center about Desertification in Spain) about one-seventh of Spanish territory is classified as high risk of desertification.

## 2.2 GROWING EMISSIONS, SHRINKING SINKS

The EEA Report “Urban sprawl –a European challenge” posed a relevant question:

*“How can we ensure that the growth of urban greenhouse gas emissions due to the dominance of car transport in the EU's sprawling cities does not threaten to undermine EU Kyoto commitments to reduce greenhouse gas emissions by 2020?”*

There are two ways in which GHG are influenced by urbanization pressure. On the one hand urban expansion implies the destruction of forests and semi natural areas, hence reduces sinks for GHG. Between 1990 and 2000 more than 165.000 Ha have been urbanized. Most of it at the expense of natural pastures, shrubs and scrubs (OSE, 2005). Forest and semi natural areas, – important GHG sinks – were the main decreasing global cover use in that decade.

On the other hand new urban patterns increase the demand of motorized transport. That is why *“Changes in urban and transport infrastructure, to reduce the need for motorized transport and shift demand to less energy intensive transport modes, may be among the most important elements of a long-term strategy for GHG mitigation in the transport sector”*. (Watson, Zinyowera, Moss, 1996)

## 2.3 TRANSPORT AND URBAN MANAGEMENT

Reducing emissions in the transport sector is a big challenge and policy-makers should coordinate urban and mobility management to address this problem. The TERM 2007 report concluded that technology measures are insufficient to meet emissions reduction targets. Travel growth outweighs the savings from technology efficiency improvements. Transport demand growth has to be tackled directly.

*“The effect of introduced mitigation measures has been more than offset by increased transport volumes. To address transport demand, measures and policy instruments must go beyond the transport sector itself and be introduced into sectors of the economy such as households, industry and service, within which the demand for transport actually originates”* (EEA 08)

According to Preparatory Document in relation to the follow-up of the Thematic Strategy on the Urban Environment (EC 2007), urban traffic is responsible of 40% of CO<sub>2</sub>

emissions and of 70% of other pollutants. At urban scale spatial planning can be very useful to manage the demand for transport, when oriented to walkers, cyclers and public transport.

## 2.4 MONITORING CHANGES

The European Community, as a party to the United Nations Framework Convention on Climate Change (UNFCCC), decided to establish a monitoring mechanism of CO<sub>2</sub> and other greenhouse gas emissions. Since 1990 national inventories greenhouse gas (GHG) are compiled and integrated in a EU inventory. It is an important element for the evaluation of actual progress.

Also EU's concern about unsustainable urbanization processes has been translated into programs to share and compare information, and into indicators to assess progress. One of those programs is CORINE (Coordination of Information on the Environment), which coordinates the compilation of data and the organization of information within the Member States and ensures that information is consistent and that data are compatible. Because *“If our environment and natural heritage are to be properly managed, decision-makers need to be provided with both an overview of existing knowledge, and information that is as complete and up-to-date as possible on changes in certain features of the biosphere”*. (EEA, 1995)

## 3 METHODOLOGY

### 3.1 CORINE LAND COVER AND GHG EMISSIONS INVENTORIES

GHGs emissions are analyzed to find connections between their production and shifts in spatial structures.

The spatial analysis is based on CORINE land cover database. According to its nomenclature, artificial surfaces include urban fabric, industrial and commercial sites, road and railway networks and associated land, as well as port areas and airports; mine, dump and construction sites; and artificial non-agricultural vegetated areas.

The GHG emissions, detailed at Regional Level were obtained from Santamarta's report *“Las emisiones de gases de invernadero en España por Comunidades Autónomas”* (GHG Emissions in Spain, detailed at Regional level)

### 3.2 SPATIAL AND TEMPORAL SCOPE OF THE RESEARCH

The research is developed at regional level, and it takes into account 16 of 19 Spanish's Autonomous Communities (Regional Governments). Ceuta y Melilla, two autonomous cities in the north of Morocco, are not being considered, given their specific and unique background. Due to lack of detailed data neither is Canarias Island included in the study.

1990, the base year in Kyoto Protocol, is chosen also as the time reference for this research. Besides this, temporal limits of the research are determined by the two time series of land use data available. The analysis is based in 1990's Corine Land Cover database (CLC 90) and Image&Corine Land Cover 2000 (CLC 00). Land uses changes are analyzed in those two years, although it must be noted that:

- CLC 90 data are derived from visual interpretation of satellite images from 1987.
- People and Housing data are collected from 1991 and 2001 Census.

### 3.3 INDICATORS DEVELOPED

Different indicators have been developed to evaluate if it is possible to establish a link between increases in GHG emissions from transport sector and changes in land consumption efficiency, as well as in urban and territorial patterns. Land use indicators have two versions, one referred to artificial surfaces for the whole area covered (historic, accumulated, total), and another one for new developments. The former takes into account total land consumption for artificial uses. The latter considers only new artificial land developed between 1990 and 2000.

#### 3.3.1 GHG emissions

Changes in urban and territorial structures are supposed to have considerable influence on the transport sector. Therefore we focus on the evolution of GHG emissions from the transport sector. Transport sector includes different modes, but road transport is certainly the main producer of GHG in the transport sector. In Spain it accounts for 90% of total transport GHG emissions.

Indicators relate greenhouse gas emissions from transport sector and urban (artificial) uses. Those uses with a stronger incidence in transport demand – transport infrastructures, low density residential areas, large commerce and industrial sites – are specifically analyzed.

#### 3.3.2 Urban continuity

Urban continuity indicator divides continuous urban fabric among total urban fabric.

CORINE Land Cover nomenclature identifies two different sorts of urban fabric: continuous and discontinuous. In the former more than 80% of the ground is covered by artificial surfaces; in the latter, vegetated areas and bare soil occupy discontinuous but significant surfaces. EIONET explains that *“the discrimination between continuous and discontinuous urban fabric is set from the presence of vegetation visible in the satellite image illustrating either single houses with gardens or scattered apartment blocks with green areas between them. The density of houses is the main criteria to attribute a land cover class to the built-up areas or to the agricultural areas. In case of patchwork of small agricultural parcels*

*and scattered houses, the cut-off-point to be applied for discontinuous urban fabric is 30 % at least of urban fabric within the patchwork area”.*

The distinction is based on vegetation, not on typology or on building density. In fact discontinuous urban fabric (an area of high blocks of flats) can be much denser than a continuous one (core centre of a town).

According to CLC classification, continuous urban fabric might be associated with compact city. It comprises different uses, facilities, industry, and local commerce, therefore it offers complexity and centrality. Discontinuous urban fabric moves away from traditional city. In low density urbanizations only 6% of total build surface are intended for non-residential uses (Hernández, 2000). They are less diversified than, for example, urban extensions around 1900 – ensanches-, in which 30% of total built surface is assigned to non-residential uses (Hernández, 2000). This can be translated in considerable increases in motorized transport demand and in vehicle kilometers driven.

In those urban areas developed between 1990 and 2000 discontinuous urban fabric can be generally identified with low-density residential areas. For that reason, the urban pattern indicator conveys clear information about the shift from traditional compact city to scattered suburban areas.

### **3.3.3 Territorial system**

Territorial indicators give information about land use changes. Map analysis allows us to identify where those changes have taken place.

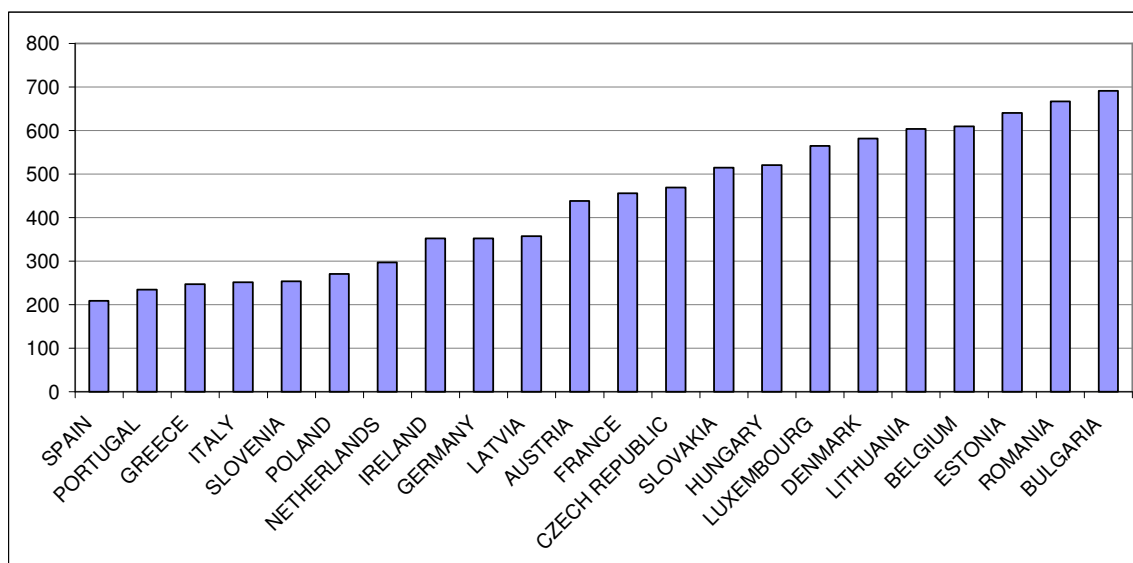
The aim is to identify if non urban areas were adjacent in 1990 to urban nuclei, how their relationship has evolved and the extent to which activities and uses have been spread along the countryside. Different indicators have been developed for this purpose. They show the weight of each use (urban fabric; industrial, commercial and transport units, mine, dump and construction sites; artificial non-agricultural vegetated areas) compared to the total artificial land.

## **4 DATA ANALYSIS, CHANGES IN LAND USE OCCUPATION AND GHG EMISSIONS**

### **4.1 THE CASE OF SPAIN, GOOD BYE LAND USE EFFICIENCY**

In 1995, as reports about land cover changes were published, Spanish data raised the alarm. Urbanization had spread at a speed never seen before. Between 1987 and 2000 land occupied by artificial uses in Spain increased by 25% while population only increased by 5%.

**Figure 1. Artificial land per capita in European countries. 2000**



Source of data: Eurostat and ETC/TE

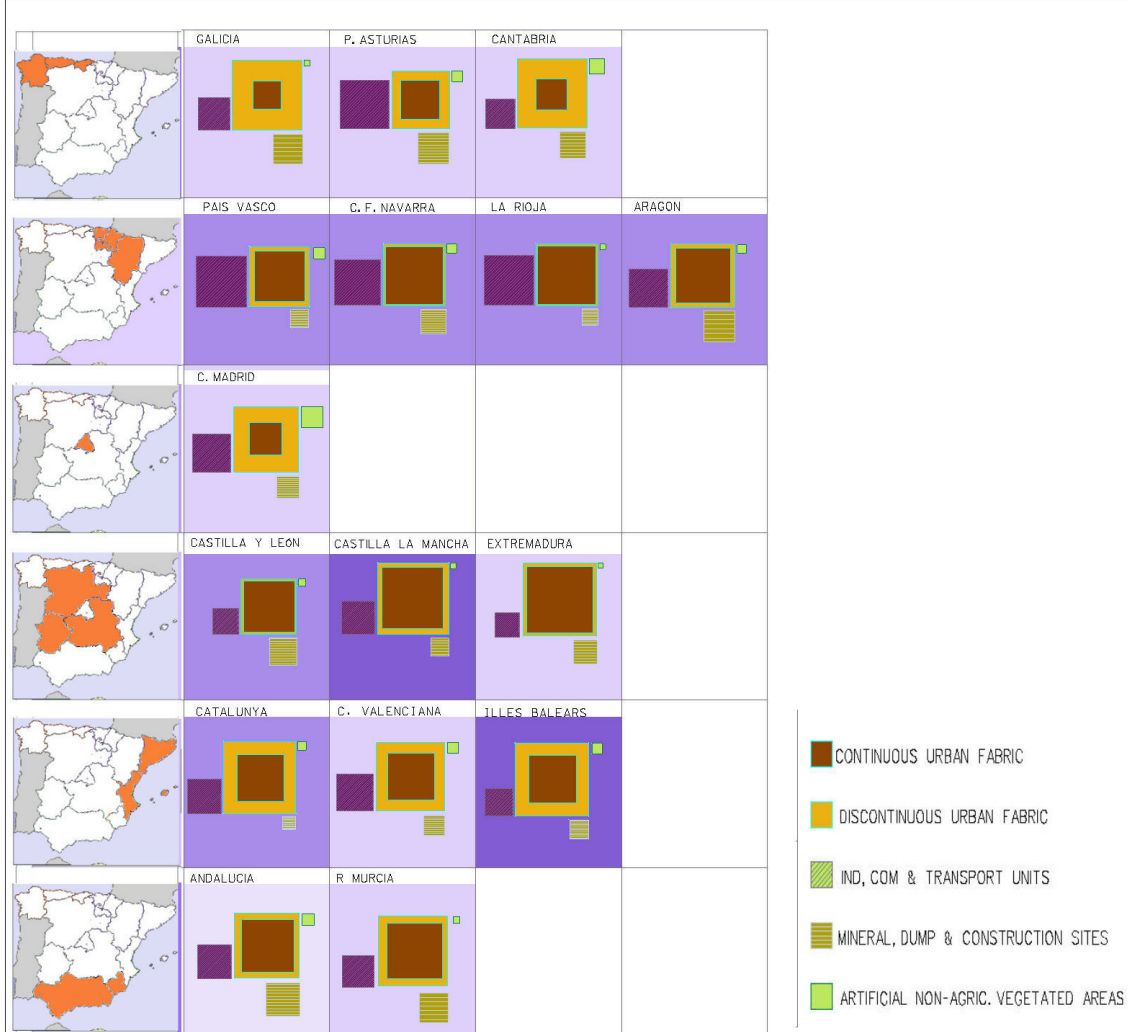
As can be observed in Figure 1, by 1990 Spain, along with other Mediterranean neighbours, were the most efficient European countries regarding artificial land consumption per capita<sup>2</sup>. Mediterranean city patterns –compactness, self-containment, relatively dense areas, mixed uses...– delivered such efficiency. In the nineties, as well as in previous decades, vivid discussions about urban sprawl, sustainability and smart growth took place. The values of Mediterranean cities were recognized and praised. Nonetheless by that time urban developments in Spain were also following the path of suburbia. Urban expansion is not due to population pressure, other factors like improved motorways and road connections, new lifestyles in suburban environments, an increased number of second homes and speculative investments in housing are driving the process. Hence, the artificial surface per capita in the areas developed between 1990 and 2000 was four times bigger than that of 1990.

## 4.2 URBAN AND TERRITORIAL SHIFTING PATTERNS.

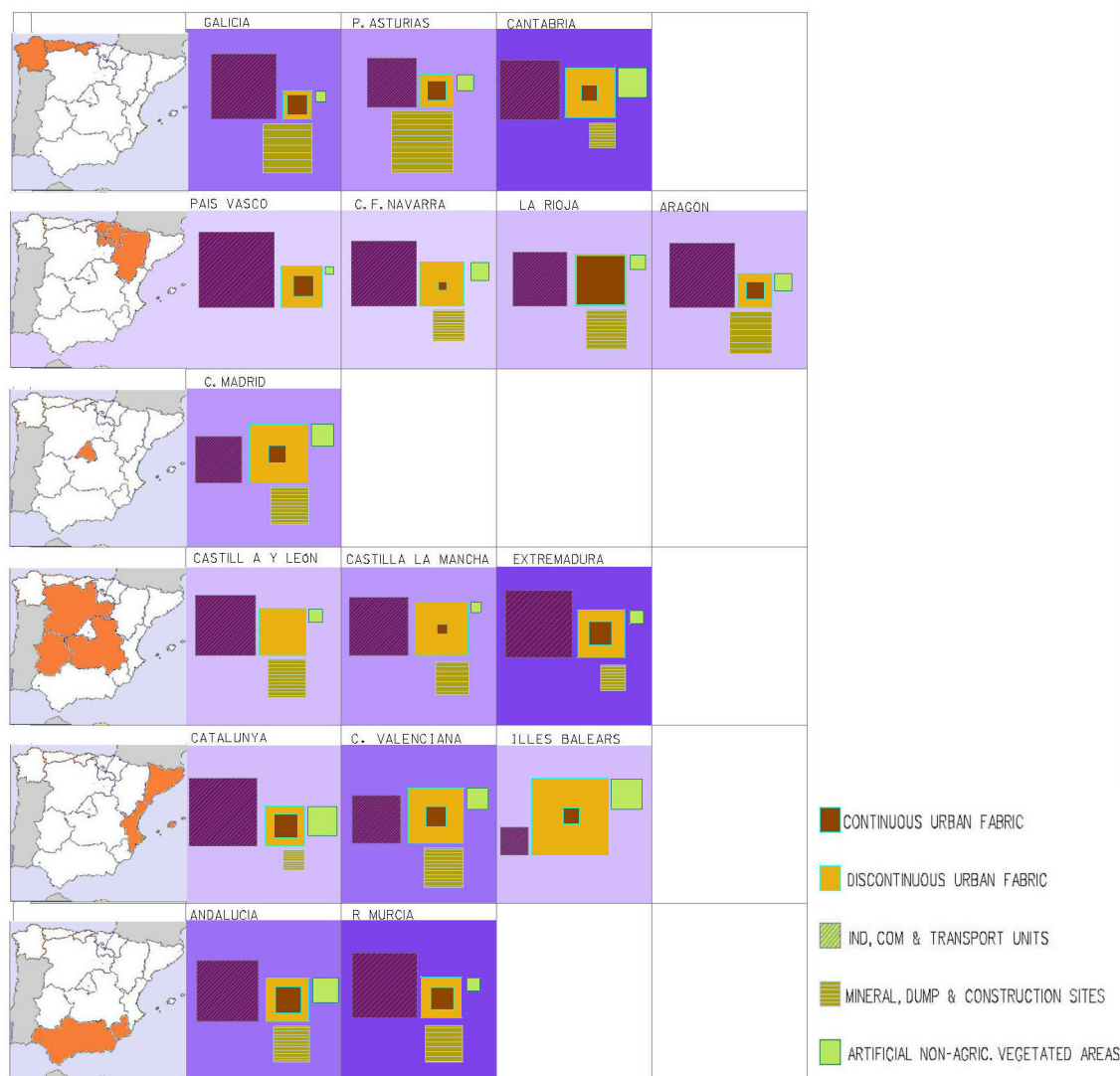
One of the main drivers of the loss of land use efficiency has been urban and territorial shifting patterns.

<sup>2</sup> The ratio of land covered by artificial uses in a municipality depends on its demographic evolution. The bigger the population, the lower the amount of artificial land per capita. On average, in those Spanish municipalities smaller than 10.000 habitants each person consumes five times the surface of artificial land of one who lives in a city over 500.000 habitants (SIMON ROJO & HERNANDEZ AJA, 2008).

**Figure 2. Territorial pattern. Spanish regions 1990**



**Figure 2. Territorial pattern. Spanish regions 1990-2000**



#### 4.2.1 Urban scale

According to CLC nomenclature, urban fabric is classified as continuous and discontinuous. Under these two categories a wide range of different morphological tissues can be found. It is necessary to be more precise when evaluating urban pattern changes, but this classification is adequate to identify trends, which is the purpose of this study.

In 1990 continuous urban fabric accounted for about 60% of total urban fabric. Figure 2 shows that differences between regions were considerable. Settlements in some westnorthern areas have been traditionally scattered, for example in Galicia there was only 16% of continuous urban fabric by 1990.

Those areas which concentrated demographic and urban growth, Madrid and other big cities, and many areas in Levante had already been expanding following discontinuous urban

patterns since around 1960, the former mostly with blocks, not with low-density residential typologies.

However between 1990 and 2000 **there has been a radical shift** almost everywhere (with the exception of Galicia and La Rioja) that has been particularly acute in inner regions (see Figure 3).

#### 4.2.2 Shifts in territorial structure

In 1990 urban fabric covered in Spain 71% of artificial land, while in those areas developed between 1990 and 2000 urban fabric only entailed 33%. In that decade, urban fabric lost importance while land occupied by **economic sites and infrastructures became the main factor of artificial land extension**. When talking about urban expansion, it does not correspond with traditional “urban” concept. And some of those pushing artificial uses, like recreational zones or commercial sites, are intended to become service centres within an expanding radius. The territorial scale of the process implies that urban sprawl and spread of uses exert a greater influence in a widening area. It is commonly accepted that highways (and motorways in general) stimulate urban sprawl (FOMENTO 2005).

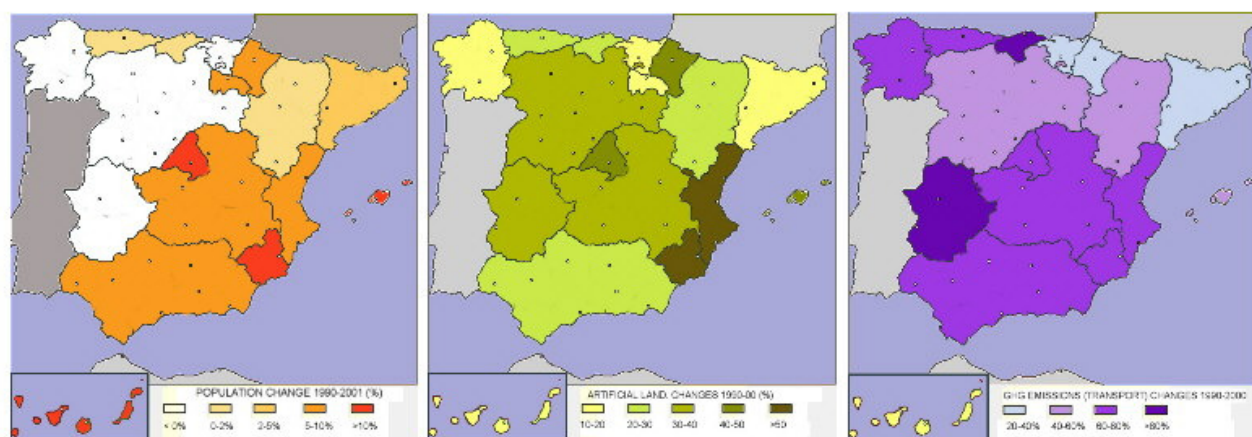
**New industrial sites have been developed along major connecting roadways, following an already established pattern.** We can find some new isolated industrial sites but it is not usual. In some cases when new industrial sites are isolated from pre-existing industrial or urban areas it is due to their functions, for instance rubbish dumps.

It has also to be noticed that new artificial land is partially oriented to provide services to the already pre-existing city. Obviously highways do not only serve to the municipalities they cross. The same can be said about dump and mine sites, leisure sites, golf resorts or about other supramunicipal facilities, like hospitals. Also big retail centres and mall’s influence area is much larger than that of the municipality where they are located. Consume and leisure trends associated with an increasing mobility, tend to broaden impact on the territory as cities’ inhabitants reach and make use of an ever-growing area.

### 4.3 GHG EMISSIONS EVOLUTION

As has already been mentioned urban expansion is not due to population pressure, other factors like growing number of households and average residential space per capita, inner city problems, improved motorways and road connections, new lifestyles in suburban environments, an increased number of second homes and speculative inversions in housing are driving the process. GHG emissions due to transport sector are growing parallel neither to demographic nor to land use transformation evolution. (SIMON ROJO, 2007)

**Figure 4. Population, artificial land and transport GHG emissions by regions. 1990-2000**



Source of data: INE, OSE, Santamarta

Absolute figures, when analyzed at regional level, reveal that in 1990, transport GHG emissions were –with a few exceptions – proportional to artificial land. But only when absolute numbers are being considered. This relationship does not hold though, when consumes per habitant are looked at. Then, one can not find a correlationship between artificial land per habitant and GHG emissions per habitant.

#### 4.4 LAND USE AND GREEN HOUSE GASSES EMISSIONS EFICIENCY

**TABLA 1. Evolution of artificial land use and transport emissions by regions**

REGION	1990				1990-2000			
	TTE/HAB	DENSITY HB/HA	LAND EFFICIENCY HA/HAB	HIGH DEMAND LAND/ARTIFICIAL LAND (%)	Δ TTE (%)	Δ ARTIFICIAL LAND (%)	Δ POB (%)	HIGH DEMAND LAND/ARTIFICIAL LAND (%)
ANDALUCÍA	116,7	74	197	39,9	70	26	6,0	33,0
EXTREMADURA	123,2	25	219	23,4	81	31	-0,3	25,2
PDO. ASTURIAS	123,9	103	157	60,0	68	15	2,1	47,2
C.MADRID	128,1	583	131	69,2	68	6	9,6	50,4
GALICIA	134,7	80	165	74,3	70	11	-1,0	45,0
CANTABRIA	144,1	98	230	71,6	90	12	1,5	45,7
C. VALENCIANA	144,2	96	199	58,2	71	28	7,9	45,0
R. MURCIA	148,8	91	216	39,9	77	24	14,5	37,5
CATALUÑA	175,8	189	228	62,9	34	16	4,7	42,3
PAIS VASCO	176,6	139	112	54,3	25	17	-1,0	49,7
LA RIOJA	184,4	52	239	43,7	51	48	5,0	40,8
ARAGÓN	188,6	20	302	39,6	50	46	1,3	34,7
CASTILLA Y LEÓN	194,1	20	350	23,5	54	89	-3,5	25,5
C.F.NAVARRA	196,3	47	163	39,2	25	25	7,0	44,1
CASTILLA LA MANCHA	217,4	19	357	38,0	67	38	6,1	35,2
ILLES BALEARS	261,6	52	311	58,3	46	15	18,7	43,8
AVERAGE	166,2	63	210	49,6	57	26	4,9	38,8

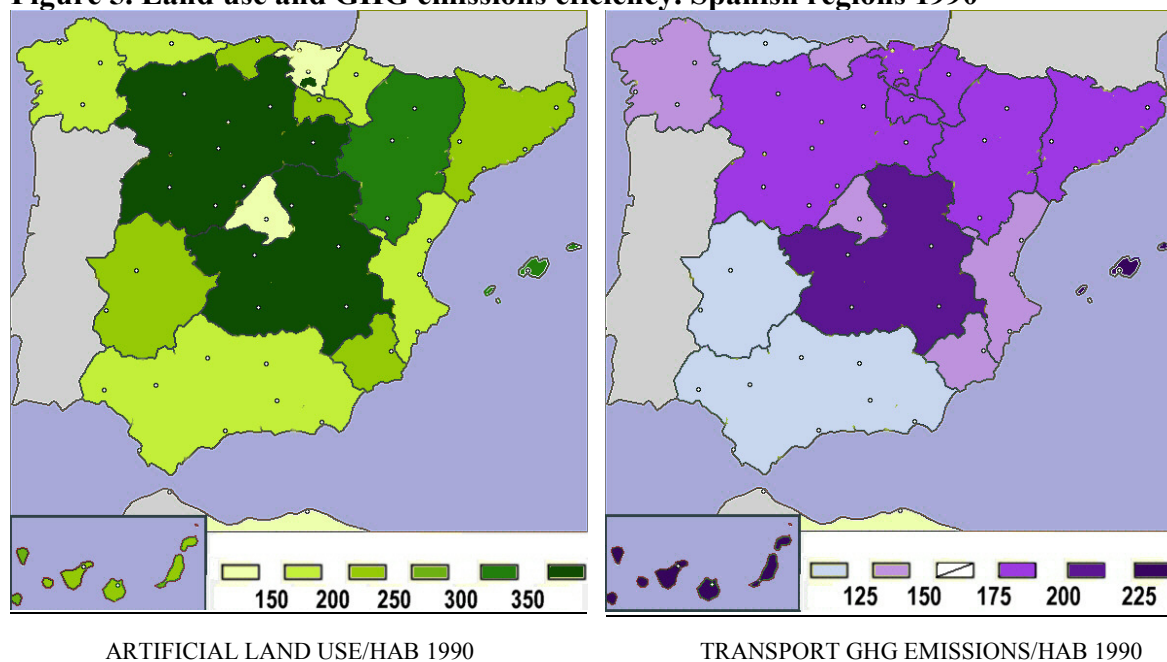
Source of data: INE, OSE, Santamarta

Between 1990 and 2000 western regions (coastal and inner) had a declining population. The highest growth rates can be found in Madrid, in the Mediterranean coast (Levamte) and in the region linking Madrid and Levante. At northwest area there were high GHG emissions

increases, with population almost stabilized and with considerably new artificial land transformed. In the northeast we find some of the lowest GHG emissions increases, paradoxically one of them in a region with both a high population and artificial land growth, (Navarra). In inner regions close to Madrid, at the north, in Castilla y Leon artificial land areas have grown by 33 % while population was shrinking (-3.5%). In the same period greenhouse gas emissions raised also by 33%.

Can a correlation between land use efficiency and transport GHG emissions efficiency be established? Patterns that might be recognized at local level are not easily found at regional level.

**Figure 5. Land use and GHG emissions efficiency. Spanish regions 1990**



At regional level some paths have been identified. The larger the artificial land, the higher levels of GHG emissions. That was clear in 1990, with very few exceptions. Efficiency in land use was translated in efficiency in emissions. Rate between both factors 0,6-0,8. Only especial areas, high density like Madrid and scarce land land high industrialization like Basque Country and Navarra. If only high demand land is taken into account no correlation appear.

In 2000 regions with more land consumption per capita maintains a relationship of efficiency around 0,8. Transport emissions have grown considerably, also in some areas with restrains in land consumption like Basque Country.

## 5 CONCLUSIONS AND URBAN PLANNING RESPONSE

Trends in land consumption by urban (direct and indirect) uses are not sustainable.

Between 1990 and 2000 there has been almost everywhere a radical shift from continuous to discontinuous urban fabric. In this decade the main factor of artificial land extension has been “Economic sites and infrastructures” (facilities).

Regarding changes in territorial patterns, artificial uses have grown at an unprecedented rate.

How can urban planning and urban design help to cope with unsustainable trends in GHG emissions due to transport sector?

As a general trend, more artificial land use leads to higher GHG emissions. Therefore new developments should be avoided to the extent possible.

Transport infrastructures induce new tertiary uses and urban developments. They should be subject to tighter controls allowing only strictly required enhancements. Demand for new infrastructures should be actively managed, aiming at a reduction in new infrastructure requirements.

As observed in CHMC 2000, *the “macro”urban structure is more important than the “micro” neighbourhood design in reducing GHG emissions from auto and transit travel by neighbourhood residents. That is, infill development is more effective than greenfield development in moderating the growth of GHG emissions, even if the new greenfield neighbourhood is neotraditional rather than typical suburban in design. However, neighbourhood design is also a significant determinant of GHG emissions and can go a long way in improving the sustainability of neighbourhoods in the outer regions of urban areas.*

Measures affecting developed areas should also be undertaken, promoting ecological urban rehabilitation to improve the sustainability of already existing areas.

CHMC, CANADA MORTGAGE AND HOUSING CORPORATION. *Greenhouse gas emissions from urban travel: tool for evaluating neighbourhood sustainability*. Research report. 2000 CMHC Canada.

EEA 1995. *Corine Land Cover*. Commission of the European Communities. <http://reports.eea.europa.eu/COR0-landcover/en>

EEA EUROPEAN ENVIRONMENT AGENCY. 2003. Annual European Community greenhouse gas inventory 1990–2001 and inventory report 2003. Submission to the UNFCCC secretariat. Prepared by Bernd Guegle, Kati Huttunen and Manfred Ritter. European Topic Centre on Air and Climate Change

EEA 2003b *Transport emissions of greenhouse gases by mode [2003.10]* [http://themes.eea.europa.eu/Sectors\\_and\\_activities/transport/indicators/consequences/TERM02,2003.10](http://themes.eea.europa.eu/Sectors_and_activities/transport/indicators/consequences/TERM02,2003.10)

EEA 2006 *Urban sprawl in Europe The ignored challenge*. Commission of the European Communities

EEA 2008. *Climate for a transport change. TERM 2007: indicators tracking transport and environment in the European Union*. EEA Report No 1/2008

MINISTERIO DE FOMENTO 2005. *PEIT, Plan Estratégico de Infraestructuras y Transporte. 2005-2020*. Madrid, Mtro Fomento.

NIETO, J; Santamarta, J. 2003 *Las emisiones de gases de invernadero en España por Comunidades Autónomas*. [The greenhouse gases emissions in Spain by Regions}. CCOO. Spain

OSE 2005. *Sostenibilidad de España 2005. Informe de primavera*. Ed Mndiprensa. Madrid. <http://www.sostenibilidad-es.org/>

SIMON ROJO, M. 2008. Urban expansion in a shrinking region. Changing land urban patterns in Region Centro (Spain)' Paper Research International Conference '*Shrinking Cities, Sprawling Suburbs, Changing Countrysides*'organized by The European Network for Housing Research, ENHR. To be found at [www.surcosurbanos.es/tut5.html](http://www.surcosurbanos.es/tut5.html)

SIMON ROJO, M. ; HERNANDEZ AJA, A. 2008 Relaciones entre cambio de modelo urbano-territorial y consumo de suelo en los municipios españoles. Congreso CCCyP Bilbao 08. To be found at: [www.surcosurbanos.es/tut6.html](http://www.surcosurbanos.es/tut6.html)

WATSON, Robert T.; ZINYOWERA, M.C.; MOSS, R.H.. 1996. *Technologies, Policies Policies and Measures for Mitigating Climate Change*. Technical Paper of the Intergovernmental Panel on Climate Change. Working Group II.

Business as usual emissions (that is, emissions in the absence of measures)  
se of 1990 as a base year

It was only belatedly, in 2004, that a strategy was put in place to enable Spain to comply with the commitment not to exceed the 1990 level of greenhouse gas (GHG) emissions by more than 15 % on average by 2008-12, as part of the EU Burden-Sharing Agreement (OECD Economic surveys: Spain Volume 2007 Issue 1, OECD 2007)

Those emissions are narrowest linked to urban spatial structure.

TTE: tte por carretera, todo el suelo artificial influye

quantifying the extent to which transportation energy consumption and emissions can be reduced as a result of alternative neighbourhood development scenarios. \*CHMC(

ransportation is the fastest-growing source of U.S. GHGs and the largest end-use source of CO<sub>2</sub>, which is the most prevalent greenhouse gas

If we look at the objective of Convention on Climate Change “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.” (art 2 United Nations Framework Convention on Climate Change) will not

While at european EC level, between 1990 and 2000, total GHG emissions without land-use change and forestry (LUCF) decreased by 125.071 Gg CO<sub>2</sub> equivalent (– 3.0 %), in Spain there was an increase of 33,7%.

In EC transport emissions increased by 20% (1990-2001), the biggest absolute increase. from national . with data in compile inventories

---

the importance of cities in addressing environmental problems that originate in cities but exceed the boundaries of the cities themselves

Research studying transportation and land use in cities worldwide find higher carbon emissions per person in densely populated, sprawling urban areas.

Increasingly researchers find that land use and land use change play a key role in global climate change. The change of non built-up areas into built areas is a key contributor. Urban expansion, including the destruction of forests and plants, has a strong effect, not only on GHG emissions, but also

on the change of the local and regional climate. For example, replacing forests with crops means less respiration and thus higher temperatures.

Local Capacities for Global Agendas; Impact of Cities on the Global Environment

Mr. Bakary Kante. Director of the Division of Policy Development and Law,

United Nations Environment Programme (UNEP) Barcelona, 15 September 2004  
Second World Urban Forum Dialogue on Urban Sustainability

enhance GHG sinks

Enfoque> Tte buildings untercio. Nuevos desarrollos mas eficientesenrgeticamente, pero Efforts, codes new buildings, rehabilitartions... pero eso no contrarresta los efectos de la expansión urbana. Cuestionar la necesidad de los crecimientos y nuevaws construcciones.

**EIONET. Corine Land Cover**

**Commision for Integrated Transport. 2007. Transport and Climate Change. Advice to Government from the Commission for Integrated Transport. London on line via [www.cfit.gov.uk](http://www.cfit.gov.uk)**

A comprehensive framework of methodologies including integrated land use, transport and environmental models was developed in

**5.1.1 PROPOLIS<sup>17</sup>**